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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	NC73661US-NP
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
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Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

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Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	73658		
Email Address	ipr.inhouse@nokia.com	Add Email	Remove Email

Application Information:

Title of the Invention	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING		
Attorney Docket Number	NC73661US-NP	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Suggested Class (if any)		**Sub Class (if any)**	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)	8	**Suggested Figure for Publication (if any)**	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S. C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

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Customer Number	73658

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	non provisional of	61/368316	2010-07-28

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

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This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(a).

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Application Number	Country [i]	Parent Filing Date (YYYY-MM-DD)	Priority Claimed
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Providing this information in the application data sheet does not substitute for compliance with any requirement of part 3 of Title 37 of the CFR to have an assignment recorded in the Office.

Assignee 1 Remove

If the Assignee is an Organization check here. ☒			
Organization Name	Nokia Corporation		
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Email Address			

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Signature:

A signature of the applicant or representative is required in accordance with 37 CFR 1.33 and 10.18. Please see 37 CFR 1.4(d) for the form of the signature.

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Signature	/Ragip Kurceren/			Date (YYYY-MM-DD)	2011-07-27
First Name	Ragip	Last Name	Kurceren	Registration Number	60158

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING

RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Application No. 61/368,316, filed July 28, 2010, which is hereby incorporated herein in its entirety by reference.

TECHNOLOGICAL FIELD

[0002] Various implementations relate generally to electronic device video coding and decoding technology and, more particularly, relate to a method and apparatus for providing complexity balanced entropy coding.

BACKGROUND

[0003] The modern communications era has brought about a tremendous expansion of wireline and wireless networks. Computer networks, television networks, and telephony networks are experiencing an unprecedented technological expansion, fueled by consumer demand. Wireless and mobile networking technologies have addressed related consumer demands, while providing more flexibility and immediacy of information transfer.

[0004] Current and future networking technologies continue to facilitate ease of information transfer and convenience to users by expanding the capabilities of mobile electronic devices while keeping cost and size of such devices relatively low. Due to the ubiquitous nature of mobile electronic devices, people of all ages and education levels are now utilizing mobile terminals to communicate with other individuals or contacts, receive services and/or to share information, media and other content. Thus, mobile electronic devices are also becoming popular mechanisms by which users communicate with each other and consume content.

[0005] Although the capabilities of mobile electronic devices with respect to acquiring and rendering content, enabling communication and providing services continue to improve, the fact that such devices are mobile and the market driven desire to keep such devices relatively small inevitably introduces challenges with respect to limits in battery life and processing resources. While battery life continues to improve, the pace of expansion of complexity and processing load continues to race forward. Thus, significant usage of a mobile electronic device

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for the services and functions described above may typically consume battery power quickly and end up forcing the user to frequently recharge the battery or limit their usage, which degrades the user experience. Accordingly, to increase user satisfaction, it is desirable to maintain high levels of capabilities in the most efficient manner possible.

BRIEF SUMMARY

[0006] A method, apparatus and computer program product are therefore provided to enable the provision of efficient processing in the area of video coding and decoding. In an example embodiment, complexity balanced entropy coding may be employed in order to provide a high level of capability with respect to video coding and decoding while keeping the costs in terms of complexity relatively low.

BRIEF DESCRIPTION OF THE DRAWING(S)

[0007] Having thus described various embodiments in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

[0008] FIG. 1 is a schematic block diagram of a mobile terminal that may employ an example embodiment;

[0009] FIG. 2 is a schematic block diagram of a wireless communications system according to an example embodiment;

[0010] FIG. 3 illustrates a block diagram of an apparatus for providing complexity balanced entropy coding according to an example embodiment;

[0011] FIG. 4 illustrates a graph showing complexity versus bitrate provided by an example embodiment;

[0012] FIG. 5 is a flowchart according to another example method for providing complexity balanced entropy coding according to an example embodiment;

[0013] FIG. 6 illustrates structure associated with an example encoding process;

[0014] FIG. 7 illustrates structure associated with an example decoding process; and

[0015] FIG. 8 illustrates a graph showing complexity versus bitrate for a conventional encoder.

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DETAILED DESCRIPTION

[0016] Some embodiments will now be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments are shown. Indeed, various embodiments may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Like reference numerals refer to like elements throughout. As used herein, the terms "data," "content," "information" and similar terms may be used interchangeably to refer to data capable of being transmitted, received and/or stored in accordance with embodiments. Thus, use of any such terms should not be taken to limit the spirit and scope of various embodiments.

[0017] Additionally, as used herein, the term 'circuitry' refers to (a) hardware-only circuit implementations (e.g., implementations in analog circuitry and/or digital circuitry); (b) combinations of circuits and computer program product(s) comprising software and/or firmware instructions stored on one or more computer readable memories that work together to cause an apparatus to perform one or more functions described herein; and (c) circuits, such as, for example, a microprocessor(s) or a portion of a microprocessor(s), that require software or firmware for operation even if the software or firmware is not physically present. This definition of 'circuitry' applies to all uses of this term herein, including in any claims. As a further example, as used herein, the term 'circuitry' also includes an implementation comprising one or more processors and/or portion(s) thereof and accompanying software and/or firmware. As another example, the term 'circuitry' as used herein also includes, for example, a baseband integrated circuit or applications processor integrated circuit for a mobile phone or a similar integrated circuit in a server, a cellular network device, other network device, and/or other computing device.

[0018] As defined herein a "computer-readable storage medium," which refers to a non-transitory, physical storage medium (e.g., volatile or non-volatile memory device), can be differentiated from a "computer-readable transmission medium," which refers to an electromagnetic signal.

[0019] Some embodiments may be employed on mobile terminals in order to perform video coding and decoding more efficiently. However, example embodiments may alternatively be practiced on other electronic devices including fixed terminals. As such, although reduced-

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complexity video coding and decoding may be particularly useful in connection with operation in resource constrained environments (e.g., mobile terminals), it should be appreciated that such complexity reductions may also be useful in other environments in which resources are not constrained.

[0020] A video codec typically includes an encoder and a decoder. The encoder may be employed for transforming a video input into a compressed representation suitable for storage and/or transmission. The decoder may be employed for uncompressing the compressed video representation back into a viewable form. In many situations, the encoder discards some information from the original video sequence in order to represent the video in a more compact form (e.g., at a lower bitrate).

[0021] A typical hybrid video codec (e.g., ITU-T H.263 and H.264) may encode video information in two phases. In the first phase, pixel values in a certain picture area (or "block") may be predicted, for example, by motion compensation (e.g., finding and indicating an area in one of the previously coded video frames that corresponds closely to the block being coded) or by spatial means (e.g., using the pixel values around the block to be coded in a specified manner). In the second phase, the prediction error (e.g., the difference between the predicted block of pixels and the original block of pixels) is coded. The second phase typically includes transforming the difference in pixel values using a specified transform (e.g. Discrete Cosine Transform (DCT) or a variant thereof), quantizing the coefficients, and entropy coding the quantized coefficients. By varying the fidelity of the quantization process, the encoder can control the balance between the accuracy of the pixel representation (picture quality) and size of the resulting coded video representation (file size or transmission bitrate). Structure associated with the encoding process described above is illustrated, for example, in FIG. 6.

[0022] A typical decoder reconstructs the output video by applying prediction means similar to the encoder to form a predicted representation of the pixel blocks (e.g., using motion or spatial information created by the encoder and stored in the compressed representation) and prediction error decoding. The prediction error decoding may be an inverse operation of the prediction error coding recovering the quantized prediction error signal in spatial pixel domain. After applying prediction and prediction error decoding, the decoder may sum up the prediction and prediction error signals (e.g., pixel values) to form an output video frame. The decoder (and encoder) may also apply additional filtering to improve the quality of the output video before

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passing it for display and/or storing it as a prediction reference for the forthcoming frames in the video sequence. Structure associated with the decoding process described above is illustrated in FIG. 7.

[0023] In typical video codecs, motion information is indicated with motion vectors associated with each motion compensated image block. Each of the motion vectors represents the displacement of the image block in the picture to be coded (in the encoder side) or decoded (in the decoder side) and the prediction source block in one of the previously coded or decoded pictures. In order to represent motion vectors efficiently, the motion vectors are typically coded differentially with respect to block specific predicted motion vectors. In typical video codecs, the predicted motion vectors are created in a predefined way such as, for example, by calculating the median of the encoded or decoded motion vectors of the adjacent blocks.

[0024] In typical video codecs, the prediction residual after motion compensation is first transformed with a transform kernel (like DCT) and then coded since there may be some correlation among the residual. Thus, transform can in some cases help reduce this correlation and provide more efficient coding.

[0025] Typical video encoders utilize Lagrangian cost functions to find optimal coding modes (e.g., the desired Macroblock mode and associated motion vectors). This kind of cost function uses a weighting factor λ to tie together the (exact or estimated) image distortion due to lossy coding methods and the (exact or estimated) amount of information that is required to represent the pixel values in an image area:

$$C = D + \lambda R \qquad \text{(Eq. 1)}$$

Where C is the Lagrangian cost to be minimized, D is the image distortion (e.g. Mean Squared Error) with the mode and motion vectors considered, and R the number of bits needed to represent the required data to reconstruct the image block in the decoder (including the amount of data to represent the candidate motion vectors).

[0026] Many video codecs define subsets of coding tools ("profiles") to be used in different use cases. This approach has the benefit of allowing different devices to implement the coding tools most appropriate for the intended usage and available resources on the implementation platform. A drawback of this approach is that there may be lost interoperability between different profiles of the codec.

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[0027] General purpose video codecs, such as H.264/AVC, define coding tools with different computational requirements in different profiles of the standard. This definition may leads to situations where implementations of the same standard cannot necessarily interoperate with each other if they support a different profile of the standard. One significant reason for having multiple profiles in H.264/AVC is the entropy coding part of the standard, where some profiles support only the low complexity Context Adaptive Variable Length Coding based approach (CAVLC) whereas some other profiles support also the Context Adaptive Binary Arithmetic Coding approach (CABAC). The CABAC support is not required for the implementations of the low complexity profiles as the computational requirements of the CABAC method increase substantially as a function of the utilized bitrate. Coding and decoding of the DCT transform coefficients in the CABAC approach may cause problems in real life implementations as the computational requirements of that operation increases significantly as a function of the video bitrate as shown in FIG. 8.

[0028] Some embodiments of the present invention may provide for implementation of a coding strategy that takes advantage of variable length coding and arithmetic coding in a unified entropy coding design. The variable length coding aspects may operate to keep complexity relatively low, while the arithmetic coding aspects may help to maintain relatively high coding efficiency. The unified entropy coding design of some example embodiments may employ a single entropy coding mechanism that operates with respect to two defined categories that are defined for different syntax elements. As such, by categorizing syntax elements differently, different categories of symbols may be operated on differently in order to achieve relatively higher efficiency in a lower complexity implementation.

[0029] FIG. 1, one example embodiment, illustrates a block diagram of a mobile terminal 10 that would benefit from various embodiments. It should be understood, however, that the mobile terminal 10 as illustrated and hereinafter described is merely illustrative of one type of device that may benefit from various embodiments and, therefore, should not be taken to limit the scope of embodiments. As such, numerous types of mobile terminals, such as portable digital assistants (PDAs), mobile telephones, pagers, mobile televisions, gaming devices, laptop computers, cameras, video recorders, audio/video players, radios, positioning devices (for example, global positioning system (GPS) devices), or any combination of the aforementioned,

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and other types of voice and text communications systems, may readily employ various embodiments.

[0030] The mobile terminal 10 may include an antenna 12 (or multiple antennas) in operable communication with a transmitter 14 and a receiver 16. The mobile terminal 10 may further include an apparatus, such as a controller 20 or other processing device, which provides signals to and receives signals from the transmitter 14 and receiver 16, respectively. The signals include signaling information in accordance with the air interface standard of the applicable cellular system, and also user speech, received data and/or user generated data. In this regard, the mobile terminal 10 is capable of operating with one or more air interface standards, communication protocols, modulation types, and access types. By way of illustration, the mobile terminal 10 is capable of operating in accordance with any of a number of first, second, third and/or fourth-generation communication protocols or the like. For example, the mobile terminal 10 may be capable of operating in accordance with second-generation (2G) wireless communication protocols IS-136 (time division multiple access (TDMA)), GSM (global system for mobile communication), and IS-95 (code division multiple access (CDMA)), or with third-generation (3G) wireless communication protocols, such as Universal Mobile Telecommunications System (UMTS), CDMA2000, wideband CDMA (WCDMA) and time division-synchronous CDMA (TD-SCDMA), with 3.9G wireless communication protocol such as E-UTRAN, with fourth-generation (4G) wireless communication protocols or the like. As an alternative (or additionally), the mobile terminal 10 may be capable of operating in accordance with non-cellular communication mechanisms. For example, the mobile terminal 10 may be capable of communication in a wireless local area network (WLAN) or other communication networks described below in connection with FIG. 2.

[0031] In some embodiments, the controller 20 may include circuitry desirable for implementing audio and logic functions of the mobile terminal 10. For example, the controller 20 may be comprised of a digital signal processor device, a microprocessor device, and various analog to digital converters, digital to analog converters, and other support circuits. Control and signal processing functions of the mobile terminal 10 are allocated between these devices according to their respective capabilities. The controller 20 thus may also include the functionality to convolutionally encode and interleave message and data prior to modulation and transmission. The controller 20 may additionally include an internal voice coder, and may

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include an internal data modem. Further, the controller 20 may include functionality to operate one or more software programs, which may be stored in memory. For example, the controller 20 may be capable of operating a connectivity program, such as a conventional Web browser. The connectivity program may then allow the mobile terminal 10 to transmit and receive Web content, such as location-based content and/or other web page content, according to a Wireless Application Protocol (WAP), Hypertext Transfer Protocol (HTTP) and/or the like, for example.

[0032] The mobile terminal 10 may also comprise a user interface including an output device such as a conventional earphone or speaker 24, a ringer 22, a microphone 26, a display 28, and a user input interface, all of which are coupled to the controller 20. The user input interface, which allows the mobile terminal 10 to receive data, may include any of a number of devices allowing the mobile terminal 10 to receive data, such as a keypad 30, a touch display (not shown) or other input device. In embodiments including the keypad 30, the keypad 30 may include the conventional numeric (0-9) and related keys (#, *), and other hard and soft keys used for operating the mobile terminal 10. Alternatively, the keypad 30 may include a conventional QWERTY keypad arrangement. The keypad 30 may also include various soft keys with associated functions. In addition, or alternatively, the mobile terminal 10 may include an interface device such as a joystick or other user input interface. The mobile terminal 10 further includes a battery 34, such as a vibrating battery pack, for powering various circuits that are required to operate the mobile terminal 10, as well as optionally providing mechanical vibration as a detectable output.

[0033] The mobile terminal 10 may further include a user identity module (UIM) 38. The UIM 38 is typically a memory device having a processor built in. The UIM 38 may include, for example, a subscriber identity module (SIM), a universal integrated circuit card (UICC), a universal subscriber identity module (USIM), a removable user identity module (R-UIM), and the like. The UIM 38 typically stores information elements related to a mobile subscriber. In addition to the UIM 38, the mobile terminal 10 may be equipped with memory. For example, the mobile terminal 10 may include volatile memory 40, such as volatile Random Access Memory (RAM) including a cache area for the temporary storage of data. The mobile terminal 10 may also include other non-volatile memory 42, which may be embedded and/or may be removable. The memories may store any of a number of pieces of information, and data, used by the mobile terminal 10 to implement the functions of the mobile terminal 10. For example, the memories

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may include an identifier, such as an international mobile equipment identification (IMEI) code, capable of uniquely identifying the mobile terminal 10.

[0034] In some embodiments, the mobile terminal 10 may further include a video encoder/decoder 48 for performing video coding and decoding operations. The video encoder/decoder 48 may be configured to encode data by transforming video input into compressed video data and decode data by converting compressed video data back into a viewable form.

[0035] FIG. 2 is a schematic block diagram of a wireless communications system according to an example embodiment. Referring now to FIG. 2, an illustration of one type of system that would benefit from various embodiments is provided. As shown in FIG. 2, a system in accordance with an example embodiment includes a communication device (for example, mobile terminal 10) and in some cases also additional communication devices that may each be capable of communication with a network 50. The communications devices of the system may be able to communicate with network devices or with each other via the network 50.

[0036] In an example embodiment, the network 50 includes a collection of various different nodes, devices or functions that are capable of communication with each other via corresponding wired and/or wireless interfaces. As such, the illustration of FIG. 2 should be understood to be an example of a broad view of certain elements of the system and not an all inclusive or detailed view of the system or the network 50. Although not necessary, in some embodiments, the network 50 may be capable of supporting communication in accordance with any one or more of a number of first-generation (1G), second-generation (2G), 2.5G, third-generation (3G), 3.5G, 3.9G, fourth-generation (4G) mobile communication protocols, Long Term Evolution (LTE), and/or the like.

[0037] One or more communication terminals such as the mobile terminal 10 and the other communication devices may be capable of communication with each other via the network 50 and each may include an antenna or antennas for transmitting signals to and for receiving signals from a base site, which could be, for example a base station that is a part of one or more cellular or mobile networks or an access point that may be coupled to a data network, such as a local area network (LAN), a metropolitan area network (MAN), and/or a wide area network (WAN), such as the Internet. In turn, other devices such as processing devices or elements (for example, personal computers, server computers or the like) may be coupled to the mobile

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terminal 10 via the network 50. By directly or indirectly connecting the mobile terminal 10 and other devices to the network 50, the mobile terminal 10 and the other devices may be enabled to communicate with each other and/or the network, for example, according to numerous communication protocols including Hypertext Transfer Protocol (HTTP) and/or the like, to thereby carry out various communication or other functions of the mobile terminal 10 and the other communication devices, respectively.

[0038] Furthermore, although not shown in FIG. 2, the mobile terminal 10 may communicate in accordance with, for example, radio frequency (RF), Bluetooth (BT), Infrared (IR) or any of a number of different wireline or wireless communication techniques, including LAN, wireless LAN (WLAN), Worldwide Interoperability for Microwave Access (WiMAX), WiFi, ultra-wide band (UWB), Wibree techniques and/or the like. As such, the mobile terminal 10 may be enabled to communicate with the network 50 and other communication devices by any of numerous different access mechanisms. For example, mobile access mechanisms such as wideband code division multiple access (W-CDMA), CDMA2000, global system for mobile communications (GSM), general packet radio service (GPRS) and/or the like may be supported as well as wireless access mechanisms such as WLAN, WiMAX, and/or the like and fixed access mechanisms such as digital subscriber line (DSL), cable modems, Ethernet and/or the like.

[0039] FIG. 3 illustrates a block diagram of an apparatus that may be employed at the mobile terminal 10 to host or otherwise facilitate the operation of an example embodiment. An example embodiment will now be described with reference to FIG. 3, in which certain elements of an apparatus for providing complexity balanced entropy coding are displayed. The apparatus of FIG. 3 may be employed, for example, on the mobile terminal 10. However, the apparatus may alternatively be embodied at a variety of other devices, both mobile and fixed (such as, for example, any of the devices listed above). Furthermore, it should be noted that the devices or elements described below may not be mandatory and thus some may be omitted in certain embodiments.

[0040] Referring now to FIG. 3, an apparatus for providing complexity balanced entropy coding is provided. The apparatus may include or otherwise be in communication with a processor 70, a user interface 72, a communication interface 74 and a memory device 76. In some embodiments, the processor 70 (and/or co-processors or any other processing circuitry assisting or otherwise associated with the processor 70) may be in communication with the

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memory device 76 via a bus for passing information among components of the apparatus. The memory device 76 may include, for example, one or more volatile and/or non-volatile memories. In other words, for example, the memory device 76 may be an electronic storage device (e.g., a computer readable storage medium) comprising gates configured to store data (e.g., bits) that may be retrievable by a machine (e.g., a computing device like the processor 70). The memory device 76 may be configured to store information, data, applications, instructions or the like for enabling the apparatus to carry out various functions in accordance with an example embodiment of the present invention. For example, the memory device 76 could be configured to buffer input data for processing by the processor 70. Additionally or alternatively, the memory device 76 could be configured to store instructions for execution by the processor 70.

[0041] The apparatus may, in some embodiments, be a mobile terminal (e.g., mobile terminal 10) or a fixed communication device or computing device configured to employ an example embodiment of the present invention. However, in some embodiments, the apparatus may be embodied as a chip or chip set. In other words, the apparatus may comprise one or more physical packages (e.g., chips) including materials, components and/or wires on a structural assembly (e.g., a baseboard). The structural assembly may provide physical strength, conservation of size, and/or limitation of electrical interaction for component circuitry included thereon. The apparatus may therefore, in some cases, be configured to implement an embodiment of the present invention on a single chip or as a single "system on a chip." As such, in some cases, a chip or chipset may constitute means for performing one or more operations for providing the functionalities described herein.

[0042] The processor 70 may be embodied in a number of different ways. For example, the processor 70 may be embodied as one or more of various processing means such as a coprocessor, a microprocessor, a controller, a digital signal processor (DSP), a processing element with or without an accompanying DSP, or various other processing circuitry including integrated circuits such as, for example, an ASIC (application specific integrated circuit), an FPGA (field programmable gate array), a microcontroller unit (MCU), a hardware accelerator, a special-purpose computer chip, or the like. As such, in some embodiments, the processor 70 may include one or more processing cores configured to perform independently. A multi-core processor may enable multiprocessing within a single physical package. Additionally or

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alternatively, the processor 70 may include one or more processors configured in tandem via the bus to enable independent execution of instructions, pipelining and/or multithreading.

[0043] In an example embodiment, the processor 70 may be configured to execute instructions stored in the memory device 76 or otherwise accessible to the processor 70. Alternatively or additionally, the processor 70 may be configured to execute hard coded functionality. As such, whether configured by hardware or software methods, or by a combination thereof, the processor 70 may represent an entity (e.g., physically embodied in circuitry) capable of performing operations according to an embodiment of the present invention while configured accordingly. Thus, for example, when the processor 70 is embodied as an ASIC, FPGA or the like, the processor 70 may be specifically configured hardware for conducting the operations described herein. Alternatively, as another example, when the processor 70 is embodied as an executor of software instructions, the instructions may specifically configure the processor 70 to perform the algorithms and/or operations described herein when the instructions are executed. However, in some cases, the processor 70 may be a processor of a specific device (e.g., a mobile terminal or network device) adapted for employing an embodiment of the present invention by further configuration of the processor 70 by instructions for performing the algorithms and/or operations described herein. The processor 70 may include, among other things, a clock, an arithmetic logic unit (ALU) and logic gates configured to support operation of the processor 70.

[0044] Meanwhile, the communication interface 74 may be any means such as a device or circuitry embodied in either hardware, software, or a combination of hardware and software that is configured to receive and/or transmit data from/to a network and/or any other device or module in communication with the apparatus. In this regard, the communication interface 74 may include, for example, an antenna (or multiple antennas) and supporting hardware and/or software for enabling communications with a wireless communication network. In some environments, the communication interface 74 may alternatively or also support wired communication. As such, for example, the communication interface 74 may include a communication modem and/or other hardware/software for supporting communication via cable, digital subscriber line (DSL), universal serial bus (USB) or other mechanisms.

[0045] The user interface 72 may be in communication with the processor 70 to receive an indication of a user input at the user interface 72 and/or to provide an audible, visual,

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mechanical or other output to the user. As such, the user interface 72 may include, for example, a keyboard, a mouse, a joystick, a display, a touch screen, soft keys, a microphone, a speaker, or other input/output mechanisms. In this regard, for example, the processor 70 may comprise user interface circuitry configured to control at least some functions of one or more elements of the user interface, such as, for example, a speaker, ringer, microphone, display, and/or the like. The processor 70 and/or user interface circuitry comprising the processor 70 may be configured to control one or more functions of one or more elements of the user interface through computer program instructions (e.g., software and/or firmware) stored on a memory accessible to the processor 70 (e.g., memory device 76, and/or the like).

[0046] In an example embodiment, the processor 70 may be embodied as, include or otherwise control an entropy coding engine 80 and a categorizer 82. As such, in some embodiments, the processor 70 may be said to cause, direct or control the execution or occurrence of the various functions attributed to the entropy coding engine 80 and the categorizer 82, respectively, as described herein. The entropy coding engine 80 and the categorizer 82 may each be any means such as a device or circuitry operating in accordance with software or otherwise embodied in hardware or a combination of hardware and software (for example, processor 70 operating under software control, the processor 70 embodied as an ASIC or FPGA specifically configured to perform the operations described herein, or a combination thereof) thereby configuring the device or circuitry to perform the corresponding functions of the entropy coding engine 80 and the categorizer 82, respectively, as described herein. Thus, in examples in which software is employed, a device or circuitry (for example, the processor 70 in one example) executing the software forms the structure associated with such means.

[0047] The categorizer 82 may be configured to divide syntax elements that may occur in a given bitstream (e.g., a bitstream associated with video content being processed) into categories. In an example embodiment, the first category includes symbols that occur relatively infrequently and the second category includes symbols that occur relatively frequently. Accordingly, for example, a threshold frequency of occurrence may be defined for symbols and those symbols that are expected to occur more frequently than the threshold frequency may be determined to be in the second category while those symbols that are expected to occur less frequently than the threshold frequency may be determined to be in the first category. In some cases, the frequency threshold may be determined based on a frequency of symbol occurrence in

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the highest bitrates allowed in a particular system. As such, symbols in the first category may not only occur relatively infrequently even at the highest bitrates allowed. Meanwhile, the second category may include symbols whose occurrence significantly increases as the total bitrate of a video bitstream increases.

[0048] After categorization has been accomplished by the categorizer 82, the entropy coding engine 80 may perform binarization and/or entropy coding operations employing different treatment based on the categories defined by the categorizer 82. For example, for the first category, binarization may be accomplished using a selected binarization technique (e.g., CABAC or Pipe/V2V (variable length to variable length) approaches) followed by a context update and entropy coding with variable bin probabilities. The syntax for the symbols in the second category may mimic traditional variable length coding and may be performed by binarizing symbols targeting a fifty percent probability for both 0 and 1 bins. For cases of residual coefficients, the binarized symbols may be generated similar to run-length coding, followed by Huffman coding, or using some other more advanced methods. After binarizing symbols with a targeted probability for 0 and 1 bins, the context update stage may be bypassed for the resulting bins. Entropy coding may then be performed with fifty percent probabilities. In some examples, a bypass coding mode may be implemented for a CABAC engine to accomplish the entropy coding.

[0049] For decoding, some example embodiments may process first category symbols using procedures corresponding to the encoding mechanism employed. For example, if encoding is performed using CABAC or Pipe/V2V related approaches, the corresponding decoding approaches for each may be implemented for first category symbols. Meanwhile, syntax elements belonging to the second category may employ the same coding engine (e.g., the entropy coding engine 80) as first category symbols except that static fifty percent bin probabilities may be employed in relation to decoding of these symbols (e.g., by employing a bypass coding mode of a CABAC engine).

[0050] Since context update operations are not performed for syntax elements belonging to the second category, the total computational requirements for coding/decoding operations undertaken by the codec (e.g., the video encoder/decoder 48) may be reduced. In this regard, for example, the total computational requirements may be within certain limits that may keep complexity relatively low while still enabling relatively high compression performance for

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the given complexity limitation. As such, in some cases, first category encoding may be structured to provide relatively high efficiency while second category encoding may be structured to provide lower complexity (e.g., by bypassing context updating). For construction of the first category, information related to quad-tree structure of coding, transform and prediction units may be considered along with information related to predication, such as a prediction mode, motion vector data and intra prediction data. Second category construction may take into account residual transform coefficient data.

[0051] Although each of the syntax elements of a given bitstream may be encoded and decoded in accordance with complexity balanced entropy coding as described above, the method and apparatus of on example embodiment may encode some of the syntax elements in accordance with complexity balanced entropy coding and others of the syntax elements in accordance with other coding schemes, such as in accordance with arithmetic coding schemes. Thus, the complexity balanced entropy coding of an example embodiment of the present invention may be utilized jointly or in combination with arithmetic or other coding schemes, if so desired.

[0052] An instance of the categorizer 82 and the entropy coding engine 80 may be provided at the video encoder/decoder 48. Alternatively, an instance of the categorizer 82 and the entropy coding engine 80 may be separately provided, but may be available to assist with video encoding and decoding operations performed by the video encoder/decoder 48.

[0053] In some modes of operation, quantized DCT coefficients may be binarized and resulting bins may be coded with equal probabilities (e.g., fifty percent for 0 bins and fifty percent for 1 bins) utilizing the same entropy coding mechanism (e.g., entropy coding engine 80) as is used for the rest of the data. The data may be encoded by any selected mechanism (e.g., CABAC in H.264/AVC). When compared to binarization of, for example, CABAC, the binarization of DCT coefficients may be performed differently targeting the resulting bins to have equal probabilities. Consequently, when allocating equal probabilities to the bins resulting from the DCT coefficients, the most complex part of the context adaptive arithmetic coding (e.g., the updating of probabilities for different bin contexts) may be bypassed completely. This may make the computational complexity associated with entropy coding of the corresponding symbols much less dependent on the bitrate and allow a low complexity operation to be realized, even at relatively high bitrates.

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[0054] FIG. 4 illustrates an example of complexity versus bitrate for an example embodiment. The dashed line 90 may indicate a desired maximum level for a low complexity mode of operation. As indicated in FIG. 4, by employing an example embodiment that categorizes syntax elements and then encodes each category differently to reduce complexity, the computational complexity as indicated by the number of DCT coefficients, is kept below the desired maximum level by utilizing context adaptive arithmetic coding while bypassing probability estimation for DCT coefficient data for some symbols. As such, FIG. 4 stands in contrast to computational complexity as a function of video bitrate for a conventional system utilizing only context adaptive arithmetic coding as shown in FIG. 8. In FIG. 8, the number of DCT coefficients is higher and increases linearly as the bitrate increases to the point where the desired maximum complexity level for a low complexity mode of operation (shown again by dashed line 90) is exceeded.

[0055] Example embodiments of the present invention may be implemented in various different ways. As an example, binarization of data symbols may be accomplished utilizing codewords defined for DCT coefficient coding or via other mechanisms. Different context adaptive entropy coding mechanisms may also be employed (e.g., CABAC, Pipe/V2V, etc.). Different data units may be categorized for low complexity processing with constant probabilities as well. In some cases, constant probabilities in low complexity processing categories may be defined as equal probabilities (as described above). However, in some alternative embodiments, the probabilities may be defined such that one or more bins are coded with unequal probabilities. The categorization of data for low complexity processing and high complexity processing may vary depending on different variables, such as bitrate. In some embodiments, categorization of syntax elements may be signaled at block, slice, picture, or sequence levels. In some cases, an indication as to whether corresponding syntax elements are to be entropy coded with high efficiency or low complexity entropy coding may be signaled at block, slice, picture, or sequence levels as well.

[0056] Some embodiments of the present invention may therefore enable complexity of a video codec to be controlled while still enabling a relatively high level of compression efficiency under different computational complexity requirements. In this regard, by categorizing the syntax elements based on their relative frequencies of occurrence, more complex operations may be performed with respect to less frequently occurring symbols and

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complex operations may be simplified or omitted with respect to more frequently occurring symbols.

[0057] FIG. 5 is a flowchart of a method and program product according to an example embodiment of the invention. It will be understood that each block of the flowchart, and combinations of blocks in the flowchart, may be implemented by various means, such as hardware, firmware, processor, circuitry and/or other device associated with execution of software including one or more computer program instructions. For example, one or more of the procedures described above may be embodied by computer program instructions. In this regard, the computer program instructions which embody the procedures described above may be stored by a memory device of a user terminal and executed by a processor in the user terminal. As will be appreciated, any such computer program instructions may be loaded onto a computer or other programmable apparatus (e.g., hardware) to produce a machine, such that the instructions which execute on the computer or other programmable apparatus create means for implementing the functions specified in the flowchart block(s). These computer program instructions may also be stored in a non-transitory computer-readable memory that may direct a computer or other programmable apparatus to function in a particular manner, such that the instructions stored in the computer-readable memory produce an article of manufacture which implements the functions specified in the flowchart block(s). The computer program instructions may also be loaded onto a computer or other programmable apparatus to cause a series of operations to be performed on the computer or other programmable apparatus to produce a computer-implemented process such that the instructions which execute on the computer or other programmable apparatus implement the functions specified in the flowchart block(s).

[0058] Accordingly, blocks of the flowchart support combinations of means for performing the specified functions and combinations of operations for performing the specified functions. It will also be understood that one or more blocks of the flowchart, and combinations of blocks in the flowchart, can be implemented by special purpose hardware-based computer systems which perform the specified functions, or combinations of special purpose hardware and computer instructions.

[0059] In this regard, a method according to one embodiment of the invention, as shown in FIG. 5, may include categorizing syntax elements of video content based on a frequency of occurrence of syntax elements in the video content at operation 110. The

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categorizing may include defining at least a first category and a second category of symbols. The method may further include performing entropy coding of symbols corresponding to the first category responsive to context updating at operation 120, and bypassing context updating prior to entropy coding of symbols corresponding to the second category at operation 130.

[0060] In some embodiments, certain ones of the operations above may be modified or further amplified as described below. Moreover, in some embodiments additional optional operations may also be included (examples of which are shown in dashed lines in FIG. 5). It should be appreciated that each of the modifications, optional additions or amplifications below may be included with the operations above either alone or in combination with any others among the features described herein. In this regard, for example, the method may further include performing binarization of symbols targeting a predetermined probability prior to bypassing the context updating at operation 125. In an example embodiment, performing binarization of symbols targeting a predetermined probability may include performing binarization targeting an even or uneven probability for each bin. The method may further include signaling high efficiency or low complexity entropy encoding for syntax elements at a block, slice, picture or sequence level at operation 140. In some cases, the method may additionally or alternatively include signaling a categorization of syntax elements at a block, slice, picture or sequence level at operation 100. In an example embodiment, categorizing syntax elements may include categorizing symbols having a frequency of occurrence below a threshold as first category symbols and categorizing symbols having a frequency of occurrence above the threshold as second category symbols. In an example embodiment, performing entropy coding of symbols corresponding to the first category further may include performing entropy coding following binarization of the data symbols.

[0061] In an example embodiment, an apparatus for performing the method of FIG. 5 above may comprise a processor (e.g., the processor 70) configured to perform some or each of the operations (100-140) described above. The processor may, for example, be configured to perform the operations (100-140) by performing hardware implemented logical functions, executing stored instructions, or executing algorithms for performing each of the operations. Alternatively, the apparatus may comprise means for performing each of the operations described above. In this regard, according to an example embodiment, examples of means for performing operations 100-140 may comprise respective ones of, for example, the categorizer 82

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and the entropy coding engine 80. Additionally or alternatively, at least by virtue of the fact that the processor 70 may be configured to control or even be embodied as the categorizer 82 and the entropy coding engine 80, the processor 70 and/or a device or circuitry for executing instructions or executing an algorithm for processing information as described above may also form example means for performing operations 100-140.

[0062] An example of an apparatus according to an example embodiment may include at least one processor and at least one memory including computer program code. The at least one memory and the computer program code may be configured to, with the at least one processor, cause the apparatus to perform the operations 100-140 (with or without the modifications and amplifications described above in any combination).

[0063] An example of a computer program product according to an example embodiment may include at least one computer-readable storage medium having computer-executable program code portions stored therein. The computer-executable program code portions may include program code instructions for performing operation 100-140 (with or without the modifications and amplifications described above in any combination).

[0064] Many modifications and other embodiments of the inventions set forth herein will come to mind to one skilled in the art to which these inventions pertain having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the inventions are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Moreover, although the foregoing descriptions and the associated drawings describe some example embodiments in the context of certain example combinations of elements and/or functions, it should be appreciated that different combinations of elements and/or functions may be provided by alternative embodiments without departing from the scope of the appended claims. In this regard, for example, different combinations of elements and/or functions than those explicitly described above are also contemplated as may be set forth in some of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

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WHAT IS CLAIMED IS:

1. A method comprising:

categorizing a plurality of syntax elements of video content into first and second categories based on a frequency of occurrence of the syntax elements in the video content;

entropy coding symbols that correspond to the first category of syntax elements and that have been subjected to a context update; and

entropy coding symbols that correspond to the second category of syntax elements and that have bypassed context updating.

2. A method according to Claim 1 further comprising causing a categorization of the syntax elements to be signaled at a block, slice, picture or sequence level.

3. A method according to Claim 1 further comprising performing binarization of the symbols that correspond to the second category of syntax elements prior to bypassing the context updating.

4. A method according to Claim 3 wherein performing binarization comprises performing binarization so as to target a predetermined probability.

5. A method according to Claim 1 further comprising causing an indication of the entropy coding to be signaled at a block, slice, picture or sequence level.

6. A method according to Claim 1 wherein categorizing the plurality of syntax elements comprises categorizing the plurality of syntax elements based on a relationship of the frequency of occurrence of the syntax elements to a predefined threshold.

7. A method according to Claim 1 further comprising performing binarization of the symbols that correspond to the first category of syntax elements prior to entropy coding the symbols that correspond to the first category of syntax elements.

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8. An apparatus comprising at least one processor and at least one memory including computer program code, the at least one memory and the computer program code configured to, with the processor, cause the apparatus to at least:

categorize a plurality of syntax elements of video content into first and second categories based on a frequency of occurrence of the syntax elements in the video content;

entropy code symbols that correspond to the first category of syntax elements and that have been subjected to a context update; and

entropy code symbols that correspond to the second category of syntax elements and that have bypassed context updating.

9. An apparatus according to Claim 8 wherein the at least one memory and the computer program code are further configured to, with the processor, cause the apparatus to cause a categorization of the syntax elements to be signaled at a block, slice, picture or sequence level.

10. An apparatus according to Claim 8 wherein the at least one memory and the computer program code are further configured to, with the processor, cause the apparatus to perform binarization of the symbols that correspond to the second category of syntax elements prior to bypassing the context updating.

11. An apparatus according to Claim 10 wherein the at least one memory and the computer program code are configured to, with the processor, cause the apparatus to perform binarization by performing binarization so as to target a predetermined probability.

12. An apparatus according to Claim 8 wherein the at least one memory and the computer program code are further configured to, with the processor, cause the apparatus to cause an indication of the entropy coding to be signaled at a block, slice, picture or sequence level.

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13. An apparatus according to Claim 8 wherein the at least one memory and the computer program code are configured to, with the processor, cause the apparatus to categorize the plurality of syntax elements by categorizing the plurality of syntax elements based on a relationship of the frequency of occurrence of the syntax elements to a predefined threshold.

14. An apparatus according to Claim 8 wherein the at least one memory and the computer program code are further configured to, with the processor, cause the apparatus to perform binarization of the symbols that correspond to the first category of syntax elements prior to entropy coding the symbols that correspond to the first category of syntax elements.

15. A computer program product comprising at least one non-transitory computer-readable storage medium having computer-executable program code instructions stored therein, the computer-executable program code instructions comprising program code instructions to:

categorize a plurality of syntax elements of video content into first and second categories based on a frequency of occurrence of the syntax elements in the video content;

entropy code symbols that correspond to the first category of syntax elements and that have been subjected to a context update; and

entropy code symbols that correspond to the second category of syntax elements and that have bypassed context updating.

16. A computer program product according to Claim 15 wherein the computer-executable program code instructions further comprise program code instructions to cause a categorization of the syntax elements to be signaled at a block, slice, picture or sequence level.

17. A computer program product according to Claim 15 wherein the computer-executable program code instructions further comprise program code instructions to perform binarization of the symbols that correspond to the second category of syntax elements prior to bypassing the context updating.

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18. A computer program product according to Claim 17 wherein the comprise program code instructions to perform binarization comprise program code instructions to perform binarization so as to target a predetermined probability.

19. A computer program product according to Claim 15 wherein the computer-executable program code instructions further comprise program code instructions to cause an indication of the entropy coding to be signaled at a block, slice, picture or sequence level.

20. A computer program product according to Claim 15 comprise the program code instructions to categorize the plurality of syntax elements comprise program code instructions to categorize the plurality of syntax elements based on a relationship of the frequency of occurrence of the syntax elements to a predefined threshold.

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ABSTRACT

A method, apparatus and computer program product are provided to enable the provision of efficient processing in the area of video coding and decoding by employing complexity balanced entropy coding in order to provide a high level of capability with respect to video coding and decoding in a cost effective manner. A method includes categorizing a plurality of syntax elements of video content into first and second categories based on a frequency of occurrence of the syntax elements in the video content. The method also entropy codes symbols that correspond to the first category of syntax elements and that have been subjected to a context update. Further, the method entropy codes symbols that correspond to the second category of syntax elements and that have bypassed context updating. A corresponding apparatus and computer program product are also provided.

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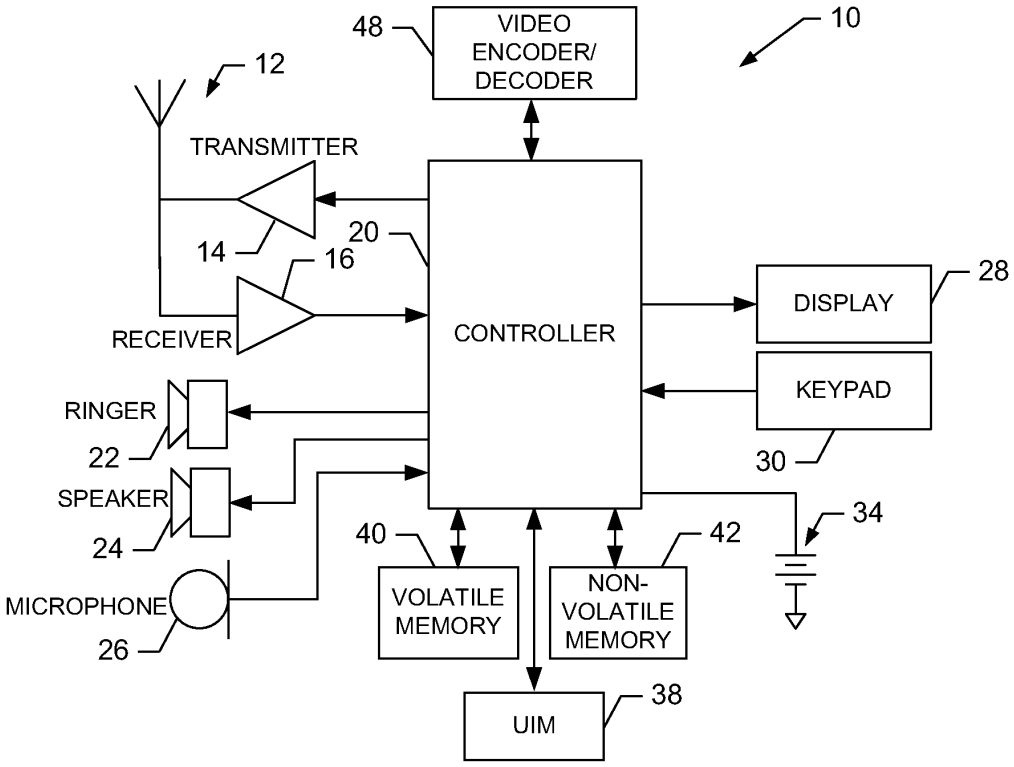

48
VIDEO ENCODER/ DECODER
10
12
TRANSMITTER
20
14
16
CONTROLLER
DISPLAY
28
RECEIVER
KEYPAD
RINGER
22
30
SPEAKER
34
24
40
42
MICROPHONE
VOLATILE MEMORY
NON-VOLATILE MEMORY
26
38
UIM

FIG. 1.

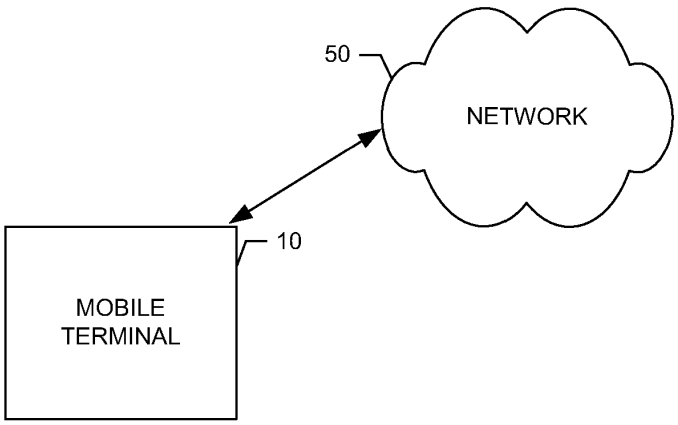


FIG. 2.

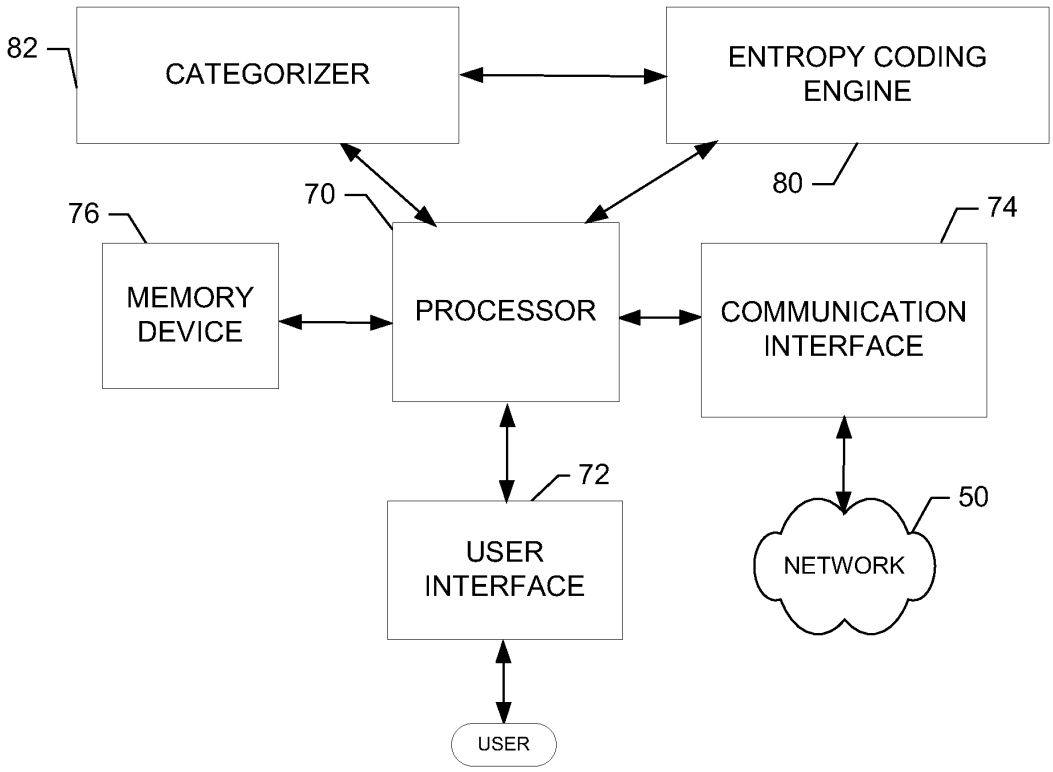

82
CATEGORIZER
ENTROPY CODING ENGINE
80
70
76
74
MEMORY DEVICE
PROCESSOR
COMMUNICATION INTERFACE
72
50
USER INTERFACE
NETWORK
USER

FIG. 3.

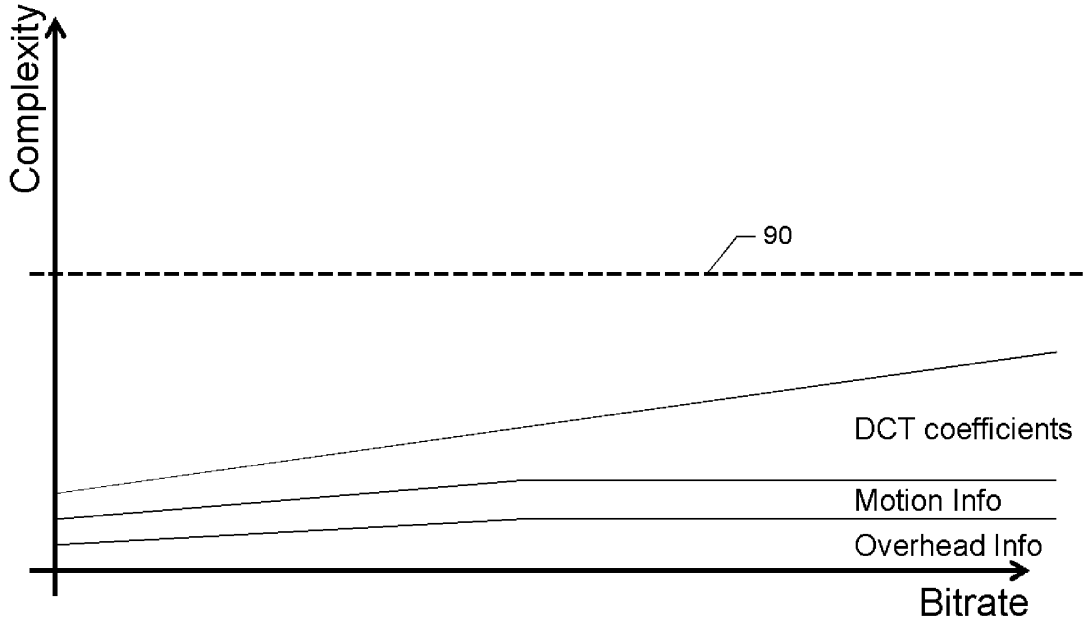

Complexity
90
DCT coefficients
Motion Info
Overhead Info
Bitrate

FIG. 4.

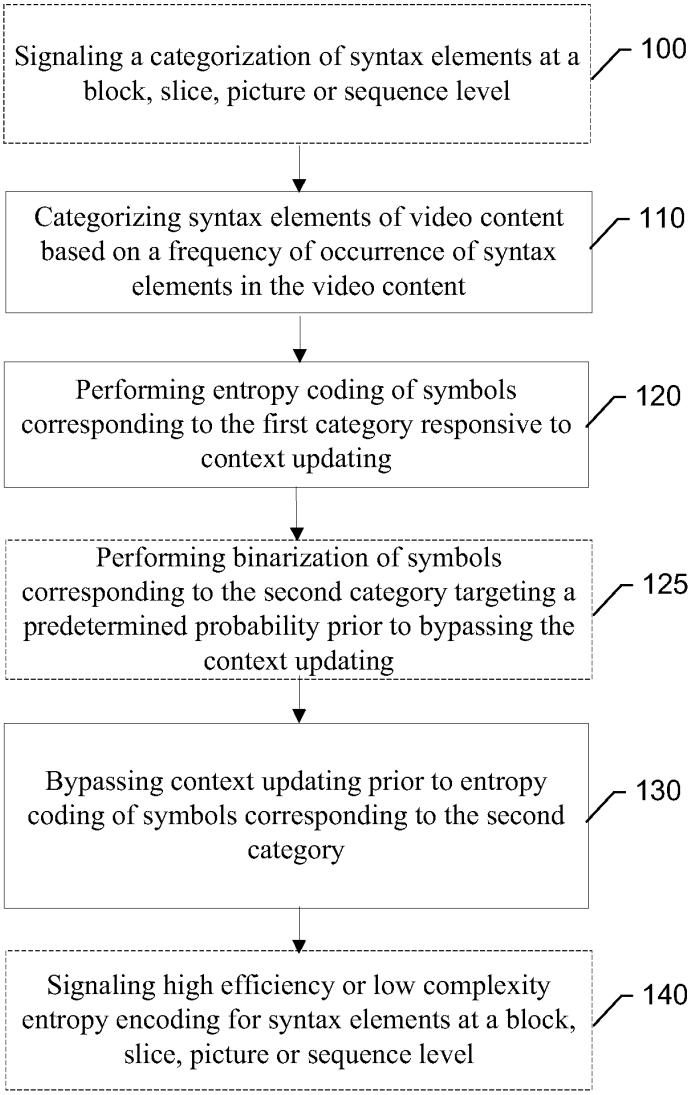
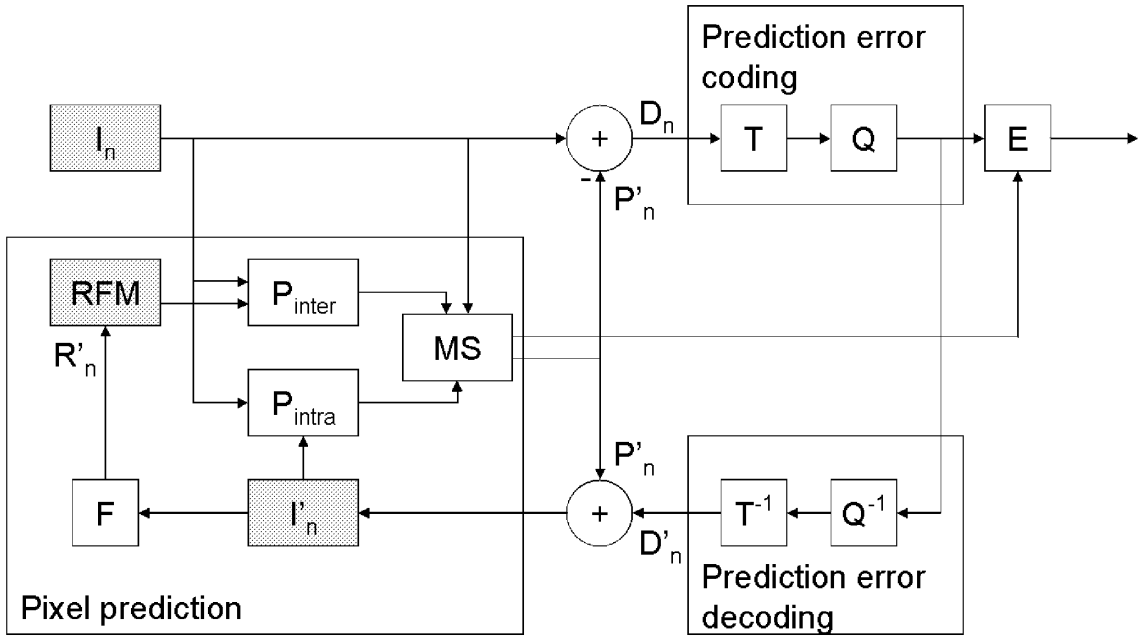

Signaling a categorization of syntax elements at a block, slice, picture or sequence level
100
Categorizing syntax elements of video content based on a frequency of occurrence of syntax elements in the video content
110
Performing entropy coding of symbols corresponding to the first category responsive to context updating
120
Performing binarization of symbols corresponding to the second category targeting a predetermined probability prior to bypassing the context updating
125
Bypassing context updating prior to entropy coding of symbols corresponding to the second category
130
Signaling high efficiency or low complexity entropy encoding for syntax elements at a block, slice, picture or sequence level
140

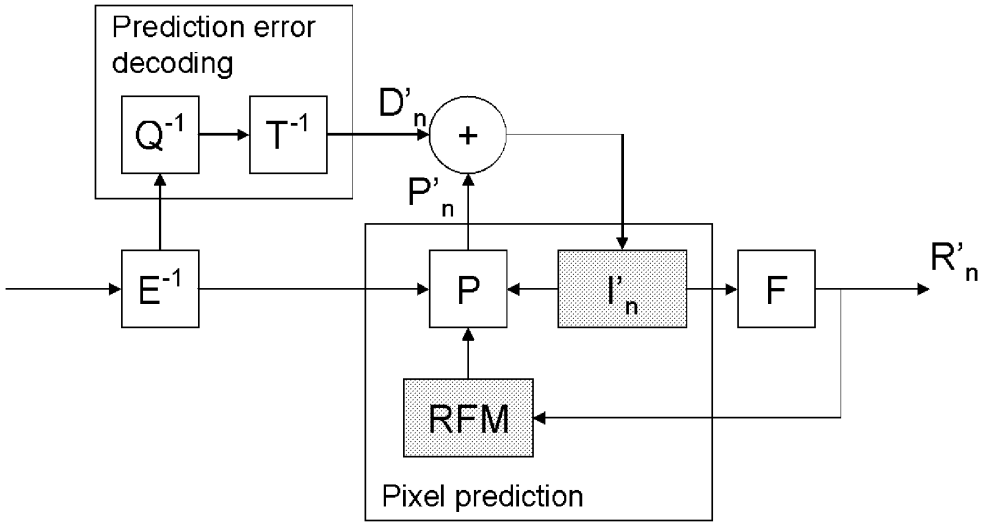
FIG. 5.



I_n: Image to be encoded
P'_n: Predicted representation of an image block
D_n: Prediction error signal
D'_n: Reconstructed prediction error signal
I'_n: Preliminary reconstructed image
R'_n: Final reconstructed image

T, T^{-1}: Transform and inverse transform
Q, Q^{-1}: Quantization and inverse quantization
E: Entropy encoding
RFM: Reference frame memory
P_{inter}: Inter prediction
P_{intra}: Intra prediction
MS: Mode selection
F: Filtering

FIG. 6.



P'_n: Predicted representation of an image block
D'_n: Reconstructed prediction error signal
I'_n: Preliminary reconstructed image
R'_n: Final reconstructed image

T^{-1}: Inverse transform
Q^{-1}: Inverse quantization
E^{-1}: Entropy decoding
RFM: Reference frame memory
P: Prediction (either inter or intra)
F: Filtering

FIG. 7.

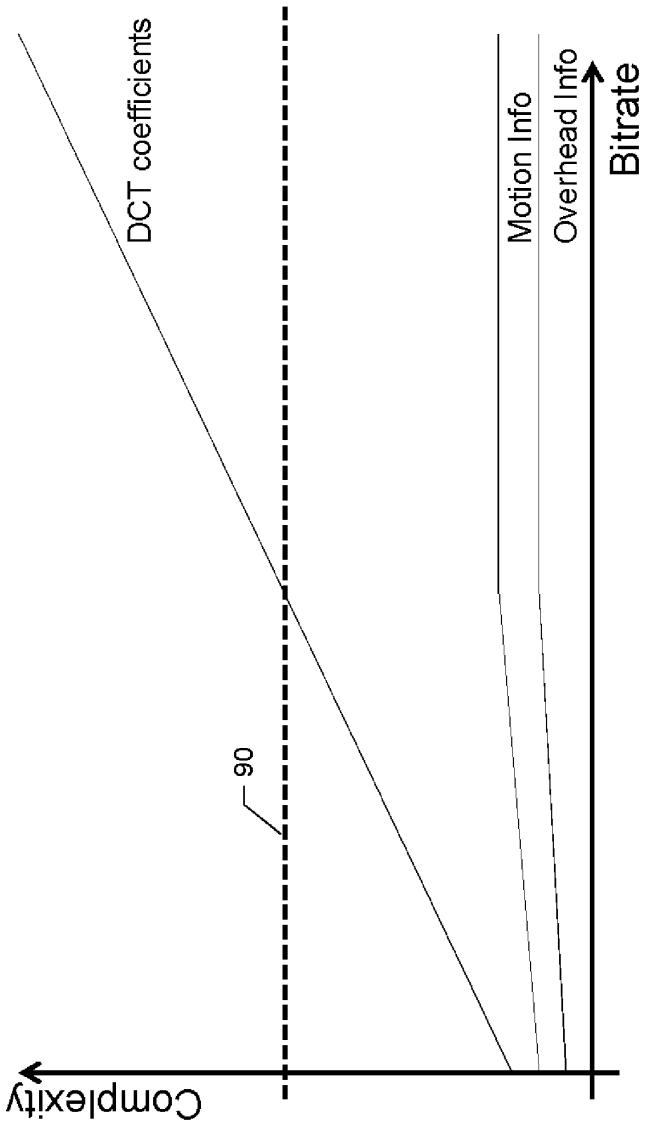

DCT coefficients
Motion Info
Overhead Info
Bitrate
Complexity
90

FIG. 8.

Electronic Patent Application Fee Transmittal	
Application Number:	
Filing Date:	
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING
First Named Inventor/Applicant Name:	Jani Lainema
Filer:	Ragip Kurceren/Denise Wilson
Attorney Docket Number:	NC73661US-NP
Filed as Large Entity	

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility application filing	1011	1	330	330
Utility Search Fee	1111	1	540	540
Utility Examination Fee	1311	1	220	220
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1090**

Electronic Acknowledgement Receipt	
EFS ID:	10611442
Application Number:	13192111
International Application Number:	
Confirmation Number:	5397
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING
First Named Inventor/Applicant Name:	Jani Lainema
Customer Number:	73658
Filer:	Ragip Kurceren/Denise Wilson
Filer Authorized By:	Ragip Kurceren
Attorney Docket Number:	NC73661US-NP
Receipt Date:	27-JUL-2011
Filing Date:	
Time Stamp:	16:47:22
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1090
RAM confirmation Number	3354
Deposit Account	500270
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	ADS.pdf	841413 55b5a8a2d16172a3c93590430c5133893d6ad014	no	5
Warnings:					
Information:					
2		application.pdf	128846 8ad787df46c9a447af4a051b7aef636e2702c281	yes	24
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Specification		1	19	
	Claims		20	23	
	Abstract		24	24	
Warnings:					
Information:					
3	Drawings-only black and white line drawings	drawings.pdf	123005 561240982989394c183975dacf4871e38dbf1775	no	8
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	33278 2cc2a335b0114cd88f64b60693f0776c87e58bef	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1126542		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

SCORE Placeholder Sheet for IFW Content

Application Number: 13192111 Document Date: 7/27/2011

The presence of this form in the IFW record indicates that the following document type was received in electronic format on the date identified above. This content is stored in the SCORE database.

- Drawings – Other than Black and White Line Drawings

Since this was an electronic submission, there is no physical artifact folder, no artifact folder is recorded in PALM, and no paper documents or physical media exist. The TIFF images in the IFW record were created from the original documents that are stored in SCORE.

To access the documents in the SCORE database, refer to instructions developed by SIRA.

At the time of document entry (noted above):

- Examiners may access SCORE content via the eDAN interface.
- Other USPTO employees can bookmark the current SCORE URL (http://es/ScoreAccessWeb/).
- External customers may access SCORE content via the Public and Private PAIR interfaces.

Form Revision Date: February 8, 2006

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/192,111	07/27/2011	Jani LAINEMA	NC73661US-NP

CONFIRMATION NO. 5397

73658
Nokia, Inc.
6021 Connection Drive, MS 2-5-520
Irving, TX 75039

FORMALITIES LETTER

OC000000049172019

Date Mailed: 08/10/2011

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The oath or declaration is missing.
  A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.
  Note: If a petition under 37 CFR 1.47 is being filed, an oath or declaration in compliance with 37 CFR 1.63 signed by all available joint inventors, or if no inventor is available by a party with sufficient proprietary interest, is required.

The applicant needs to satisfy supplemental fees problems indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- A surcharge (for late submission of filing fee, search fee, examination fee or oath or declaration) as set forth in 37 CFR 1.16(f) of $**130** for a non-small entity, must be submitted.

SUMMARY OF FEES DUE:

Total fee(s) required within **TWO MONTHS** from the date of this Notice is $**130** for a non-small entity
- $**130** Surcharge.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web.
https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at **1-866-217-9197** or visit our website at http://www.uspto.gov/ebc.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

/mhaile/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
13/192,111	07/27/2011	2819	1090	NC73661US-NP	20	3

CONFIRMATION NO. 5397

73658
Nokia, Inc.
6021 Connection Drive, MS 2-5-520
Irving, TX 75039

FILING RECEIPT

OC000000049172018

Date Mailed: 08/10/2011

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Jani LAINEMA, Tampere, FINLAND;
Kemal UGUR, Tampere, FINLAND;
Antti Olli HALLAPURO, Tampere, FINLAND;

Assignment For Published Patent Application

NOKIA CORPORATION, Espoo, FINLAND

Power of Attorney: None

Domestic Priority data as claimed by applicant

This appln claims benefit of 61/368,316 07/28/2010

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)

If Required, Foreign Filing License Granted: 08/05/2011

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/192,111**

Projected Publication Date: To Be Determined - pending completion of Missing Parts

Non-Publication Request: No

Early Publication Request: No

Title

METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING

Preliminary Class

341

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as

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set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/192,111

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	330
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	540
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	220
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*			OR	x 52 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*				x 220 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $270 ($135 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1090

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

Doc Code: PET.OP
Document Description: Petition for Review by the Office of Petitions

PTO/SB/64 (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PETITION FOR REVIVAL OF AN APPLICATION FOR PATENT ABANDONED UNINTENTIONALLY UNDER 37 CFR 1.137(b)	Docket Number (Optional) NC73661US-NP

First named inventor: Jani Lainema

Application No.: 13/192111 Art Unit: _____

Filed: July 27, 2011 Examiner: _____

Title: Method and Apparatus for Providing Complexity Balanced Entropy Coding

Attention: Office of Petitions
Mail Stop Petition
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450
FAX (571) 273-8300

NOTE: If information or assistance is needed in completing this form, please contact Petitions Information at (571) 272-3282.

The above-identified application became abandoned for failure to file a timely and proper reply to a notice or action by the United States Patent and Trademark Office. The date of abandonment is the day after the expiration date of the period set for reply in the office notice or action plus any extensions of time actually obtained.

APPLICANT HEREBY PETITIONS FOR REVIVAL OF THIS APPLICATION

NOTE: A grantable petition requires the following items:
(1) Petition fee;
(2) Reply and/or issue fee;
(3) Terminal disclaimer with disclaimer fee - required for all utility and plant applications filed before June 8, 1995; and for all design applications; and
(4) Statement that the entire delay was unintentional

1. Petition Fee

☐ Small entity-fee $_____ (37 CFR 1.17(m)). Application claims small entity status. See 37 CFR 1.27.

☑ Other than small entity-fee $ 1860.00 (37 CFR 1.17(m))

2. Reply and/or fee

A. The reply and/or fee to the above-noted Office action in the form of Declaration of Inventorship, Power of Attorn (identify type of reply):

☐ has been filed previously on _____.

☑ is enclosed herewith.

B. The issue fee and publication fee (if applicable) of $_____.

☐ has been paid previously on _____.

☐ is enclosed herewith.

This collection of information is required by 37 CFR 1.137(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1.0 hour to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Mail Stop Petition, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

3. Terminal disclaimer with disclaimer fee

☐ Since this utility/plant application was filed on or after June 8, 1995, no terminal disclaimer is required.

☐ A terminal disclaimer (and disclaimer fee (37 CFR 1.20(d)) of $_____ for a small entity or $_____ for other than a small entity) disclaiming the required period of time is enclosed herewith (see PTO/SB/63).

4. STATEMENT: The entire delay in filing the required reply from the due date for the required reply until the filing of a grantable petition under 37 CFR 1.137(b) was unintentional. [NOTE: The United States Patent and Trademark Office may require additional information if there is a question as to whether either the abandonment or the delay in filing a petition under 37 CFR 1.137(b) was unintentional (MPEP 711.03(c), subsections (III)(C) and (D)).]

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

/Thomas J. Arria/	March 23, 2012
Signature	Date
Thomas J. Arria	60223
Type or Printed name	Registration Number, If applicable
Nokia Inc., Attn: Intellectual Property Rights Docketing	781-219-8760
Address	Telephone Number
200 South Mathilda Ave., Sunnyvale, CA 94086	
Address	

Enclosures:

☑ Fee Payment

☑ Reply

☐ Terminal Disclaimer Form

☐ Additional sheets containing statements establishing unintentional delay

☐ Other: _____

CERTIFICATE OF MAILING OR TRANSMISSION [37 CFR 1.8(a)]

I hereby certify that this correspondence is being:

☐ Deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Mail Stop Petition, Commissioner for Patents, P. O. Box 1450, Alexandria, VA 22313-1450.

☐ Transmitted by facsimile on the date shown below to the United States Patent and Trademark Office at (571) 273-8300.

Date	Signature
	Typed or printed name of person signing certificate

Docket No.: NC73661US-NP

DECLARATION (37 CFR 1.63) FOR UTILITY APPLICATION
USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Method and Apparatus for Providing Complexity Balanced Entropy Coding

As the below named inventor(s), I/we declare that:

This Declaration is directed to (check all that apply):

☐ The attached application, or

☒ U.S. Application No. 13/192111 filed on July 27, 2011

which is a 371 National Stage of _____ filed on _____

As amended on _____ (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application nand the national or PCT International filing date of the continuation-in-part application.

All statements made herein of my/our own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF THE INVENTOR(S)

Inventor one: Jani Lainema Date: Jan-25-2012

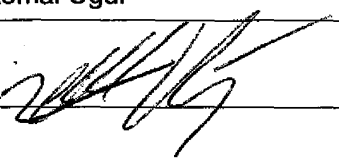
Signature: _____ Citizen of: FI

Docket No.: NC73661US-NP

All statements made herein of my/our own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF THE INVENTOR(S)

Inventor two: Kemal Ugur Date: 25 Jan 2012

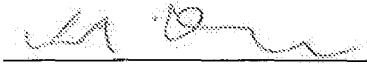
Signature:  Citizen of: TR

Docket No.: NC73661US-NP

All statements made herein of my/our own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF THE INVENTOR(S)

Inventor three: Antti Olli Hallapuro Date: Jan-25-2012

Signature:  Citizen of: FI

PTO/SB/81 (01-06)
Approved for use through 12/31/2008. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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POWER OF ATTORNEY and CORRESPONDENCE ADDRESS INDICATION FORM

Application Number	13/192111
Filing Date	July 27, 2011
First Named Inventor	Jani Lainema
Title	Method and Apparatus for Providing
Art Unit	TBD
Examiner Name	TBD
Attorney Docket Number	NC73661US-NP

I hereby revoke all previous powers of attorney given in the above-identified application.

I hereby appoint:

☑ Practitioners associated with the Customer Number: 73658

OR

☐ Practitioner(s) named below:

Name	Registration Number

as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith.

Please recognize or change the correspondence address for the above-identified application to:

☑ The address associated with the above-mentioned Customer Number:

OR

☐ The address associated with Customer Number:

OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the:

☐ Applicant/Inventor.

☑ Assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)

SIGNATURE of Applicant or Assignee of Record

Signature	/Thomas J. Arria/	Date	March 23 2012
Name	Thomas J. Arria	Telephone	781-219-8760
Title and Company	Senior IPR Specialist, Nokia Corporation		

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

☑ *Total of one forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/SB/96 (01-08)
Approved for use through 03/31/2008. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Jani Lainema

Application No./Patent No.: 13/192111 Filed/Issue Date: July 27, 2011

Entitled: Method and Apparatus for Providing Complexity Balanced Entropy Coding

Nokia Corporation, a Corporation

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that it is:

1. ☑ the assignee of the entire right, title, and interest; or

2. ☐ an assignee of less than the entire right, title and interest
(The extent (by percentage) of its ownership interest is_____ %)

in the patent application/patent identified above by virtue of either:

A. ☑ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel 026860, Frame 0637, or for which a copy thereof is attached.

OR

B. ☐ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

2. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

3. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet.

☑ As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (*i.e.*, a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Thomas J. Arria/	March 23 2012
Signature	Date
Thomas J. Arria	781-219-8760
Printed or Typed Name	Telephone Number
Senior IPR Specialist, Nokia Corporation	
Title	

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

NOKIA

LIMITED POWER OF ATTORNEY

that we, the undersigned, under the authority granted to each of us to sign jointly on behalf of

NOKIA CORPORATION
Keilalahdentie 4
02150 Espoo
Finland

hereby authorize the following person

Thomas Arria
Nokia Corporation
5 Wayside Road
01803 Burlington
U.S.A.

Nokia Corporation
P.O.Box 226,
FI-00045 NOKIA GROUP, Finland
(Keilalahdentie 4, 02150 ESPOO)

Tel. +358 7180 08000
Fax +358 7180 38226

Business Identity Code
0112038-9, Helsinki

in his capacity as Senior IP Specialist, Patenting, to sign alone in the name of Nokia Corporation all the documents that relate to the filing, prosecution and registration of patent applications, as well as post-grant operations relating to patents granted based on such patent applications. Such documents may include without limitation Assignment Deeds for assigning the ownership of an invention to Nokia, Novelty Declarations and Inventorship Declarations.

The rights granted under this Power of Attorney may not be transferred further.

The authority granted by this Power of Attorney shall expire six (6) months from the date of execution.

Notwithstanding the foregoing, the authority granted by this Power of Attorney shall expire when the authorized person's employment with Nokia ends.

This Power of Attorney is duly signed on this day of January 1, 2012.

NOKIA CORPORATION

By:
Name:
Title: Director,
Legal and Intellectual Property

By:
Name: Paul Melin
Title: Vice President,
Legal and Intellectual Property

Snap - Exhibit 1002
Snap v. Nokia - IPR2025-01345
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Docket No.: NC73661US-NP

ASSIGNMENT

Title of Invention	Method and Apparatus for Providing Complexity Balanced Entropy Coding

This Assignment is directed to (check all that apply):

☒ U.S. Provisional No. 61/368316 filed on July 28, 2010

☒ U.S. Application No. 13/192111 filed on July 27, 2011

☐ which is a 371 National Stage of _____ filed on _____

As the below named inventor(s), I/we have invented certain improvements in the patent application for which I/we have filed an application for Letters Patent of the United States of America as identified above;

WHEREAS, I/we authorize the attorney of record to update this document to include Patent Office information as deemed necessary (i.e., filing date, serial number, etc.);

WHEREAS, NOKIA CORPORATION, a corporation organized under the laws of Finland, having its principal office in Espoo, Finland (hereinafter referred to as "ASSIGNEE"), is desirous of acquiring the entire right, title and interest in and under the said invention and the said application, and in and to any and all Letters Patent which shall be granted therefore in the United States of America and in any and all foreign countries;

NOW, THEREFORE, for good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, I/we have sold and do hereby sell, assign, transfer and convey unto said ASSIGNEE, its successors, assigns and legal representatives, the entire right, title and interest in and to said invention and application, and in all divisionals, reissues, substitutions, continuations, continuation-in-part and, in any and all Letters Patents of the United States of America and all foreign countries or reissues, reexaminations, or extensions thereof which may be granted therefore or thereon, for the full end of the term for which said Letters Patent may be granted, together with the right to claim the priority of said application in all foreign countries in accordance with the International Convention, the same to be held and enjoyed by said ASSIGNEE, its successors and assigns, as fully and entirely as the same would have been held and enjoyed by me if this assignment and sale had not been made.

I/WE ALSO HEREBY authorize and request the Commissioner of Patents and Trademarks to issue all patents for said invention, or patents resulting therefrom to the said ASSIGNEE of my/our entire right, title and interest.

I/WE FURTHER HEREBY sell and assign to said ASSIGNEE, its successors, assigns and legal representatives the full and exclusive rights, title and interest to the invention disclosed in said application throughout the world, including, without limitation, the right to file applications and obtain patents, utility models, industrial models and designs for said invention in its own name throughout the world including all rights of priority, all rights to publish cautionary notices reserving ownership of said invention and all rights to register said invention in appropriate registries. I/we further agree to execute any and all powers of attorney, applications, assignments, declarations, affidavits, and any other papers in connection therewith necessary to perfect such rights, title and interest in ASSIGNEE, its successors, assigns and legal representatives.

I/WE HEREBY covenant that I/we have not and I/we will not execute any agreement in conflict herewith.

Docket No.: NC73661US-NP

ASSIGNMENT

I/WE HEREBY further covenant, and agree to bind my/our heirs, legal representatives, and assigns, promptly to communicate to said ASSIGNEE or its representatives any facts known to me relating to said invention, to testify in any interference or legal proceedings involving said invention, to execute any additional papers which may be requested to confirm the right of the assignee, its representatives, successors, or assigns to secure patent or similar protection for the said invention in all countries and to vest in the assignee complete title to the said invention and Letters Patent, without further compensation, but at the expense of said ASSIGNEE, its successors, assigns, and other legal representatives.

IN WITNESS WHEREOF, I/we have hereunto set my/our hand and seal on the date indicated below.

Inventor: Jani Lainema Date: Jan-25-2012

Signature: [signature] Residence: Tampere, Finland

Witness Signature: [signature]

Printed Name: OGUZ BICI Date: JAN-25-2012

Docket No.: NC73661US-NP

ASSIGNMENT

IN WITNESS WHEREOF, I/we have hereunto set my/our hand and seal on the date indicated below.

Inventor: Kemal Ugur Date: 25 Jan 2012

Signature:  Residence: Tampere, Finland

Witness Signature: 

Printed Name: OGUZ BICI Date: 25 Jan 2012

Docket No.: NC73661US-NP

ASSIGNMENT

IN WITNESS WHEREOF, I/we have hereunto set my/our hand and seal on the date indicated below.

Inventor: Antti Olli Hallapuro Date: Jan-25-2012

Signature: [signature] Residence: Tampere, Finland

Witness Signature: [signature]

Printed Name: OLLI BICI Date: Jan-25-2012

Electronic Patent Application Fee Transmittal

Application Number:	13192111
Filing Date:	27-Jul-2011
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING
First Named Inventor/Applicant Name:	Jani LAINEMA
Filer:	Thomas Joseph Arria
Attorney Docket Number:	NC73661US-NP

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Late filing fee for oath or declaration	1051	1	130	130
Petition:				
Petition-revive unintent. abandoned appl	1453	1	1860	1860
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1990**

Electronic Acknowledgement Receipt

EFS ID:	12378238
Application Number:	13192111
International Application Number:	
Confirmation Number:	5397
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING
First Named Inventor/Applicant Name:	Jani LAINEMA
Customer Number:	73658
Filer:	Thomas Joseph Arria
Filer Authorized By:	
Attorney Docket Number:	NC73661US-NP
Receipt Date:	23-MAR-2012
Filing Date:	27-JUL-2011
Time Stamp:	12:43:07
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1990
RAM confirmation Number	10721
Deposit Account	500270
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1		response.pdf	635135 68fdb5f8d6c9d354e8f154c55a0720e85a559fdd	yes	12

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Petition for review by the Office of Petitions.	1	2
Oath or Declaration filed	3	5
Power of Attorney	6	6
Assignee showing of ownership per 37 CFR 3.73(b).	7	12

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	32331 9645cdbacd65714c8bf7d61a2e702432a9bdc275	no	2

Warnings:

Information:

Total Files Size (in bytes):	667466

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	13192111
	Filing Date	2011-07-27
	First Named Inventor	Jani LAINEMA
	Art Unit	2819
	Examiner Name	TBD
	Attorney Docket Number	NC73661US-NP

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20090273491	A1	2009-11-05	SAKAGUCHI HIROAKI et al.	
	2	20080276078	A1	2008-11-06	HU YENDO	
	3	20110001643	A1	2011-01-06	SZE VIVIENNE et al.	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] ¡	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2008053755	WO	A2	2008-05-08	CANON KK et al.		☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13192111
	Filing Date	2011-07-27
	First Named Inventor	Jani LAINEMA
	Art Unit	2819
	Examiner Name	TBD
	Attorney Docket Number	NC73661US-NP

	2	2011075071	WO	A1	2011-06-23	ERICSSON TELEFON AB L M et al.		☐

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	International Search Report and Written Opinion, received in corresponding Patent Cooperation Treaty Application No. PCT/IB2011/053356, dated December 29, 2011, 13 pages.	☐
	2	UGUR, Kemal, "Description of Video Coding Technology Proposal by Tandberg, Nokia, Ericsson", JCT-VC meeting; April 15, 2010 - April 23, 2010, JCTVC-A119; whole document.	☐
	3	UGUR, Kemal, "High Performance Low Complexity Video Coding and the Emerging HEVC Standard", IEEE Transactions on Circuits and Systems for Video Technology, December 01, 2010, Vol. 20, nr. 12, pages 1688-1697, ISSN 1051-8215.	☐
	4	UGUR, Kemal, "Low Complexity Video Coding and the Emerging HEVC Standard", Picture Coding Symposium 2010, December 08, 2010 - December 12, 2010, Nagoya, 20101208.	☐
	5	LAM, Bonnie, "Parallel Architectures for Entropy Coding in a Dual-Standard Ultra-HD Video Encoder", Massachusetts Institute of Technology, Dept. of Electrical Engineering and Computer Science, May 21, 2010; pages 39-58; Chapter 3.	☐

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13192111
	Filing Date	2011-07-27
	First Named Inventor	Jani LAINEMA
	Art Unit	2819
	Examiner Name	TBD
	Attorney Docket Number	NC73661US-NP

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Thomas J. Arria/	Date (YYYY-MM-DD)	2012-03-30
Name/Print	Thomas J. Arria	Registration Number	60223

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Snap - Exhibit 1002
Snap v. Nokia - IPR2025-01345
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PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To:
Nokia Corporation
IPR Department, Ari Aarnio
Keilalahdentie 4
FI-02150 Espoo
Finland

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

	Date of mailing *(day/month/year)* 29-12-2011
Applicant's or agent's file reference NC73661WO	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/IB2011/053356	International filing date *(day/month/year)* 27-07-2011
Applicant Nokia Corporation et al	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statements under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 338 82 70

   For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 – 9.011.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with any request to forward the texts of both the protest and the decision thereon to the designated Offices.

   ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. Following the expiration of 30 months from the priority date, these comments will also be made available to the public.

   Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the technical preparations for international publication (Rules 90*bis*.1 and 90*bis*.3).

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

   In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

   For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the *PCT Applicant's Guide*, National Chapters.

Name and mailing address of the ISA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM	Authorized officer Riitta Vartiainen
Facsimile No. + 46 8 666 02 86	Telephone No. + 46 8 782 25 00

Form PCT/ISA/220 (July 2010)

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PATENT COOPERATION TREATY

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INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference NC73661WO	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/IB2011/053356	International filing date *(day/month/year)* 27-07-2011	(Earliest) Priority Date *(day/month/year)* 28-07-2010
Applicant Nokia Corporation et al		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 4 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of:
      ☒ the international application in the language in which it was filed.
      ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).
   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).
   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (See Box No. II).

3. ☐ **Unity of invention is lacking** (See Box No. III).

4. With regard to the **title**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,
   a. the figure of the **drawings** to be published with the abstract is Figure No. 5
      ☐ as suggested by the applicant.
      ☒ as selected by this Authority, because the applicant failed to suggest a figure.
      ☐ as selected by this Authority, because this figure better characterizes the invention.
   b. ☐ none of the figures is to be published with the abstract.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2011/053356

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: G06T, H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data, COMPENDEX, INSPEC, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 20090273491 A1 (SAKAGUCHI HIROAKI ET AL), 5 November 2009 (2009-11-05); paragraphs [0015]-[0022], [0096]-[0105]; claims 1-10 --	1-28
X	US 20080276078 A1 (HU YENDO), 6 November 2008 (2008-11-06); paragraphs [0009], [0029]-[0030], [0036]-[0038]; claims 1-7 --	1-28
X	Lam, Bonnie K. Y, "Parallel architectures for entropy coding in a dual-standard ultra-HD video encoder", Massachusetts Institute of Technology. Dept. of Electrical Engineering and Computer Science, 20100521; pages 39-58; Chapter 3 --	1-28

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22-12-2011	29-12-2011

Name and mailing address of the ISA/SE	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Henrik Andersson Telephone No. + 46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 2009)

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P, X	US 20110001643 A1 (SZE VIVIENNE ET AL), 6 January 2011 (2011-01-06); paragraphs [0076]-[0081]; claims --	1-28
A	WO 2008053755 A2 (CANON KK ET AL), 8 May 2008 (2008-05-08); whole document --	1-28
A	UGUR K et al. "Description of video coding technology proposal by Tandberg, Nokia, Ericsson", 1. JCT-VC meeting; 15-4-2010 - 23-4-2010; Dresden; (Joint Collaborative Team on Video Coding of ISO/IEC JTC1/SC29/WG11 and ITU-T SG.16); <URL: http://wftp3.itu.int/av-arch/jctvc-site/>, nr. JCTVC-A119, 2010-04-12; whole document --	1-28
P, A	UGUR K et al. "High Performance, Low Complexity Video Coding and the Emerging HEVC Standard", IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, 2010-12-01, Vol. 20, nr. 12, p. 1688-1697, ISSN 1051-8215; whole document --	1-28
P, A	Kemal Ugur; Kenneth Andersson; Arild Fuldseth; Gisle Bjontegaard; Lars Peter Enderssen; Jani Lainema; Antti Hallapuro; Dmytro Rusanovskyy; Cixun Zhang; Andrey Norkin; Clinton Priddle; Thomas Rusert; Jonatan Samuelsson; Rickard Sjoberg; Zhuangfei Wu; Justin Ridge, "Low Complexity Video Coding and the Emerging HEVC Standard", Picture Coding Symposium 2010; 8-12-2010 - 10-12-2010; Nagoya, 20101208,; whole document --	1-28
P, A	WO 2011075071 A1 (ERICSSON TELEFON AB L M ET AL), 23 June 2011 (2011-06-23); whole document -- --------	1-28

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Continuation of: second sheet
International Patent Classification (IPC)
H04N 7/26 (2006.01)

Download your patent documents at www.prv.se
The cited patent documents can be downloaded:

- From "Cited documents" found under our online services at www.prv.se (English version)
- From "Anförda dokument" found under "e-tjänster" at www.prv.se (Swedish version)

Use the application number as username. The password is **SVUFJIRHTD**.

Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

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US	20090273491 A1	05/11/2009	JP	2009268031 A	12/11/2009
			US	7884743 B2	08/02/2011
US	20080276078 A1	06/11/2008	NONE		
US	20110001643 A1	06/01/2011	WO	2011002914 A1	06/01/2011
WO	2008053755 A2	08/05/2008	JP	2008113374 A	15/05/2008
			US	7898445 B2	01/03/2011
			US	20100259427 A1	14/10/2010
WO	2011075071 A1	23/06/2011	WO	2011075072 A1	23/06/2011

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PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
Nokia Corporation
IPR Department, Ari Aarnio
Keilalahdentie 4
FI-02150 Espoo
Finland

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	29-12-2011
Applicant's or agent's file reference: NC73661WO	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/IB2011/053356	27-07-2011	28-07-2010

International Patent Classification (IPC) or both national classification and IPC
See Supplemental Box

Applicant
Nokia Corporation et al

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☒ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☒ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will no be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/SE	Date of completion of this opinion	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	22-12-2011	Henrik Andersson Telephone No. + 46 8 782 25 00

Form PCT/ISA/237 (cover sheet) (July 2009)

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of: cover sheet

International Patent Classification (IPC)

H04N 7/26 (2006.01)

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WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/IB2011/053356

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing filed or furnished:

   a. (means)

   ☐ on paper

   ☐ in electronic form

   b. (time)

   ☐ in the international application as filed

   ☐ together with the international application in electronic form

   ☐ subsequently to this Authority for the purposes of search

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

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WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/IB2011/053356

Box No. II Priority

1. ☒ The validity of the priority claim has not been considered because the International Searching Authority does not have in its possession a copy of the earlier application whose priority has been claimed or, where required, a translation of that earlier application. This opinion has nevertheless been established on the assumption that the relevant data (Rules 43*bis*.1 and 64.1) is the claimed priority date.

2. ☐ This opinion has been established as if no priority had been claimed due to the fact that the priority claim has been found invalid (Rules 43*bis*.1 and 64.1). Thus for the purposes of this opinion, the international filing date indicated above is considered to be the relevant date.

3. Additional observations, if necessary:

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WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
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Box No. V **Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	2-7,9-14,16-21,23-28	YES
	Claims	1,8,15,22	NO
Inventive step (IS)	Claims		YES
	Claims	1-28	NO
Industrial applicability (IA)	Claims	1-28	YES
	Claims		NO

2. Citations and explanations

The object of the invention according to the applicant is to present a more efficient video coding and decoding process in HVEC ("High Efficiency Video Coding"). This problem appears to be solved by categorizing syntax elements of video content, based on a frequency of occurrence of syntax elements in the video content, in at least two categories of symbols and performing entropy coding of symbols corresponding to the first category responsive to context updating and bypassing context updating prior to entropy coding of symbols corresponding to the second category.

Documents cited in the International Search Report:

D1: US20090273491 A1
D2: US20080276078 A1
D3: Lam, Bonnie K. Y, "Parallel architectures for entropy coding in a dual-standard ultra-HD video encoder", Massachusetts Institute of Technology. Dept. of Electrical Engineering and Computer Science, 20100521
D4: WO2008053755 A2
D5: UGUR K et al. "Description of video coding technology proposal by Tandberg, Nokia, Ericsson", 1. JCT-VC meeting; 15-4-2010 - 23-4-2010; Dresden; (Joint Collaborative Team on Video Coding of ISO/IEC JTC1/SC29/WG11 and ITU-T SG.16); <URL: http://wftp3.itu.int/av-arch/jctvc-site/>, nr. JCTVC-A119, 2010-04-12

D1-D3 is considered to be the most relevant documents.

D1 discloses a context-adaptive binary arithmetic coding (CABAC) system and an entropy coding system that are classifying syntax elements and placing them in different groups depending on the syntax elements frequency of occurrence and update or change the context in accordance with thatt occurrence and group and coding and decoding these elements in dependence of which group they belong (see [0015]-[0022], [0096]-[0105] and the claims).

D2 discloses a method that classifies the syntax element as high use or low use and sends the syntax element from the digital signal processing engine to a logic unit, distinct from the digital processing engine, for binarization if the syntax element is high use, generating a context address for the syntax element at the logic unit if the syntax

.../...

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Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of: Box No. V

element is high use, and arithmetically coding, at the logic unit, the plurality of binarizations based on the context address, which is updated continiously in the process (see claims 1-7, [0009], [0029]-[0030] and [0036]-[0038]).

D3 discloses a method where an entropy coder process data generated from a quad full-HD video at a frame rate of 30 frames per second and performs lossless compression to generate an output bitstream. This is integrated into a dual-standard video encoder chip. Parallelisms, as well as other techniques applied at the syntax element or bit level, are used to achieve the overall throughput requirements where syntax elements can be categorized in at least two categories based on probability of occurrence, and where the context is updated according to these requirements, and coded or decoded based on these classifications (see Chapter 3, page 39-58).

D4-D5 is considered to represent the general state of the art.

Claims 1, 8, 15 and 22:
Since all the technical features of claim 1 are considered to be disclosed in D1, D2 or D3, the requirements with respect to novelty are not met for the subject-matter claimed in claims 1, 8, 15 and 22. The technical features described in these claims are the same as those described in D1, D2 or D3. This is due to the vague description of the method in these claims and in the detailed description of the invention.

Therefore, the invention claimed in claims 1, 8, 15 and 22 lacks novelty.

Claims 2-7, 9-14, 16-21 and 23-28:
The invention as defined in these claims differs from D1, D2 or D3 in obvious details concerning categorization of syntax elements and entropy coding according to claims 1, 8, 15 and 22.

More specifically, the additional features described in these claims, different signaling categories or binarization methods or predefined thresholds, are either known from prior art documents or generally known in the technical field of coding and decoding video content. The inclusion of such features is regarded as part of the customary praxis the skilled person would consider in accordance with circumstances.

In D1-D5 equivalent techniques are also described and used.

From what is described in these claims, it is considered obvious to a person skilled in the art, with knowledge of D1, D2 or D3, to accomplish what is described in these claims, if confronted with these problems. Hence, the invention claimed in claims 2-7, 9-14, 16-21 and 23-28 is not considered to involve an inventive step.

According to the arguments stated above, the invention claimed in claims 1-28 is considered to be industrially applicable but claims 1, 8, 15 and 22 lack novelty and claims 2-7, 9-14, 16-21 and 23-28 are not considered to involve an inventive step.

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Box No. VI Certain documents cited

1. Certain published documents (Rules 43*bis*.1 and 70.10)

Application No. Patent No.	Publication date *(day/month/year)*	Filing date *(day/month/year)*	Priority date (valid claim) *(day/month/year)*
(P) US20110001643 A1	06/01/2011	30/06/2010	
(P) WO2011075071 A1	23/06/2011	17/12/2010	17/12/2009

(P) UGUR K et al. "High Performance, Low Complexity Video Coding and the Emerging HEVC Standard", IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, 2010-12-01, Vol. 20, nr. 12, p. 1688-1697, ISSN 1051-8215

(P) Kemal Ugur; Kenneth Andersson; Arild Fuldseth; Gisle Bjontegaard; Lars Peter Enderssen; Jani Lainema; Antti Hallapuro; Dmytro Rusanovskyy; Cixun Zhang; Andrey Norkin; Clinton Priddle; Thomas Rusert; Jonatan Samuelsson; Rickard Sjoberg; Zhuangfei Wu; Justin Ridge, "Low Complexity Video Coding and the Emerging HEVC Standard", Picture Coding Symposium 2010; 8-12-2010 - 10-12-2010; Nagoya, 20101208,

2. Non-written disclosures (Rules 43*bis*.1 and 70.9)

Kind of non-written disclosure	Date of non-written disclosure *(day/month/year)*	Date of written disclosure referring to non-written disclosure *(day/month/year)*

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(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
8 May 2008 (08.05.2008)

PCT

(10) International Publication Number
WO 2008/053755 A2

(51) International Patent Classification: Not classified

(21) International Application Number:
PCT/JP2007/070680

(22) International Filing Date: 17 October 2007 (17.10.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2006-296500 31 October 2006 (31.10.2006) JP

(71) Applicant *(for all designated States except US)*: **CANON KABUSHIKI KAISHA** [JP/JP]; 30-2, Shimomaruko 3-chome, Ohta-ku, Tokyo, 1468501 (JP).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **OTSUKA, Katsumi** [JP/JP]; c/o CANON KABUSHIKI KAISHA, 30-2, Shimomaruko 3-chome, Ohta-ku, Tokyo, 1468501 (JP).

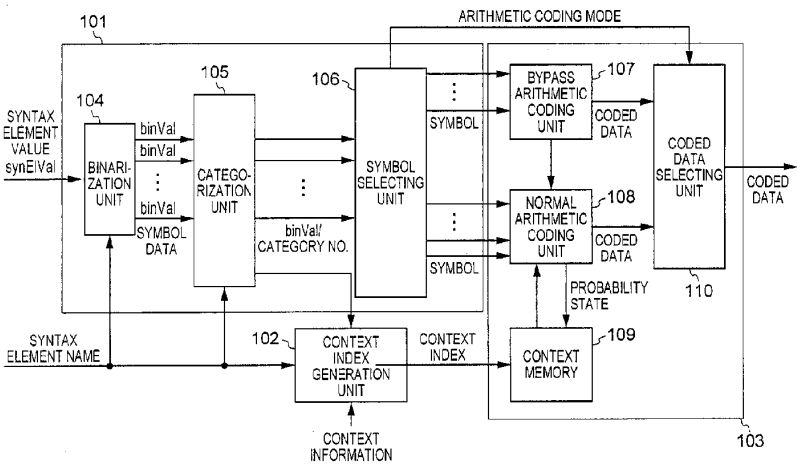
(74) Agent: **OHTSUKA, Yasunori**; 7th FL., KIOICHO PARK BLDG., 3-6, KIOICHO, CHIYODA-KU, Tokyo, 1020094 (JP).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

(54) Title: ENTROPY CODING APPARATUS



(57) Abstract: An entropy coding apparatus configured to categorize each binarized symbol according to a corresponding bit position and a target arithmetic coding mode, and configured to parallelly perform arithmetic coding of a plurality of symbols belonging to an identical category is provided.

WO 2008/053755 A2

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DESCRIPTION

ENTROPY CODING APPARATUS

TECHNICAL FIELD

[0001] The present invention relates to entropy coding techniques. More particularly, the present invention relates to an entropy coding technique that employs arithmetic coding processing as entropy coding processing.

BACKGROUND ART

[0002] Recently, the JVT (Joint Video Team) has standardized the H.264 (ITU-T (International Telecommunication Union-Telecommunication Standardization Sector) Recommendation H.264|ISO (International Organization for Standardization)/IEC (International Electrotechnical Commission) 14496-10 AVC (Advanced Video Coding)) coding method as a highly efficient video coding method. In H.264, image data is handled as digital data as in the case of JPEG (Joint Photographic Experts Group), which is known as a still image coding method, and of MPEG(Moving Picture Experts Group)-2 or MPEG-4 (version 2) which are known as video coding methods.

[0003] Furthermore, particularly in the video coding method, image data is compressed using hybrid coding to reduce redundant information between frames

(i.e., in the temporal direction) and redundant information of pixels within a frame (i.e., in the spatial direction) for the purpose of highly efficient information transmission and storage. In the hybrid coding, a technique, referred to as entropy coding, for performing variable-length coding using information deviation is employed together with orthogonal transformation, such as discrete cosine transform, and motion compensation.

[0004] Regarding the entropy coding employed in H.264, CAVLC (Context-Based Adaptive Variable Length Coding) that employs Huffman coding and CABAC (Context-Based Adaptive Binary Arithmetic Coding) that employs arithmetic coding are defined according to profile types. More specifically, CAVLC is selected in a baseline profile constituted by less complex coding tools for communication applications. On the other hand, CABAC is selected in main and extended profiles that focus on coding efficiency.

[0005] Japanese Patent Laid-Open Nos. 11-103257 and 2005-130099 disclose techniques for realizing CABAC by hardware. In these techniques, generation of addresses to be supplied to a context memory that holds status data and an arithmetic coding operation are performed as pipeline processing, whereby arithmetic coding of symbol data is performed during each clock

cycle without delay.

[0006] With the recent rapid increase in resolution, which is represented by high-definition images, high-speed coding apparatuses are desired. In the hybrid coding represented by H. 264, an increase in the processing speed of, particularly, an entropy coding apparatus is one factor that dictates the processing speed of the entire coding apparatus.

[0007] However, a circuit for performing arithmetic coding that is implemented using the techniques disclosed in the above-described Japanese Patent Laid-Open Nos. 11-103257 and 2005-130099 realizes arithmetic coding of only one symbol during one cycle at the maximum. Thus, it is difficult to realize high-speed arithmetic coding processing.

DISCLOSURE OF INVENTION

[0008] In view of the above-described problem, the present invention provides an entropy coding apparatus that realizes parallel arithmetic coding of a plurality of symbols during one cycle.

[0009] According to an aspect of the present invention, an entropy coding apparatus is provided that includes a binarization unit configured to binarize a value of an input syntax element to generate a symbol data string including at least one symbol, a

categorization unit configured to categorize, according to a bit position corresponding to each of the at least one symbol and a target arithmetic coding mode, each of the at least one symbol generated by the binarization unit, a symbol selecting unit configured to select at least one symbol belonging to an identical category among the symbols input from the categorization unit and output the at least one selected symbol and configured to specify an arithmetic coding mode to be applied to the selected symbol, and an arithmetic coding section configured to parallelly perform arithmetic coding of the at least one symbol, selected by the symbol selecting unit and belonging to the identical category, using the arithmetic coding mode specified by the symbol selecting unit.

[0010] The present invention allows arithmetic coding of a plurality of symbols to be performed parallelly during one cycle by categorizing each of binarized symbols according to a corresponding bit position and a target arithmetic coding mode and by parallelly performing arithmetic coding of a plurality of symbols belonging to an identical category. This permits high-speed arithmetic coding processing to be performed when compared to the processing speed of entropy coding apparatuses in the related art.

[0011] Further features of the present invention

will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0012] Fig. 1 is a block diagram of an entropy coding apparatus according to a first exemplary embodiment of the present invention.

[0013] Fig. 2 is a flowchart of a function EncodeDecision() in CABAC processing according to an exemplary embodiment of the present invention.

[0014] Fig. 3 is a flowchart of a function RemormE() in CABAC processing according to an exemplary embodiment of the present invention.

[0015] Fig. 4 is a flowchart of a function PutBit() in CABAC processing according to an exemplary embodiment of the present invention.

[0016] Fig. 5 is a flowchart of a function EncodeBypass() in CABAC processing according to an exemplary embodiment of the present invention.

[0017] Fig. 6 is a block diagram illustrating an internal configuration of a binarization unit according to an exemplary embodiment of the present invention.

[0018] Fig. 7 is a schematic diagram showing a categorization method employed in a categorization unit according to an exemplary embodiment of the present

invention.

[0019] Fig. 8 is a block diagram showing an internal configuration of a normal arithmetic coding unit according to an exemplary embodiment of the present invention.

[0020] Fig. 9 is a block diagram showing an internal configuration of a bypass arithmetic coding unit according to an exemplary embodiment of the present invention.

[0021] Fig. 10 is a schematic diagram showing a decoding method performed by a decoding unit according to an exemplary embodiment of the present invention.

[0022] Fig. 11 is a timing chart of operations performed by an entropy coding apparatus according to a first exemplary embodiment of the present invention.

[0023] Fig. 12 is a timing chart of operations performed by an entropy coding apparatus according to the related art.

[0024] Fig. 13 is a diagram showing distribution of transform coefficient values in a 4×4 block that are input to an entropy coding apparatus according to a first exemplary embodiment of the present invention.

[0025] Fig. 14 is a schematic diagram illustrating an operation performed by a concatenated unary/k-th order exponential Golomb binarization unit according to an exemplary embodiment of the present invention.

[0026] Fig. 15 is a timing chart of operations performed by an entropy coding apparatus according to a second exemplary embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0027] Exemplary embodiments of the present invention will now be described in detail in accordance with the accompanying drawings.

First Exemplary Embodiment

[0028] Fig. 1 is a block diagram of an entropy coding apparatus according to a first exemplary embodiment of the present invention that employs CABAC (Context-Based Adaptive Binary Arithmetic Coding), which is one of entropy coding methods of H.264 coding method.

[0029] Two arithmetic coding modes are defined for CABAC in the recommendation of H.264 (ITU-T (International Telecommunication Union-Telecommunication Standardization Sector) Recommendation H.264|ISO (International Organization for Standardization)/IEC (International Electrotechnical Commission) 14496-10 AVC (Advanced Video Coding)).

[0030] One is an arithmetic coding mode for arithmetic coding processing defined as a function

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EncodeDecision() shown in Figs. 2 to 4 that employs status variables of an arithmetic coding engine and context variables uniquely selected in accordance with a context index. The other is an arithmetic coding mode for bypass coding processing defined as a function EncodeBypass() shown in Fig. 5 that employs the status variables of the arithmetic coding engine.

[0031] In this exemplary embodiment, for ease of explanation, the arithmetic coding processing corresponding to the function EncodeDecision() is referred as normal arithmetic coding, whereas the bypass coding processing corresponding to the function EncodeBypass() is referred as bypass arithmetic coding.

[0032] An exemplary configuration of an entropy coding apparatus shown in Fig. 1 will be described next. Values of all syntax elements (hereinafter, referred to as "SE") that are specified to be coded using CABAC in the H.264 recommendation are input to the entropy coding apparatus as data. The input syntax element (SE) value synElVal is supplied to a binarization unit 104 of a binarization section 101. The binarization unit 104 binarizes the supplied syntax element (SE) value synElVal to generate a symbol data string including at least one symbol (also referred to as "symbol data").

[0033] Fig. 6 is a block diagram showing an

exemplary internal configuration of the binarization unit 104. As shown in Fig. 6, the binarization unit 104 includes seven parallel-arranged binarization units 601 to 607 that are defined in the H.264 recommendation. A selector 608 selects one of outputs from the seven binarization units according to the type of the SE, and outputs binary data bit values binVal (hereinafter, each referred to as "symbol" or "symbol data"), namely, a binarization result, and the number of effective symbols.

[0034] Referring back to Fig. 1, a categorization unit 105 categorizes each symbol, which is generated by the binarization unit 104 and input thereto in parallel, according to the type of the SE, a bit position binIdx of the symbol (hereinafter, also referred to as a symbol data position representing value binIdx), a context index ctxIdx, and the arithmetic coding mode. The categorization unit 105 categorizes symbols having an identical context index ctxIdx and an identical assigned arithmetic coding mode, which are used by an arithmetic coding section 103, into an identical category. The categorization unit 105 determines the context index ctxIdx and the arithmetic coding mode on the basis of the type of the SE of each symbol and the bit position binIdx of the symbol using a method described later, and outputs a category number

corresponding to each symbol.

[0035] Fig. 7 is a schematic diagram showing a categorization method employed in the categorization unit 105 in a case where the type of a syntax element (SE) is coeff_abs_level_minus1. Referring to Fig. 7, the symbol data position representing value binIdx varies from 0 to a value obtained by subtracting 1 from the number of effective symbols supplied from the selector 608 of the binarization unit 104. The context index ctxIdx corresponding to each symbol can be determined using the following equations.

[0036] [In the case of the symbol data position representing value is equal to 0 (binIdx==0)]

ctxIdxInc = ((numDecodAbsLevelGt1!=0)?:0:Min(4,1+numDecodAbsLevelEq1)) - (Equation 1)

[In the case of the symbol data position representing value is not equal to 0 (binIdx!=0)]

ctxIdxInc = 5+Min(4,numDecodAbsLevelGt1) - (Equation 2)

[0037] Here, a value numDecodAbsLevelGt1 represents a cumulative number of transform coefficients, in the transform coefficient block currently undergoing the coding processing, having a level whose absolute value is greater than 1. A value numDecdAbsLevelEq1 represents a cumulative number of

transform coefficients having a level whose absolute value is equal to 1.

[0038] A value obtained by further adding 227 to the value ctxIdxInc resulting from Equations 1 and 2 corresponds to the context index ctxIdx, according to which as well as Equations 1 and 2, it is obvious that values of context index ctxIdx differ from one another.

[0039] Accordingly, categories differ between a symbol having the symbol data position representing value binIdx equal to 0 and other symbols. Now, suppose that a category number 0 is assigned to a symbol having the symbol data position representing value binIdx equal to 0.

[0040] The arithmetic coding modes corresponding to symbols will be discussed next. In cases where the symbol data position representing value binIdx is not greater than 14, which are indicated by a thick frame in Fig. 7, the normal arithmetic coding mode is selected. On the other hand, in cases where the symbol data position representing value binIdx is not less than 15, the bypass arithmetic coding mode is selected. Accordingly, the categorization unit 105 categorizes symbols having the symbol data position representing value binIdx that is between 1 and 14 into an identical category, and assigns a category number of 1 to the category. The categorization unit 105 also categorizes

all symbols having the symbol data position representing value binIdx that is not less than 15 into another identical category, and assigns a category number of 2 to the category.

[0041] As described above, the categorization unit 105 assigns the category number to all of the symbols, and outputs the category number and the symbol data to a symbol selecting unit 106 shown in Fig. 1. The categorization unit 105 also supplies the result of categorization to a context index generation unit 102.

[0042] The symbol selecting unit 106 will be described next. The symbol selecting unit 106 parallelly supplies the arithmetic coding section 103 a plurality of symbols belonging to the identical category on the basis of the input symbols and the category number of the category including the symbols. The symbol selecting unit 106 also supplies the arithmetic coding section 103 an arithmetic coding mode corresponding to each symbol. More specifically, the symbol selecting unit 106 outputs at least one symbol belonging to the identical category selected from the symbols supplied thereto from the categorization unit 105, and also specifies the arithmetic coding mode to be applied to the symbol. However, the maximum number of symbols to be output at the same time depends on the number of symbols processable by a normal arithmetic

coding unit 108 and a bypass arithmetic coding unit 107 of the arithmetic coding section 103 in parallel. The number of symbols processable in parallel is uniquely decided at the time of implementation. In this exemplary embodiment, it is assumed that the normal arithmetic coding unit (corresponding to a first arithmetic coding unit) 108 and the bypass arithmetic coding unit (corresponding to a second arithmetic coding unit) 107 can perform arithmetic coding of a maximum of two symbols and of a maximum of four symbols at the same time, respectively.

[0043] The arithmetic coding section (corresponding to an arithmetic coding unit) 103 parallelly performs arithmetic coding of symbols, selected by the symbol selecting unit 106 and belonging to the identical category, using the arithmetic coding mode specified by the symbol selecting unit 106. In addition, the arithmetic coding section 103 performs CABAC as the arithmetic coding.

[0044] The normal arithmetic coding unit 108 and the bypass arithmetic coding unit 107 included in the arithmetic coding section 103 will be described next.

[0045] Firstly, the normal arithmetic coding unit 108 will be described. Fig. 8 is a block diagram showing an exemplary internal configuration of the normal arithmetic coding unit 108. Symbol data 1 and

symbol data 2 are parallelly supplied to a first normal arithmetic coding unit 802 and a second normal arithmetic coding unit 803 from the symbol selecting unit 106, respectively. A context memory 109 holds most probable symbol values MPS and probability status variables (pStateIdx) for a context model, which are context variables corresponding to all of the context indices. The normal arithmetic coding unit 108 performs arithmetic coding processing using the context model representing the probability state.

[0046] The context variables, specified and output using a context index as an address, are input to the first normal arithmetic coding unit 802. Furthermore, coding engine status variables codlLow and codlRange stored in a coding engine status variable storage unit 807 are also input to the first normal arithmetic coding unit 802.

[0047] The first normal arithmetic coding unit 802 performs processing shown in Figs. 2 to 4 on the input symbol data 1 using the context variables and the coding engine status variables. The first normal arithmetic coding unit 802 then outputs the newly updated coding engine status variables codlLow' and codlRange' as well as the context variables MPS' and pStateIdx' to the second normal arithmetic coding unit 803. The first normal arithmetic coding unit 802 also

outputs the coded data, i.e., the result of the arithmetic coding, at the same time.

[0048] On the other hand, the second normal arithmetic coding unit 803 performs processing shown in Figs. 2 to 4 on the input symbol data 2 as in the case of the first normal arithmetic coding unit 802. The second normal arithmetic coding unit 803 then outputs the updated coding engine status variables codlLow'' and codlRange'' as well as the context variables MPS'' and pStateIdx''.

[0049] Selectors 804 and 805 select either the coding engine status variables and the context variables output from the first normal arithmetic coding unit 802 or the coding engine status variables and the context variables output from the second normal arithmetic coding unit 803. More specifically, a symbol 2 valid flag indicates whether or not the symbol data 2 is valid. When the symbol 2 valid flag indicates that the symbol data 2 is valid, the outputs from the second normal arithmetic coding unit 803 are selected. On the other hand, when the symbol 2 valid flag indicates that the symbol data 2 is invalid, the outputs from the first normal arithmetic coding unit 802 are selected.

[0050] The selected context variables are then written back in the context memory 109, whereas the

selected coding engine status variables are written back in the coding engine status variable storage unit 807. The coded data output from each of the first normal arithmetic coding unit 802 and the second normal arithmetic coding unit 803 is input to a concatenator 806. When the symbol 2 valid flag indicates that the symbol data 2 is valid, the concatenator 806 concatenates two pieces of coded data, and outputs the concatenated coded data. On the other hand, when the symbol 2 valid flag indicates that the symbol data 2 is invalid, the concatenator 806 outputs only the coded data from the first normal arithmetic coding unit 802.

[0051] The bypass arithmetic coding unit 107 will be described next. Fig. 9 is a block diagram showing an exemplary internal configuration of the bypass arithmetic coding unit 107. The bypass arithmetic coding unit 107 includes four bypass arithmetic coding units, namely, first to fourth bypass arithmetic coding units 902 to 905. Each of the first to fourth bypass arithmetic coding units 902 to 905 is parallelly supplied with a symbol, and performs bypass coding processing shown in Fig. 5. The bypass arithmetic coding unit 107 performs arithmetic coding processing without using the context model representing the probability state. As shown in Fig. 9, in the bypass coding processing, the coding engine status variables

are input and newly updated coding engine status variables and coded data are output.

[0052] The bypass arithmetic coding unit 107 further includes a decoding unit 901, a selector 906, and a concatenator 907.

[0053] The decoding unit 901 is supplied with a symbol 2 valid flag, a symbol 3 valid flag, and a symbol 4 valid flag for indicating whether or not symbol data 2, 3, and 4 are valid, respectively. The decoding unit 901 performs decoding processing shown in Fig. 10, and outputs the decoding result to the concatenator 907 and the selector 906. Items In0, In1, and In2 shown in Fig. 10 indicate the symbol 2 valid flag, the symbol 3 valid flag, and the symbol 4 valid flag, respectively.

[0054] The updated coding engine status variables codlLow''''' and codlRange''''', namely, outputs of the selector 906, are input to a selector 808 included in the normal arithmetic coding unit 108 shown in Fig. 8. The selector 808 selects the input updated coding engine status variables according to the current arithmetic coding mode. The selected coding engine status variables are written back in the coding engine status variable storage unit 807.

[0055] A coded data selecting unit 110 shown in Fig. 1 selects one of the coded data supplied from the

normal arithmetic coding unit 108 and the coded data supplied from the bypass arithmetic coding unit 107 according to the arithmetic coding mode, and outputs the selected coded data as the output coded data of the entropy coding apparatus.

[0056] The context index generation unit 102 shown in Fig. 1 generates a context index, namely, an address to be supplied to the context memory 109, corresponding to a symbol output from the symbol selecting unit 106 according to the type of the syntax element and the result of the categorization performed by the categorization unit 105. Context index generating methods employed in the context index generation unit 102 are disclosed in detail according to the types of the syntax element (SE) in the H.264 recommendation, thus the description thereof is omitted herein.

[0057] A flow of operations performed by the entropy coding apparatus shown in Fig. 1 will be described next. Fig. 11 shows a timing chart of operations performed by the entropy coding apparatus according to the first exemplary embodiment of the present invention, whereas Fig. 12 shows a timing chart of operations performed by an entropy coding apparatus according to the related art, for plainly illustrating advantages provided by the exemplary embodiment of the present invention.

[0058] In addition, Fig. 13 shows a distribution of transform coefficient values in a 4×4 block that are input to the entropy coding apparatus according to the first exemplary embodiment of the present invention. Values obtained by subtracting 1 from absolute values of the transform coefficients in the 4×4 block shown in Fig. 13 are input to the entropy coding apparatus as a syntax element (SE) coef_abs_level_minus1 in an order of inverse zigzag scan. The concatenated unary/K-th order exponential Golomb binarization unit 603 included in the binarization unit 104 performs binarization processing shown in Fig. 14 on this syntax element coef_abs_level_minus1. Since the syntax element coef_abs_level_minus1 for "-2", which is a first significant coefficient in the inverse zigzag scan order, is equal to 1, a symbol data string "01" including two symbols is generated. This operation is performed during a cycle 1 in both Figs. 11 and 12.

[0059] Furthermore, the fixed length binarization unit 604 of the binarization unit 104 performs binarization processing on a sign of the transform coefficient value. However, since the length of an SE value synElVal for the sign is one bit and the length of a symbol data string generated by the binarization processing is also one bit, the binarization of the sign can be realized by simply outputting the most

significant bit of the input SE value synElVal.

[0060] The context index generation unit 102 generates a context index corresponding to a leading symbol (binIdx0). In this case, since the value ctxIdxInc is determined to be equal to 0 (ctxIdxInc = 0) on the basis of the equations and the offset of the syntax element coef_abs_level_minus1 is equal to 227 (ctxIdxOffset = 227) according to the H.264 recommendation, the generated context index is equal to 227 (ctxIdx = 227).

[0061] Subsequently, during cycles 3 and 4 shown in Fig. 11, the symbol selecting unit 106 sequentially outputs symbols to the normal arithmetic coding unit 108 and the bypass arithmetic coding unit 107 according to the result of categorization performed by the categorization unit 105 using the method shown in Fig. 7. By this operation, entropy coding of the first transform coefficient value "-2" is realized.

[0062] Subsequently, during a cycle 5, binarization processing is performed on a syntax element coef_abs_level_minus1 corresponding to the next transform coefficient value "18". In this case, the number of symbols generated in the binarization unit 104 is 19. When the symbol for the sign is included, the number of symbols generated in the binarization unit 104 is a total of 20 symbols.

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[0063] During cycles 5 to 12, as described above, the symbol selecting unit 106 selects symbols categorized by the categorization unit 105, and outputs the selected symbols to the normal arithmetic coding unit 108 and the bypass arithmetic coding unit 107. However, this operation differs from the above-described one in two respects described below.

[0064] A first respect is a method for outputting symbols belonging to the category 1 to the normal arithmetic coding unit 108. In this operation, the symbol selecting unit 106 parallelly selects two symbols. However, since the 16th symbol (binIdx15) is the last symbol belonging to the category 1, only one symbol is selected.

[0065] A second respect is that symbols for the syntax element coef_abs_level_minus1 and a symbol for the sign (i.e., sign shown in Fig. 11) are categorized into an identical category of the category 2. Since the bypass arithmetic coding unit 107 is used for the arithmetic coding of the symbol for the sign, the symbols for syntax element coef_abs_level_minus1 and the symbol for the sign can be categorized into the identical category. Accordingly, the categorization unit 105 categorizes the syntax element coef_abs_level_minus1 and the sign into the identical category. By repeatedly performing the above-described

processing for all of the syntax elements, high-speed entropy coding can be realized.

Second Exemplary Embodiment

[0066] In a second exemplary embodiment of the present invention, it is assumed that a normal arithmetic coding unit (corresponding to a first arithmetic coding unit) 108 is capable of performing arithmetic coding of a maximum of one symbol at the same time, whereas a bypass arithmetic coding unit (corresponding to a second arithmetic coding unit) 107 is capable of performing arithmetic coding of a maximum of four symbols at the same time. In the second exemplary embodiment, a configuration of an entropy coding apparatus can be realized as illustrated by the block diagram shown in Fig. 1.

[0067] Fig. 15 shows a timing chart of operations performed by an entropy coding apparatus according to the second exemplary embodiment of the present invention. A method for selecting symbols belonging to a category 1 employed in the second exemplary embodiment differs from that employed in the first exemplary embodiment.

[0068] More specifically, in the second exemplary embodiment, a symbol selecting unit 106 sequentially selects only one symbol belonging to the category 1 per

cycle, and outputs the selected symbol to the normal arithmetic coding unit 108. Other operations are similar to those of the first exemplary embodiment. The use of the second exemplary embodiment of the present invention allows the number of symbols parallelly processed by the normal arithmetic coding unit 108 or the bypass arithmetic coding unit 107 to be selected according to a semiconductor process and a operation clock frequency of an LSI (large-scale integrated circuit) implementing the entropy coding apparatus.

Third Exemplary Embodiment

[0069] Functions of entropy coding apparatuses according to the above-described first and second exemplary embodiments of the present invention can also be realized by supplying a storage medium that stores a software program for realizing the functions to a system or an apparatus, and by a computer (or a CPU (central processing unit) and an MPU (microprocessing unit)) of the system or the apparatus reading out and executing the software program stored on the storage medium. In such a case, the program read out from the storage medium realizes the functions of the entropy coding apparatuses according to the above-described exemplary embodiments. The program and a computer-

readable storage medium storing the program are also included in the scope of the present invention.

[0070] For example, a flexible disk, a hard disk, an optical disk such as a CD-ROM (Compact Disk-Read Only Memory), a CD-R(Recordable), or a DVD (Digital Versatile Disk), a magneto-optical disk, a magnetic tape, non-volatile memory card, and a ROM can be used as the storage medium used for supplying the program. In addition to realization of the functions of the entropy coding apparatuses according to the above-described exemplary embodiments by executing the program read out by the computer, an operating system (OS) or the like working on the computer may perform some or all of the actual processing operations on the basis of instructions of the program, and the functions of the entropy coding apparatuses according to the above-described exemplary embodiments may be realized by the processing operations. Such a case is also included in the scope of the present invention.

[0071] Moreover, the program read out from the storage medium may be written in a memory included in a function expansion board inserted into the computer or a memory included in a function expansion unit connected to the computer. Then, on the basis of instructions of the program, a CPU or the like included in the function expansion board or the function

expansion unit executes some or all of the processing operations, and the functions of the entropy coding apparatuses according to the above-described exemplary embodiments may be realized by the processing operations. Such a case is also included in the scope of the present invention.

[0072] While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all modifications, equivalent structures and functions.

[0073] This application claims the benefit of Japanese Patent Application No. 2006-296500, filed on October 31, 2006, which is hereby incorporated by reference herein its entirety.

CLAIMS

1. An entropy coding apparatus comprising:

a binarization unit configured to binarize a value of an input syntax element to generate a symbol data string including at least one symbol;

a categorization unit configured to categorize, according to a bit position corresponding to each of the at least one symbol and a target arithmetic coding mode, each of the at least one symbol generated by the binarization unit;

a symbol selecting unit configured to select at least one symbol belonging to an identical category among the symbols input from the categorization unit and output the at least one selected symbol and configured to specify an arithmetic coding mode to be applied to the selected symbol; and

an arithmetic coding section configured to parallelly perform arithmetic coding of the at least one symbol, wherein the at least one symbol is selected by the symbol selecting unit and belongs to the identical category, and wherein the arithmetic coding uses the arithmetic coding mode specified by the symbol selecting unit.

2. The entropy coding apparatus according to Claim 1, further comprising:

a context index generation unit, wherein

the arithmetic coding section includes a context memory configured to hold a plurality of values representing probability states of a context model, and wherein

the context index generation unit generates, according to a type of the input syntax element and the result of the categorization performed by the categorization unit, a context index corresponding to each symbol output from the symbol selecting unit, and wherein

the context index is address information to be supplied to the context memory.

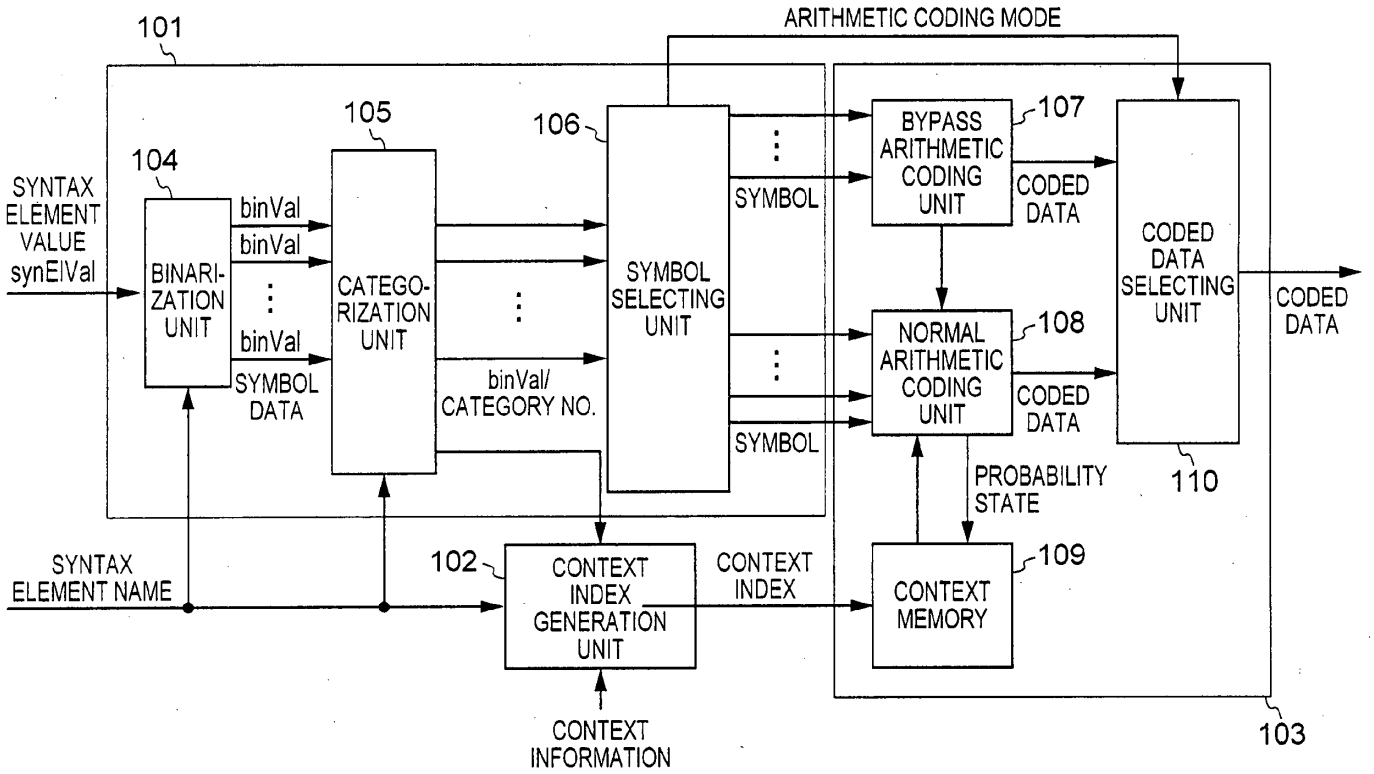
3. The entropy coding apparatus according to Claim 1, wherein the arithmetic coding section includes a first arithmetic coding unit configured to perform arithmetic coding processing using a context model representing probability states and a second arithmetic coding unit configured to perform arithmetic coding processing without using the context model.

4. The entropy coding apparatus according to Claim 3, wherein each of the first arithmetic coding unit and the second arithmetic coding unit parallelly performs arithmetic coding of a plurality of symbols.

5. The entropy coding apparatus according to Claim 3, wherein only the second arithmetic coding unit parallelly performs arithmetic coding of a plurality of symbols.

6. The entropy coding apparatus according to Claim 1, wherein the arithmetic coding section performs context-based adaptive binary arithmetic coding (CABAC).

FIG. 1



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FIG. 2

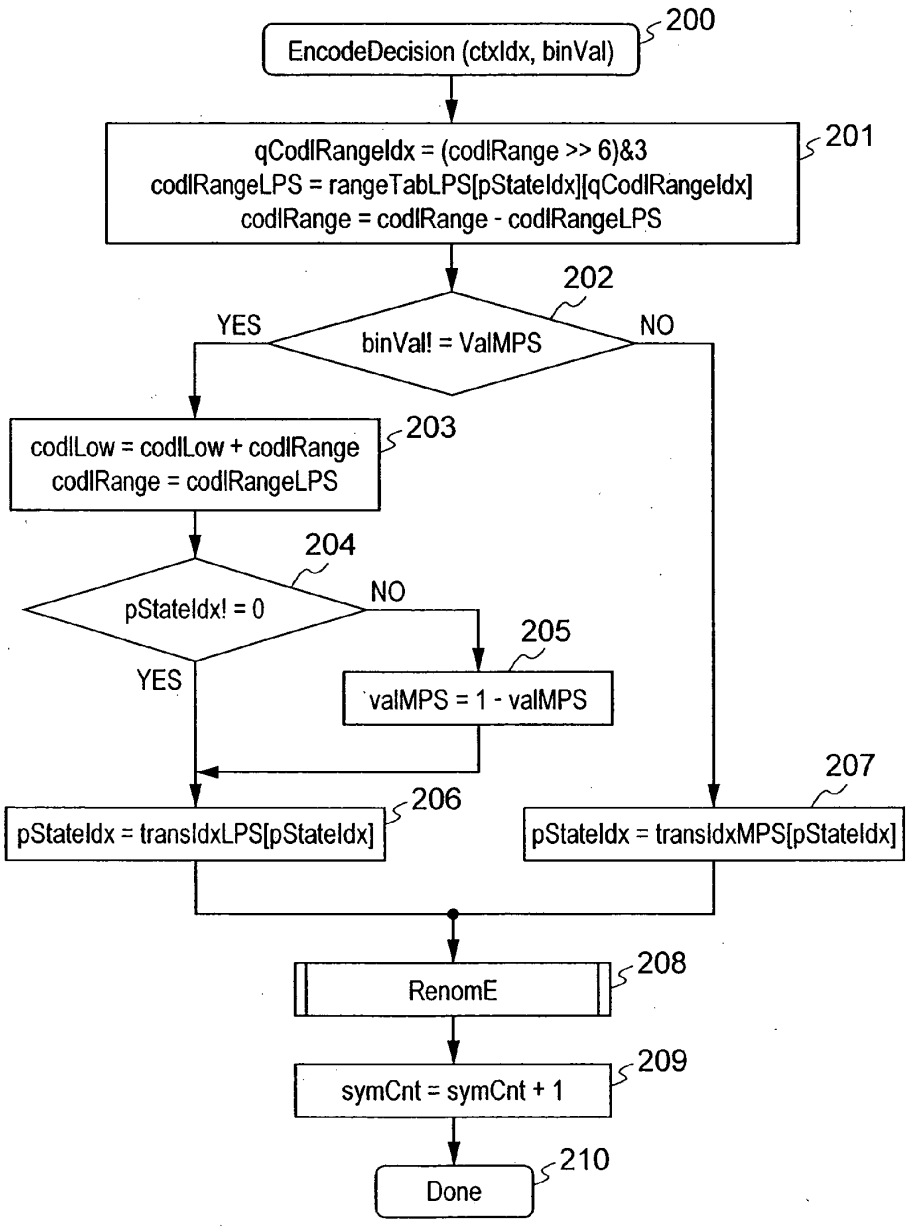
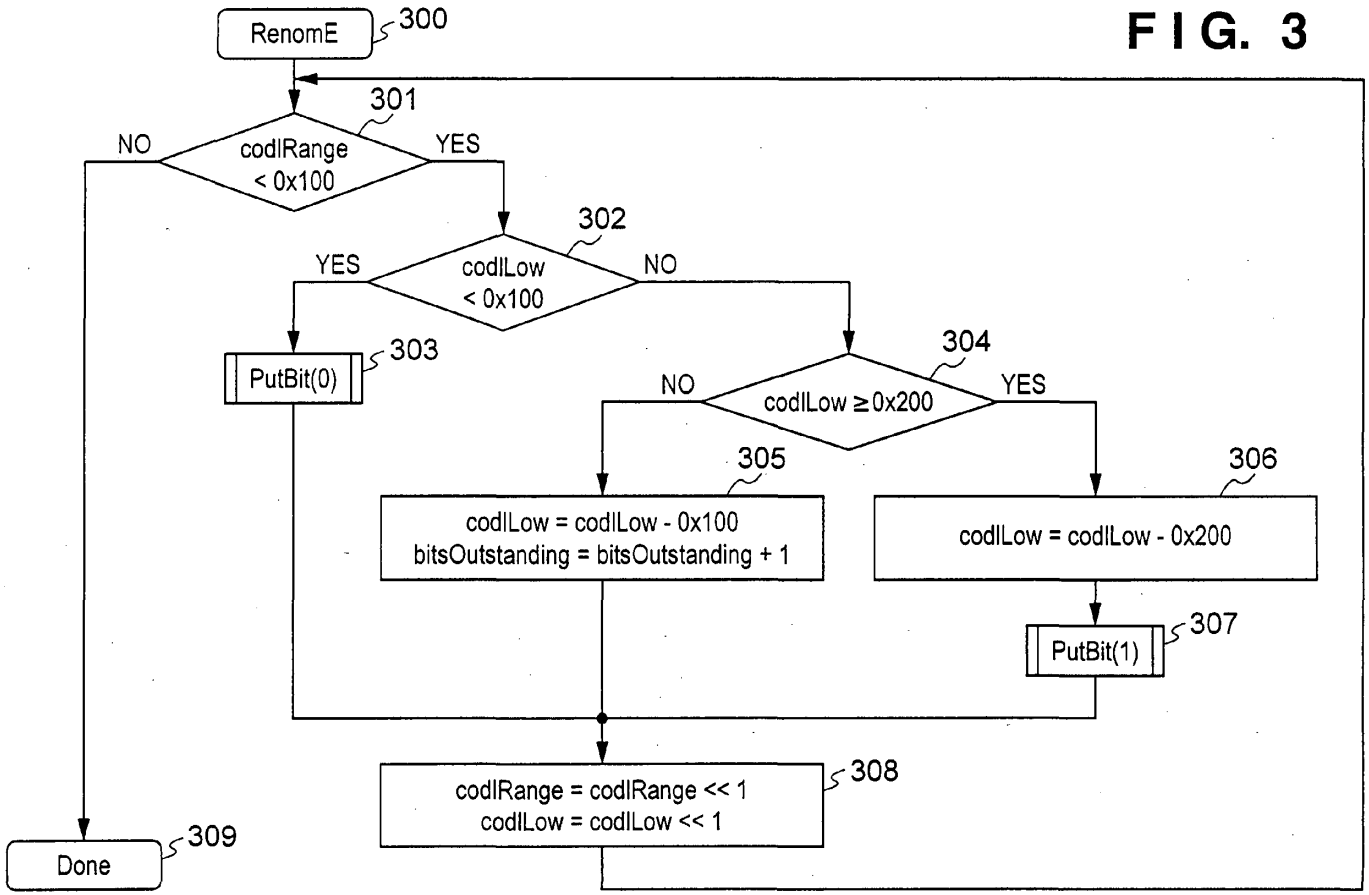
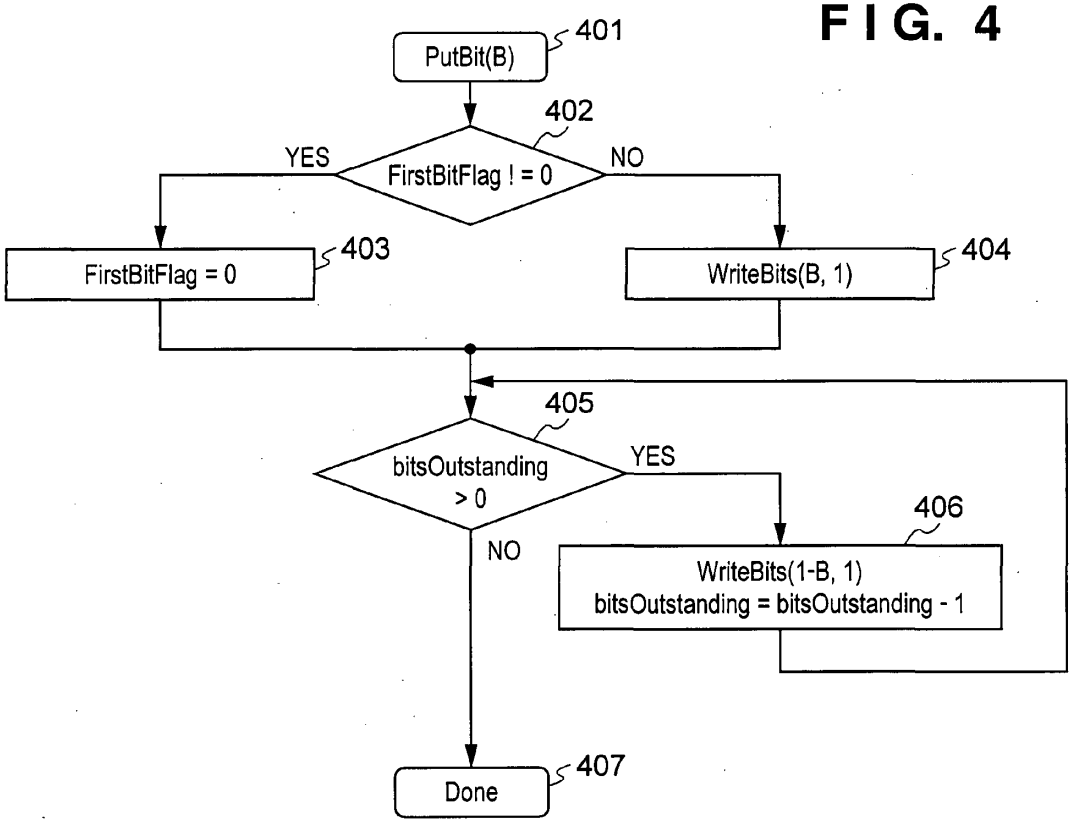

EncodeDecision (ctxIdx, binVal)
200
qCodIRangeIdx = (codIRange >> 6)&3
codIRangeLPS = rangeTabLPS[pStateIdx][qCodIRangeIdx]
codIRange = codIRange - codIRangeLPS
201
binVal! = ValMPS
202
YES
NO
codILow = codILow + codIRange
codIRange = codIRangeLPS
203
pStateIdx! = 0
204
NO
YES
valMPS = 1 - valMPS
205
pStateIdx = transIdxLPS[pStateIdx]
206
pStateIdx = transIdxMPS[pStateIdx]
207
RenomE
208
symCnt = symCnt + 1
209
Done
210

FIG. 3



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FIG. 4



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FIG. 5

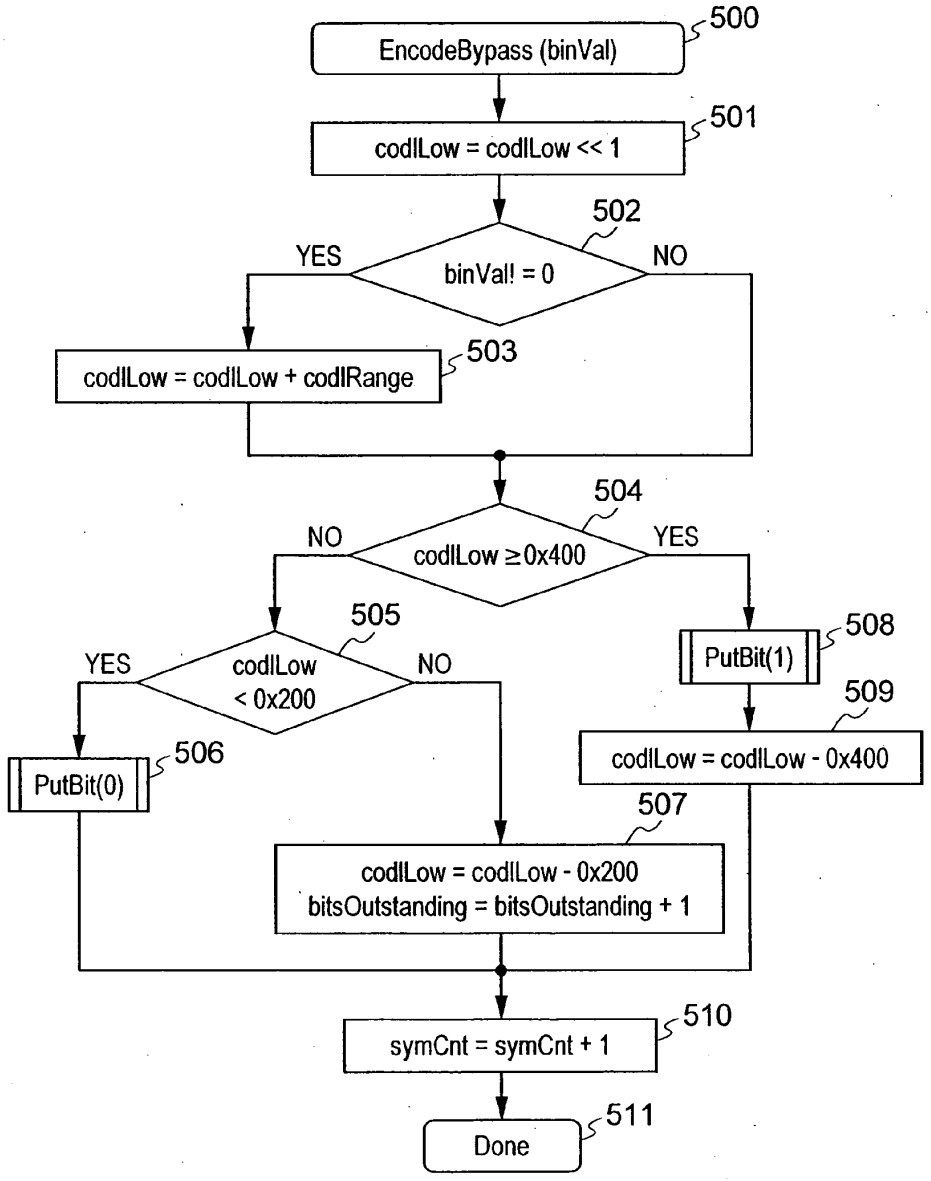

EncodeBypass (binVal)
500
codILow = codILow << 1
501
binVal! = 0
502
YES
NO
codILow = codILow + codIRange
503
codILow ≥ 0x400
504
NO
YES
codILow < 0x200
505
YES
NO
PutBit(0)
506
PutBit(1)
508
codILow = codILow - 0x400
509
codILow = codILow - 0x200
bitsOutstanding = bitsOutstanding + 1
507
symCnt = symCnt + 1
510
Done
511

FIG. 6

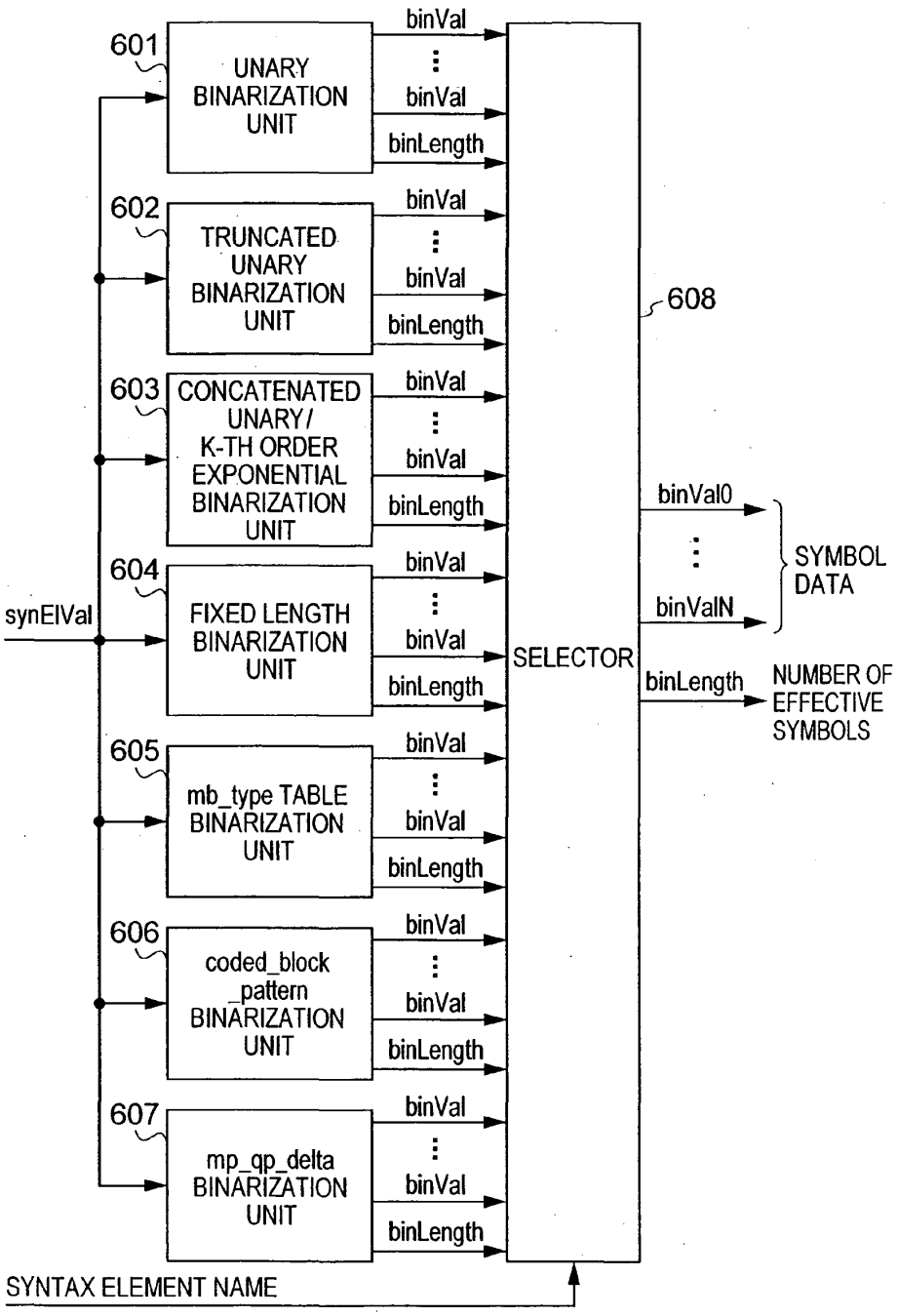
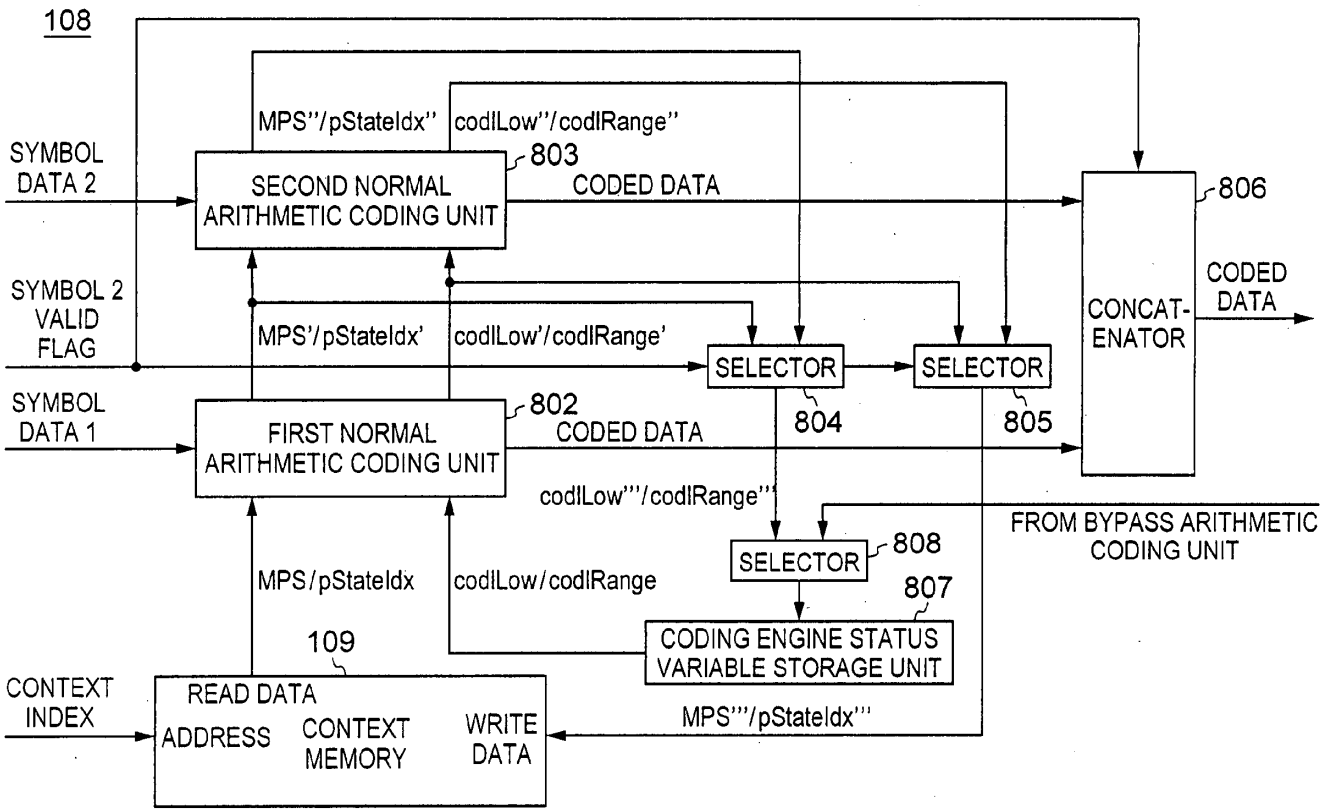

104
601
UNARY BINARIZATION UNIT
602
TRUNCATED UNARY BINARIZATION UNIT
603
CONCATENATED UNARY/ K-TH ORDER EXPONENTIAL BINARIZATION UNIT
604
FIXED LENGTH BINARIZATION UNIT
605
mb_type TABLE BINARIZATION UNIT
606
coded_block _pattern BINARIZATION UNIT
607
mp_qp_delta BINARIZATION UNIT
synElVal
binVal
binLength
608
SELECTOR
binVal0
binValN
SYMBOL DATA
binLength
NUMBER OF EFFECTIVE SYMBOLS
SYNTAX ELEMENT NAME

FIG. 7

LOCATION OF SYMBOL DATA (binIdx)	CONTEXT INDEX (ctxIdx)	ARITHMETIC CODING MODE	CATEGORY NUMBER
0	EQUATION 1	NORMAL ARITHMETIC CODING	0
1	EQUATION 2	NORMAL ARITHMETIC CODING	1
2		NORMAL ARITHMETIC CODING	1
3		NORMAL ARITHMETIC CODING	1
...	...	...	...
14	EQUATION 2	NORMAL ARITHMETIC CODING	1
15	—	BYPASS ARITHMETIC CODING	2
16	—	BYPASS ARITHMETIC CODING	2
...	...	...	...

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FIG. 8



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FIG. 9

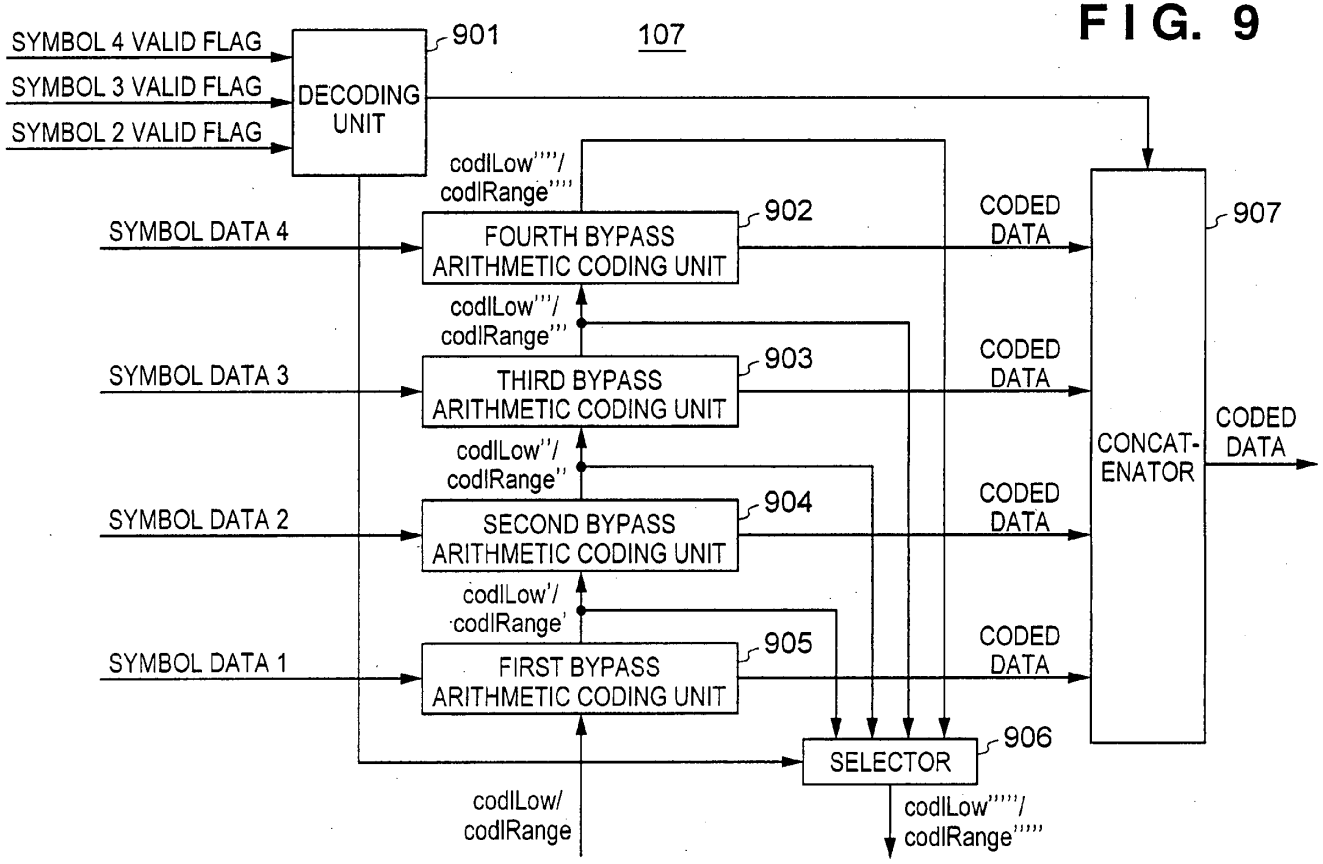

107
901
DECODING UNIT
SYMBOL 4 VALID FLAG
SYMBOL 3 VALID FLAG
SYMBOL 2 VALID FLAG
codlLow''''/
codlRange''''
902
FOURTH BYPASS ARITHMETIC CODING UNIT
SYMBOL DATA 4
codlLow'''/
codlRange'''
903
THIRD BYPASS ARITHMETIC CODING UNIT
SYMBOL DATA 3
codlLow''/
codlRange''
904
SECOND BYPASS ARITHMETIC CODING UNIT
SYMBOL DATA 2
codlLow'/
codlRange'
905
FIRST BYPASS ARITHMETIC CODING UNIT
SYMBOL DATA 1
CODED DATA
907
CONCAT-ENATOR
CODED DATA
906
SELECTOR
codlLow/
codlRange
codlLow'''''/
codlRange'''''

FIG. 10

In0	In1	In2	CODED-DATA CONCATENATION TARGET	CODING-ENGINE-STATUS-VARIABLE SELECTION TARGET
VALID	VALID	VALID	FIRST BYPASS ARITHMETIC CODING UNIT SECOND BYPASS ARITHMETIC CODING UNIT THIRD BYPASS ARITHMETIC CODING UNIT FOURTH BYPASS ARITHMETIC CODING UNIT	FOURTH BYPASS ARITHMETIC CODING UNIT
VALID	VALID	INVALID	FIRST BYPASS ARITHMETIC CODING UNIT SECOND BYPASS ARITHMETIC CODING UNIT THIRD BYPASS ARITHMETIC CODING UNIT	THIRD BYPASS ARITHMETIC CODING UNIT
VALID	INVALID	INVALID	FIRST BYPASS ARITHMETIC CODING UNIT SECOND BYPASS ARITHMETIC CODING UNIT	SECOND BYPASS ARITHMETIC CODING UNIT
INVALID	INVALID	INVALID	FIRST BYPASS ARITHMETIC CODING UNIT	FIRST BYPASS ARITHMETIC CODING UNIT

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FIG. 11

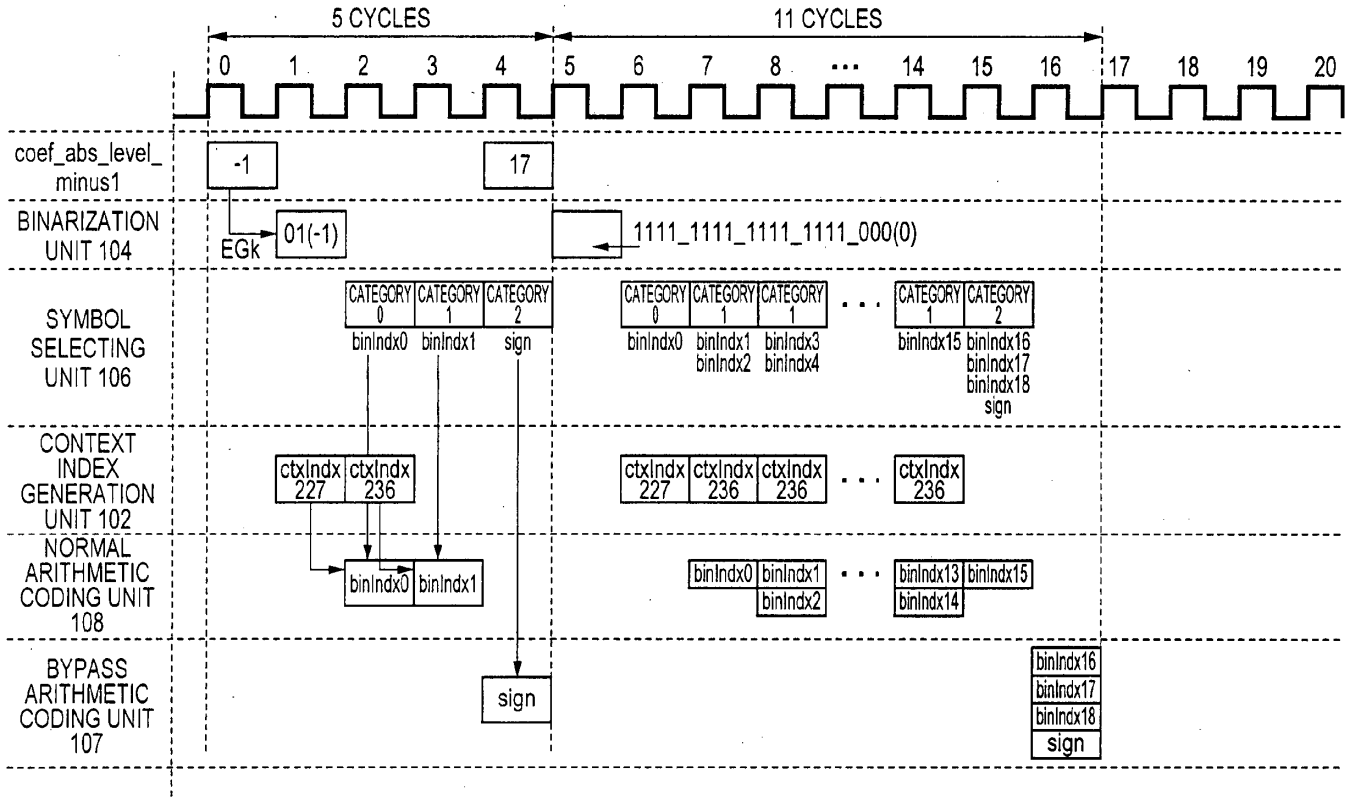

5 CYCLES
11 CYCLES
0 1 2 3 4 5 6 7 8 ··· 14 15 16 17 18 19 20
coef_abs_level_minus1
-1
17
BINARIZATION UNIT 104
EGk
01(-1)
1111_1111_1111_1111_000(0)
SYMBOL SELECTING UNIT 106
CATEGORY 0
CATEGORY 1
CATEGORY 2
binIndx0
binIndx1
sign
binIndx2
binIndx3
binIndx4
binIndx15
binIndx16
binIndx17
binIndx18
CONTEXT INDEX GENERATION UNIT 102
ctxIndx
227
236
NORMAL ARITHMETIC CODING UNIT 108
binIndx13
binIndx14
BYPASS ARITHMETIC CODING UNIT 107

FIG. 12

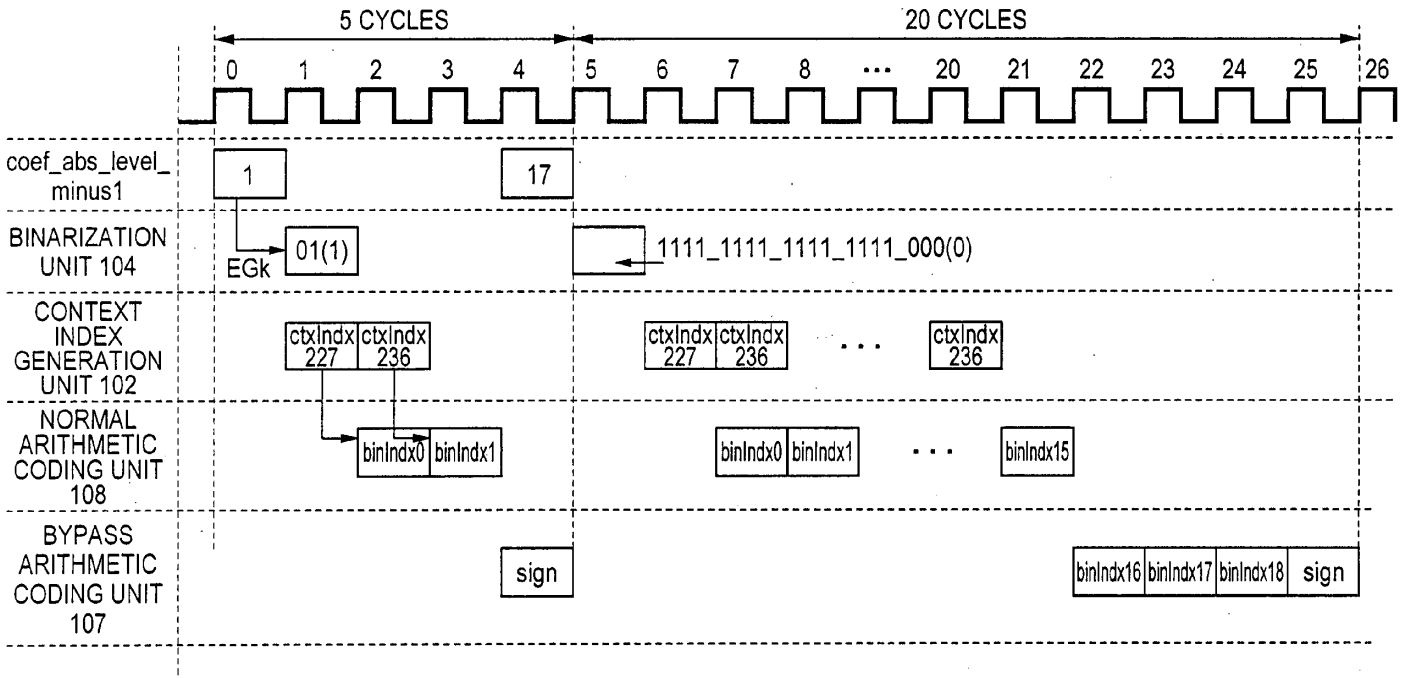

5 CYCLES
20 CYCLES
0 1 2 3 4 5 6 7 8 ... 20 21 22 23 24 25 26
coef_abs_level_minus1
1
17
BINARIZATION UNIT 104
EGk
01(1)
1111_1111_1111_1111_000(0)
CONTEXT INDEX GENERATION UNIT 102
ctxIndx 227
ctxIndx 236
NORMAL ARITHMETIC CODING UNIT 108
binIndx0
binIndx1
binIndx15
BYPASS ARITHMETIC CODING UNIT 107
sign
binIndx16
binIndx17
binIndx18

FIG. 13

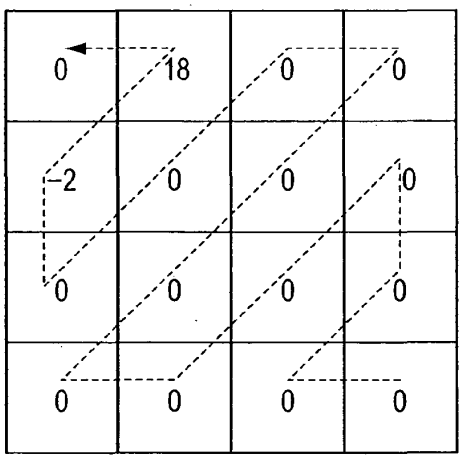
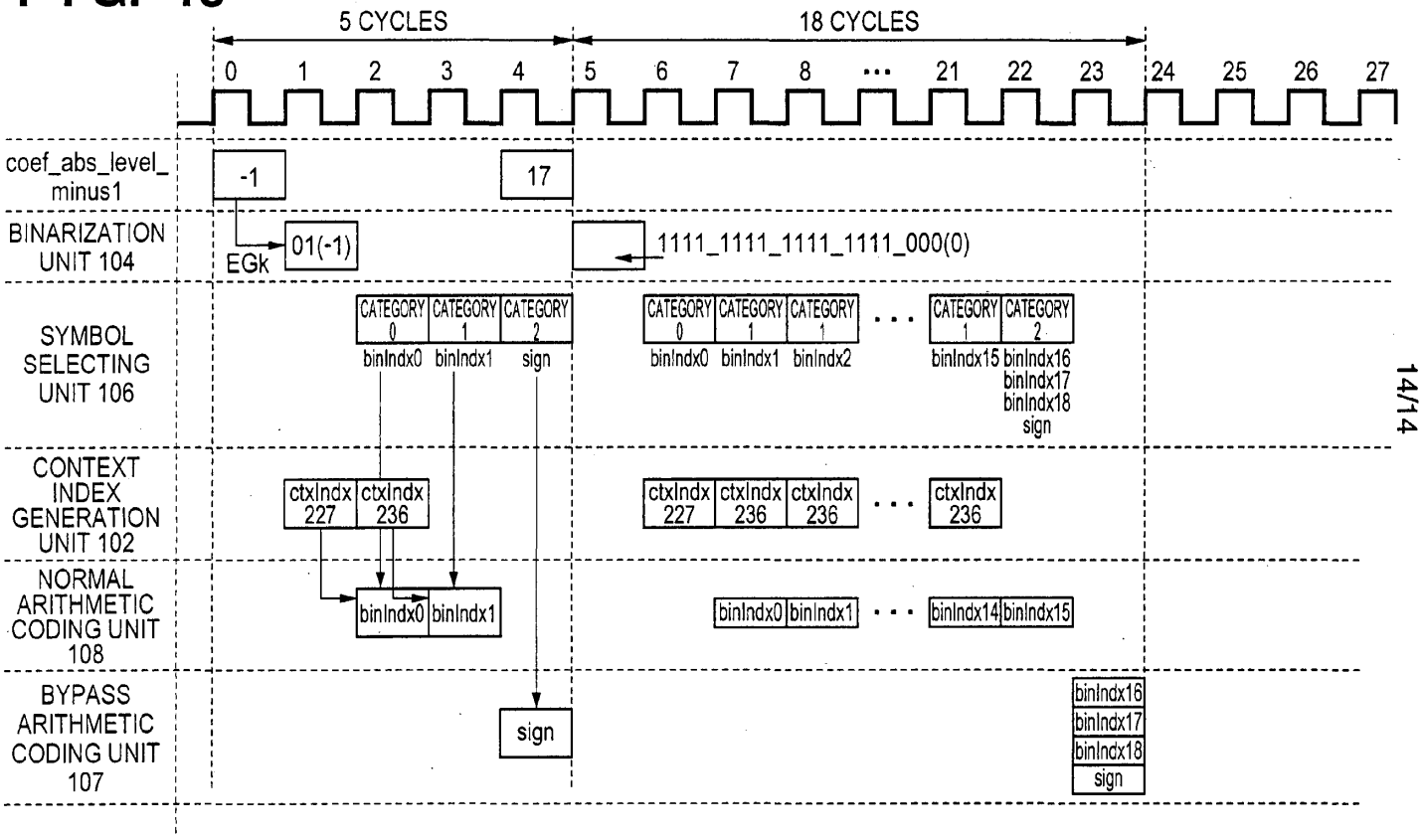


FIG. 14

coef_abs_level_minus1	UT	Golomb
0	0	
1	1 0	
2	1 1 0	
3	1 1 1 0	
4	1 1 1 1 0	
...	...	...
13	1 1 1 1 1 1 1 1 1 1 1 1 1 0	
14	1 1 1 1 1 1 1 1 1 1 1 1 1 1 0	
15	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0	
16	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 1	
17	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0	
...	...	...

FIG. 15


5 CYCLES
18 CYCLES
0 1 2 3 4 5 6 7 8 ... 21 22 23 24 25 26 27
coef_abs_level_minus1
-1
17
BINARIZATION UNIT 104
EGk
01(-1)
1111_1111_1111_1111_000(0)
SYMBOL SELECTING UNIT 106
CATEGORY 0
CATEGORY 1
CATEGORY 2
binIndx0
binIndx1
sign
binIndx2
binIndx15
binIndx16
binIndx17
binIndx18
CONTEXT INDEX GENERATION UNIT 102
ctxIndx
227
236
NORMAL ARITHMETIC CODING UNIT 108
binIndx14
binIndx15
BYPASS ARITHMETIC CODING UNIT 107

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[Continued on next page]

(54) Title: METHOD AND ARRANGEMENT FOR VIDEO CODING

(57) Abstract: Methods and arrangements in video encoding and decoding entities. The methods and arrangements relate to the joint encoding of reference information associated with encoded video.T he method and arrangement in a decoding entity relate to obtaining (402) a single syntax element associated with an encoded block B_e,and identifying (404) a reference mode and one or more reference pictures based on the obtained syntax element. The method and arrangement further relate to-decoding (406)of the block B_e based on the identified reference mode and one or more reference pictures, thus providing a decoded block, B, of pixels.

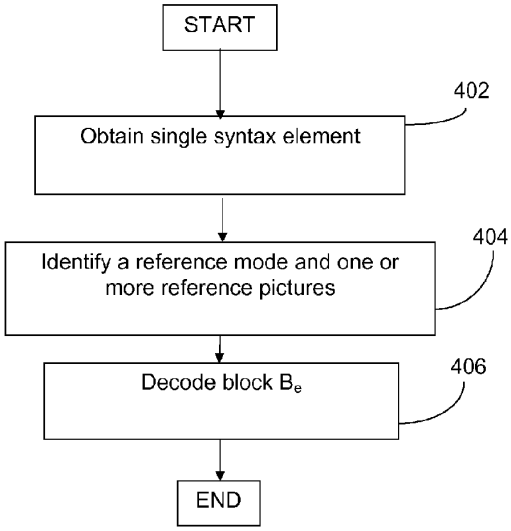


Figure 4

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Published:

— *with international search report (Art. 21(3))*

METHOD AND ARRANGEMENT FOR VIDEO CODING

TECHNICAL FIELD

[0001] The invention relates generally to a method and an arrangement for encoding of information related to video coding.

BACKGROUND

[0002] Video coding may be performed in intra mode and/ or inter mode. Intra mode exploits redundancies within a video frame, and inter mode exploits redundancies between video frames. In inter mode, pixel luma/ chroma predictions are obtained from already coded/ decoded pictures called reference pictures. Depending on the number of reference pictures used for prediction, inter mode is categorized into uni-prediction mode (or uni-directional mode), bi-prediction mode (B mode), and possibly tri-prediction mode, etc., where, respectively, 1, 2 and 3 reference pictures are used. Within this document, these different modes, i.e. uni-prediction, bi-prediction, etc., will be referred to as "reference modes".

[0003] Advanced Video Coding (AVC), which is also known as H.264 and MPEG-4 Part 10, is the state of the art standard for 2D video coding from ITU-T (International Telecommunication Union - Telecommunication Standardization Sector) and MPEG (Moving Picture Experts Group). The AVC codec is a hybrid codec, which takes advantage of eliminating redundancy between frames and within one frame.

[0004] In AVC, indicators of the relevant reference pictures are placed in order into two reference lists. The indicators are denoted reference indices, and are numbered from 0 to N, e.g. (0,1,…,N). The first list, List 0 (L0), primarily manages the past reference pictures, i.e. reference pictures preceding a current picture in time, and the second list, List 1 (L1), typically manages the future reference pictures, i.e. reference pictures subsequent to a current picture in time. For low delay video

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coding, L1 can also manage past reference pictures. Each list can hold indices of up to 15 reference pictures, i.e. N=14).

[0005] Further, in AVC, an indicator, or reference mode index, specifying the selection of one of the reference picture lists (e.g. for uni-prediction), or both reference picture lists (e.g. for bi-prediction), is coded together with the partition structure in Macro Block (MB) mode/ sub-MB mode, while the indicators, or reference picture indices, specifying the selected reference pictures in the respective lists are coded as separate syntax elements. "Partition structure" refers to partitions, such as e.g. 16x16, 16x8 or 8x16, of a 16x16 MB. A partition, e.g. 16x16, is typically associated with one motion vector (MV) and one reference index when uni-prediction is used, and with two MVs and two reference indices when bi-prediction is used. An MV has an horizontal component MVx and a vertical component MVy that describes how pixels of the current partition are produced from the corresponding reference picture, such as Ipred(x,y)=Iref(x-MVx,y-MVy).

[0006] The number of reference pictures associated with a picture or partition depends on the reference mode associated with the same partition, i.e. whether it is uni-prediction or bi-prediction, etc. When decoding the reference information in a decoder, both the reference mode index and the one or more reference picture indices associated with a picture or partition must be correctly decoded, in order for the decoder to be able to decode the picture or partition correctly. Incorrect decoding of either of the reference mode index and the one or more reference picture indices may result in erroneous interpretation of the reference information.

[0007] The current methods of coding reference information, such as the method of AVC described above, require a relatively large number of bits in order to convey the reference information associated with each block. This is identified as inefficient in terms of coding efficiency .

SUMMARY

[0008] It would be desirable to enable an improved coding efficiency for reference information, i.e. the information identifying the one or more reference pictures used for prediction of a current frame. It is an object of the invention to enable an improved coding efficiency for reference information. Further, it is an object of the invention to provide a method and an arrangement for enabling an improved encoding of reference information. These objects may be met by a method and arrangement according to the attached independent claims. Optional embodiments are defined by the dependent claims. The prediction, encoding and decoding described below may be performed within the same entity or node, or in different entities or nodes.

[0009] According to a first aspect, a method is provided in a video decoding entity. The method comprises the obtaining of a single syntax element associated with an encoded block B_e. The method further comprises identifying a reference mode and one or more reference pictures based on the obtained syntax element, and the decoding of the block B_e, based on the identified reference mode and one or more reference pictures, thus providing a decoded block, B, of pixels.

[0010] According to a second aspect, an arrangement is provided in a video decoding entity. The arrangement comprises a functional unit, which is adapted to obtain a single syntax element associated with an encoded block B_e. The arrangement further comprises a functional unit, which is adapted to identify a reference mode and one or more reference pictures based on the obtained syntax element. The arrangement further comprises a functional unit, which is adapted to decode the block B_e based on the identified reference mode and one or more reference pictures, thus providing a decoded block B of pixels.

[0011] According to a third aspect, a method is provided in a video encoding entity. The method comprises the encoding of a block B of pixels using a reference

mode and one or more reference pictures, thus providing an encoded block B_e. The method further comprises deriving a single syntax element identifying the reference mode and the one or more reference picture(s) and providing the single syntax element to a decoder of the block B_e.

[0012] According to a fourth aspect, an arrangement is provided in a video encoding entity. The arrangement comprises a functional unit, which is adapted to encode a block B of pixels using a reference mode and one or more reference pictures, thus providing an encoded block B_e. The arrangement further comprises a functional unit, which is adapted to derive a single syntax element identifying the reference mode and the one or more reference pictures. The arrangement further comprises a functional unit, which is adapted to provide the single syntax element to a decoder of the block B_e.

[0013] The above methods and arrangements may be used for improving coding efficiency. The coding efficiency may be improved, due to that the use of less bits in order to identify the one or more reference pictures used for prediction of a current frame is enabled. The above methods and arrangements may further enable an improved error resilience performance. Further, by the bundling of reference information to form a single syntax element, easy manipulation of reference index numbers becomes feasible. Further, the use of a syntax element as described above will enable the utilization of that some combinations of reference index and reference mode are more probable than others, by enabling efficient coding of these combinations. For example, shorter code words could be assigned to more probable combinations of reference index and reference mode.

[0014] The above methods and arrangements may be implemented in different embodiments. In some embodiments the identification of a reference mode and one or more reference pictures is based on a predefined mapping between the syntax element and the reference mode and one or more specific reference pictures. In

some embodiments, the single syntax element represents an entry in a first predefined reference lists, which may comprise one or more entries. An entry may identify a plurality of reference pictures or a single reference picture, and may also further identify a reference mode.

[0015] The single syntax element may further represent a reference mode and an entry in a second predefined reference list, which may comprise one or more entries identifying a single reference picture, respectively.

[0016] The entries in the lists may be identified by list indices. Further, the number of bits representing the obtained syntax element may be related to the probability of the specific values of the syntax element.

[0017] In some embodiments, reference information prediction may be performed for Be (or B when in encoding entity), based on single syntax elements associated with neighboring blocks of Be (or B). Further, in some embodiments sub-regions of a block associated with multi-prediction may be identified, for which sub-regions the respective corresponding regions of the multi-prediction reference blocks have a relatively low correlation between them, and then an alternative prediction, instead of the multi-prediction, may be used for the identified sub-regions.

[0018] The embodiments above have mainly been described in terms of a method. However, the description above is also intended to embrace embodiments of the arrangements, adapted to enable the performance of the above described features. The different features of the exemplary embodiments above may be combined in different ways according to need, requirements or preference.

[0019] According to yet another aspect, a computer program is provided, which comprises computer readable code means, which when executed in one or more processing units, causes any of the arrangements described above to perform the corresponding procedure according to one of the methods described above.

[0020] According to yet another aspect, a computer program product is provided, which comprises the computer program of above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The invention will now be described in more detail by means of example embodiments and with reference to the accompanying drawings, in which:

[0022] Figure 1 is a schematic view illustrating a conversion from a reference information representation according to the prior art to a reference information representation according to an example embodiment

[0023] Figure 2 is a table showing differences between AVC reference index representation and a reference index representation according to an example embodiment.

[0024] Figure 3 is a schematic view illustrating assignment of reference information indicators according to an example embodiment

[0025] Figure 4 is a flow chart illustrating a procedure for decoding of jointly encoded information related to a reference mode and one or more reference pictures in a video decoding entity, according to an example embodiment.

[0026] Figure 5 is a block diagram illustrating an arrangement adapted for decoding of jointly encoded information related to a reference mode and one or more reference pictures in a video decoding entity, according to an example embodiment.

[0027] Figures 6 is a flow chart illustrating a procedure for joint encoding of information related to a reference mode and one or more reference pictures in a video encoding entity, according to an example embodiment.

[0028] Figure 7 is a block diagram illustrating an arrangement adapted for joint encoding of information related to a reference mode and one or more reference pictures in a video encoding entity, according to an example embodiment.

[0029] Figure 8 is a schematic view illustrating an arrangement in a video encoding/ decoding entity, according to an example embodiment.

[0030] Figures 9 and 10 are schematic views illustrating the determining of the frequency of occurrence of different combinations of a reference mode and one or more reference pictures associated with neighboring blocks of a current block, according to exemplifying embodiments.

[0031] Figure 11 is a schematic view illustrating assignment of indicators (code words) to different index symbols, according to the prior art.

[0032] Figure 12 is a schematic view illustrating assignment of indicators (code words), according to an exemplifying embodiment.

[0033] Figure 13 is a schematic view illustrating partitioning based on implicit information, according to an exemplifying embodiment.

DETAILED DESCRIPTION

[0034] Briefly described, a new procedure for representing and conveying reference information, i.e. reference mode(s) and reference picture(s), is provided for inter predictive coding and decoding. The procedure may be referred to as Reference Index Signaling, or Reference information Indicator Signaling (RIS).

[0035] Within this document, the term "neighboring blocks of block X" is used as referring to blocks which are neighbors of block X, i.e. located adjacent to or in the vicinity of block X. Further, within this document, the term "block" is used as referring to a unit of pixels. The term "reference picture" or "reference block" is used

as referring to a previously coded/ decoded picture, a block, a region or an area of a picture, which picture, block, region etc, is used as reference for prediction.

[0036] When using RIS, instead of e.g. encoding an indicator of the reference mode in close association with an indicator of the partition structure, and encoding indicators of reference pictures separately, e.g. as in AVC, the indicator of reference mode and the indicator(s) of reference picture(s) associated with an encoded block are "bundled together in one place", i.e. are jointly encoded. The joint encoding of the indicators of reference mode and reference picture(s), i.e. reference information, results in that one single syntax element, or indicator, represents all information on reference mode(s) and reference picture(s) needed, in order to decode the encoded block in a satisfactory manner. That is, once this single syntax element is given for an encoded block, a decoder should be able to identify the reference picture(s) required for decoding the block. The "syntax element" may also be denoted e.g. "syntax unit", "joint indication unit" or "joint identification unit".

[0037] One way to describe RIS is to describe a "conversion" or mapping from a traditional representation, such as e.g. the AVC representation of reference information using two separate lists, to an illustrative representation of reference information according to RIS. Such a conversion to RIS representation could basically be made in three steps, as illustrated in figure 1.

[0038] The first step 102 could be to form one single reference index list from multiple index lists. For example, instead of managing two reference index lists, as in AVC, all reference picture indices may be sorted in a certain order into a single joint list, as an alternative or a complement to the two lists of AVC. This is illustrated in figure 1, where the picture reference index lists L0 and L1 are merged, or multiplexed, into a new list L_{RIS}, in an interleaved way. Further, in a second step,

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104, the index numbers may be re-assigned accordingly, to follow a consecutive order, i.e. 0-5 in the new list I_{RIS}.

[0039] The index numbers, or entries, in the list I_{RIS} after step 104, represent information regarding both a reference mode (backward or forward uni-prediction) and a reference picture. An index to an entry in I_{RIS} may be denoted, e.g. a "RIS index" or "index parameter". The RIS index numbers 0 - 5 in I_{RIS}, after step 104 in this example, represent uni-prediction from four past pictures (originally in I0 = (0,1,2,3)), and two future pictures (originally in I1 = (0,1)).

[0040] Further, one or more list entries representing bi-prediction may be added to I_{RIS}, e.g. by insertion or appending. Thus, RIS indices indicative of the entries representing bi-prediction do not point to a single reference picture but rather to two reference pictures. Thus, a RIS index can identify a combination of a reference mode and one or more reference pictures.

[0041] Consequently, in a final step106, entries related to bi-prediction mode, where two reference pictures are used for prediction, may be appended consecutively to I_{RIS}, and be indicated or represented by RIS indices. For example, the entry with RIS index number 7 can be set to signal or imply that the current picture is using picture number 0 and picture number 1 as bi-prediction references. Thus, this information is inherent in the RIS index 7. Index number 8 can in a similar way be set to imply that the current picture is using picture number 0 and picture number 2 as bi-prediction references. Analogously, the list I_{RIS} may further be extended with entries representing tri-prediction, identifying three reference pictures, and so forth.

[0042] Alternativley, the steps 104 and 106 may be performed in the reverse order, such that the entries related to bi-prediction mode are first added, e.g. inserted or appended, and then the index numbers are re-assigned accordingly. As previously described the entries related to bi-prediction mode could also be inserted,

e .g. between the entries related to uni-prediction, which would require that re-assignment of index numbers was performed after the insertion, as a complement or alternative to step 104. In this example, the mapping is represented by a single reference list, of which the indices of the different entries represent a reference mode and one or more reference pictures. It should be noted that this is just an optional example, and that the mapping may involve several steps, and that no explicit list or record of the exemplified type is requisite for performing the mapping.

[0043] An example of the difference between an AVC reference index representation and a RIS index representation, according to an example embodiment, is shown in a table in figure 2. In this example, it is assumed that there are four reference pictures available for coding of a current picture, of which two reference pictures are past reference pictures and two are future reference pictures. In this example RIS representation, the indices 0, 1, 3 and 4 are set to indicate uni-prediction from a respective one of the four reference pictures. The indices 2 and 5 are set to indicate bi-prediction from a respective pair of the four reference pictures. It should be noted that the AVC-signaling of the reference indices also would comprise information related to partitions, since this information is coded together with the reference mode index, such as e.g. "INTER_16x16_I0". This is, however, not shown in figure 2.

[0044] In the example shown in the table in figure 2, some of the RIS indices indicating or representing bi-prediction are placed immediately after the "closest" uni-prediction RIS indices, i.e. interleaved with the indices representing uni-prediction. This RIS index representation is further illustrated in figure 3, which shows a so-called 7B hierarchical Group Of Pictures (BGOP). In the figure, the so-called "current frame" i.e. the frame to be encoded, is frame 3 in the 7B GOP. The RIS indices shown in figure 3 correspond to the RIS indices 0-7 in the table in figure 2. An alternative RIS representation could be to let the RIS indices 0-3

indicate uni-prediction, and the following RIS indices indicate bi-prediction, as in the example illustrated in figure 1.

[0045] The ways to define the meaning of a RIS index, or RIS parameter, are not limited by the examples given in this document. For example, a mathematic formula could be defined to interpret the meaning of the RIS index, e.g. a function with 2 variables f(RIS_index, current_frame_num) which returns identification of 2 reference picture indices for a bi-prediction RIS index and identifies one reference picture index for a uni-directional RIS index, and so forth. In one example, current_frame_num corresponds to the frame number inside a BGOP of 7 B pictures, where 0 is the first frame in display order and 8 is the last frame in the BGOP. In another example, RIS index is always assigned using the formula:

Forward: refidx0

Range: [0~I0_len-1]

Backward: I0_len+refidx1

Range: [I0_len~I0_len+I1_len-1]

Bi: (I0_len+I1_len)+refidx0*I1_len+refidx1

Range: [I0_len+I1_len~ I0_len+I1_len+I0_len*I1_len-1]

Where refidx0 and refidx1 are the index into reference list I0 and I1 respectively. I0_len and I1_len are the length of list I0 and I1 respectively.

Alternatively, a table may be used to match the RIS index with two corresponding unidirectional indices in case of bi-prediction and one unidirectional index for the case of a single prediction. Which method to select depends e.g. on hardware/ software constraints.

[0046] However, irrespective of which method that is used for the deriving of a syntax element, the method should be known to both encoder and decoder, such that the encoder is enabled to derive and provide a correct syntax element, and the decoder is enabled to interpret the syntax element correctly and thus identify the reference information needed to decode the encoded block or frame in question.

[0047] The RIS index can apply to different levels of video coding, e.g., frame level, large MB level, MB level or sub MB level.

Example procedure, figure 4, decoding

[0048] An embodiment of the decoding part of the procedure of conveying reference information will now be described with reference to figure 4. The procedure could be performed in a video decoding entity, which could be a video decoder or an entity comprising further functional units in addition to a video decoder. Initially, a single syntax element associated with an encoded block B_e is obtained in an action 402. The single syntax element may be a unit, e.g. a symbol, in "the bit stream", i.e. the encoded representation of e.g. a video sequence, or be a unit, which is decoded from the bit stream. The syntax element is one or more bits representing a number that corresponds to the reference information, such as e.g. a RIS index. Typically, fewer bits are used to represent RIS indices that are relatively common as compared to the number of bits used to represent RIS indices that are less common. The syntax element is decoded from the bit stream to obtain the number, e.g. RIS index, it represents. Decoding can be made according to VLC (Variable Length Coding) or arithmetic coding, such as CABAC (Context Adapted Binary Arithmetic Coding), for example.

[0049] Then, in an action 404, a reference mode and one or more reference pictures to be used when decoding the block B_e are identified based on the obtained syntax element. The identified reference mode and one or more reference pictures correspond to the mode and reference pictures used when encoding the

block in an encoder. The identification may involve e.g. the demapping, deciphering or "decoding" of the syntax element using a mapping table, a reference list or other predefined information or function, by use of which a reference mode and one or more reference pictures may be identified, given a syntax element. Further, when having identified the reference mode and one or more reference pictures needed, the encoded block B_e, which is assumed to be obtained using conventional methods, is decoded in an action 406.

[0050] The single syntax element may be an indicator or index, e.g. denoted RIS index, of an entry in a reference list, which reference list may comprise a plurality of entries, each entry representing or identifying one or more reference modes and one or more reference pictures. Alternatively, the syntax element is a codeword corresponding to an entry in a lookup table. The lookup table may link the codeword e.g. to a reference mode and one or more entries in one or more reference lists, such as e.g. L0 and L1 in AVC. The reference mode may define which single reference list or multiple reference lists that should be used in decoding of the block.

Example arrangement, figure 5, decoding

[0051] Below, an example arrangement 500, adapted to enable the performance of the above described procedure of decoding, will be described with reference to figure 5. The arrangement is illustrated as being located in a video decoding entity, 501, which could be a video decoder or an entity comprising further functional units in addition to a video decoder, such as e.g. a computer, a mobile terminal or a video-dedicated device. The arrangement 500 is further illustrated to communicate with other entities via a communication unit 502, which may be considered to comprise conventional means for any type of wired or wireless communication. Encoded video to be decoded is assumed to be obtained from the communication unit 502 or a memory by an obtaining unit 504, and

encoded blocks are assumed to be decoded in a decoding unit 508, where the functional unit 508 uses conventional decoding methods.

[0052] The obtaining unit 504 is adapted to obtain a single syntax element associated with an encoded block B_e. The arrangement 500 further comprises an identifying unit 506, which is adapted to identify a reference mode and one or more reference picture(s) to be used when decoding the block B_e, based on the obtained syntax element. As previously described, the arrangement 500 further comprises a decoding unit 508, which is adapted to decode the block B_e based on the determined reference mode and reference picture(s), thus providing a decoded block B of pixels.

[0053] In this arrangement the syntax element may be an indicator or index of an entry in a reference list, which reference list may comprise a plurality of entries, each entry representing or identifying one or more reference modes and one or more reference pictures. Alternatively, the arrangement may be adapted to another case when the syntax element is a codeword corresponding to an entry in a lookup table. The lookup table may link the codeword e.g. to a reference mode and one or more entries in one or more reference lists, such as e.g. I0 and I1 in AVC.

[0054] The video decoding entity 501 may further comprise e.g. a displaying unit 510, adapted to display the decoded video.

Example procedure, figure 6, encoding

[0055] An embodiment of the encoding part of the procedure of conveying reference information will now be described with reference to figure 6. The procedure could be performed in a video encoding entity, which could be a video encoder, or an entity comprising further functional units in addition to a video encoder. Initially, a block B of pixels is encoded in an action 602, using a reference mode and one or more reference pictures, thus providing an encoded block B_e.

[0056] Then, a single syntax element is derived, in an action 604, based on the reference mode and the one or more reference pictures used for encoding, which syntax element thereby identifies, directly or indirectly, the reference mode and the one or more reference pictures used for encoding the block B. The syntax element could e.g. be derived by locating a list entry, corresponding to the reference mode and reference picture(s) used, in a predefined reference list, and then setting the index number of said entry to constitute the syntax element. Alternatively, a predefined mapping table or lookup table could provide a mapping between different combinations of reference modes and reference pictures and different syntax elements. The syntax element could further be an argument to a predefined function, which function returns a reference mode indicator and one or more reference picture indicators. Such an "argument" syntax element could be derived e.g. by means of a predefined "reverse function", taking a reference mode indicator and one or more reference picture indicators as arguments and returning a single syntax element.

[0057] Further, the derived syntax element is provided to a decoder of the block B_e, in association with the block B_e, in an action 606. Thus, the reference information, i.e. the information on the reference mode and on the one or more reference pictures used when encoding the block B, also to be used when decoding the encoded block B_e, can be conveyed to a decoder in a compact and error resilient way. The syntax element could e.g. be provided by being transmitted over a radio channel to an entity or node comprising a decoder. Further, the syntax element could e.g. be stored in a memory together with the associated encoded video and be accessed by a decoding entity at another point in time.

Example arrangement, figure 7, encoding

[0058] Below, an example arrangement 700, adapted to enable the performance of the above described procedure related to encoding, will be

described with reference to figure 7. The arrangement is illustrated as being located in a video encoding entity, 701, which could be a video encoder or an entity comprising further functional units in addition to a video encoder, such as e.g. a computer, a mobile terminal or a video-dedicated device. The arrangement 700 may communicate with other entities via a communication unit (not shown), which may be considered to comprise conventional means for any type of wired or wireless communication. Uncoded video to be encoded is assumed to be obtained e.g. from the communication unit or a memory.

[0059] The arrangement 700 comprises an encoding unit 702, which is adapted to encode a block, B, of pixels using a reference mode and one or more reference pictures, thus providing an encoded block B_e. The arrangement 700 further comprises a deriving unit 704, which is adapted to derive a single syntax element, which identifies, directly or indirectly, the reference mode and the one or more reference pictures used when encoding the block B. The index element could be derived in different ways, as previously described, and could be e.g. an indicator, such as e.g. an index, or a codeword, etc.

[0060] The arrangement 700 further comprises a providing unit 706, which is adapted to provide the single syntax element to a decoder of the block B_e, possibly via a communication unit. The single syntax element may be provided e.g. by transmission over a radio channel to an entity or node comprising a decoder.

Example arrangement, figure 8

[0061] Figure 8 schematically shows an embodiment of an arrangement 800 in a video decoding entity, which also can be an alternative way of disclosing an embodiment of the arrangement for decoding in a video decoding entity illustrated in figure 5. Comprised in the arrangement 800 are here a processing unit 806, e.g. with a DSP (Digital Signal Processor). The processing unit 806 can be a single unit or a plurality of units to perform different actions of procedures described

herein. The arrangement 800 may also comprise an input unit 802 for receiving signals from other entities, and an output unit 804 for providing signal(s) to other entities. The input unit 802 and the output unit 804 may be arranged as an integrated entity.

[0062] Furthermore, the arrangement 800 comprises at least one computer program product 808 in the form of a non-volatile memory, e.g. an EEPROM (Electrically Erasable Programmable Read-Only Memory), a flash memory and a hard drive. The computer program product 808 comprises a computer program 810, which comprises code means, which when executed in the processing unit 806 in the arrangement 800 causes the arrangement and/ or the video decoding entity to perform the actions of the procedures described earlier in conjunction with figure 4.

[0063] The computer program 810 may be configured as a computer program code structured in computer program modules. Hence in the example embodiments described, the code means in the computer program 810 of the arrangement 800 comprises an obtaining module 810a for obtaining a single syntax element associated with an encoded video unit/ block, e.g., by decoding it from a bit stream originating from a data transmitting entity or from a storage, e.g. a memory. The computer program further comprises an identifying module 810b for identifying a reference mode and one or more reference pictures based on the obtained syntax element. The computer program 810 further comprises a decoding module 810c for decoding of the encoded block.

[0064] The modules 810a-c could essentially perform the actions of the flow illustrated in figure 4, to emulate the arrangement in a video decoding entity illustrated in figure 5. In other words, when the different modules 810a-c are executed in the processing unit 806, they correspond to the units 502-506 of figure 5.

[0065] Similarly, a corresponding alternative to the arrangement illustrated in figure 7 is possible.

[0066] Although the code means in the embodiment disclosed above in conjunction with figure 8 are implemented as computer program modules which when executed in the processing unit causes the arrangement and/ or video handling/ presenting entity to perform the actions described above in the conjunction with figures mentioned above, at least one of the code means may in alternative embodiments be implemented at least partly as hardware circuits.

[0067] The processor may be a single CPU (Central processing unit), but could also comprise two or more processing units. For example, the processor may include general purpose microprocessors; instruction set processors and/ or related chips sets and/ or special purpose microprocessors such as ASICs (Application Specific Integrated Circuit). The processor may also comprise board memory for caching purposes. The computer program may be carried by a computer program product connected to the processor. The computer program product comprises a computer readable medium on which the computer program is stored. For example, the computer program product may be a flash memory, a RAM (Random-access memory) ROM (Read-Only Memory) or an EEPROM, and the computer program modules described above could in alternative embodiments be distributed on different computer program products in the form of memories within the data receiving unit.

[0068] Further, it is realized that one problem with existing video coding technology is that no satisfying reference mode/ reference picture prediction scheme is defined or applied. Below, such a prediction scheme will be described. It is realized that in, for example, a scene-cut/ fading/ flash scenario, it is quite common that the same e.g. combination of reference mode and reference pictures is used for the prediction of neighboring or adjacent MBs. Further, it is realized that the current

coding methods do not take advantage of the correlation between the reference modes/ reference picture(s) used for neighboring MBs. In previous solutions, the separate components identifying the MB reference information are encoded independently and conveyed to a video decoder.

[0069] An exemplifying prediction scheme on MB level could be described as follows. The exemplifying prediction scheme applies to both encoder and decoder, and it could be applied for any block size.

[0070] In association with the encoding/ decoding of a current MB, the encoder/ decoder is arranged to analyze the reference indicators of the encoded MBs in the surrounding, also called "the context" of the MB. These surrounding blocks could also be denoted the "neighboring blocks" of the current block. The encoder/ decoder counts the number of times each one out of a set of candidate indicators or indices appears amongst the neighboring blocks, and selects one, e.g. according to a predefined scheme, with the highest count, as being a prediction or estimate. The selected reference indicator should be related to inter prediction. The selected reference indicator is set to be a prediction or estimate of which reference picture(s) (and reference mode) that may be suitable to use when encoding/ decoding the current MB. The prediction is derived through analysis of information related to the encoded/ decoded neighboring blocks of the MB, rather than through analysis of the current MB itself. In an encoder, the MB may either be coded or uncoded during this selection of a prediction, since in this example, the prediction is not to be used for the selecting of reference picture(s) (and reference mode) to use when encoding the current MB. In a decoder, the current MB is coded during the prediction.

[0071] An exemplifying neighboring block reference indicator analysis and selection of an estimate is illustrated in figure 9. In the example illustrated in figure 9, four neighboring blocks of a current block are considered. However, the

method is applicable also for other sets or subsets of considered neighboring blocks. One example set or neighboring blocks could consist of, e.g., a left block, a top left block and an above block relative to the current block. Another example set could comprise only the left block and above block. In figure 9, the neighboring blocks of the current block are associated with the respective reference indicators, or indices, 1, 1, 2 and 0. Thus, the reference indicator "1" has the highest count, i.e. the highest frequency of occurrence, by appearing twice amongst the neighboring blocks. Thus, the reference indicator "1" is selected to represent the prediction or estimate of the reference picture(s) (and mode) used, or to be used, when encoding the current block, or, when the prediction takes place in a decoder, the prediction of the reference picture(s) (and mode) to be used when decoding the current block.

[0072] When counting the number of occurrences of a certain reference indicator amongst the neighboring blocks, more than one candidate may have the same highest counting number. This is illustrated in figure 10, where the reference indicators "1" and "2" both appear four times. This could be solved, e.g., by selecting the reference indicators in accordance with a predefined ranking scheme. For example, when the reference indicators are represented by the numbers 0-2, as illustrated in figures 9 and 10, the reference indicator represented by the highest, or lowest, number could be selected as prediction.

[0073] The difference between a block of predicted pixel values and the original pixel values, i.e. the source before being encoded, is coded by transform coding, e.g. DCT (Discrete Cosine Transform). The output of the transform comprises transform coefficients, which are then quantized. The number of transform coefficients associated with a block reflects how good the match is between the predicted block and the original block, for the given quantization. Relatively few transform coefficients indicate that there is a good match. Consequently, reference

indicators associated with blocks having few transform coefficients could be considered more reliable.

[0074] Thus, the counting of occurrences could also be weighted according to e.g. the coded transform coefficients associated with the reference blocks. As described above, a reference index associated with a neighboring block with few coded transform coefficients could be considered a more reliable prediction than a reference index associated with a neighboring block with many transform coefficients, and may thus be assigned a larger weight for the reference index prediction. In another example, blocks with coded coefficients may have larger weight than blocks without coded coefficients, i.e. skipped blocks. In another example, a reference index associated with a neighboring block that has a large MV partition, for example a large MB, could be considered more reliable than a neighboring block with a smaller MV partition, and would thus be assigned a larger weight for the reference index prediction. Using weights which are multiples of 2 is beneficial in view of complexity. The weighted counting could also be implemented by use of a lookup table.

[0075] Some reference indicators may be more related to each other than others. For example, when using jointly encoded reference information, the reference indicator representing bi-prediction using the reference frames ref0 and ref1 will be more related to the reference indicator representing uni-prediction using one of ref0 and ref1, than for example to a reference indicator representing uni-prediction using reference frame ref2. Thus, when counting a bi-prediction indicator, the corresponding indicators representing uni-prediction using the same reference frames could be updated with some minor count value, i.e. lower than the count value for a "full match". Similarly, reference indicators representing uni-prediction using e.g. ref0 and ref1 are more related to the corresponding reference indicator representing bi-prediction using ref0 and ref1, than to other bi-prediction reference indicators. Thus, when counting a uni-directional reference indicator, the count of

reference indicators corresponding to a multi-prediction where the reference frame in question is used can also be updated with some minor value.

[0076] Figure 10 illustrates another exemplifying embodiment of determining the frequency of occurrence of certain reference indicators for a current block, by the counting of reference indicators associated with the neighboring blocks of the current block. Here, the current block is a large MB, and the neighboring blocks are smaller in size than the current block. In some cases it may be of interest to have the same number of neighboring blocks in the context independently of the block size of the blocks in question.

[0077] One advantage of introducing reference indicator prediction, or reference index prediction, is to allow more efficient mapping of a VLC table. By considering prediction and the VLC table together, more compression can be obtained. For example, when assuming coding of 3 indices, e.g., (0,1,2), without the use of prediction, a fixed VLC table may be assigned, as the one illustrated in figure 11. Assuming that the index symbol "2" occurs most frequently, the table illustrated in figure 11 would have a sub-optimal design, since "2" is encoded using a codeword with two bits, i.e. "11", while the less frequent "0" is encoded using one bit, i.e. "0".

[0078] When prediction is added, a better VLC table design is enabled. An example of such an improved VLC table design is illustrated in figure 12. In such an improved VLC design, the bits spent for encoding a reference indicator or index symbol can be adapted based on the prediction and thus on the context of the current block. In the table illustrated in figure 12, the most frequently occurring reference indicator in the context of the current block is encoded using a single bit code word, in this example "0". The code words "10", and "11", comprising two bits, could be defined to identify e.g. the reference indicator having the second highest frequency of occurrence and the reference indicator having the third highest

frequency of occurrence, respectively. Both the encoder and decoder of reference indicators should be aware of, and agree on, how to perform the prediction and how to interpret the code words.

[0079] The example described above is just a simple example, and it should be noted that the possible design is not limited to this. There are various ways to assign different VLC tables to reference indicators or index symbols, e.g. when more reference indicators or index symbols are involved. An example approach could be to vary the indexing with the probability of occurrence of the indices, such that a frequently occurring reference indicator is assigned a low index number, and vice versa, and that a low index number cost less bits to encode than a high index number. Context-Adaptive Binary Arithmetic Coding (CABAC) can be used to achieve varying bit cost for representing reference indicators or indices according to their probability. Some examples of different contexts are e.g. the reference indicators associated with the neighboring blocks, a counting number of reference indicators, or a weighted counting number of reference indicators, as described above.

[0080] In state of the art, e.g. using H.264, the generation of a bi-prediction block using two MVs/ reference pictures, blocks or areas, involves averaging over the two reference areas. When an MV points to a sub-pel (sub-pixel) position in a reference area, the sub-pel position pixel values need to be generated first, before averaging. The generation of sub-pel position pixel values is referred to as "spatial filtering", i.e. the generation process involves spatial filtering of the respective reference areas. Thus, the state of the art process for generation of a bi-prediction block using two reference areas involves spatial filtering of the first area; spatial filtering of the second area, and finally averaging over the filtered areas. Spatial filtering is relatively demanding in terms of computational complexity.

[0081] It is realized that this computational complexity could be reduced, which will be described below. In order to reduce complexity, a block may first be constructed based on integer motion, e.g. by adding the two reference blocks together (without performing spatial filtering). This adding is an operation which is relatively cheap in terms of computational complexity. Then, the resulting block may be filtered, e.g. interpolated, in order to obtain e.g. half or quarter-pel resolution. The sub-pel adjustment can be performed according to one of the MVs, or based on e.g. separately coded/ decoded additional information.

[0082] When a block is associated with more than one MV and reference index, which is here referred to as "multi-prediction", the respective uni-directional prediction components of the multi-prediction can be determined. Uni-prediction may be referred to as "single-prediction", as can also e.g. intra prediction. It is realized that partitioning information could be derived based on the absolute difference between these uni-directional predictions. The partitioning information could be derived both in the encoder and the decoder, in order to avoid overhead when conveying fine grained partition information.

[0083] In regions where the absolute difference between the uni-directional predictions is relatively large, a single uni-directional prediction or a special bi-prediction could be used. The single uni-directional prediction could be made according to the reference index and MV indicated in the bit stream for one of the uni-prediction components of the bi-prediction (or multi-prediction). In other regions of the block, where the absolute difference between the uni-directional predictions is relatively small, bi-prediction can be used as indicated in the bit stream for the block. The decision of whether to use a single bi-prediction/ special bi-prediction for a region, or to use the bi-prediction indicated in the bit-stream, could be based e.g. on a comparison of the absolute difference between the uni-directional predictions associated with the region and a predefined threshold.

[0084] Assuming a bi-prediction block associated with 2 MVs and 2 reference areas. Conventionally, at this stage, this block is not further divided, but is encoded as is. However, it is realized that the "implicit" information obtained from analyzing the absolute differences or the "difference map", could be used for dividing the block into further partitions, both in the encoder and decoder.

[0085] When the absolute difference of 2 reference areas or predictions is calculated, there will be some region(s) in the difference map with higher absolute value(s) and some region(s) with lower absolute value(s). A low value of the absolute difference in a region usually represents that the same object is depicted in this region in both reference areas. If different objects would be depicted in the region in the respective reference areas, the absolute difference would be large. If the same object is depicted in a corresponding region in the respective reference areas, it is suitable and appropriate to average the regions. If the corresponding regions depict different objects, it does not make sense to average them.

[0086] For example, a threshold could be defined, where difference values higher than the threshold represent "different objects regions", and difference values lower than the threshold represent "same object regions". The block could be partitioned in accordance with these regions, according to a predefined scheme. As previously stated, the partitioning could be performed based on implicit information, i.e. without explicit signaling describing the partitioning. Another advantage of this is that "non square partitioning" can be supported. For example, when half of a ball is depicted in one block, the partitioning of the block could be made very precise around the ball's border.

[0087] The encoder could signal to the decoder if the partitioning approach described above should be used. When signaled that the partitioning approach should be used, the encoder may optionally signal, for regions having a relatively high absolute difference value, which of the uni-directional predictions to use or

which special bi-prediction to use. For example, weighted bi-prediction (other than average and possibly with DC offset) could be used. In some cases it may be needed to code/ decode some additional information to determine local parameters to be able to produce the special bi-prediction. The obtained partition information can also be used for prediction of partition information and the encoder may code changes compared to the predicted partition to be decoded and used by the decoder. Deriving partition information based on the difference between the reference areas can give a rough indication of how the partitioning should be done. Further refinement by sending refinements of the predicted partition information is also possible

[0088] One example to obtain the partition information is to divide the block into 4 equally sized sub-blocks. The sub-block with largest normalized SAD (Sum of Absolute Differences (divided by the number of pixels on which it was calculated)) is iteratively divided into 4 equally sized regions if the normalized SAD of the sub-block is e.g. equal to or larger than the normalized SAD of the 4 times larger "parent" block. Normalized SAD refers to SAD per pixel or SAD per one specific sub-block size. Instead of SAD, other metrics of pixel differences could alternatively be used. One example is a metric with more weight on strong local image structure, e.g. edges/ lines. A remaining sub-block, which is not divided further, is then set to be the partition that should use e.g. some modification of the bi-prediction.

The figure 13 shows an exemplifying embodiment of the partitioning method. The block on the left side, 1302:a, is bi-predicted. SAD calculation are performed on the block (now denoted 1302:b), and the high SAD areas are identified and selected out, and are handled accordingly. In this example, the high SAD area is handled by changing to uni-directional prediction with only backward MV. Thus, the original block may be partitioned into two partitions, of which one uses the bi-prediction indicated in the bit stream, and one (illustrated as comprising circles) uses uni-prediction (one of the components of the bi-prediction). Rate Distortion

Optimization (RDO) could be used to select the best uni-prediction (component of the bi-prediction).

[0089] Another example of how to obtain partitioning information is to divide e.g. a bi-prediction block into a number of e.g. equally sized sub-blocks; determine the maximum SAD of the sub-block size in question, and select the sub-blocks having a SAD "close" to, e.g. within a certain interval from, this maximum value, to be part of a region that is to use some modified version of the bi-prediction, or a uni-directional prediction.

[0090] Besides partitioning, this approach can be used e.g. to determine the previously described RIS index or state of the art reference indices, when a bi-prediction mode is used. For example, a smooth difference map for a region may suggest, and be interpreted as, that the region is possibly associated with a "bi-RIS index". The approach could further be used as an alternative prediction or in combination with the previously described Reference Indicator index Prediction. The selection can be made in both the encoder and the decoder based on the SAD between possible candidates of bi-prediction to select the combination with least SAD.

[0091] It should be noted that with the above described multi-prediction based partitioning approach, instead of deriving a block-based partitioning, other kinds of partitioning could be derived both at the encoder and the decoder. This includes linear (e.g. horizontal, vertical, or diagonal) or non-linear partitioning of the block into two or more partitions, e.g. according to non-linear image processing methods such as edge detection and/ or segmentation. For example, the multi-prediction difference signal can be segmented according to an image-segmentation method such as edge detection or region-growing, and then the block partition is derived based on the segmented difference signal.

[0092] The number of sub-partitions could be either derived through image-processing methods such as image segmentation, or could be signaled from the encoder to the decoder. As an alternative to linear or non-linear partitioning, also pixel-based partitioning can be applied. One variant would be to signal from the encoder to the decoder which partitioning method is used, another variant would be that the partitioning method is agreed between encoder and decoder through other signaling means. The advantage with multi-prediction based methods is that the partitioning information can be derived based on information that is already available at the encoder and the decoder, i.e. it does not have to be explicitly signaled, thus reducing the number of bits used for coding.

[0093] It should be noted that according to multi-prediction based partitioning, instead of switching from bi-prediction to uni-prediction with uni-directional MVs derived from the MVs used for bi-prediction, it is also possible to signal additional MVs and/ or prediction modes (uni-directional inter-picture prediction, bi-directional inter-picture prediction, or intra-picture prediction) for sub-partitions. In other words, the number and shapes of the partitions for a block could either be explicitly signaled and/ or be derived from implicit information, based on e.g. a segmentation method. Further, MVs and/ or prediction mode may be signaled for some or all of the resulting sub-partitions.

[0094] While the procedure as suggested above has been described with reference to specific embodiments provided as examples, the description is generally only intended to illustrate the inventive concept and should not be taken as limiting the scope of the suggested methods and arrangements, which are defined by the appended claims. While described in general terms, the methods and arrangements may be applicable e.g. for different types of communication systems, using commonly available communication technologies, such as e.g. GSM/ EDGE, WCDMA or LTE or broadcast technologies over satellite, terrestrial, or cable e.g. DVB-S, DVB-T, or DVB-C, but also for storage/ retrieval of video to/ from memory.

[0095] It is also to be understood that the choice of interacting units or modules, as well as the naming of the units are only for exemplifying purpose, and video handling entities suitable to execute any of the methods described above may be configured in a plurality of alternative ways in order to be able to execute the suggested process actions.

[0096] It should also be noted that the units or modules described in this disclosure are to be regarded as logical entities and not with necessity as separate physical entities.

ABBREVIATIONS

AVC	Advanced Video Coding
CABAC	Context Adapted Binary Arithmetic Coding
GOP	Group Of Pictures
MB	Macro Block
MV	Motion Vector
RIS	Reference Index Signaling/ Reference information Indicator Signaling
SAD	Sum of Absolute Difference
VLC	Variable Length Coding

CIAIMS

1. Method in a video decoding entity, the method comprising:

-obtaining (402) a single syntax element associated with an encoded block B_e,
-identifying (404) a reference mode and one or more reference pictures based on the obtained syntax element, and
-decoding (406) the block B_e based on the identified reference mode and one or more reference pictures, thus providing a decoded block, B, of pixels.

2. Method according to claim 1, wherein the identification of a reference mode and one or more reference pictures is based on a predefined mapping between the obtained syntax element and the reference mode and one or more specific reference pictures to be used when decoding the block B_e.

3. Method according to claim 1 or 2, wherein the single syntax element represents an entry in a first predefined reference lists.

4. Method according to claim 3, wherein the first list comprises one or more entries identifying at least one of:

-a plurality of reference pictures,
-a single reference picture.

5. Method according to claim 4, wherein each entry in the first list further identifies a reference mode.

6. Method according to claim 3 or 4, wherein the single syntax element further represents a reference mode and an entry in a second predefined reference list.

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7. Method according to claim 6, wherein the second list comprises one or more entries identifying a single reference picture.

8. Method according to any of the claims 3-7, where the one or more list entries are identified by a list index.

9. Method according to any of the preceding claims, wherein the number of bits representing the obtained syntax element is related to the probability of the specific values of the syntax element, where few bits imply probable values, and more bits imply less probable values.

10. Method according to any of the preceding claims, further comprising the performing of reference information prediction for Be, based on single syntax elements associated with neighboring blocks.

11. Method according to any of the preceding claims, further comprising:

-identifying one or more sub-regions of a block associated with multi-prediction, for which sub-regions the respective corresponding regions of the multi-prediction reference blocks have a relatively low correlation between them, and
-using an alternative prediction, instead of the multi-prediction, for the identified one or more sub-regions of the block.

12. Arrangement (500) in a video decoding entity (501), comprising:

-an obtaining unit (504), adapted to obtain a single syntax element associated with an encoded block B_e, and
-an identifying unit (506), adapted to identify a reference mode and one or more reference pictures based on the obtained syntax element, and
-a decoding unit (508), adapted to decode the block B_e based on the

identified reference mode and one or more reference pictures, thus providing a decoded block B of pixels.

13. Arrangement according to claim 12, further adapted to identify the reference mode and the one or more reference pictures based on a predefined mapping between the obtained syntax element and the reference mode and one or more specific reference pictures to be used when decoding the block B_e.

14. Arrangement according to claim 12 or 13, further adapted to interpret the single syntax element as representing an entry in a first predefined reference list.

15. Arrangement according to claim 14, the first list comprising one or more entries identifying at least one of:

-a plurality of reference pictures,
-a single reference picture.

16. Arrangement according to claim 15, wherein each entry in the first list further identifies a reference mode.

17. Arrangement according to any claim 14 or 15, further adapted to interpret the single syntax element as further representing a reference mode and an entry in a second predefined reference lists.

18. Arrangement according to claim 17, the second list comprising one or more entries identifying a single reference picture.

19. Arrangement according to any of the claims 14-18, the one or more list entries being identified by a list index.

20. Arrangement according to any of the claims 12-19, further adapted to interpret the number of bits representing the obtained syntax element as correlated to the probability of the specific values of the syntax element, such that few bits imply probable values, and more bits imply less probable values.

21. Arrangement according to any of the claims 12-20, further adapted to perform reference information prediction for Be, based on single syntax elements associated with neighboring blocks.

22. Arrangement according to any of the claims 12-21, further adapted to identify one or more sub-regions of a block associated with multi-prediction, for which sub-regions the respective corresponding regions of the multi-prediction reference blocks have a relatively low correlation between them, and,
the arrangement being further adapted to use an alternative prediction, instead of the multi-prediction, for the identified one or more sub-regions of the block.

23. Method in a video encoding entity, the method comprising:

-encoding (602) a block B of pixels using a reference mode and one or more reference pictures, thus providing an encoded block B_e,
-deriving (604) a single syntax element identifying the reference mode and the one or more reference picture(s)
-providing (606) the single syntax element to a decoder of the block B_e.

24. Method according to claim 23, wherein the syntax element is derived by that the used reference mode and one or more reference pictures are mapped to the syntax element according to a predefined mapping scheme.

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25. Method according to claim 23 or 24, wherein the single syntax element represents an entry in a first predefined reference list.

26. Method according to claim 25, wherein the first list comprises one or more entries identifying at least one of:

-a plurality of reference pictures
-a respective single reference picture.

27. Method according to claim 26, wherein each entry in the first list further identifies a reference mode.

28. Method according to claim 25 or 26, wherein the single syntax element further represents a reference mode and an entry in a second predefined reference lists.

29. Method according to claim 28, wherein the second list comprises one or more entries identifying a respective single reference picture.

30. Method according to any of the claims 25-29, where the one or more list entries are identified by a list index.

31. Method according to any of the claims 23-30, further comprising:

-selecting the number of bits representing the syntax element such as to be correlated to the probability of the specific mode(s) and picture(s), which the syntax element identifies, such that higher probability corresponds to few bits, and lower probability corresponds to more bits.

32. Method according to any of the claims 23-31, further comprising the performing of reference information prediction for B or Be, based on single syntax elements associated with neighboring blocks of B.

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33. Method according to any of the claims 23-32, further comprising:

-identifying one or more sub-regions of a block associated with multi-prediction, for which sub-regions the respective corresponding regions of the multi-prediction reference blocks have a relatively low correlation between them, and

-using an alternative prediction, instead of the multi-prediction, for the identified one or more sub-regions of the block.

34. Arrangement (700) in a video encoding entity, comprising:

-an encoding unit (702), adapted to encode a block B of pixels using a reference mode and one or more reference pictures, thus providing an encoded block B_e,

-a deriving unit (704), adapted to derive a single syntax element identifying the reference mode and the one or more reference pictures,

-a providing unit (706), adapted to provide the single syntax element to a decoder of the block B_e.

35. Arrangement according to claim 34, further adapted to derive the syntax element from a predetermined mapping between the reference mode and one or more reference pictures and the syntax element.

36. Arrangement according to claim 34 or 35, further adapted to derive the single syntax element by selecting a single syntax element representing an entry in a first predefined reference list.

37. Arrangement according to claim 36, the first list comprising one or more entries identifying at least one of:

-a plurality of reference pictures,

-a respective single reference picture.

38. Arrangement according to claim 37, where each entry in the first list further identifies a reference mode.

39. Arrangement according to claim 36 or 37, further adapted derive the single syntax element such as to further represent a reference mode and an entry in a second predefined reference lists.

40. Arrangement according to claim 39, the second list comprising one or more entries identifying a respective single reference picture.

41. Arrangement according to any of the claims 36-40, further adapted to derive the single syntax element by the selection of a list index identifying one or more entries in one or more predefined reference lists.

42. Arrangement according to any of the claims 34-41, further adapted to select the number of bits representing the syntax element such as to be correlated to the probability of the specific mode(s) and picture(s), which the syntax element identifies, such that higher probability corresponds to few bits, and lower probability corresponds to more bits.

43. Arrangement according to any of the claims 34-42, further adapted to perform reference information prediction for B or Be, based on single syntax elements associated with neighboring blocks.

44. Arrangement according to any of the claims 34-43, further adapted to identify one or more sub-regions of a block associated with multi-prediction, for which sub-regions the respective corresponding regions of the multi-prediction reference blocks have a relatively low correlation between them, and,
the arrangement being further adapted to use an alternative prediction,

instead of the multi-prediction, for the identified one or more sub-regions of the block.

45. A computer program (810), comprising computer readable code means, which when executed in an arrangement according to any of the claims 12-22 and 34-44, causes the arrangement to perform the corresponding procedure according to any of the claims 1-11 and 23-33.

46. A computer program product (808), comprising the computer program according to claim 45.

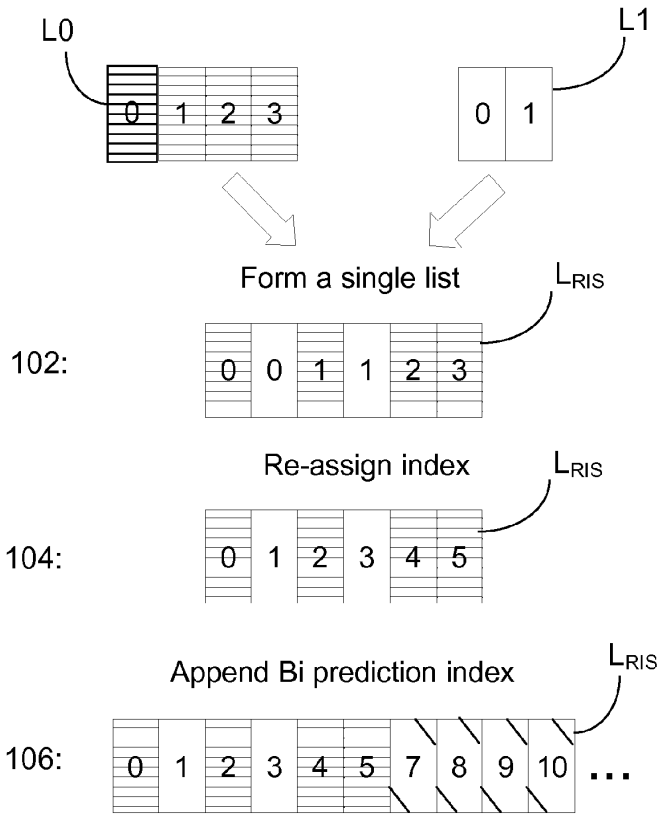

L0
0 1 2 3
L1
0 1
Form a single list
L_{RIS}
102:
0 0 1 1 2 3
Re-assign index
L_{RIS}
104:
0 1 2 3 4 5
Append Bi prediction index
L_{RIS}
106:
0 1 2 3 4 5 7 8 9 10 ...

Figure 1

	AVC	RIS
Number of reference picture lists	2	1
Reference index contained in each list	L0: 0, 1 L1: 0, 1	L: 0, 1, 2, 3, 4, 5, 6, 7
Uni-directional prediction	List = L0; Idx = 0	Idx = 0
	List = L1; Idx= 0	Idx = 1
	List = L0; Idx = 1	Idx = 3
	List = L1; Idx = 1	Idx = 4
Bi-prediction	List = L0; Idx = 0, List = L1; Idx = 0	Idx = 2
Bi-prediction	List = L0; Idx = 1, List = L1; Idx = 1	Idx = 5
Bi-prediction	List = L0; Idx = 0, List = L1; Idx = 1	Idx = 6
Bi-prediction	List = L0; Idx = 1, List = L1; Idx = 0	Idx = 7

Figure 2

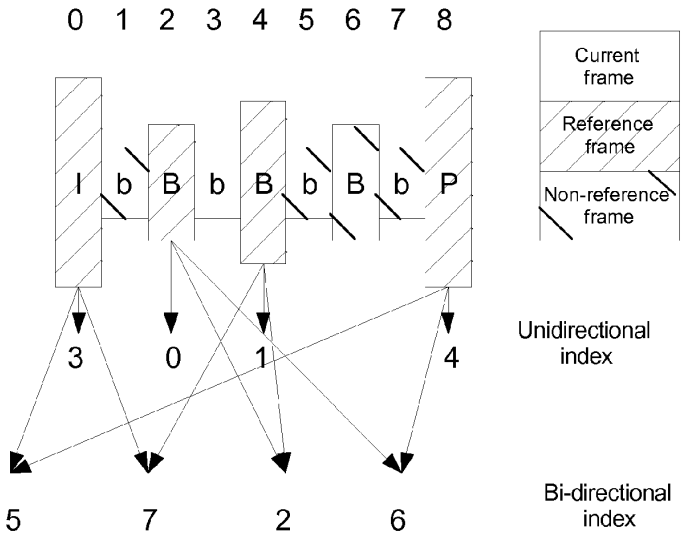

0 1 2 3 4 5 6 7 8
I b B b B b B b P
Current frame
Reference frame
Non-reference frame
3 0 1 4
Unidirectional index
5 7 2 6
Bi-directional index

Figure 3

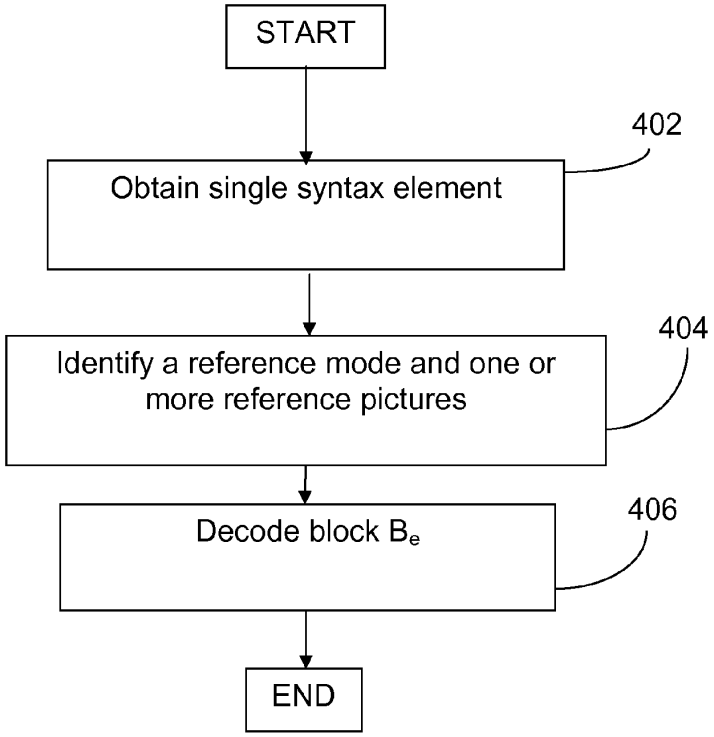

START
402
Obtain single syntax element
404
Identify a reference mode and one or more reference pictures
406
Decode block B_e
END

Figure 4

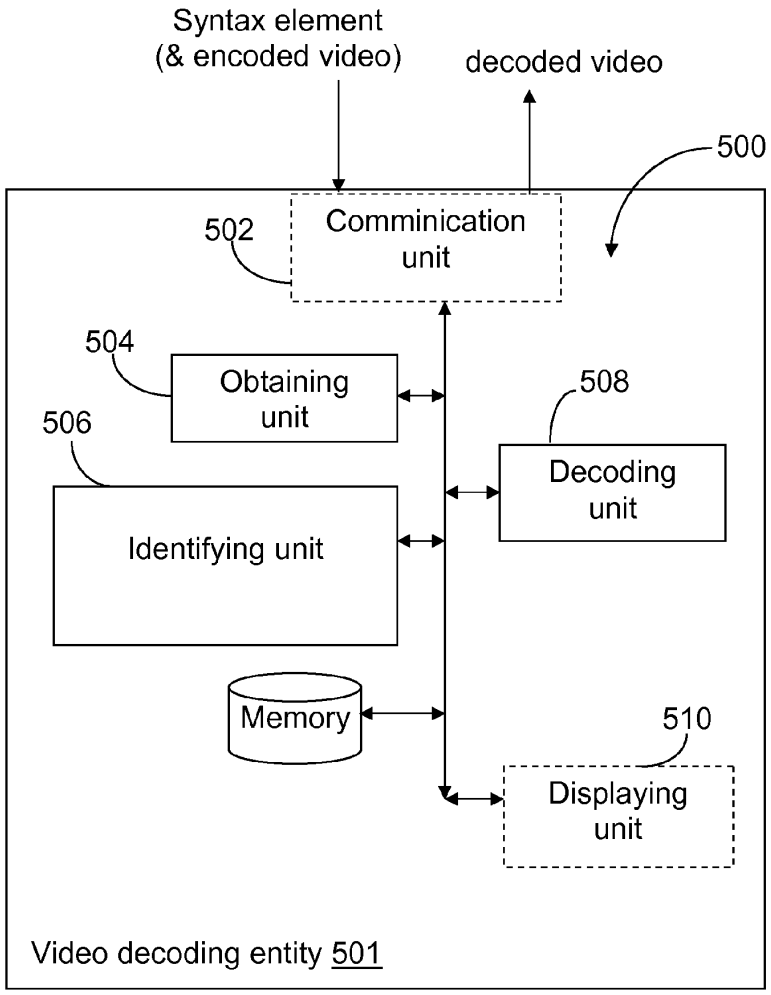

Syntax element
(& encoded video)
decoded video
500
502
Comminication unit
504
Obtaining unit
506
Identifying unit
508
Decoding unit
Memory
510
Displaying unit
Video decoding entity 501

Figure 5

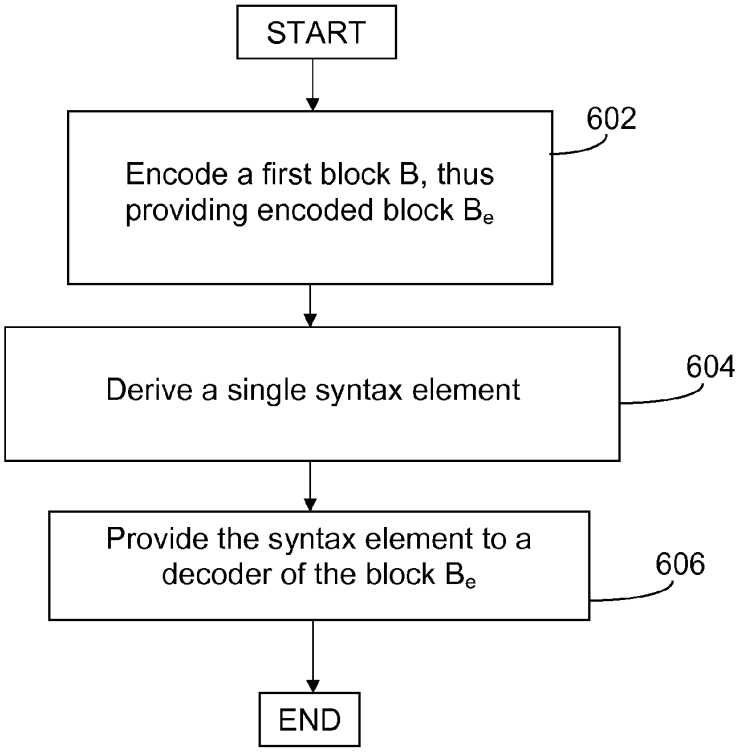

START
Encode a first block B, thus providing encoded block B_e
602
Derive a single syntax element
604
Provide the syntax element to a decoder of the block B_e
606
END

Figure 6

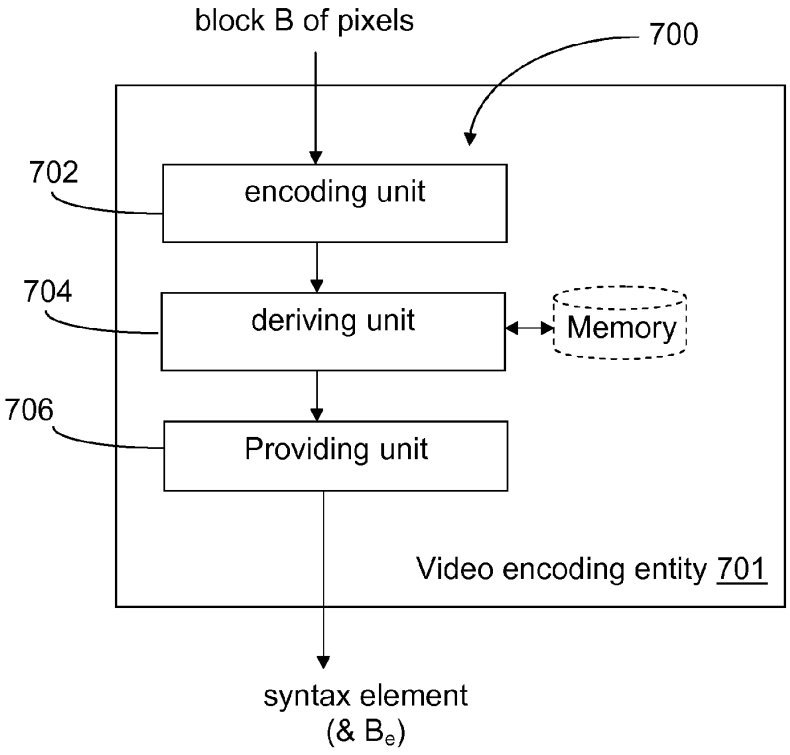

block B of pixels
700
702
encoding unit
704
deriving unit
Memory
706
Providing unit
Video encoding entity 701
syntax element
(& B_e)

Figure 7

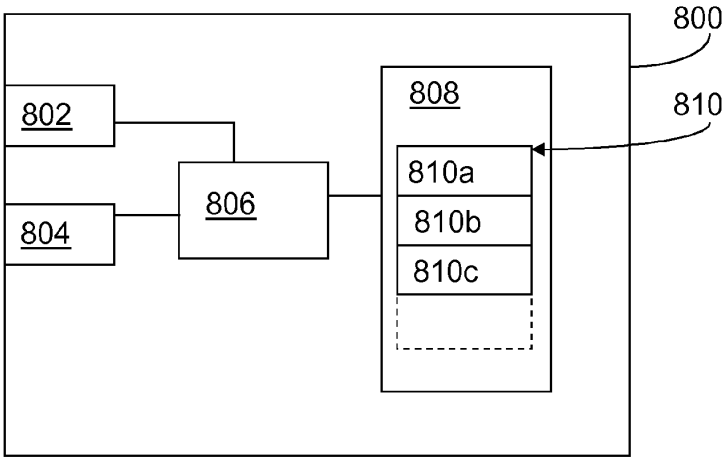


Figure 8

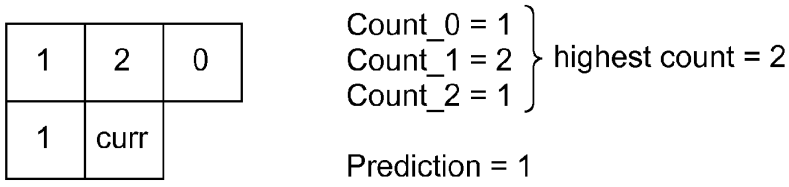


Figure 9

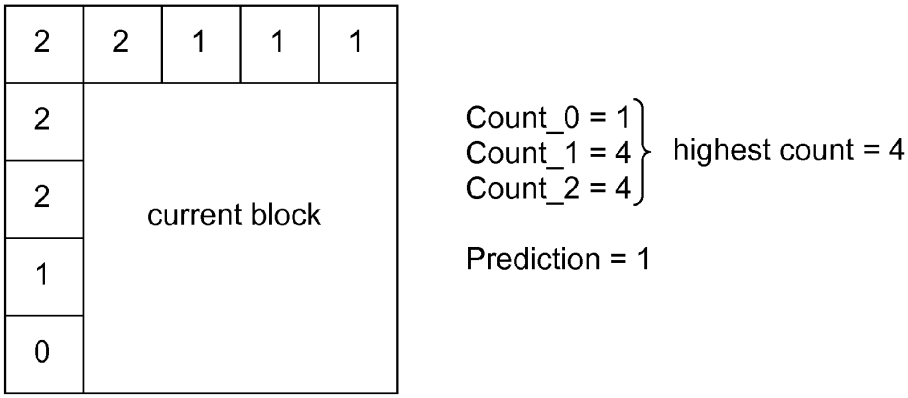


Figure 10

Index symbol	codeword
0	0
1	10
2	11

Figure 11

Index symbol	codeword
Equal to prediction	0
Unequal to prediction	10
Unequal to prediction	11

Figure 12

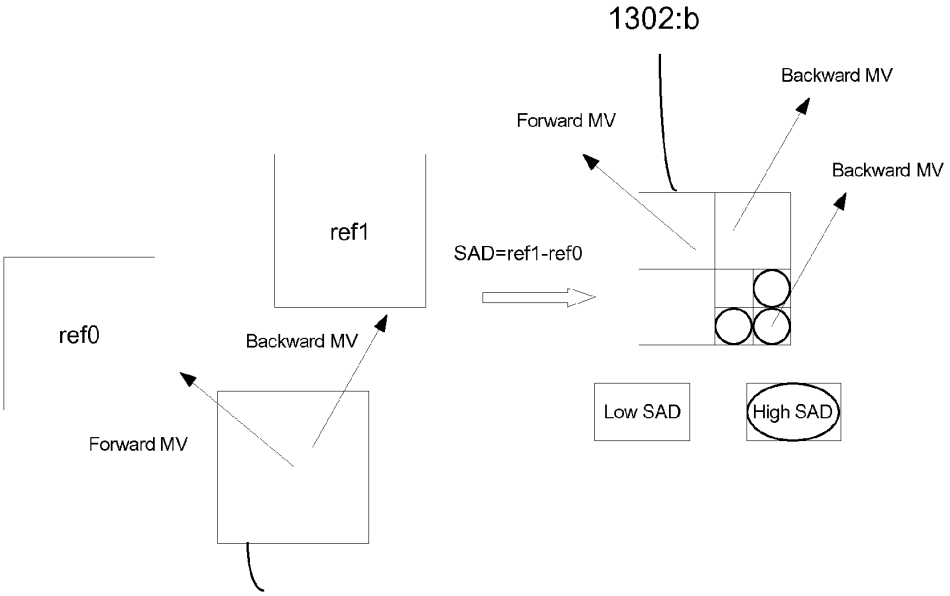

1302:b
Backward MV
Forward MV
Backward MV
ref1
SAD=ref1-ref0
ref0
Backward MV
Forward MV
Low SAD
High SAD
1302:a

Figure 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2010/051412

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 20090187960 A1 (LEE J.H. ET AL), 23 July 2009 (23.07.2009), figures 14,18, paragraphs [0013], [0095],[0121]-[0128],[0150]-[0151],[0171]	1-46
A	US 20060093038 A1 (BOYCE J. MACDONALD), 4 May 2006 (04.05.2006), paragraphs [0029],[0055],[0067]	1-46
A	US 20060153297 A1 (BOYCE J. MACDONALD), 13 July 2006 (13.07.2006), claims 8,9, paragraphs [0048],[0052]	1-46
A	US 20080159638 A1 (SONG H-S ET AL), 3 July 2008 (03.07.2008), claim 2, paragraph [0016]	1-46

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 March 2011	25 -03- 2011
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Jesper Bergstrand/ELY Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2010/051412

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1427216 A1 (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.), 9 June 2004 (09.06.2004), paragraph [0307] -- --------	1-46

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

International patent classification (IPC)

H04N 7/26 (2006.01)

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Use the application number as username. The password is **FHOTYTXEAI**.

Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

US	20090187960	A1	23/07/2009	NONE		
US	20060093038	A1	04/05/2006	NONE		
US	20060153297	A1	13/07/2006	NONE		
US	20080159638	A1	03/07/2008	NONE		
EP	1427216	A1	09/06/2004	AU	2003242037 A	23/01/2004
				CN	1666532 A	07/09/2005
				US	20040234143 A	25/11/2004
				WO	2004006586 A	15/01/2004

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Electronic Acknowledgement Receipt

EFS ID:	12434789
Application Number:	13192111
International Application Number:	
Confirmation Number:	5397
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING
First Named Inventor/Applicant Name:	Jani LAINEMA
Customer Number:	73658
Filer:	Thomas Joseph Arria/Brian O'Donoghue
Filer Authorized By:	Thomas Joseph Arria
Attorney Docket Number:	NC73661US-NP
Receipt Date:	30-MAR-2012
Filing Date:	27-JUL-2011
Time Stamp:	14:09:01
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	IDS.pdf	612610 69eb81e06b8685a12187954ef4ff87c2c3daf83a	no	4

Warnings:	
Information:	

2	Foreign Reference	ISR-WO.pdf	611421 ffcb8d85075275230267be37bb035e0fe6d12227	no	13
Warnings:					
Information:					
3	Non Patent Literature	LAM-BonnieKY-ParallelArch.pdf	21046745 06e7af5dd152501eac587168ae2074235c151020	no	98
Warnings:					
Information:					
4	Non Patent Literature	UGUR-Kemal-DescriptionofVideo.pdf	1865298 75264c3d389e5735a529344b0734c085f0d4e02d	no	34
Warnings:					
Information:					
5	Non Patent Literature	UGUR-Kemal-HighPerformance.pdf	1658381 13c854a6c64c5783f587167ee5d40be00a5194ff	no	10
Warnings:					
Information:					
6	Non Patent Literature	UGUR-Kemal-LowComplexityVideo.pdf	470552 c74390157d01bb14bca4a253d96399fae85e4a0c	no	4
Warnings:					
Information:					
7	Foreign Reference	WO2008053755A2.pdf	4080124 7f9c4d902ab175bb5b86e2b9fbbc7b8dce832224	no	43
Warnings:					
Information:					
8	Foreign Reference	WO2011075071A1.pdf	4971787 1c0847787d62ca080079e03cb9f8d05713058f9e	no	54
Warnings:					
Information:					
		Total Files Size (in bytes):	35316918		

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New International Application Filed with the USPTO as a Receiving Office
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Nokia, Inc.
Attn: Intellectual Property Rights Docketing
200 South Mathilda Ave
Sunnyvale CA 94086

MAILED
JUN 12 2012
OFFICE OF PETITIONS

In re Application of :
LAINEMA et al. : DECISION ON PETITION
Application No. 13/192,111 :
Filed: 07/27/2011 :
Attorney Docket No. NC73661US-NP :

This is a decision on the petition under 37 CFR 1.137(b), filed March 23, 2012, to revive the above-identified application.

The petition is **GRANTED**.

On August 10, 2011, the Office mailed a Notice to File Missing Parts of Nonprovisional Application, which set a two-month extendable period to reply. No extensions of the period of response were obtained. In the absence of a timely filed reply to the Notice to File Missing Parts, the above-identified application became abandoned on October 11, 2011.

Petitioner has met the requirements to revive the above-identified application pursuant to 37 CFR 1.137(b). Petitioner submitted the required reply, paid the petition fee, and made a proper statement of unintentional delay.

This matter is being referred to the Office of Patent Application Processing.

Telephone inquiries specific to this decision may be directed to the undersigned at (571) 272-3211.

/Christina Tartera Donnell/

Christina Tartera Donnell
Senior Petitions Attorney
Office of Petitions

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
13/192,111	07/27/2011	2819	1220	NC73661US-NP	20	3

CONFIRMATION NO. 5397

UPDATED FILING RECEIPT

73658
Nokia, Inc.
Attn: Intellectual Property Rights Docketing
200 South Mathilda Ave
Sunnyvale, CA 94086

OC000000054987984

Date Mailed: 06/27/2012

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Jani LAINEMA, Tampere, FINLAND;
Kemal UGUR, Tampere, FINLAND;
Antti Olli HALLAPURO, Tampere, FINLAND;

Assignment For Published Patent Application

NOKIA CORPORATION, Espoo, FINLAND

Power of Attorney: The patent practitioners associated with Customer Number 73658

Domestic Priority data as claimed by applicant

This appln claims benefit of 61/368,316 07/28/2010

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)

If Required, Foreign Filing License Granted: 08/05/2011

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/192,111**

Projected Publication Date: 10/04/2012

Non-Publication Request: No

Early Publication Request: No

Title

METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING

Preliminary Class

341

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Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

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The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage, facilitate, and accelerate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/192,111

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	380
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	620
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	250
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*			OR	x 60 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*				x 250 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1250

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/192,111	07/27/2011	Jani LAINEMA	NC73661US-NP

CONFIRMATION NO. 5397

73658
Nokia, Inc.
Attn: Intellectual Property Rights Docketing
200 South Mathilda Ave
Sunnyvale, CA 94086

POA ACCEPTANCE LETTER

OC000000054987937

Date Mailed: 06/27/2012

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 03/23/2012.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/ttran/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/192,111	07/27/2011	Jani LAINEMA	NC73661US-NP

CONFIRMATION NO. 5397

73658
Nokia, Inc.
Attn: Intellectual Property Rights Docketing
200 South Mathilda Ave
Sunnyvale, CA 94086

PUBLICATION NOTICE

OC000000056915201

Title:METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING

Publication No.US-2012-0250763-A1
Publication Date:10/04/2012

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently http://pair.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/192,111	07/27/2011	Jani LAINEMA	NC73661US-NP	5397

73658 7590 10/31/2013

Nokia, Inc.
Attn: Intellectual Property Rights Docketing
200 South Mathilda Ave
Sunnyvale, CA 94086

EXAMINER	
GEROLEO, FRANCIS	
ART UNIT	PAPER NUMBER
2485	

NOTIFICATION DATE	DELIVERY MODE
10/31/2013	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

brian.odonoghue@nokia.com
thao.pham@nokia.com
sandy.fong-hou@nokia.com

Office Action Summary	Application No. 13/192,111	Applicant(s) LAINEMA ET AL.	
	Examiner FRANCIS G. GEROLEO	Art Unit 2485	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

5)☒ Claim(s) 1-20 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) 1-20 is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on 27 July 2011 is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some * c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

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Snap v. Nokia - IPR2025-01345
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DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 1-20 are rejected under 35 U.S.C. 102(b) as being anticipated by US 2009/0141806 A1 ("Marpe").

Marpe, in Figures, 1-16, discloses a Video Frame Encoding and Decoding that is the same apparatus/method and computer program product, as specified in claims 1, 8, 15 of the present invention, comprising:

categorizing a plurality of syntax elements of video content (e.g. 104 in fig. 2) into first and second categories (e.g. 113 in fig. 2 (i.e. regular or bypass)) based on a frequency of occurrence of the syntax elements in the video content (e.g. based on whether the bits corresponding to a bin string have a 50/50 chance to be 1 or 0) (paragraph [0054]);

entropy coding symbols that correspond to the first category of syntax elements (e.g. 118 in fig. 2) and that have been subjected to a context update (e.g. 112 in fig. 2); and

entropy coding symbols that correspond to the second category of syntax elements (e.g. 120 in fig. 2) and that have bypassed context updating (e.g. as illustrated in fig. 2, when switch 113 is connected to bypass, 112 context modeler is bypassed).

Regarding claims 2, 9, 16, Marpe further discloses further comprising causing a categorization of the syntax elements to be signaled at a block, slice, picture or sequence level (see fig. 2; paragraph [0044]).

Regarding claims 3, 10, 17, Marpe further discloses further comprising performing binarization of the symbols that correspond to the second category of syntax elements prior to bypassing the context updating (see 102 in fig. 2).

Regarding claims 4, 11, 18, Marpe further discloses wherein performing binarization comprises performing binarization so as to target a predetermined probability (see paragraph [0052]).

Regarding claims 5, 12, 19 Marpe further discloses further comprising causing an indication of the entropy coding to be signaled at a block, slice, picture or sequence level (see fig. 2; paragraph [0044]).

Regarding claims 6, 13, 20, Marpe further discloses wherein categorizing the plurality of syntax elements comprises categorizing the plurality of syntax elements based on a relationship of the frequency of occurrence of the syntax elements to a predefined threshold (see paragraph [0054]).

Regarding claims 7, 14, Marpe further discloses further comprising performing binarization of the symbols that correspond to the first category of syntax elements prior to entropy coding the symbols that correspond to the first category of syntax elements (see 102 in fig. 2).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to FRANCIS G. GEROLEO whose telephone number is (571)270-7206. The examiner can normally be reached on Monday - Friday 8:00am-5:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jay Patel can be reached on 5712722988. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Young Lee/
Primary Examiner, Art Unit 2485

/FRANCIS G GEROLEO/
Examiner, Art Unit 2485

Notice of References Cited	Application/Control No. 13/192,111	Applicant(s)/Patent Under Reexamination LAINEMA ET AL.	
	Examiner FRANCIS G. GEROLEO	Art Unit 2485	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2009/0141806 A1	06-2009	MARPE et al.	375/240.24
	B	US-			
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13192111	LAINEMA ET AL.
	Examiner	Art Unit
	FRANCIS G GEROLEO	2485

CPC- SEARCHED		
Symbol	Date	Examiner
H04N 7/26	8/13/13	fgg

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
375	240.08	8/13/13	fgg

SEARCH NOTES		
Search Notes	Date	Examiner
EAST including inventor; NPL (Google)	8/13/13	fgg

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S3	3	("20080276078" | "20090273491" | "20110001643").PN.	US-PGPUB; USPAT	OR	ON	2013/08/12 14:38
S4	750	375/240.08.ccls.	US-PGPUB; USPAT	OR	ON	2013/08/12 14:40
S5	68	(jani near2 lainema).in.	US-PGPUB; USPAT	OR	ON	2013/08/12 14:41
S6	34	(kemal near2 ugur).in.	US-PGPUB; USPAT	OR	ON	2013/08/12 14:41
S7	28	(antti near2 hallapuro).in.	US-PGPUB; USPAT	OR	ON	2013/08/12 14:41
S8	3	S4 and S5	US-PGPUB; USPAT	OR	ON	2013/08/12 14:41
S12	237	(complexity near5 entropy near5 (cod$3 or encod$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/08/12 14:49
S13	5	(complexity near5 balanc$3 near5 entropy near5 (cod$3 or encod$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/08/12 14:49
S14	2996	(categoriz$3 near7 (syntax or element))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/08/12 14:52
S15	0	(categoriz$3 near7 (syntax or element)) with (frequency near7 (occur$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/08/12 14:52
S16	1	(categoriz$3 near7 (syntax or element)) same (frequency near7 (occur$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/08/12 14:53
S17	17	(categoriz$3 near7 (syntax or element)) with frequency	US-PGPUB; USPAT;	OR	ON	2013/08/12 14:53

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Snap v. Nokia - IPR2025-01345
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			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S18	2996	(categoriz$3 near7 (syntax or element))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/08/12 14:55
S20	1316	((context near5 updat$3) and bypass$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/08/12 14:56
S21	37	S18 and S20	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/08/12 14:56
S22	2	S18 and S20 and S12	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/08/12 14:57
S23	18890	(entropy near5 (cod$3 or encod$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/08/12 14:57
S24	1046	((entropy near5 (cod$3 or encod$3)) same complexity)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/08/12 14:57
S25	2	S18 and S20 and S24	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/08/12 14:57
S26	2	S18 and S20 and S23	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/08/12 14:58

Snap - Exhibit 1002
Snap v. Nokia - IPR2025-01345
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S27	190	S20 and S23	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/08/12 14:58
S28	24	S20 and S24	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/08/12 14:59
S29	73	(("20100002761") or ("20100067577") or ("20100194992") or ("20100194992") or ("20110261882") or ("20110110417") or ("20110261174") or ("20100309316") or ("20100290524") or ("20100321485") or ("20120007968") or ("20110058017") or ("20110235700") or ("20100283834") or ("20100289895") or ("20100289891") or ("20100321482") or ("20110001805") or ("20110001819") or ("20110316971") or ("20110001883") or ("20110001815") or ("20110001815") or ("20110007141") or ("20110037843") or ("20110018977") or ("20110012996") or ("20110249093") or ("20110018969") or ("20110169939") or ("20110025843") or ("20110025843") or ("20110012998") or ("20120013726") or ("20110122227") or ("20110298890") or ("20120044988") or ("20100295923") or ("20110176601") or ("20110242362") or ("20110149056") or ("20110149023") or ("20110149023") or ("20120092500") or ("20120092500") or ("20120086707") or ("20110255598") or ("20110116548") or ("20110116548") or ("20110142134") or ("20110249726") or ("20120250772") or ("20110317764") or ("20110317764") or ("20120033043") or ("20120033043") or ("20120287239") or ("20120287239") or ("20110279661") or ("20110279662") or ("20110279680") or ("20110279680") or ("20120287240") or ("20120194669") or ("20110176604") or ("20110286521") or ("20120002723") or ("20130003863") or ("20120051431") or ("20130002845") or ("20120001904") or ("20120169860") or ("20120176491") or ("20130002857") or ("20120050482") or ("20120050482") or ("20120013730") or ("20120050484") or ("20120050484") or ("20120250763") or ("20120027080") or ("20110298896") or ("20110304691") or ("20110298915") or ("20130044219")).PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/08/12 15:03
S30	4	S29 and cabac	US-PGPUB; USPAT	OR	ON	2013/08/12 15:03
S31	18	S29 and (quantizer or quantization)	US-PGPUB; USPAT	OR	ON	2013/08/12 15:04
S32	3	S18 and S20 and cabac	US-PGPUB;	OR	ON	2013/08/12

Snap - Exhibit 1002
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			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			15:07
S33	4	("2008/0276078").URPN.	USPAT	OR	ON	2013/08/12 15:12
S34	431968	((categoriz$3 or group$3) near7 (syntax or element))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/08/12 15:14
S35	26	S34 and S20 and cabac	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/08/12 15:15
S36	3	("2007300517").PN.	JPO; DERWENT	OR	OFF	2013/08/12 15:29
S37	1	2008-A68084.NRAN.	DERWENT	OR	ON	2013/08/12 15:30
S38	1	("20090304075").PN.	JPO; DERWENT	OR	OFF	2013/08/12 15:30
S39	2	("20090304075").PN.	US-PGPUB; USPAT; JPO; DERWENT	OR	OFF	2013/08/12 15:31
S40	2694	((bypass$3 circumvent$3 or omit$4 or sidestep$4) near7 (context))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/08/12 16:32
S41	209	S34 and S40	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/08/12 16:33
S42	26	S41 and entropy	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/08/12 16:34

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Snap - Exhibit 1002
Snap v. Nokia - IPR2025-01345
Page 200 of 378

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13192111	LAINEMA ET AL.
	Examiner	Art Unit
	FRANCIS G GEROLEO	2485

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	08/13/2013								
	1	✓								
	2	✓								
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	18	✓								
	19	✓								
	20	✓								

Snap - Exhibit 1002
Snap v. Nokia - IPR2025-01345
Page 201 of 378

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)		
	Application Number	13192111
	Filing Date	2011-07-27
	First Named Inventor	Jani LAINEMA
	Art Unit	~~2619~~
	Examiner Name	TBD
	Attorney Docket Number	NC73661US-NP

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	1	20090273491	A1	2009-11-05	SAKAGUCHI HIROAKI et al.	
	2	20080276078	A1	2008-11-06	HU YENDO	
	3	20110001643	A1	2011-01-06	SZE VIVIENNE et al.	
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	1	2008053755	WO	A2	2008-05-08	CANON KK et al.		☐

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Receipt date: 03/30/2012	Application Number	13192111 13192111 - GAU: 2485
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Filing Date	2011-07-27
	First Named Inventor	Jani LAINEMA
	Art Unit	~~2619~~
	Examiner Name	TBD
	Attorney Docket Number	NC73661US-NP

	2	2011075071	WO	A1	2011-06-23	ERICSSON TELEFON AB L M et al.		☐

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	International Search Report and Written Opinion, received in corresponding Patent Cooperation Treaty Application No. PCT/IB2011/053356, dated December 29, 2011, 13 pages.	☐
	2	UGUR, Kemal, "Description of Video Coding Technology Proposal by Tandberg, Nokia, Ericsson", JCT-VC meeting; April 15, 2010 - April 23, 2010, JCTVC-A119; whole document.	☐
	3	UGUR, Kemal, "High Performance Low Complexity Video Coding and the Emerging HEVC Standard", IEEE Transactions on Circuits and Systems for Video Technology, December 01, 2010, Vol. 20, nr. 12, pages 1688-1697, ISSN 1051-8215.	☐
	4	UGUR, Kemal, "Low Complexity Video Coding and the Emerging HEVC Standard", Picture Coding Symposium 2010, December 08, 2010 - December 12, 2010, Nagoya, 20101208.	☐
	5	LAM, Bonnie, "Parallel Architectures for Entropy Coding in a Dual-Standard Ultra-HD Video Encoder", Massachusetts Institute of Technology, Dept. of Electrical Engineering and Computer Science, May 21, 2010; pages 39-58; Chapter 3.	☐

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	First Named Inventor	Jani LAINEMA
	Art Unit	~~2819~~
	Examiner Name	TBD
	Attorney Docket Number	NC73661US-NP

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Signature	/Thomas J. Arria/	Date (YYYY-MM-DD)	2012-03-30
Name/Print	Thomas J. Arria	Registration Number	60223

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CONFIRMATION NO. 5397

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
13/192,111	07/27/2011	375	2485	NC73661US-NP

APPLICANTS

Jani LAINEMA, Tampere, FINLAND;
Kemal UGUR, Tampere, FINLAND;
Antti Olli HALLAPURO, Tampere, FINLAND;

**** CONTINUING DATA ***************************

This appln claims benefit of 61/368,316 07/28/2010

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****

08/05/2011

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☐ No Verified and Acknowledged /FRANCIS GEROLEO/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		FINLAND	8	20	3

ADDRESS

Nokia, Inc.
Attn: Intellectual Property Rights Docketing
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Sunnyvale, CA 94086
UNITED STATES

TITLE

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	Application Number	13192111
	Filing Date	2011-07-27
	First Named Inventor	Jani Lainema
	Art Unit	2485
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13192111
	Filing Date	2011-07-27
	First Named Inventor	Jani Lainema
	Art Unit	2485
	Examiner Name	Francis Geroleo
	Attorney Docket Number	NC73661US-NP

	1	European Search Report received for corresponding European Patent Application No. 11811919.7 dated December 20, 2013, 6 pages.	☐
	2	Vivienne et al., "A High Throughput CABAC Algorithm Using Syntax Element Partitioning", Image Processing (ICIP) 2009, 16th IEEE International Conference on IEEE, Piscataway, NJ, USA, November 7, 2009, pages 773-776.	☐
	3	Marpe et al., "Context-Based Adaptive Binary Arithmetic Coding in the H.264/AVC Video Compression Standard", IEEE Transactions on Circuits and Systems for Video Technology, IEEE Service Center, Piscataway, NF, US, Vol. 13, No. 7, July 1, 2003, pages 620-636.	☐

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Signature	/Thomas J. Arria/	Date (YYYY-MM-DD)	2014-01-06
Name/Print	Thomas J. Arria	Registration Number	60223

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Snap - Exhibit 1002
Snap v. Nokia - IPR2025-01345
Page 210 of 378

Electronic Acknowledgement Receipt

EFS ID:	17834308
Application Number:	13192111
International Application Number:	
Confirmation Number:	5397
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING
First Named Inventor/Applicant Name:	Jani LAINEMA
Customer Number:	73658
Filer:	Thomas Joseph Arria/thao pham
Filer Authorized By:	Thomas Joseph Arria
Attorney Docket Number:	NC73661US-NP
Receipt Date:	06-JAN-2014
Filing Date:	27-JUL-2011
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Application Type:	Utility under 35 USC 111(a)

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Application Number	13/192,111
Filing Date	July 27, 2011
First Named Inventor	Lainema et al.
Art Unit	2485
Examiner Name	Francis Geroleo
Attorney Docket Number	042933/442419

Please change the Correspondence Address for the above-identified patent application to:

☑ The address associated with Customer Number: **10949**

OR

☐ Firm or Individual Name

Address

City	State	Zip

Country

Telephone	Email

This form cannot be used to change the data associated with a Customer Number. To change the data associated with an existing Customer Number use "Request for Customer Number Data Change" (PTO/SB/124).

I am the:

☐ Applicant/Inventor

☐ Assignee of record of the entire interest.
Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96).

☑ Attorney or agent of record. Registration Number 34,610.

☐ Registered practitioner named in the application transmittal letter in an application without an executed oath or declaration. See 37 CFR 1.33(a)(1). Registration Number_____.

Signature	/Guy R. Gosnell/
Typed or Printed Name	Guy R. Gosnell
Date 02/17/2014	Telephone 704-444-1000

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

☐ *Total of _____forms are submitted.

This collection of information is required by 37 CFR 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	18217927
Application Number:	13192111
International Application Number:	
Confirmation Number:	5397
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING
First Named Inventor/Applicant Name:	Jani LAINEMA
Customer Number:	73658
Filer:	Robert Flynt Strean/RIEKO WELCH
Filer Authorized By:	Robert Flynt Strean
Attorney Docket Number:	NC73661US-NP
Receipt Date:	17-FEB-2014
Filing Date:	27-JUL-2011
Time Stamp:	15:05:02
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	442419_POA_02-17-2014.PDF	61638 7e5a7b6da657db19ba853fe5fc10bedf9948ee4f	no	1

Warnings:

The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing					
Information:					
2	Assignee showing of ownership per 37 CFR 3.73.	442419_373b_Statement_12-27-2013.PDF	560618 52cd660c18d570c972963dd80e2ce424085ee35d	no	2
Warnings:					
Information:					
3	Change of Address	442419_Change_Correspondence_Address_02-17-2014.PDF	321100 eb72d54c9b27136925e27488f71af08c6aaf2346	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	943356	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby appoint:

☒ Practitioners associated with the Customer Number: **10949**

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) and are authorized to act on behalf of the Assignee in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(b).

Assignee Name and Address:

NOKIA CORPORATION
Keilalahdentie 4
FIN-02150 Espoo, Finland

A copy of this form, together with a statement under 37 CFR 3.73(b) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record
The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Name:	Virpi Tognetty	
Signature:	Virpi Tognetty	Date: 20 December 2012
Title:	Director, Patenting Operations Legal and Intellectual Property	Telephone:
Name:		
Signature:	Jukka Nihtilä	Date: 20 December 2012
Title:	Head, Business Development Legal & IP	Telephone:

PTO/SB/96 (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Lainema et al.

Application No./Patent No.: 13/192,111 Filed/Issue Date: July 27, 2011

Titled: METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING

Nokia Corporation , a corporation
(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that it is:

1. [x] the assignee of the entire right, title, and interest in;

2. [ ] an assignee of less than the entire right, title, and interest in
(The extent (by percentage) of its ownership interest is _____ %); or

3. [ ] the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

A. [x] An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel 027916, Frame 0428, or for which a copy therefore is attached.

OR

B. [ ] A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

2. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

3. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

[ ] Additional documents in the chain of title are listed on a supplemental sheet(s).

[x] As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (*i.e.*, a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Guy R. Gosnell/ 02/17/2014
Signature Date

Guy R. Gosnell Reg. No. 34,610
Printed or Typed Name Title

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

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The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/192,111	07/27/2011	Jani LAINEMA	042933/442419

CONFIRMATION NO. 5397

10949
Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

POA ACCEPTANCE LETTER

OC000000066660326

Date Mailed: 02/26/2014

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 02/17/2014.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/ttkim/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/192,111	07/27/2011	Jani LAINEMA	NC73661US-NP

CONFIRMATION NO. 5397

73658
Nokia, Inc.
Attn: Intellectual Property Rights Docketing
200 South Mathilda Ave
Sunnyvale, CA 94086

POWER OF ATTORNEY NOTICE

OC000000066660304

Date Mailed: 02/26/2014

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 02/17/2014.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

/ttkim/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

Substitute for form 1449/PTO (Revised 07/2007)				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(Use as many sheets as necessary)*				Application Number	13/192,111
				Filing Date	July 27, 2011
				First Named Inventor	Lainema et al.
				Art Unit	2485
				Examiner Name	F. Geroleo
Sheet	*1*	of	1	Attorney Docket Number	042933/442419

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
	1	Office Action for Korean Application No. 10-2013-7005051 dated February 27, 2014	Partial

Examiner Signature		Date Considered	

*Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. LEGAL02/34758998v1

Submitted March 28, 2014

Electronic Acknowledgement Receipt

EFS ID:	18617216
Application Number:	13192111
International Application Number:	
Confirmation Number:	5397
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING
First Named Inventor/Applicant Name:	Jani LAINEMA
Customer Number:	10949
Filer:	Christopher Jason Gegg/Joyce Smith
Filer Authorized By:	Christopher Jason Gegg
Attorney Docket Number:	042933/442419
Receipt Date:	28-MAR-2014
Filing Date:	27-JUL-2011
Time Stamp:	17:10:57
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		IDS442419.PDF	589395 1473abcc77c23f86293b51c7034ec42a557b4aa1	yes	11

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Transmittal Letter	1	2
	Information Disclosure Statement (IDS) Form (SB08)	3	3
	Non Patent Literature	4	11
Warnings:			
Information:			
	Total Files Size (in bytes):	589395	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Attorney's Docket No. 042933/442419

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Lainema et al.	Confirmation No.:	5397
Appl. No.:	13/192,111	Group Art Unit:	2485
Filed:	July 27, 2011	Examiner:	F. Geroleo
For:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING		

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT UNDER 37 C.F.R. § 1.97(c)

Attached is a document listed on form PTO-1449 along with a copy of the non-patent literature document in accordance with 37 CFR 1.98(a)(2).

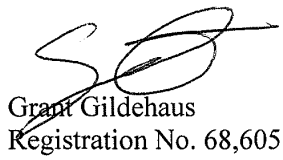
It is requested that the Examiner consider this document and officially make it of record in accordance with the provisions of 37 C.F.R. § 1.97 and Section 609 of the MPEP. By identifying the listed document, Applicant in no way makes any admission as to the prior art status of the listed document, but is instead identifying the listed document for the sake of full disclosure.

This Information Disclosure Statement is submitted in accordance with 37 C.F.R. § 1.97(c), before final Office Action or Allowance, whichever is earlier.

In accordance with the requirements of 37 C.F.R. § 1.97(c), the following statement as specified in 37 C.F.R. § 1.97(e) is made:

Each item of information contained in this statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three (3) months prior to the filing of this statement. In this regard, Applicants note that the communication from the foreign patent office was not received by any individual designated by 37 CFR 1.56(c) more than thirty (30) days prior to the filing of this Information Disclosure Statement.

Respectfully submitted,



Grant Gildehaus
Registration No. 68,605

CUSTOMER NO. 10949
ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000
Fax Charlotte Office (704) 444-1111
#34759016v1

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.:	13/192,111	Confirmation No.: 5397
Applicant(s):	Lainema et al.	
Filed:	July 27, 2011	
Art Unit:	2485	
Examiner:	Francis Geroleo	
Title:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING	

Docket No.: 042933/442419
Customer No.: 10949

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE UNDER 37 C.F.R. § 1.111

In response to the Office Action dated October 31, 2013, please consider the following:

Listing of claims begins on page 2 of this paper.

Remarks begin on page 6 of this paper.

Listing of the Claims:

1. (Original) A method comprising:

categorizing a plurality of syntax elements of video content into first and second categories based on a frequency of occurrence of the syntax elements in the video content;

entropy coding symbols that correspond to the first category of syntax elements and that have been subjected to a context update; and

entropy coding symbols that correspond to the second category of syntax elements and that have bypassed context updating.

2. (Original) A method according to Claim 1 further comprising causing a categorization of the syntax elements to be signaled at a block, slice, picture or sequence level.

3. (Original) A method according to Claim 1 further comprising performing binarization of the symbols that correspond to the second category of syntax elements prior to bypassing the context updating.

4. (Original) A method according to Claim 3 wherein performing binarization comprises performing binarization so as to target a predetermined probability.

5. (Original) A method according to Claim 1 further comprising causing an indication of the entropy coding to be signaled at a block, slice, picture or sequence level.

6. (Original) A method according to Claim 1 wherein categorizing the plurality of syntax elements comprises categorizing the plurality of syntax elements based on a relationship of the frequency of occurrence of the syntax elements to a predefined threshold.

7. (Original) A method according to Claim 1 further comprising performing binarization of the symbols that correspond to the first category of syntax elements prior to entropy coding the symbols that correspond to the first category of syntax elements.

Snap - Exhibit 1002
Snap v. Nokia - IPR2025-01345
Page 228 of 378

8. (Original) An apparatus comprising at least one processor and at least one memory including computer program code, the at least one memory and the computer program code configured to, with the processor, cause the apparatus to at least:

categorize a plurality of syntax elements of video content into first and second categories based on a frequency of occurrence of the syntax elements in the video content;

entropy code symbols that correspond to the first category of syntax elements and that have been subjected to a context update; and

entropy code symbols that correspond to the second category of syntax elements and that have bypassed context updating.

9. (Original) An apparatus according to Claim 8 wherein the at least one memory and the computer program code are further configured to, with the processor, cause the apparatus to cause a categorization of the syntax elements to be signaled at a block, slice, picture or sequence level.

10. (Original) An apparatus according to Claim 8 wherein the at least one memory and the computer program code are further configured to, with the processor, cause the apparatus to perform binarization of the symbols that correspond to the second category of syntax elements prior to bypassing the context updating.

11. (Original) An apparatus according to Claim 10 wherein the at least one memory and the computer program code are configured to, with the processor, cause the apparatus to perform binarization by performing binarization so as to target a predetermined probability.

12. (Original) An apparatus according to Claim 8 wherein the at least one memory and the computer program code are further configured to, with the processor, cause the apparatus to cause an indication of the entropy coding to be signaled at a block, slice, picture or sequence level.

Snap - Exhibit 1002
Snap v. Nokia - IPR2025-01345
Page 229 of 378

13. (Original) An apparatus according to Claim 8 wherein the at least one memory and the computer program code are configured to, with the processor, cause the apparatus to categorize the plurality of syntax elements by categorizing the plurality of syntax elements based on a relationship of the frequency of occurrence of the syntax elements to a predefined threshold.

14. (Original) An apparatus according to Claim 8 wherein the at least one memory and the computer program code are further configured to, with the processor, cause the apparatus to perform binarization of the symbols that correspond to the first category of syntax elements prior to entropy coding the symbols that correspond to the first category of syntax elements.

15. (Original) A computer program product comprising at least one non-transitory computer-readable storage medium having computer-executable program code instructions stored therein, the computer-executable program code instructions comprising program code instructions to:

categorize a plurality of syntax elements of video content into first and second categories based on a frequency of occurrence of the syntax elements in the video content;

entropy code symbols that correspond to the first category of syntax elements and that have been subjected to a context update; and

entropy code symbols that correspond to the second category of syntax elements and that have bypassed context updating.

16. (Original) A computer program product according to Claim 15 wherein the computer-executable program code instructions further comprise program code instructions to cause a categorization of the syntax elements to be signaled at a block, slice, picture or sequence level.

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Snap v. Nokia - IPR2025-01345
Page 230 of 378

17. (Original) A computer program product according to Claim 15 wherein the computer-executable program code instructions further comprise program code instructions to perform binarization of the symbols that correspond to the second category of syntax elements prior to bypassing the context updating.

18. (Original) A computer program product according to Claim 17 wherein the comprise program code instructions to perform binarization comprise program code instructions to perform binarization so as to target a predetermined probability.

19. (Original) A computer program product according to Claim 15 wherein the computer-executable program code instructions further comprise program code instructions to cause an indication of the entropy coding to be signaled at a block, slice, picture or sequence level.

20. (Original) A computer program product according to Claim 15 comprise the program code instructions to categorize the plurality of syntax elements comprise program code instructions to categorize the plurality of syntax elements based on a relationship of the frequency of occurrence of the syntax elements to a predefined threshold.

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REMARKS

The present application includes Claims 1-20.Claims 1-20 were rejected.

Rejections under 35 U.S.C. § 102

The Office Action rejects Claims 1-20 under 35 USC 102(b) as being anticipated by US 2009/0141806 A1 ("Marpe").

Applicant respectfully asserts that Marpe does not teach or suggest each of the elements recited in independent Claim 1, 8, or 15. In particular, independent Claims 1, 8, and 15 each recite, albeit in somewhat different language, "categorizing a plurality of syntax elements of video content into first and second categories based on a frequency of occurrence of the syntax elements in the video content." Applicant respectfully asserts that Marpe fails to teach or suggest at least this recitation of the independent Claims 1, 8, and 15.

The Office Action asserts that the categorizing of a plurality of syntax elements of video content into first and second categories "based on frequency of occurrence of syntax elements in the video content" is taught in Paragraph 54 "based on whether the bits corresponding to a bin string have a 50/50 chance of being 1 or 0." (Office Action mailed October 31, 2013; Pg. 2). Paragraph 54 is reproduced below.

> The aim of switch 113 is to ease the subsequent binary arithmetic coding performed in stage 100 *c*. To be more precise, some of the bins in the bin string output by binarizer 102 show heuristically nearly an equi-probable distribution. This means, the corresponding bits are, with a probability of nearly 50%, 1 and, with a probability of nearly 50%, 0, or, in other words, the bits corresponding to this bin in a bin string have a 50/50 chance to be 1 or 0. These bins are fed to the bypass-coding input terminal 116 and are binary arithmetically coded by use of an equi-probable probability estimation, which is constant and, therefore, needs no adaption or updating overhead. For all other bins, it has been heuristically determined that the probability distribution of these bins depends on other bins as output by stage 10 *a* so that it is worthwhile to adapt or update the probability estimation used for binary arithmetically coding of the respective bin as it will be described in more detail below exemplarily with respect to exemplary syntax

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> elements. The latter bins are thus fed by switch 113 to the input terminal of context modeler 112.
> (Paragraph 54).

Paragraph 52 and 53 disclose binary bins as portions of the binary output stream of the binaizer which transfers the syntax element into a suitable binary representation. The switch merely determines if the bin will have a 50/50 split of 1s and 0s or not. If the binary bin has an equal-probable 1 and 0 ratio the bin is sent to the bypass code engine. If the bin is not 50/50 the bin is sent to the regular code engine via the context modeler. This is not "categorizing a plurality of syntax elements of video content into first and second categories based on a frequency of occurrence of the syntax elements in the video content" as recited in the independent claims.

To provide a more contextual example, in Marpe if a syntax element is received by the binaizer it may produce a binary output stream of 11010010010010101001111010111110, which may processed in 6 bit bins 110100, 100100, 101010, 011110, 111110. The switch would send the first and third bin to the bypass code engine, due to having 50/50 split of 1s and 0s, whereas the second, forth, and fifth would be sent to the regular coding engine. This determination is based only on the binary makeup of the bin and not the syntax element. Since the determination is not based on the syntax element, it cannot be made based on the frequency of occurrence of a syntax element. Further, Marpe is not categorizing syntax elements as the first portion of the element recites, as discussed, Marpe is categorizing bit stream bins, not the syntax elements. Marpe fails to teach or suggest "**categorizing a plurality of syntax elements** of video content into first and second categories **based on a frequency of occurrence of the syntax elements** in the video content," as recited in each of the independent claims, and therefore fails to anticipate these claims.

For at least the foregoing reasons, Applicant respectfully asserts that Marpe does not anticipate independent Claim 1, 8, 15 and respectfully requests that the rejection of these claims be withdrawn.

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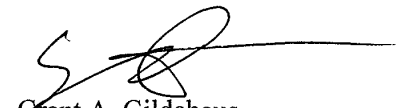
The patentability of the independent claim has been argued as set forth above and thus the Applicants will not take this opportunity to argue the merits of the rejection with regard to the dependent claims. However, the Applicants do not concede that the dependent claims are not independently patentable and reserve the right to argue the patentability of the dependent claims at a later date if necessary.

CONCLUSION

In light of the remarks above, Applicant respectfully submits that the application is in condition for allowance and respectfully requests that a Notice of Allowance be issued. The Examiner is encouraged to contact Applicant's undersigned attorney to resolve any remaining issues in order to expedite examination of the present application.

It is not believed that extensions of time or fees for net addition of claims are required, beyond those that may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time are necessary to allow consideration of this paper, such extensions are hereby petitioned under 37 CFR § 1.136(a), and any fee required therefor (including fees for net addition of claims) is hereby authorized to be charged to Deposit Account No. 16-0605.

Respectfully submitted,



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LEGAL02/34814253v1

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Electronic Patent Application Fee Transmittal

Application Number:	13192111
Filing Date:	27-Jul-2011
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING
First Named Inventor/Applicant Name:	Jani LAINEMA
Filer:	Grant Allen Gildehaus/Jan Moore
Attorney Docket Number:	042933/442419

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Extension - 3 months with $0 paid	1253	1	1400	1400

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
		Total in USD ($)		**1400**

Electronic Acknowledgement Receipt

EFS ID:	18905814
Application Number:	13192111
International Application Number:	
Confirmation Number:	5397
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING
First Named Inventor/Applicant Name:	Jani LAINEMA
Customer Number:	10949
Filer:	Grant Allen Gildehaus/Jan Moore
Filer Authorized By:	Grant Allen Gildehaus
Attorney Docket Number:	042933/442419
Receipt Date:	30-APR-2014
Filing Date:	27-JUL-2011
Time Stamp:	15:33:48
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1400
RAM confirmation Number	2213
Deposit Account	160605
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Extension of Time	442419_EOT.PDF	186851 d41dfbeca3656f5c9923389855b6d791acab5c16	no	2
Warnings:					
Information:					
2		442419_Response.pdf	373994 35c50451fb5835d832b1bfb071eead05df629c34	yes	8

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	5
	Applicant Arguments/Remarks Made in an Amendment	6	8

Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30468 72cb2e7eeec888beffb3c68cc373c949ddb22064	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	591313		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/22 (03-13)
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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)

Docket Number (Optional): 042933/442419

Application Number: 13/192,111

Filed: July 27, 2011

For: METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING

Art Unit: 2485

Examiner: Francis Geroleo

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

		Fee	Small Entity Fee	Micro Entity Fee	
☐	One month (37 CFR 1.17(a)(1))	$200	$100	$50	$
☐	Two months (37 CFR 1.17(a)(2))	$600	$300	$150	$
☑	Three months (37 CFR 1.17(a)(3))	$1,400	$700	$350	$ 1,400
☐	Four months (37 CFR 1.17(a)(4))	$2,200	$1,100	$550	$
☐	Five months (37 CFR 1.17(a)(5))	$3,000	$1,500	$750	$

☐ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 16-0605.

☑ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant/inventor.

☐ assignee of record of the entire interest. See 37 CFR 3.71. 37 CFR 3.73(b) statement is enclosed (Form PTO/SB/96).

☑ attorney or agent of record. Registration number 68,805.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/Grant A. Gildehaus/ — Signature

April 30, 2014 — Date

Grant A. Gildehaus — Typed or printed name

704-444-1129 — Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☐ * Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/192,111	Filing Date 07/27/2011	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT 04/30/2014

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X $80 =	0
Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $420 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/DENISE HOPKINS/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/192,111	07/27/2011	Jani LAINEMA	042933/442419	5397

10949 7590 06/04/2014

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

EXAMINER	
GEROLEO, FRANCIS	
ART UNIT	PAPER NUMBER
2485	

NOTIFICATION DATE	DELIVERY MODE
06/04/2014	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

usptomail@alston.com

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Snap v. Nokia - IPR2025-01345
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Office Action Summary	Application No. 13/192,111	Applicant(s) LAINEMA ET AL.	
	Examiner FRANCIS G. GEROLEO	Art Unit 2485	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *4/30/14*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-20* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-20* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

This communication is in response to US Patent Application No.: 13/192111 filed on 7/27/2011 that claims benefit to a US Provisional Application No.: 61/368316 filed on 7/28/2010. A reply was filed on 4/30/2014 in response to the non-final office action dated 10/31/2013. Claims 1-20 are currently pending.

Notice of Pre-AIA or AIA Status

1. The present application is being examined under the pre-AIA first to invent provisions.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

3. Claims 1-20 are rejected under 35 U.S.C. 102(b) as being anticipated by US 2009/0141806 A1 ("Marpe") for the same reasons as set forth in Section 2 of the last office action, dated 10/31/2013.

Response to Arguments

4. Applicant's arguments filed 4/30/2014 have been fully considered but they are not persuasive.

Applicant asserts on pages 6-7 of the Remarks that Marpe does not disclose categorizing a plurality of syntax elements based on a frequency of occurrence of the syntax elements because the determining in Marpe is based only on the binary makeup of the bin and not the syntax element and concludes that " since the determination is not based on the syntax element, it cannot be made

based on the frequency of occurrence of a syntax element.". Applicant further asserts on page 7 that Marpe does not disclose categorizing syntax elements because "Marpe is categorizing bit stream bins, not the syntax elements.".

However, it is noted in Figure 2 of Marpe, for instance see "binary valued syntax element" and "non-binary valued syntax element" that syntax elements can be binary or non-binary valued (see also paragraph [0047]-[0048] for specific examples of binary and non-binary valued syntax elements). And as illustrated in Figure 2 of Marpe, the categorization is done on binarized syntax elements (see 108 in fig. 2).

Conclusion

5. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

a. Winger, US 2005/0179572 A1, Method for selection of contexts for arithmetic coding of reference picture and motion vector residual bitstream syntax elements

b. Hu, US 8213499 B2, Method and apparatus for context address generation for motion vectors and coefficients

c. Girardeau, US 7714754 B2, Entropy decoder with pipelined processing and methods for use therewith

6. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to FRANCIS G. GEROLEO whose telephone number is (571)270-7206. The examiner can normally be reached on Monday - Friday 8:00am-5:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jay Patel can be reached on 5712722988. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/FRANCIS G GEROLEO/
Examiner, Art Unit 2485

/Jayanti K Patel/
Supervisory Patent Examiner, Art Unit 2485
May 28, 2014

Notice of References Cited	Application/Control No. 13/192,111	Applicant(s)/Patent Under Reexamination LAINEMA ET AL.	
	Examiner FRANCIS G. GEROLEO	Art Unit 2485	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2005/0179572	08-2005	Winger, Lowell L.	341/107
*	B	US-8,213,499	07-2012	Hu, Yendo	375/240.01
*	C	US-7,714,754	05-2010	Girardeau, Jr., James Ward	341/107
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
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FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
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	Q					
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NON-PATENT DOCUMENTS

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*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Substitute for form 1449/PTO (Revised 07/2007)				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(Use as many sheets as necessary)*				Application Number	13/192,111
				Filing Date	July 27, 2011
				First Named Inventor	Lainema et al.
				Art Unit	2485
				Examiner Name	F. Geroleo
Sheet	*1*	of	1	Attorney Docket Number	042933/442419

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
	1	Office Action for Korean Application No. 10-2013-7005051 dated February 27, 2014	Partial

Examiner Signature	/Francis G Geroleo/	Date Considered	5/4/14

*Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. LEGAL02/34758998v1

Submitted March 28, 2014

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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13192111	LAINEMA ET AL.
	Examiner	**Art Unit**
	FRANCIS G GEROLEO	2485

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	08/13/2013	05/04/2014							
	1	✓	✓							
	2	✓	✓							
	3	✓	✓							
	4	✓	✓							
	5	✓	✓							
	6	✓	✓							
	7	✓	✓							
	8	✓	✓							
	9	✓	✓							
	10	✓	✓							
	11	✓	✓							
	12	✓	✓							
	13	✓	✓							
	14	✓	✓							
	15	✓	✓							
	16	✓	✓							
	17	✓	✓							
	18	✓	✓							
	19	✓	✓							
	20	✓	✓							

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Snap v. Nokia - IPR2025-01345
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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13192111	LAINEMA ET AL.
	Examiner	Art Unit
	FRANCIS G GEROLEO	2485

CPC- SEARCHED		
Symbol	Date	Examiner
H04N 7/26	8/13/13	fgg
H04N 19/00551, 19/00884, 19/00121	5/4/14	fgg

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
375	240.08	8/13/13	fgg

SEARCH NOTES		
Search Notes	Date	Examiner
EAST including inventor; NPL (Google)	8/13/13	fgg
updated search	5/14/14	fgg

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

/FRANCIS G GEROLEO/ Examiner.Art Unit 2485	

PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	13192111
Filing Date	2011-07-27
First Named Inventor	Jani Lainema
Art Unit	2485
Examiner Name	Francis Geroleo
Attorney Docket Number	NC73661US-NP

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Receipt date: 01/06/2014	Application Number	13192111 13192111 - GAU: 2485
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)	Filing Date	2011-07-27
	First Named Inventor	Jani Lainema
	Art Unit	2485
	Examiner Name	Francis Geroleo
	Attorney Docket Number	NC73661US-NP

	1	European Search Report received for corresponding European Patent Application No. 11811919.7 dated December 20, 2013, 6 pages.	☐
	2	Vivienne et al., "A High Throughput CABAC Algorithm Using Syntax Element Partitioning", Image Processing (ICIP) 2009, 16th IEEE International Conference on IEEE, Piscataway, NJ, USA, November 7, 2009, pages 773-776.	☐
	3	Marpe et al., "Context-Based Adaptive Binary Arithmetic Coding in the H.264/AVC Video Compression Standard", IEEE Transactions on Circuits and Systems for Video Technology, IEEE Service Center, Piscataway, NF, US, Vol. 13, No. 7, July 1, 2003, pages 620-636.	☐

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EXAMINER SIGNATURE

Examiner Signature	/Francis G Geroleo/	Date Considered	5/4/14

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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Receipt date: 01/06/2014	Application Number	13192111 13192111 - GAU: 2485
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Filing Date	2011-07-27
	First Named Inventor	Jani Lainema
	Art Unit	2485
	Examiner Name	Francis Geroleo
	Attorney Docket Number	NC73661US-NP

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☒ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Thomas J. Arria/	Date (YYYY-MM-DD)	2014-01-06
Name/Print	Thomas J. Arria	Registration Number	60223

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L13	149	h04n19/00551.cpc.	USPAT	OR	OFF	2014/05/04 14:59
L14	1429	h04n19/00884.cpc.	USPAT	OR	OFF	2014/05/04 14:59
L15	1322	h04n19/00121.cpc.	USPAT	OR	OFF	2014/05/04 15:00
L16	2634	(13 or 14 or 15)	USPAT	OR	OFF	2014/05/04 15:00
L17	1634	((categoriz$3 or group$3 or classify$3) with (syntax))	USPAT	OR	OFF	2014/05/04 15:00
L18	1605	((occurrence or occuring or probability or frequency) same (syntax))	USPAT	OR	OFF	2014/05/04 15:01
L19	448770	(coding or coder or encoding or encoder)	USPAT	OR	OFF	2014/05/04 15:01
L20	345	"71" and 18	USPAT	OR	OFF	2014/05/04 15:01
L21	149	17 and 18 and 19	USPAT	OR	OFF	2014/05/04 15:02
L22	27	16 and 21	USPAT	OR	OFF	2014/05/04 15:02
L23	27	16 and 21	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/04 15:02
L24	2329	h04n19/00551.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/04 15:02
L25	12728	h04n19/00884.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/04 15:02
L26	9374	h04n19/00121.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/04 15:03
L27	4233	((categoriz$3 or group$3 or classify$3) with (syntax))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/04 15:03
L28	4922	((occurrence or occuring or probability or frequency) same (syntax))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/04 15:03

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L29	1720727	(coding or coder or encoding or encoder)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/04 15:03
L30	21850	(24 or 25 or 26)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/04 15:03
L31	152	27 and 28 and 29 and 30	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/04 15:04
L32	57	31 and (@pd<"20110727" or @ad<"20100728")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/04 15:06
L33	50954	(context near5 (updat$3 or model$3 or chang$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/04 15:07
L34	20	32 and 33	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/04 15:08
L35	954	375/240.08.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/04 15:51
L36	22659	(24 or 25 or 26 or 35)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/04 15:52
L37	153	27 and 28 and 29 and 36	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/04 15:52
L38	58	37 and (@pd<"20110727" or @ad<"20100728")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/04 15:52
L40	20	38 and 33	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/04 15:53
L41	0	40 not 34	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/04 15:53

EAST Search History (Interference)

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5/4/2014 3:54:52 PM
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Snap - Exhibit 1002
Snap v. Nokia - IPR2025-01345
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PTO/SB/30 (07-09)
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Request for Continued Examination (RCE) Transmittal

Address to:
Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Application Number	13/192,111
Filing Date	July 27, 2011
First Named Inventor	Lainema et al.
Art Unit	2485
Examiner Name	Francis Geroleo
Attorney Docket Number	042933/442419

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. See Instruction Sheet for RCEs (not to be submitted to the USPTO) on page 2.

1. Submission required under 37 CFR 1.114 Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

   a. ☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

      i. ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____

      ii. ☐ Other _____

   b. ☑ Enclosed

      i. ☑ Amendment/Reply

      ii. ☐ Affidavit(s)/ Declaration(s)

      iii. ☐ Information Disclosure Statement (IDS)

      iv. ☐ Other _____

2. Miscellaneous

   a. ☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of _____ months. (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

   b. ☐ Other _____

3. Fees The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.

   a. ☑ The Director is hereby authorized to charge the following fees, any underpayment of fees, or credit any overpayments, to Deposit Account No. 160605.

      i. ☑ RCE fee required under 37 CFR 1.17(e)

      ii. ☑ Extension of time fee (37 CFR 1.136 and 1.17)

      iii. ☐ Other _____

   b. ☐ Check in the amount of $ _____ enclosed

   c. ☐ Payment by credit card (Form PTO-2038 enclosed)

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

Signature		Date	12/2/2014
Name (Print/Type)	Grant Gildehaus	Registration No.	68,805

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This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Mail Stop RCE, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.:	13/192,111	Confirmation No.: 5397
Applicant(s):	Lainema et al.	
Filed:	July 27, 2011	
Art Unit:	2485	
Examiner:	Francis Geroleo	
Title:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING	

Docket No.: 042933/442419
Customer No.: 10949

Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT AFTER FINAL UNDER 37 CFR § 1.116

Sir:

In response to the Final Office Action dated June 4, 2014, please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims beginning on page 2 of this paper.

Remarks begin on page 7 of this paper.

Amendments to the Claims:

1. (Currently Amended) A method comprising:

determining a frequency of occurrence threshold based on an expected frequency of occurrence of syntax elements in a bit stream;

categorizing a plurality of syntax elements of video content into first and second categories based on ~~a~~the frequency of occurrence threshold, wherein ~~of the~~ syntax elements ~~in the video content~~which occur greater than the frequency of occurrence threshold are categorized into the first category and syntax elements which occur less than the frequency of occurrence are categorized into the second category;

entropy coding symbols that correspond to the first category of syntax elements and that have been subjected to a context update; and

entropy coding symbols that correspond to the second category of syntax elements and that have bypassed context updating.

2. (Original) A method according to Claim 1 further comprising causing a categorization of the syntax elements to be signaled at a block, slice, picture or sequence level.

3. (Original) A method according to Claim 1 further comprising performing binarization of the symbols that correspond to the second category of syntax elements prior to bypassing the context updating.

4. (Original) A method according to Claim 3 wherein performing binarization comprises performing binarization so as to target a predetermined probability.

5. (Original) A method according to Claim 1 further comprising causing an indication of the entropy coding to be signaled at a block, slice, picture or sequence level.

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6. (Original) A method according to Claim 1 wherein categorizing the plurality of syntax elements comprises categorizing the plurality of syntax elements based on a relationship of the frequency of occurrence of the syntax elements to a predefined threshold.

7. (Original) A method according to Claim 1 further comprising performing binarization of the symbols that correspond to the first category of syntax elements prior to entropy coding the symbols that correspond to the first category of syntax elements.

8. (Currently Amended) An apparatus comprising at least one processor and at least one memory including computer program code, the at least one memory and the computer program code configured to, with the processor, cause the apparatus to at least:

determine a frequency of occurrence threshold based on an expected frequency of occurrence of syntax elements in a bit stream;

categorize a plurality of syntax elements of video content into first and second categories based on athe frequency of occurrence threshold, wherein ~~of the~~ syntax elements ~~in the video content~~which occur greater than the frequency of occurrence threshold are categorized into the first category and syntax elements which occur less than the frequency of occurrence are categorized into the second category;

entropy code symbols that correspond to the first category of syntax elements and that have been subjected to a context update; and

entropy code symbols that correspond to the second category of syntax elements and that have bypassed context updating.

9. (Original) An apparatus according to Claim 8 wherein the at least one memory and the computer program code are further configured to, with the processor, cause the apparatus to cause a categorization of the syntax elements to be signaled at a block, slice, picture or sequence level.

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10. (Original) An apparatus according to Claim 8 wherein the at least one memory and the computer program code are further configured to, with the processor, cause the apparatus to perform binarization of the symbols that correspond to the second category of syntax elements prior to bypassing the context updating.

11. (Original) An apparatus according to Claim 10 wherein the at least one memory and the computer program code are configured to, with the processor, cause the apparatus to perform binarization by performing binarization so as to target a predetermined probability.

12. (Original) An apparatus according to Claim 8 wherein the at least one memory and the computer program code are further configured to, with the processor, cause the apparatus to cause an indication of the entropy coding to be signaled at a block, slice, picture or sequence level.

13. (Original) An apparatus according to Claim 8 wherein the at least one memory and the computer program code are configured to, with the processor, cause the apparatus to categorize the plurality of syntax elements by categorizing the plurality of syntax elements based on a relationship of the frequency of occurrence of the syntax elements to a predefined threshold.

14. (Original) An apparatus according to Claim 8 wherein the at least one memory and the computer program code are further configured to, with the processor, cause the apparatus to perform binarization of the symbols that correspond to the first category of syntax elements prior to entropy coding the symbols that correspond to the first category of syntax elements.

15. (Currently Amended) A computer program product comprising at least one non-transitory computer-readable storage medium having computer-executable program code instructions stored therein, the computer-executable program code instructions comprising program code instructions to:

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determine a frequency of occurrence threshold based on an expected frequency of occurrence of syntax elements in a bit stream;

categorize a plurality of syntax elements of video content into first and second categories based on athe frequency of occurrence threshold, wherein ~~of the~~ syntax elements ~~in the video content~~which occur greater than the frequency of occurrence threshold are categorized into the first category and syntax elements which occur less than the frequency of occurrence are categorized into the second category;

entropy code symbols that correspond to the first category of syntax elements and that have been subjected to a context update; and

entropy code symbols that correspond to the second category of syntax elements and that have bypassed context updating.

16. (Original) A computer program product according to Claim 15 wherein the computer-executable program code instructions further comprise program code instructions to cause a categorization of the syntax elements to be signaled at a block, slice, picture or sequence level.

17. (Original) A computer program product according to Claim 15 wherein the computer-executable program code instructions further comprise program code instructions to perform binarization of the symbols that correspond to the second category of syntax elements prior to bypassing the context updating.

18. (Original) A computer program product according to Claim 17 wherein the comprise program code instructions to perform binarization comprise program code instructions to perform binarization so as to target a predetermined probability.

19. (Original) A computer program product according to Claim 15 wherein the computer-executable program code instructions further comprise program code instructions to

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cause an indication of the entropy coding to be signaled at a block, slice, picture or sequence level.

20. (Original) A computer program product according to Claim 15 comprise the program code instructions to categorize the plurality of syntax elements comprise program code instructions to categorize the plurality of syntax elements based on a relationship of the frequency of occurrence of the syntax elements to a predefined threshold.

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REMARKS

The present application includes Claims 1-20. Claims 1-20 were rejected. By this Amendment, Claims 1, 8, and 15 have been amended. Support for the amendments may be found in at least Paragraph 48. As such, the amendments do not introduce new matter.

Claim Rejections – 35 USC § 102

Claims 1-20 were rejected under 35 U.S.C. § 102(b) as being anticipated by Marpe et al. (US 2009/0141806 A1) for the same reasons set forth in Section 2 of the last office action.

Applicant respectfully asserts that Marpe does not disclose, teach, or suggest each of the elements recited in independent Claim 1, 8, or 15. In particular, independent Claims 1, 8, and 15, as amended, each recite, albeit in somewhat different language, "determining a frequency of occurrence threshold based on an expected frequency of occurrence of syntax elements in a bit stream" and "categorizing a plurality of syntax elements of video content into first and second categories based on the frequency of occurrence threshold, wherein syntax elements which occur greater than the frequency of occurrence threshold are categorized into the first category and syntax elements which occur less than the frequency of occurrence are categorized into the second category." Applicant respectfully asserts that Marpe fails to disclose, teach, or suggest at least this recitation of the independent Claims 1, 8, and 15.

The Office Action asserts that the categorizing of a plurality of syntax elements of video content into first and second categories "based on frequency of occurrence of syntax elements in the video content" is taught in Paragraph 54 "based on whether the bits corresponding to a bin string have a 50/50 chance of being 1 or 0." (Office Action mailed October 31, 2013; Pg. 2). Paragraph 54 is reproduced below.

> The aim of switch 113 is to ease the subsequent binary arithmetic coding performed in stage 100 *c*. To be more precise, some of the bins in the bin string output by binarizer 102 show heuristically nearly an equi-probable distribution. This means, the corresponding bits are, with a probability of nearly 50%, 1 and, with a probability of nearly 50%, 0, or, in other words, the bits corresponding to

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> this bin in a bin string have a 50/50 chance to be 1 or 0. These bins are fed to the bypass-coding input terminal 116 and are binary arithmetically coded by use of an equi-probable probability estimation, which is constant and, therefore, needs no adaption or updating overhead. For all other bins, it has been heuristically determined that the probability distribution of these bins depends on other bins as output by stage 10 *a* so that it is worthwhile to adapt or update the probability estimation used for binary arithmetically coding of the respective bin as it will be described in more detail below exemplarily with respect to exemplary syntax elements. The latter bins are thus fed by switch 113 to the input terminal of context modeler 112.
> (Paragraph 54).

Paragraphs 52 and 53 disclose binary bins as portions of the binary output stream of the binaizer which transfers the syntax element into a suitable binary representation. The switch merely determines if the bin will have a 50/50 split of 1s and 0s or not. If the binary bin has an equal-probable 1 and 0 ratio the bin is sent to the bypass code engine. If the bin is not 50/50 the bin is sent to the regular code engine via the context modeler. The 50/50 bin composition determination is to "ease the subsequent binary arithmetic coding," there is no teaching or suggestion of "determining a frequency of occurrence threshold based on the *expected* frequency of occurrence of syntax elements in a bit stream."

Further, providing a more contextual example, in Marpe if a syntax element is received by the binaizer it may produce a binary output stream of 1101001001001010011110111110, which may processed in 6 bit bins 110100, 100100, 101010, 011110, 111110. The switch would send the first and third bin to the bypass code engine, due to having 50/50 split of 1s and 0s, whereas the second, forth, and fifth would be sent to the regular coding engine. This determination is **based only on the binary makeup of the bin** and not the frequency of occurrence of the syntax element. Marpe fails to teach or suggest "categorizing a plurality of syntax elements of video content into first and second categories based on the **frequency of occurrence threshold**, wherein syntax elements which occur greater than the frequency of occurrence threshold are categorized into the first category and syntax elements which occur less than the frequency of occurrence are categorized into the second category." as recited in each of the independent claims, and therefore fails to anticipate these claims.

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For at least the foregoing reasons, Applicant respectfully asserts that Marpe does not anticipate independent Claim 1, 8, or 15 and respectfully requests that the rejection of these claims be withdrawn

The patentability of the independent claims has been argued as set forth above and thus the Applicant will not take this opportunity to argue the merits of the rejection with regard to the dependent claims. However, the Applicant does not concede that the dependent claims are not independently patentable and reserves the right to argue the patentability of the dependent claims at a later date if necessary.

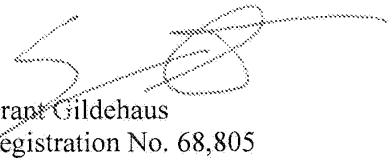
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CONCLUSION

In light of the remarks above, Applicant respectfully submits that the application is in condition for allowance and respectfully requests that a Notice of Allowance be issued. The Examiner is encouraged to contact Applicant's undersigned attorney to resolve any remaining issues in order to expedite examination of the present application.

It is not believed that extensions of time or fees for net addition of claims are required, beyond those that may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time are necessary to allow consideration of this paper, such extensions are hereby petitioned under 37 CFR § 1.136(a), and any fee required therefor (including fees for net addition of claims) is hereby authorized to be charged to Deposit Account No. 16-0605.

Respectfully submitted,



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Electronic Patent Application Fee Transmittal	
Application Number:	13192111
Filing Date:	27-Jul-2011
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING
First Named Inventor/Applicant Name:	Jani LAINEMA
Filer:	Grant Allen Gildehaus/Emma Pham
Attorney Docket Number:	042933/442419
Filed as Large Entity	

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Extension - 3 months with $0 paid	1253	1	1400	1400

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Request for Continued Examination	1801	1	1200	1200
		Total in USD ($)		**2600**

Electronic Acknowledgement Receipt	
EFS ID:	20837714
Application Number:	13192111
International Application Number:	
Confirmation Number:	5397
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING
First Named Inventor/Applicant Name:	Jani LAINEMA
Customer Number:	10949
Filer:	Grant Allen Gildehaus/Emma Pham
Filer Authorized By:	Grant Allen Gildehaus
Attorney Docket Number:	042933/442419
Receipt Date:	02-DEC-2014
Filing Date:	27-JUL-2011
Time Stamp:	11:35:25
Application Type:	Utility under 35 USC 111(a)

Payment information:

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Payment Type	Deposit Account
Payment was successfully received in RAM	$2600
RAM confirmation Number	10519
Deposit Account	160605
Authorized User	
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		Response.pdf	1571451 7e2815decef5f05ee191acb8a85022452c219125	yes	11

Multipart Description/PDF files in .zip description

Document Description	Start	End
Request for Continued Examination (RCE)	1	1
Response After Final Action	2	2
Claims	3	7
Applicant Arguments/Remarks Made in an Amendment	8	11

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	32482 1acf670bdc5693909bb10adbf136a57db9ca3846	no	2

Warnings:

Information:

Total Files Size (in bytes):	1603933

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PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/192,111	Filing Date 07/27/2011	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)		
FOR	NUMBER FILED	NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	12/02/2014	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X $80 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $420 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	0

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/EVELYN NIMMONS/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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NOTICE OF ALLOWANCE AND FEE(S) DUE

10949 7590 01/21/2015

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

EXAMINER
GEROLEO, FRANCIS

ART UNIT	PAPER NUMBER
2485	

DATE MAILED: 01/21/2015

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/192,111	07/27/2011	Jani LAINEMA	042933/442419	5397

TITLE OF INVENTION: METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	04/21/2015

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

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III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PTOL-85 (Rev. 02/11)

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PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
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10949 7590 01/21/2015
Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

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(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/192,111	07/27/2011	Jani LAINEMA	042933/442419	5397

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nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	04/21/2015

EXAMINER	ART UNIT	CLASS-SUBCLASS
GEROLEO, FRANCIS	2485	375-240080

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
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3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

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- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ❑ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ❑ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/192,111	07/27/2011	Jani LAINEMA	042933/442419	5397

10949 7590 01/21/2015

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

EXAMINER	
GEROLEO, FRANCIS	
ART UNIT	PAPER NUMBER
2485	

DATE MAILED: 01/21/2015

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

PTOL-85 (Rev. 02/11)

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OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 13/192,111	Applicant(s) LAINEMA ET AL.	
	Examiner FRANCIS G. GEROLEO	Art Unit 2485	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *the amendment filed on 12/2/14*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *1-20*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov .
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   Certified copies:
   a) ☐ All b) ☐ Some *c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☐ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/FRANCIS G GEROLEO/ Examiner, Art Unit 2485	/Jayanti K Patel/ Supervisory Patent Examiner, Art Unit 2485

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Notice of References Cited	Application/Control No. 13/192,111	Applicant(s)/Patent Under Reexamination LAINEMA ET AL.	
	Examiner FRANCIS G. GEROLEO	Art Unit 2485	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2002/0131506 A1	09-2002	Kerofsky et al.	375/240.23
*	B	US-2012/0014433 A1	01-2012	Karczewicz et al.	375/240.02
*	C	US-8,294,603 B2	10-2012	Sze et al.	341/107
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13192111	LAINEMA ET AL.
	Examiner	Art Unit
	FRANCIS G GEROLEO	2485

CPC- SEARCHED		
Symbol	Date	Examiner
H04N 7/26	8/13/13	fgg
H04N 19/00551, 19/00884, 19/00121	5/4/14	fgg

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
375	240.08	8/13/13	fgg

SEARCH NOTES		
Search Notes	Date	Examiner
EAST including inventor; NPL (Google)	8/13/13	fgg
updated search	5/14/14	fgg
updated search	1/5/15	fgg

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
	General interference and search of claims (USPGPUB, UPAD)	1/5/15	fgg

/FRANCIS G GEROLEO/ Examiner.Art Unit 2485	

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13192111	LAINEMA ET AL.
	Examiner	**Art Unit**
	FRANCIS G GEROLEO	2485

CPC						
Symbol					**Type**	**Version**
H04N	/	19	/	463	F	2014-11-01
H04N	/	19	/	70	I	2014-11-01
H04N	/	19	/	13	I	2014-11-01
	/		/			
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CPC Combination Sets							
Symbol				**Type**	**Set**	**Ranking**	**Version**
	/		/				
	/		/				

/FRANCIS G GEROLEO/ Examiner.Art Unit 2485	1/5/15	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	20	
/JAY AU 2485 PATEL/ Supervisory Patent Examiner.Art Unit 2485	01/10/2015	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	3

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13192111	LAINEMA ET AL.
	Examiner	**Art Unit**
	FRANCIS G GEROLEO	2485

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
375	240.08	H	0	4	N	7 / 26 (2006.0)						

CROSS REFERENCE(S)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					

/FRANCIS G GEROLEO/ Examiner.Art Unit 2485	1/5/15	**Total Claims Allowed:** 20	
(Assistant Examiner)	(Date)		
/JAY AU 2485 PATEL/ Supervisory Patent Examiner.Art Unit 2485	01/10/2015	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	3

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Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13192111	LAINEMA ET AL.
	Examiner	**Art Unit**
	FRANCIS G GEROLEO	2485

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original

/FRANCIS G GEROLEO/ Examiner.Art Unit 2485	1/5/15	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	20	
/JAY AU 2485 PATEL/ Supervisory Patent Examiner.Art Unit 2485	01/10/2015	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	3

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S102	2	("20120250763").PN.	US-PGPUB; USPAT; DERWENT	OR	OFF	2015/01/05 07:23
S103	1	2012-B49332.NRAN.	DERWENT	OR	OFF	2015/01/05 07:23
S104	25397	(entropy near2 (cod$3 or encod$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 07:43
S105	22319	(context near5 model$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 07:44
S106	95636	(syntax)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 07:44
S107	131224	((frequency or number) near5 (occurrence or occurring))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 07:45
S108	2072	S104 and S105	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 07:45
S109	183	S104 and S105 and S106 and S107	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 07:45
S110	161	(S106 same S107)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 07:46
S111	4	S108 and S110	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 07:46
S112	2	S111 and (@ad<"20100728" or @pd<"20100728" or @rlad<"20100728" or @ptpd<"20100728")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	2015/01/05 07:47

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			IBM_TDB			
S113	2	S111 not S112	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 07:47
S117	2066	((categoriz$3 or group$3 or classify$3) near5 (syntax))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 07:51
S118	10	S117 same S107	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 07:52
S120	1	S118 and (@ad<"20100728" or @pd<"20100728" or @rlad<"20100728" or @ptpd<"20100728")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 07:52
S121	101	S117 and S107	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 07:54
S122	42	S104 and S121	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 07:54
S123	9	S122 and (@ad<"20100728" or @pd<"20100728" or @rlad<"20100728" or @ptpd<"20100728")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 07:54
S124	487	h04n19/00551.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/01/05 08:21
S125	2042	h04n19/00884.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/01/05 08:21
S126	1189	h04n19/00121.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/01/05 08:21
S127	1064	375/240.08.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/01/05 08:21
S128	4351	(S124 or S125 or S126 or S127)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	ON	2015/01/05 08:21

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			IBM_TDB			
S129	4351	S128	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 08:21
S130	161	(((frequency or number) near5 (occurrence or occurring)) same (syntax))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 08:22
S131	4	S129 and S130	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 08:22
S132	1	S131 and (@ad<"20100728" or @pd<"20100728" or @rlad<"20100728" or @ptpd<"20100728")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 08:22
S133	53	(((frequency or number) near5 (occurrence or occurring)) with (syntax))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 08:32
S134	16	S133 and "375"/$.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 08:33
S135	7	S134 and (@ad<"20100728" or @pd<"20100728" or @rlad<"20100728" or @ptpd<"20100728")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 08:33
S136	107	((categoriz$3 or group$3 or classify$3 or divid$3) same (syntax) same (occur or exist$3) same (frequent$3 or frequency))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 08:43
S137	9	((categoriz$3 or group$3 or classify$3 or divid$3) same (syntax) same (occur or exist$3) same (frequent$3 or frequency)) same threshold	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 08:43
S138	8	S137 and (@ad<"20100728" or @pd<"20100728" or @rlad<"20100728" or @ptpd<"20100728")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 08:44
S139	4400	((group or category or categories) with (syntax))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 10:36
S140	39	S130 and S139	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	2015/01/05 10:37

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			IBM_TDB			
S141	25	S140 and (@ad<"20100728" or @pd<"20100728" or @rlad<"20100728" or @ptpd<"20100728")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 10:37
S142	174	((occurrence or occuring or probability or frequency) same (syntax)) same threshold	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/01/05 12:14
S143	152	S142 and (@ad<"20100728" or @pd<"20100728" or @rlad<"20100728" or @ptpd<"20100728")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 12:15
S144	14	S143 and "375"/$.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 12:25
S145	819	h04n19/463.cpc.	US-PGPUB; USPAT	OR	ON	2015/01/05 13:54
S146	4658	h04n19/70.cpc.	US-PGPUB; USPAT	OR	ON	2015/01/05 13:54
S147	2854	h04n19/13.cpc.	US-PGPUB; USPAT	OR	ON	2015/01/05 13:54
S148	7450	(S145 S146 S147)	US-PGPUB; USPAT	OR	ON	2015/01/05 13:54
S149	9	S148 and S142	US-PGPUB; USPAT	OR	ON	2015/01/05 13:54
S150	4	S149 and (@ad<"20100728" or @pd<"20100728" or @rlad<"20100728" or @ptpd<"20100728")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 13:55
S151	10	S148 and (((frequency or number) near5 (occurrence or occurring)) with (syntax))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 14:22
S152	6	S151 and (@ad<"20100728" or @pd<"20100728" or @rlad<"20100728" or @ptpd<"20100728")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/05 14:23

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S158	5281	(frequency near2 occurrence).clm.	US-PGPUB; USPAT; UPAD	OR	OFF	2015/01/05 14:57
S159	800	(syntax near2 element).clm.	US-PGPUB; USPAT; UPAD	OR	OFF	2015/01/05 14:57
S160	1655	(entropy near2 cod$3).clm.	US-PGPUB; USPAT; UPAD	OR	OFF	2015/01/05 14:57
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			UPAD			14:58
S162	5	S161 and "45"	US-PGPUB; USPAT; UPAD	OR	OFF	2015/01/05 14:59
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S165	1103	(syntax near2 element).clm.	US-PGPUB; USPAT; UPAD	OR	ON	2015/01/05 15:02
S166	9	S164 and S165	US-PGPUB; USPAT; UPAD	OR	ON	2015/01/05 15:02
S167	2	S166 and S160	US-PGPUB; USPAT; UPAD	OR	OFF	2015/01/05 15:03

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Examiner Initials*	Cite No.	Document Number Number - Kind Code (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages of Relevant Figures Appear
		US			
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Examiner Initials	Cite No.	Foreign Patent Document Country Code - Number Kind Code (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	English Language Translation Attached
		CA 2,643,705	10-04-2007	Ye et al.		
		***Abstract Only**				

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
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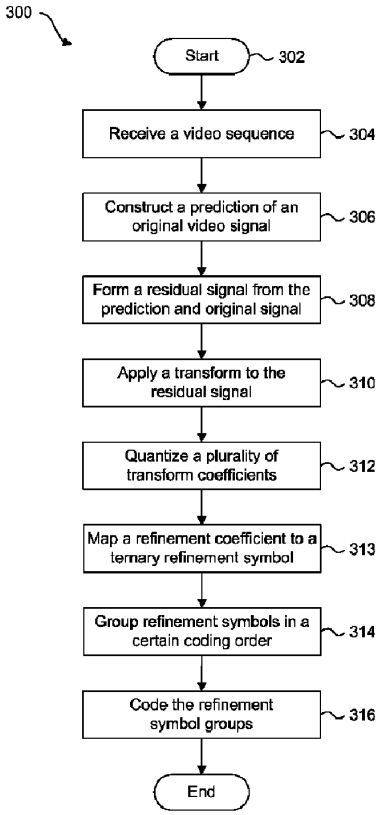
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(54) Title: METHODS AND SYSTEMS FOR REFINEMENT COEFFICIENT CODING IN VIDEO COMPRESSION



(57) Abrégé/Abstract:
A method for coding refinement coefficients in a signal-to-noise ratio (SNR) scalable enhancement layer of a compressed video sequence is disclosed. A video sequence is received. A prediction of an original video signal in a current frame is constructed from

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(57) Abrégé(suite)/Abstract(continued):
the video sequence. A residual signal is formed by subtracting the prediction of the original video signal from the original video signal in the current frame. A transform is applied to the residual signal. A plurality of transform coefficients is quantized. A refinement coefficient is mapped to a ternary refinement symbol. Refinement symbols are grouped in a certain coding order. The refinement symbol groups are coded using variable length codes.

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METHODS AND SYSTEMS FOR REFINEMENT COEFFICIENT CODING IN VIDEO COMPRESSION

TECHNICAL FIELD

[0002] The present disclosure relates generally to video processing. More specifically, the present disclosure relates to methods and systems for encoding and decoding information relating to video compression techniques.

BACKGROUND

[0003] Computer technologies have continued to progress in video compression techniques. Video compression refers to compression of digital video data. Video compression is desirable for efficient coding of video data in video file formats and streaming and broadcasting video formats. Compression is a conversion of data to a format that requires fewer bits, usually performed so that the data can be stored or transmitted more efficiently. Decompression, which is the inverse of compression, produces a replica of the original data.

[0004] Today, many video compression methods apply a certain type of discrete transform such as Discrete Cosine Transform (DCT) for reducing a remaining spatial redundancy in a prediction residual, which is generated using either temporal or spatial prediction techniques. Many video compression techniques also involve quantization, which may be either scalar quantization or vector quantization. After quantization, quantized coefficients may be entropy coded and placed into a compressed video bit stream. The compressed bit stream is then sent to a decoder, which will decompress the bit stream and recover a close approximation of the original video data.

[0005] Video compression techniques may benefit consumers of various forms of media. For example, in broadcast engineering, digital television is made practical

by video compression. TV stations can broadcast not only HDTV, but multiple virtual channels on the same physical channel as well. Digital video broadcast may use the MPEG-2 standard video compression format. H.264/MPEG-4 and VC-1 are beginning to emerge as new standards in video compression.

[0006] Unfortunately, known systems and methods for coding information in video compression suffer from various drawbacks. Accordingly, benefits may be realized by improved systems and methods for coding information in video compression. Some systems and methods for coding information in video compression are described herein.

SUMMARY

In one aspect of the present invention, there is provided a method for coding refinement coefficients in a signal-to-noise ratio (SNR) scalable enhancement layer of a compressed video sequence comprising: receiving a video sequence; constructing a prediction of an original video signal in a current frame from the video sequence; forming a residual signal by subtracting the prediction of the original video signal from the original video signal in the current frame; applying a transform to the residual signal so as to convert the residual signal into a domain in which the residual signal is represented by a plurality of transform coefficients; quantizing the plurality of transform coefficients to generate a plurality of nonzero transform coefficients, wherein each of the nonzero transform coefficients has a value of nonzero and at least some of the nonzero transform coefficients are refinement coefficients, wherein each of the refinement coefficients has the value of nonzero prior to quantizing; mapping each refinement coefficient to a ternary refinement symbol to generate a plurality of refinement symbols, wherein the ternary refinement symbol has three values and each refinement symbol has one of the three values; grouping the refinement symbols in a certain coding order to generate a plurality of refinement symbol groups; and coding the refinement symbol groups using variable length codes.

In another aspect of the present invention, there is provided an electronic device that is configured to encode refinement coefficients in a signal-to-noise ratio (SNR) scalable enhancement layer of a compressed video sequence, the electronic device comprising: a processor; memory in electronic communication with the processor; instructions stored in the memory, the instructions being executable to: receive a video sequence; construct a prediction of an original video signal in a current frame from the video sequence; form a residual frame by subtracting the prediction of the original video signal from the original video signal in the current frame; apply a transform to the residual signal so as to convert the residual signal into a domain in which the residual signal is represented by a plurality of transform coefficients; quantize the plurality of transform coefficients to generate a plurality of nonzero transform coefficients, wherein each of the nonzero transform coefficients has a value of nonzero and at least some of the nonzero transform coefficients are refinement coefficients, wherein each of the refinement coefficients has the value of nonzero prior to quantizing; map each refinement coefficient to a ternary refinement symbol to generate a plurality of refinement symbols, wherein the ternary refinement symbol has three values and each refinement symbol has one of the three values; group the refinement symbols in a certain coding order to generate a plurality of refinement symbol groups; and code the refinement symbol groups using variable length codes.

In another aspect of the present invention, there is provided a computer-readable medium comprising executable instructions for coding refinement coefficients in a signal-to-noise ratio (SNR) scalable enhancement layer of a compressed video sequence, the instructions comprising: receiving a video sequence; constructing a prediction of an original video signal in a current frame from the video sequence; forming a residual signal by subtracting the prediction of the original video signal from the original video signal in the current frame; applying a transform to the residual signal so as to convert the residual signal into a domain in which the residual signal is represented by a plurality of transform coefficients; quantizing the plurality of transform coefficients to generate a plurality of nonzero

transform coefficients, wherein each of the nonzero transform coefficients has a value of nonzero and at least some of the nonzero transform coefficients are refinement coefficients, wherein each of the refinement coefficients has the value of nonzero prior to quantizing; mapping each refinement coefficient to a ternary refinement symbol to generate a plurality of refinement symbols, wherein the ternary refinement symbol has three values and each refinement symbol has one of the three values; grouping the refinement symbols in a certain coding order to generate a plurality of refinement symbol groups; and coding the refinement symbol groups using variable length codes.

In another aspect of the present invention, there is provided a method for decoding refinement coefficients in an encoded video sequence comprising: receiving an encoded video sequence; decoding refinement symbols of the video sequence using a variable length coding table, wherein the refinement symbols were encoded using a plurality of refinement coefficients, wherein each refinement coefficient is mapped to a ternary refinement symbol to generate the refinement symbols, and wherein the ternary refinement symbol has three values and each refinement symbol has one of the three values; decoding the refinement coefficients using the refinement symbols, wherein the refinement coefficients were grouped in a certain coding order and wherein the refinement coefficients are comprised within a plurality of transform coefficients; dequantizing the plurality of transform coefficients to generate a refinement signal; applying an inverse transform to the refinement signal; and constructing a video sequence using the inverse transform of the refinement signal.

In another aspect of the present invention, there is provided an electronic device that is configured to encode refinement coefficients in a signal-to-noise ratio (SNR) scalable enhancement layer of a compressed video sequence, the electronic device comprising: means for receiving a video sequence; means for constructing a prediction of an original video signal in a current frame from the video sequence; means for forming a residual frame by subtracting the prediction of the original video signal from the original video signal in the current frame; means for

applying a transform to the residual signal so as to convert the residual signal into a domain in which the residual signal is represented by a plurality of transform coefficients; means for quantizing the plurality of transform coefficients to generate a plurality of nonzero transform coefficients, wherein each of the nonzero transform coefficients has a value of nonzero and at least some of the nonzero transform coefficients are refinement coefficients, wherein each of the refinement coefficients has the value of nonzero prior to quantizing; means for mapping each refinement the plurality of transform coefficients to a ternary refinement symbol to generate a plurality of refinement symbols, wherein the ternary refinement symbol has three values and each refinement symbol has one of the three values; means for grouping the refinement symbols in a certain coding order to generate a plurality of refinement symbol groups; and means for coding the refinement symbol groups using variable length codes.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Figure 1 illustrates one embodiment of a scalable video coding bitstream structure;

[0008] Figure 2 illustrates one embodiment of a base layer and a plurality of enhancement layers being sent from an encoder across a network to a decoder;

[0009] Figure 3 illustrates a method for encoding information;

[0010] Figure 4 illustrates one embodiment of a method to decode an encoded video sequence;

[0011] Figure 5 illustrates one embodiment of a picture frame divided into a plurality of macroblocks;

[0012] Figure 6 illustrates one embodiment of classifying significant and refinement coefficients;

[0013] Figure 7 illustrates a drawback of one variable length coding (VLC) refinement coding scheme;

[0014] Figure 8 illustrates one embodiment of a subband-based coding order;

[0015] Figure 9 illustrates one embodiment of refinement symbols that may be associated with syntaxes used in refinement coding;

[0016] Figure 10 illustrates one embodiment of a variable length coding (VLC) table;

[0017] Figure 11 illustrates one embodiment of multiple fine granularity scalability (FGS) layers;

[0018] Figure 12 illustrates one embodiment of a solution to a problem due to grouping of refinement coefficients when significance and refinement coding are interleaved;

[0019] Figure 13 illustrates another embodiment where significance coding and refinement coding may be interleaved and subband FGS coding order is used;

[0020] Figure 14 illustrates one embodiment of a method of a decoder-based solution;

[0021] Figure 15 illustrates one embodiment of a method of an encoder-based solution; and

[0022] Figure 16 illustrates a block diagram illustrating major hardware components typically utilized to process digital images and/or digital video.

DETAILED DESCRIPTION

[0023] A method for coding refinement coefficients in a signal-to-noise ratio ("SNR") scalable enhancement layer of a compressed video sequence is disclosed. A video sequence is received. A prediction of an original video signal in a current frame is constructed from the video sequence. A residual signal is formed by subtracting the prediction of the original video signal from the original video signal in the current frame. A transform is applied to the residual signal. A plurality of transform coefficients is quantized. A refinement coefficient is mapped to a ternary refinement symbol. Refinement symbols are grouped in a certain coding order. The refinement symbol groups are coded using variable length codes.

[0024] A variable length coding table is adaptively selected for different enhancement layers. In an embodiment, the variable length coding table is adaptively selected based on a probability estimation of the refinement symbols. The selection of a specific variable length coding table may be based on a level of an enhancement layer. In an embodiment, the selection of the specific variable length coding table is based on whether a coefficient is being refined for the first time or whether the coefficient has been refined in a previous layer.

[0025] In an embodiment, the method interleaves significant coefficients and refinement coefficients. A slice is identified that includes a plurality of blocks. The plurality of blocks may be scanned before the grouping of the refinement coefficients. An order is determined with which the refinement coefficients will be coded. The refinement coefficients may be stored in a queue according to the order that was determined.

[0026] In an embodiment, every fixed-number of consecutive refinement coefficients are coded together using the variable length coding table. In an embodiment, refinement coefficients of a slice are grouped together. A flushing operation may be performed. The variable length coding table includes a 27-entry variable length coding table, wherein the group length is three. The subband-based coding order is used on the enhancement layer.

[0027] An electronic device implementing a method for coding refinement coefficients in an SNR scalable enhancement layer of a compressed video sequence is also disclosed. The electronic device includes a processor and memory in electronic communication with the processor. Instructions stored in the memory are included. A video sequence is received. A prediction of an original video signal in a current frame is constructed from the video sequence. A residual signal is formed by subtracting the prediction of the original video signal from the original video signal in the current frame. A transform is applied to the residual signal. A plurality of transform coefficients is quantized. A refinement coefficient is mapped to a ternary refinement symbol. Refinement symbols are grouped in a certain coding order. The refinement symbol groups are coded using variable length codes.

[0028] A computer-readable medium including instructions for implementing a method for coding refinement coefficients in an SNR scalable enhancement layer of a compressed video sequence is also disclosed. A video sequence is received. A prediction of an original video signal in a current frame is constructed from the video sequence. A residual signal is formed by subtracting the prediction of the original video signal from the original video signal in the current frame. A transform is applied to the residual signal. A plurality of transform coefficients is quantized. A refinement coefficient is mapped to a ternary refinement symbol. Refinement symbols are grouped

in a certain coding order. The refinement symbol groups are coded using variable length codes.

[0029] A method for decoding refinement coefficients in an encoded video sequence is also disclosed. An encoded video sequence is received. Refinement symbols are decoded using a variable length coding table. Refinement coefficients are decoded using the refinement symbols, wherein the refinement coefficients were grouped in a certain coding order. A plurality of transform coefficients is dequantized. An inverse transform is applied to a refinement signal. A video sequence is constructed.

[0030] In an embodiment, the encoded video stream includes interleaved significant symbols and refinement symbols. A location of the refinement coefficients being requested is stored. A sign of the corresponding base layer coefficient is stored. A counter is incremented that relates to a number of requests made. In an embodiment, it is determined if the counter reaches a predefined count. A read operation is invoked causing normal variable length coding table decoding. A group of refinement symbols are obtained.

[0031] Various embodiments of the disclosure are now described with reference to the Figures, where like reference numbers indicate identical or functionally similar elements. The embodiments of the present disclosure, as generally described and illustrated in the Figures herein, could be arranged and designed in a wide variety of different configurations. Thus, the following more detailed description of several embodiments of the present disclosure, as represented in the Figures, is not intended to limit the scope of the disclosure, as claimed, but is merely representative of the embodiments of the disclosure.

[0032] Many features of the embodiments disclosed herein may be implemented as computer software, electronic hardware, or combinations of both. To clearly illustrate this interchangeability of hardware and software, various components will be described generally in terms of their functionality. Whether such functionality is implemented as hardware or software may depend upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such implementation

decisions should not be interpreted as causing a departure from the scope of the present disclosure.

[0033] Where the described functionality is implemented as computer software, such software may include any type of computer instruction or machine-executable code stored within a memory device and/or transmitted as electronic signals over a system bus or network. Software that implements the functionality associated with components described herein may comprise a single instruction, or many instructions, and may be distributed over several different code segments, among different programs, and across several memory devices.

[0034] After general video compression techniques, such as prediction, transform, and quantization, a next step is to perform entropy coding on syntax elements and quantized coefficients to form a bitstream. In a video decoder, an inverse process is performed. Syntax elements and the quantized coefficients are decoded from the bitstream. Then inverse quantization and inverse transform steps are performed. Finally, a reconstructed residual is added to the prediction to reconstruct the video signal.

[0035] A Joint Video Team (JVT), which consists of the video coding experts from ISO/IEC MPEG and ITU-T VCEG, is working on the Scalable Video Coding (SVC) extension to H.264/AVC. The common software, called JSVM (Joint Scalable Video Model), is being used by the participants. JSVM supports various scalability features. An SVC bitstream can have fine-granularity scalability, spatial scalability, temporal scalability, or any combinations of the three.

[0036] Fine granularity scalability, hereafter referred to as FGS, is an important and highly desired feature for video coding. This feature allows the compressed video bitstream to be almost arbitrarily truncated, while at the same time providing the end user with graceful degradation of the decoded video quality. As the video decoder receives and decodes more bits in this layer, it will produce better video quality. Moreover, FGS in JSVM has been designed in a way that the improvement in video quality is evenly spread out across the entire video frame, as opposed to being concentrated within only a certain spatial area of the frame, since the latter case will be visually objectionable to the end viewer.

[0037] FGS achieves graceful improvement of video quality using bit-plane coding. If the base or previous layer video frame is quantized using a quantization parameter QP, then the current enhancement layer video is quantized using a quantization parameter typically around QP-6, which effectively cuts the quantization step size in half. As a result of lower quantization step size, more transform coefficients will become nonzero in the enhancement layer. All of the nonzero coefficients in the enhancement layer can be classified into three types: non-significant coefficients, significant coefficients, and refinement coefficients. "Non-significant" coefficients refer to those coefficients that are zero in the enhancement layer, and the corresponding coefficients in the base or previous layer are zero. "Significant" coefficients refer to those coefficients that become nonzero in the enhancement layer and the corresponding coefficients in the base or previous layer are zero. "Refinement" coefficients refer to those coefficients that are already nonzero (i.e., significant) in the base or previous layer. Their values will be refined in the current enhancement layer.

[0038] Because refinement coefficients have different statistics from other coefficients, they are coded separately in the FGS layer. Similar to H.264/AVC, the SVC draft recommendation also supports two entropy coding modes: the Context-based Adaptive Binary Arithmetic Coding (CABAC) mode and the Context-based Adaptive Variable Length Coding (CAVLC) mode. Details for an improved refinement coefficient coding scheme in the CAVLC mode is provided that is shown to not only improve coding efficiency, but also greatly reduce implementation complexity for both the encoder and decoder.

[0039] In the FGS layer, refinement coefficients are sent using two syntax elements: coeff_refinement_flag and coeff_refinement_direction_flag. The first syntax element, coeff_refinement_flag, specifies whether or not a refinement coefficient level is equal to 0. Without losing generality, it is assumed that if coeff_refinement_flag is equal to 0 the value of a refinement coefficient level is equal to 0, while coeff_refinement_flag equal to 1 specifies that the value of a refinement coefficient level is either equal to –1 or equal to 1. The second element, coeff_refinement_direction_flag, specifies whether the sign of a transform coefficient refinement level is the same or different from the sign of its base or previous layer representation. Without losing generality, it is assumed that if coeff_refinement_direction_flag is equal to 0, the sign of the transform coefficient

refinement level is equal to the sign of the corresponding coefficient in the base layer; otherwise, the refinement level has the opposite sign.

[0040] In the CAVLC mode, one way of coding the refinement coefficients in the FGS layer is to process the refinement coefficients block by block. Once the video coder starts coding the refinement coefficients in a block, all of the refinement coefficients in the current block are coded before the video coder starts coding other coefficients. Such a scheme was once adopted in one version of JSVM.

[0041] Table 1 provides such a block-based refinement encoding process summarized in the following pseudo-code.

```
// refinement level coding
// vlcTab1 is the VLC table to be used for coding refinement level
while (still refinement coefficient left in the current block) {
    get the next refinement coefficient in the zig-zag order
    let m = level of the coefficient
    code the level m using the current vlcTab1
    update the refinement level stats
    update the value of vlcTab1
}
flush the refinement level bits left in the bit buffer

// refinement direction flag coding
// vlcTab2 is the VLC table to be used for coding refinement direction
while (still refinement coefficient left in the current block) {
  get the next refinement coefficient in the zig-zag order
  if(current refinement level is non-zero)
  {
    if(level has the same sign as base coeff)
      let refinement direction s = 0
    else
      let refinement direction s = 1
    code the direction s using the current vlcTab2
    update the refinement direction stats
    update the value of vlcTab2
  }
}
flush the refinement direction bits left in the bit buffer
```

Table 1

[0042] The refinement decoding process is carried out in the reverse order to recover the syntaxes coeff_refinement_flag and coeff_refinement_direction_flag. With

these two flags, together with the base or previous layer coefficients, the decoder is able to reconstruct the refinement coefficients. The decoder also maintains and updates statistical information in buffers in the same way to stay in sync with the encoder.

[0043] In Table 1, vlcTab (vlcTab1 or vlcTab2) may take one of three values, indicating different ways to perform VLC coding on the refinement flag syntaxes. If vlcTab = 0, the refinement syntaxes are sent bit by bit (flag coding). If vlcTab = 1, the refinement syntaxes are sent in groups of three bits. If vlcTab = 2, the refinement syntaxes are sent in groups of four bits. The value of vlcTab is adaptively determined according to the accumulated statistics of the refinement coefficients in the current video slice. Also, both the encoder and the decoder keep track of the value of the most probable symbol (MPS) and switch the actual symbol being coded if the MPS changes from 0 to 1 or vice versa.

[0044] The current CAVLC refinement coding method may have relatively high computational complexity. For example, the current method may need to maintain and update the accumulated statistics of both refinement syntaxes (level syntax and direction syntax). The current method may need to update the values of vlcTaband MPS. The current method may need to make sure the probability counts for 0 and 1 will not overflow by scaling them back when needed. Changing the group length adaptively may also complicate the implementation.

[0045] Even with its relative high complexity, the current refinement coding may be inefficient. Simulations show that, for some sequences, the CAVLC refinement coding can take up to twice as many bits (100% penalty) compared the CABAC refinement coding, whereas the overall bit rate penalty of using the CAVLC mode instead of CABAC is usually only around 15% or less. This inefficiency is largely due to the fact that the CAVLC refinement coding carries out two rounds of bit flushing operations at the end of each block (one for the level syntax, and the other for the direction syntax). If a block contains very few refinement coefficients (e.g., only 1 or 2 coefficients), then the frequent flushing operations may make it impossible to group 3 or 4 bits together, hence incurring a heavy bit penalty because variable length coding cannot be used according to this scheme.

[0046] As used herein, the terms "an embodiment", "embodiment", "embodiments", "the embodiment", "the embodiments", "one or more embodiments", "some

embodiments", "certain embodiments", "one embodiment, "another embodiment" and the like mean "one or more (but not necessarily all) embodiments of the disclosed disclosure(s)," unless expressly specified otherwise.

[0047] The term "determining" (and grammatical variants thereof) is used in an extremely broad sense. The term "determining" encompasses a wide variety of actions and therefore "determining" can include calculating, computing, processing, deriving, investigating, looking up (e.g., looking up in a table, a database or another data structure), ascertaining and the like. Also, "determining" can include receiving (e.g., receiving information), accessing (e.g., accessing data in a memory) and the like. Also, "determining" can include resolving, selecting, choosing, establishing, and the like.

[0048] The phrase "based on" does not mean "based only on," unless expressly specified otherwise. In other words, the phrase "based on" describes both "based only on" and "based at least on."

[0049] Figure 1 illustrates one embodiment 100 of a scalable video coding bitstream structure referred to as Fine Granularity Scalability (FGS). In FGS, a video sequence is compressed into a single video stream with at least two layers: a base layer 106 and an enhancement layer 104. As illustrated, FGS may further include N enhancement layers 102.

[0050] In one embodiment, the base layer 106 is a nonscalable coding of the video sequence and typically has the lowest quality of the video sequence. The enhancement layer 104 and the N enhancement layers 102 have varying levels of quality above that of the base layer 106. Decoding each additional enhancement layer coded after the base layer 106 results in an increased quality of the video sequence. In addition, FGS bitstream has one significant advantage that during or after encoding, the bits pertaining to the enhancement layer 104 and the N enhancement layers 102 may be truncated (reducing the bit rate and thus the decoded picture quality) in real time. This provides flexible control over the transmitted bit rate and allows the enhancement layer 104 and the N enhancement layers 102 to be adjusted to match the available transmission bit rate.

[0051] Figure 2 is a network block diagram 200 illustrating the base layer 202 and N enhancement layers 204 being sent from an encoder 208 across a network 210 to a decoder 212. The decoder 212 may decode and use the base layer 202 and all or

portions of one or more enhancement layers 204. The decoder 212 constructs an optimal approximation 214 of the original video sequence 206. In one embodiment, the optimal approximation 214 is displayed on a display 216 such as a computer monitor, television, PDA, projector, etc. A video sequence 206 is encoded as a base layer 202 and one or more enhancement layers 204. The lower quality base layer 202 represents the minimum quality standard and each of the enhancement layers 204 are improvements upon the base layer 202 picture quality. In one embodiment, the video sequence 206 is encoded using the FGS video coding format as explained in Figure 1. The FGS coding format may be particularly useful for video streaming and broadcasting applications where the available transmission bandwidth may not be known in advance. During or after encoding, the enhancement layers 204 may be truncated arbitrarily to match the available transmission bit rate. As the available bit rate changes, the enhancement layers 204 can be truncated accordingly in real time to provide the optimal quality decoded video sequence with respect to the current bandwidth. For example, the network 200 may truncate the enhancement layers 204 and then send bit streams with different bit rates to different destinations.

[0052] Figure 3 illustrates a method 300 for encoding information. In one embodiment, the information to be encoded comprises a video sequence. The method 300 may be carried out within a video encoder, and the inverse of the method 300 may be executed by a video decoder. An encoder is a device used to change a signal or data into a code. The decoder may then produce the original signal or an approximation of the original signal from the code. The encoder and decoder may be collectively referred to as a video CODEC, which encodes a source image or video sequence into a compressed form and decodes this to produce a copy or approximation of the source sequence.

[0053] The method 300 begins 302 with the encoder receiving 304 the video sequence. In one embodiment, the video sequence is an uncompressed video signal. The encoder begins to compress the video sequence by exploiting the similarities between neighboring video frames and constructing 306 a prediction of the current video signal. The prediction is formed from one or more previous or future frames and is improved by compensating for differences between the frames. A residual signal is then formed 308 by subtracting the prediction frame from the actual current frame. The

encoder makes use of the similarities between neighboring samples of the prediction residual to reduce spatial redundancy.

[0054] The method 300 continues by applying 310 a transform to the residual signal to reduce remaining spatial redundancy. The transform converts the prediction residual signals into another domain in which they are represented by transform coefficients. The coefficients are quantized 312 to remove insignificant values, leaving a small number of significant coefficients that provide a more compact representation of the residual samples. In one embodiment, the coefficients are quantized using QP-6, which effectively reduces the quantization step size in half. As a result of a reduced quantized step size, an increased quantity of transform coefficients will become nonzero in the current frame. For example, the prediction residual being encoded using the method 300 may be in an enhancement layer. If the previous layer of the video frame or the base layer of the video frame were quantized 312 using the quantization parameter QP, then the current enhancement layer is quantized312 using QP-6.

[0055] In one embodiment, the nonzero quantized coefficients in the enhancement layer may be classified as non-significant, significant, or refinement coefficients. "Non-significant" coefficients refer to those coefficients that are zero in the base or previous layer and remain zero in the current enhancement layer. "Significant" coefficients refer to those coefficients that are zero in the base or previous layer but become nonzero coefficients in the current enhancement layer. "Refinement" coefficients refer to those coefficients that are already nonzero in a base or previous layer. In one embodiment, each refinement coefficient is mapped 313 to a ternary refinement symbol. The ternary refinement symbol may have one of three values. The encoder scans the current enhancement layer and groups 314 the refinement symbols in a certain coding order. In one embodiment, the encoder groups 314 the consecutive refinement symbols in the subband-based coding order. Each group of refinement symbols is referred to as a "Refinement Symbol Group." The encoder then codes 316 the Refinement Symbol Groups and adds these codes to the bitstream. In one embodiment, the encoder codes 316 a Refinement Symbol Group using a variable length code (VLC) from a VLC table. In another embodiment, the VLC table used to encode one Refinement Symbol Group may be dynamically selected from a set of VLC tables, based on the current estimation of the statistical distribution of the refinement coefficients.

[0056] In an additional embodiment, the encoder may encode the refinement symbols from multiple enhancement layers. For example, the encoder may encode multiple enhancement layers under the FGS coding format. In one embodiment, the Refinement Symbol Groups from the multiple FGS enhancement layers are coded using an adaptive VLC table selection. In another embodiment, the VLC table is fixed for one FGS layer, but may be different from the VLC table used in another FGS layer.

[0057] Figure 4 illustrates one embodiment of a method 400 to decode an encoded video sequence. The decoding method 400 may be an inverse of the encoding method 300 of Figure 3. The decoding method 400 begins 402 by a decoder receiving 404 the encoded video sequence. The encoded video sequence may also be referred to as the bitstream. The decoder decodes 406 the Refinement Symbol Groups using the VLC table. If the Refinement Symbol Groups are encoded using the adaptive VLC tables based on the statistical distribution of the refinement coefficients, the same statistical information is used in the decoder to select the correct VLC table. If encoded refinement symbols from multiple enhancement layers are received by the decoder, the decoder may adapt the VLC table used to decode the refinement symbols according to their respective enhancement layers.

[0058] The method 400 continues and the decoder decodes 408 the refinement coefficients using the recently decoded refinement symbols. The decoder then proceeds to dequantize 410 the decoded refinement coefficients before they are added back to the base or previous layer dequantized coefficients. The method 400 proceeds by applying 412 an inverse transform to the dequantized coefficients. In one embodiment, the inverse transform may include the inverse discrete cosine transform. After the decoder applies 412 the inverse transform to the refinement coefficients, the decoder constructs 414 an approximation of the original video sequence as it existed before the encoding method 300 of Figure 3.

[0059] Figure 5 illustrates one embodiment of a video frame 500 divided into a plurality of macroblocks. Macroblocks are the basic data units in the decoding process. As illustrated, the video frame 500 may be partitioned into the plurality of fixed-sized macroblocks that each includes a sample of the video frame 500. In one embodiment, each macroblock includes a sample of 16x16 pixels. In an additional embodiment, each macroblock includes a luminance (luma) component and two chrominance (chroma)

components. The luma component relates to the brightness of the particular sample while the chroma components relate to the color characteristics of the sample. In one embodiment, the video frame 500 is further partitioned into a plurality of slices, slice A 502, slice B 504, and slice C 506. A slice is a sequence of macroblocks which are processed consecutively in a certain coding order. For example, slice A 502 and the macroblocks contained within slice A 502, may be encoded and sent to the decoder before slice B 504 and slice C 506. In an additional embodiment, the order of encoding the various slices 502, 504, and 506 and sending them to the decoder may be arbitrary. For example, slice B 504 may be encoded sent to the decoder before the other slices. Similarly, slice C 506 may be encoded and sent to the decoder before the other two slices. Each macroblock in the N enhancement layers corresponds to a macroblock in each of the N-1 enhancement layers and base layer.

[0060] Figure 6 illustrates an example of how to classify coefficients. A base layer coefficient block 602 and an enhancement layer coefficient block 604 are provided. The blank spaces in the base layer 602 and the enhancement layer 604 represent coefficients of zero. These coefficients are referred to as non-significant coefficients. The remaining spaces, 606, 608, 608a, and 608b each represent a coefficient that may have a nonzero value. In one embodiment, the base layer coefficient block 602 is in previous enhancement layer using the FGS video coding format. As previously explained, during the encoding method 300 of Figure 3, transform coefficients are quantized. After quantization, the nonzero coefficients in the enhancement layer coefficient block 604 that their corresponding coefficients in the base layer coefficient block 602 are zero are referred to as significant coefficients 606. These coefficients whose corresponding coefficients in the base layer are nonzero are referred to as refinement coefficients 608. Because significant coefficients 606 and refinement coefficients 608 have different statistics, they are coded separately in the enhancement layer 604 following the FGS coding format.

[0061] In one embodiment, significant coefficients 606 are those coefficients whose corresponding coefficients 606a and 606b (the coefficient representing the same subband) in the base or previous layer are zero. Refinement coefficients 608 are those coefficients whose corresponding coefficients 608a and 608b in the base or previous layer are nonzero.

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[0062] Figure 7 illustrates a drawback 700 of the current CAVLC refinement coding scheme in which the block-by-block coding order is used. The block-by-block order will inherently generate spatially uneven quality improvement within the video frame 710. As shown in Figure 7, when the bitstream 708 is truncated, all the video blocks represented in the bitstream 708 prior to truncation 704 (blocks 0, 1, ... n-1) will have better video quality 712 compared to the video blocks 706 (blocks n and on) whose refinement coefficients are lost during truncation 714. A better order to encode these refinement coefficients is to use the subband-based coding order, which is detailed in the next Figure.

[0063] Figure 8 illustrates one embodiment of the subband-based coding order 800. In one embodiment, a first block 802, a second block 804, and a third block 806 are three blocks of coefficients in the same enhancement layer. In one embodiment, the blocks 802, 804, and 806 are blocks in the first FGS enhancement layer such that the subband-based FGS coding order 800 may be extended to and used on the first FGS layer. Compared to the block-based order, the subband-based coding order 800 sends refinement coefficients according to the transform domain subband they belong to. In one embodiment, the notation Bx,y illustrated in the blocks 802, 804, and 806 may represent a coefficient in subband y and in block x. For example, B0,0 represents a coefficient in the first subband (subband 0) and in the first block 802.

[0064] In one embodiment, the encoder first encodes any refinement coefficients present at positions B0,0, B1,0, and B2,0. The encoder then encodes any refinement coefficients present at positions B0,1, B1,1, and B2, 1, and so forth. The subband coding order 800 facilitates the refinement coefficients to be encoded and sent according to the transform domain subband they belong to. Using the subband coding order 800 results in more even quality improvement spatially as more refinement bits are received.

[0065] Figure 9 illustrates one embodiment 900 of refinement symbols (ref_symbol) 906 that may be associated with the two syntaxes used in refinement coding, coeff_refinement_flag 902 and coeff_refinement_dir_flag 904. As previously explained, if a refinement coefficient has the value of 0, the syntax element coeff_refinement_flag 902 is assigned the value of 0. Accordingly, the ref_symbol 906 assigned is also 0. If the refinement coefficient has a nonzero value, the coeff_ref_flag

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902 is assigned the value of 1. If the refinement coefficient has the same sign as the corresponding refinement coefficient in the base layer or previous enhancement layer, the coeff_ref_dir_flag 904 is assigned the value of 0. If the sign of the refinement coefficient in the base layer or previous enhancement layer is opposite the sign of the refinement coefficient in the current layer being encoded, the coeff_ref_dir_flag 904 is assigned the value of 1. In another embodiment, the parameters defining the value of the coeff_ref_dir_flag 904 are reversed.

[0066] If the coeff_ref_dir_flag 904 is assigned the value of 0, the ref_symbol 906 is assigned the value of 1 and if the coeff_ref_dir_flag 904 is assigned the value of 1, the ref_symbol 906 is assigned the value of 2. The values of the ref_symbol 906 are then encoded and included in the bitstream. One embodiment of encoding the values of the ref_symbol 906 is provided below.

[0067] Figure 10 illustrates one embodiment of a variable length coding (VLC) table 1000 used to encode the values of the refinement symbols as explained in Figure 9. Under the subband coding order, consecutive refinement symbols may be grouped together and a Refinement Symbol Group 1002 is encoded using the VLC table 1000. The table 1000 includes a plurality of entries. Each entry has a value of a Refinement Symbol Group 1002 as explained in Figure 9, a code length 1004 of variable length code for coding the Refinement Symbol Group 1002 of a particular value, and a code word 1006 of the variable length code for coding the Refinement Symbol Group 1002 of a particular value. The code word 1006 is then included in the bitstream and sent to the decoder.

[0068] In one embodiment, a single VLC table like the table 1000 is used in refinement coding, it is not necessary for the encoder and the decoder to constantly accumulate and update refinement symbol statistics, thus, the computational complexity may be greatly reduced. In another embodiment, a VLC table is selected from multiple tables based on the estimation of the statistical distribution of the refinement coefficients, the performance can be improved with additional complexity of probability estimation and table selection.

[0069] Referring now to Figure 11, current SVC standards allow multiple layers on top of a discrete base layer 1102. When there is more than one FGS layer 1104 and 1106, starting from the second FGS layer 1106 and going up, all refinement coefficients

belong to one of two classes: the "old" refinement coefficients are those that already have refinement coefficients in the previous FGS layer 1104, and the "new" refinement coefficients are those that just became significant in the previous FGS layer 1104 and are just entering the refinement stage in the current layer 1106. Figure 11 provides an example of having two FGS layers 1104 and 1106. The first FGS layer 1104 contains significant coefficients 1108 as well as refinement coefficients 1110. The second FGS layer 1106 includes "old" refinement coefficients 1112 as well as "new" refinement coefficients 1114. The coefficient 1116 is new significant coefficient in the second FGS layer 1106. The remaining blank positions are non-significant coefficients that have no nonzero values.

[0070] The two types of refinement coefficients 1112 and 1114 have different symbol probability distributions. Therefore, in one embodiment, it is better to use different VLC tables to encode them. Furthermore, different VLC coding tables may be used depending on the level of the current FGS layer. For example, a different VLC table may be used to encode the refinement coefficients included in the second FGS layer 1106 than that used to used the refinement coefficients included in the first FGS layer 1104. Hence, a coding table more tuned for such probability distribution should be used to improve performance. Such VLC table adaptation has very low complexity as it is solely based on the refinement coefficient class and the FGS layer level, rather than relying on collecting and updating the symbol statistics. In another embodiment, VLC table can be selected dynamically based on the estimation of the statistical distribution of the refinement coefficients for the current FGS layer.

[0071] Figure 12 illustrates one embodiment 1200 of a solution to the problem due to grouping of refinement symbols when significance and refinement coding are interleaved. In FGS coding, the significance coding pass and the refinement coding pass for different blocks are usually interleaved together. One reason for this is that one block might contain fewer significant coefficients than the other block. When the significance coding pass of a certain block is over, the refinement pass for this block will start next, while the block next to this one will still be going through its significance coding pass. In one embodiment, the significance coding (of S0,0 and then EOB) for block A 1202 is over after two rounds. Then the refinement coding of R0,0

(and later R0,1) will start. But at the same time the significance coding of block B 1204 (coefficients S1,2 and EOB) is still ongoing.

[0072] Another reason for interleaved significance and refinement coding is the use of the subband coding order. Figure 13 illustrates another embodiment 1300 where significance coding and refinement coding may be interleaved. In one embodiment, the coefficients are scanned in subbands. For example, when scanning the 0-th subband 1306, block A 1302 contains a significance coefficient S0,0. Hence, significance coding of S0,0 is carried out. Similarly, when the 0-th subband 1306 of block B 1304 is scanned, refinement coding of refinement coefficient R1,0, is carried out.

[0073] This behavior of interleaved significance and refinement coding generates a problem when the refinement coding is done by grouping of multiple (for example, three) refinement coefficients. At the encoder side, three refinement symbols are buffered up before a VLC code word is sent out. But at the decoder side, whenever the decoding of a refinement coefficient is encountered, the decoder will attempt to read from the bitstream a VLC code word representing a group of three refinement symbols. But this code word is still buffered in the encoder's encoding buffer and has not yet been sent. The loss of sync between the encoder and the decoder means such a coding scheme (grouping of refinement symbols when significance and refinement passes are interleaved) will fail. Two solutions are provided to solve this problem and are provided below.

[0074] Figure 14 illustrates a method of a decoder-based solution 1400 that requires no change at the encoder side. The encoder may always try to group every three refinement symbols together before sending out a codeword. At the decoding side, when a refinement coefficient is requested, the following operations are carried out. The method 1400 begins by initializing 1402 a counter to zero. The location of the refinement coefficient being requested is stored 1404, the sign of the corresponding base layer coefficient is stored 1406, a counter (initialized to zero at the start of the slice decoding) is incremented to keep track of how many such requests have been made 1408, if this counter reaches three 1410, a "read" operation is invoked 1412 and normal VLC decoding is carried out. A group of three refinement symbols are returned, which are then dispensed back to the corresponding coefficient locations as previously stored

1414, and the counter is reset to zero 1416. If the counter is not yet three 1410, the method 1400 returns to step 1402 and continues on.

[0075] While the decoder-side solution places more burdens on the decoder, the encoder-side solution has minimal complexity impact on the decoder. The basic concept is that the encoder always sends in advance multiple (for example, three) refinement coefficients, the decoder is guaranteed to have sufficient refinement symbols exist in the buffer when a refinement coefficients is requested. Figure 15 illustrates a method 1500 of one type of encoder-based solution. The encoder pre-scans 1502 a certain number of blocks in the slice and determines the order 1504 with which all the refinement coefficients will be sent during the actual coding stage. Along the way the refinement coefficients are stored 1506 in a queue according to this coding order. At the coding stage, when a refinement coefficient needs to be sent, it is determined 1508 whether it has been grouped together with previous coefficient(s) and already sent out. If so, then no action is taken 1510; otherwise, this refinement coefficient is sent 1512 together with the two coefficients immediately next to it in the queue. The method 1500 continues on until the coding pass is over.

[0076] Note that both the encoder-based and the decoder-based solutions apply to any type of interleaving of the significance pass and the refinement pass from different blocks, including but not limited to the two coding orders currently supported in the SVC draft recommendation. These two solutions also apply to grouping of any number of refinement symbols, and are not just limited to grouping of three symbols.

[0077] It should be also noted that both the decoder-based and encoder-based solutions can be applied to the block-based refinement coding as defined in SVC Joint Draft 5 (JD5), thus making it unnecessary to flush out the remaining refinement bits stored in the buffer at the end of every block. For the decoder-based solution, a further change at the encoder side can guarantee encoder and decoder synchronization. Because the block-based refinement coding scheme in JD5 adapts the VLC table, the number of grouped refinement symbols can change among 1, 3, and 4. At the end of a block, the encoder should suspend the VLC table adaptation until it encounters sufficient number of refinement coefficients (this will happen some time later as the encoder carries out the refinement coding of the subsequent blocks). When sufficient refinement coefficients have been encountered to invoke a write operation of a VLC code word, the

encoder can resume the normal VLC table adaptation. Under this scheme, the frequent flushing operation (done one every block) as used in the current refinement coding can be minimized, and coding performance can be greatly improved.

[0078] At the end of coding a certain number of refinement coefficients, a flushing operation may be used if the number of remaining refinement coefficients is not zero and is less than the group size used in a typical coding process. One way of performing the flushing operation is to add the most probable symbols to make a complete group, and code the last group as other groups. For example, assume that the typical group size is assumed to be 3, that there is one remaining coefficient to be coded in the flushing operation, and that the symbol is 2. The group (2, 0, 0) will be coded, assuming the symbol "0" is the most probable symbol in the ternary symbol set. At the decoder side, these padded symbols are discarded. Flushing operations may also be performed more frequently to reduce the implementation complexity. A group of refinement coefficients that are coded together are from different locations. Limiting the distance among the coefficients in the same group will result in some un-grouped symbols that need to be handled by flushing operations. In another embodiment, instead of forming a complete group by adding the most probable symbols which will be discarded by the decoder, the VLC tables designed for coding smaller groups are used. This may be used when the number of refinement coefficients to be flushed will be known exactly by the decoder. Assume the group size is 3, and there is only one coefficient "R" to be flushed. Instead of coding the group (R, 0, 0) using the VLC tables for coding group of 3 symbols, it is more efficient to use a special VLC table. For example, a refinement symbol of value "0" is coded as "1", a refinement symbol of value "1' is coded as "01" and a refinement symbol of value "2" is coded as "00". Similarly, if the group size is 3, and there are two coefficients, "R1" and "R2", to be flushed. Instead of coding the group (R1, R2, 0), different VLC tables can be used for coding the smaller group (R1, R2). In one embodiment, the Exponential-Golomb code is used for coding the index of the group which is calculated as R1*3 + R2. It is to be noted that equivalently the index of the group coded can also be formed as R1 + R2 * 3.

[0079] Figure 16 illustrates a device 1600 configured to process digital images and/or digital video. The device 1600 may represent or be implemented in a digital television, a digital direct broadcast system, a wireless communication device, a

personal digital assistant (PDA), a laptop computer, a desktop computer, a digital camera, a digital recording device, a network-enabled digital television, a cellular or satellite radio telephone, or any telecommunication device with video telephony (VT) capabilities.

[0080] The device 1600 may process, encode, decode, transmit and/or receive image and/or video data. The video data may be captured by a video camera, such as a video capture unit (or image sensor) 1612, retrieved from a video archive, or obtained in another manner. A video coding unit 1610 in the device 1600 may use a video coding standard such as MPEG-4, ITU-T H.263, ITU-T H.264, or any other video coding standard. The video coding unit 1610 may support inter-frame coding techniques, such as motion estimation and motion compensation, and intra-frame coding techniques, such as spatial estimation and intra-prediction coding techniques.

[0081] The device 1600 may include an image/video capture device 1612, such as a camera or video camera, to capture images or video sequences and store the captured images or sequences in a memory 1614. An image/video processing unit 1602 may process images and/or video sequences. The memory 1604 may store the images and/or video sequences before and after such processing.

[0082] A transceiver 1616 may receive and/or transmit coded video sequences to another device. The transceiver 1616 may use a wireless communication standard such as code division multiple access (CDMA). Examples of CDMA standards include CDMA 1xEV-DO, WCDMA, etc.

[0083] One or more elements of the device 1600 may be communicatively coupled via a communication bus 1618. In addition to or instead of the elements shown in FIG. 16, other elements may be included in the device 1600. The architecture illustrated in FIG. 16 is merely an example. The techniques described herein may be implemented with a variety of other architectures.

[0084] The memory 1614 may have a relatively large memory space. The memory 1614 may comprise dynamic random access memory (DRAM), or FLASH memory. The memory 1614 may comprise "NOR" or "NAND" gate memory technology, or any other data storage technology. In other examples, the memory 1614 may comprise a non-volatile memory or any other type of data storage unit.

[0085] The image/video processing unit 1602 may comprise a chip set for a mobile radiotelephone, which may include hardware, software, firmware, and/or one or more microprocessors, digital signal processors (DSPs), application specific integrated circuits (ASICs), field programmable gate arrays (FPGAs), or various combinations thereof. The processing unit 1602 may include a local memory 1604 coupled to a front-end image/video processing unit 1608 and an image/video coding unit 1610. The coding unit 1610 may comprise an encoder/decoder (CODEC) for encoding (or compressing) and decoding (or decompressing) digital video data.

[0086] The local memory 1604 may comprise a smaller and faster memory space relative to the memory 1614. For example, the local memory 1604 may comprise synchronous dynamic random access memory (SDRAM). The local memory 1604 may comprise "on-chip" memory integrated with the other components of the processing unit 1602 to provide fast access to data during a processor-intensive coding process. However, the memories 1614 and 1604 may be combined into one memory, or may be implemented in a number of other configurations. A memory controller 1606 may control memory fetches and write-backs to the local memory 1604.

[0087] The front-end image/video processing unit 1608 may perform one or more image processing techniques on the frames of a video sequence to improve image quality, and thereby improve the quality of a video sequence. For example, the front-end image/video processing unit 1608 may perform techniques such as demosaicing, lens rolloff correction, scaling, color correction, color conversion, and spatial filtering. The front-end image/video processing unit 1608 may also perform other techniques. In general, the techniques performed by the unit 1608 are referred to as "front-end" image processing techniques because the techniques precede coding by the image/video coding unit 1610.

[0088] The image/video capture unit 1612 may comprise image sensors that include color filter arrays (CFAs) arranged on a surface of the sensors. Front-end image processing performed by the unit 1608 may improve the quality of the video sequence captured by the capture unit 1612. For example, the front-end processing unit 1608 and/or the coding unit 1610 may comprise a DSP programmed to process images captured by the capture unit 1612. The same area of memory 1604 (or memory 1614) may used for both front-end image processing purposes and for other storage purposes.

[0089] The image/video coding unit 1610 may perform image and/or video coding, which may include one or more video compression techniques, such as inter-frame compression and/or intra-frame compression. For example, the coding unit 1610 may implement motion estimation and motion compensation techniques to exploit temporal or inter-frame data correlation to provide inter-frame compression. Alternatively or additionally, the coding unit 1610 may perform spatial estimation and intra-prediction techniques to exploit spatial or intra-frame data correlation to provide intra-frame compression. The output of motion compensation (or intra-prediction) is referred to as "residual," and may comprise a block of data indicative of differences between a current video block to be coded and a prediction block identified by motion estimation or spatial estimation.

[0090] After the coding unit 1610 performs motion compensation (or intra-prediction) to create the residual, a series of additional steps may be performed to further code the residual and further compress the data. The additional steps may depend on the coding standard being used, but are generally referred to as "residual coding." The coding unit 1610 may perform one or more of these video compression techniques to reduce the amount of data needed to communicate a video sequence to another device via the transceiver 1616.

[0091] Information and signals may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the above description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

[0092] The various illustrative logical blocks, modules, circuits, and algorithm steps described in connection with the embodiments disclosed herein may be implemented as electronic hardware, computer software, or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for

each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the present disclosure.

[0093] The various illustrative logical blocks, modules, and circuits described in connection with the embodiments disclosed herein may be implemented or performed with a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array signal (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

[0094] The steps of a method or algorithm described in connection with the embodiments disclosed herein may be embodied directly in hardware, in a software module executed by a processor, or in a combination of the two. A software module may reside in RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, hard disk, a removable disk, a CD-ROM, or any other form of storage medium known in the art. A storage medium is coupled to the processor such that the processor can read information from, and write information to, the storage medium. In the alternative, the storage medium may be integral to the processor. The processor and the storage medium may reside in an ASIC. The ASIC may reside in a user terminal. In the alternative, the processor and the storage medium may reside as discrete components in a user terminal.

[0095] The methods disclosed herein comprise one or more steps or actions for achieving the described method. The method steps and/or actions may be interchanged with one another without departing from the scope of the present disclosure. In other words, unless a specific order of steps or actions is required for proper operation of the embodiment, the order and/or use of specific steps and/or actions may be modified without departing from the scope of the present disclosure.

[0096] While specific embodiments and applications of the present disclosure have been illustrated and described, it is to be understood that the disclosure is not limited to the precise configuration and components disclosed herein. Various modifications, changes, and variations which will be apparent to those skilled in the art may be made in the arrangement, operation, and details of the methods and systems of the present disclosure disclosed herein without departing from the scope of the claims.

[0097] What is claimed is:

74769-2149

CLAIMS:

1. A method for coding refinement coefficients in a signal-to-noise ratio (SNR) scalable enhancement layer of a compressed video sequence comprising:

receiving a video sequence;

constructing a prediction of an original video signal in a current frame from the video sequence;

forming a residual signal by subtracting the prediction of the original video signal from the original video signal in the current frame;

applying a transform to the residual signal so as to convert the residual signal into a domain in which the residual signal is represented by a plurality of transform coefficients;

quantizing the plurality of transform coefficients to generate a plurality of nonzero transform coefficients, wherein each of the nonzero transform coefficients has a value of nonzero and at least some of the nonzero transform coefficients are refinement coefficients, wherein each of the refinement coefficients has the value of nonzero prior to quantizing;

mapping each refinement coefficient to a ternary refinement symbol to generate a plurality of refinement symbols, wherein the ternary refinement symbol has three values and each refinement symbol has one of the three values;

grouping the refinement symbols in a certain coding order to generate a plurality of refinement symbol groups; and

coding the refinement symbol groups using variable length codes.

2. The method of claim 1, further comprising using a variable length coding table adaptively selected for different enhancement layers.

3. The method of claim 1, further comprising using a variable length coding table adaptively selected based on a probability estimation of the refinement symbols.

4. The method of claim 2, wherein the selection of a specific variable length coding table is based on a level of an enhancement layer.

5. The method of claim 4, wherein the selection of the specific variable length coding table is based on whether a coefficient is being refined for the first time or whether the coefficient has been refined in a previous layer.

6. The method of claim 1, wherein the method interleaves significant coefficients and refinement coefficients, further comprising:

identifying a video slice that includes a plurality of blocks;

scanning the plurality of blocks before the grouping of the refinement coefficients;

determining an order with which the refinement coefficients will be coded; and

storing the refinement coefficients in a queue according to the order that was determined.

7. The method of claim 1, further comprising identifying a video slice that includes a plurality of blocks.

8. The method of claim 7, further comprising scanning the plurality of blocks before the grouping of the refinement coefficients.

9. The method of claim 1, further comprising determining an order with which the refinement coefficients will be coded.

10. The method of claim 9, further comprising storing the refinement coefficients in a queue according to the order that was determined.

11. The method of claim 1, wherein every fixed-number of consecutive refinement coefficients are coded together using the variable length coding table.

12. The method of claim 7, further comprising grouping refinement coefficients of the video slice together.

13. The method of claim 1, further comprising performing a flushing operation.

14. The method of claim 13, wherein the flushing operation includes adding one or more most probable symbols to one or more refinement symbols to make a complete group.

15. The method of claim 13, wherein the flushing operation includes using a variable length coding table which is selected based on the number of refinement coefficients to be processed in the flushing operation.

16. The method of claim 1, wherein the variable length coding table comprises a 27-entry variable length coding table, wherein the group length is three.

17. The method of claim 1, further comprising using the subband-based coding order on the enhancement layer.

18. An electronic device that is configured to encode refinement coefficients in a signal-to-noise ratio (SNR) scalable enhancement layer of a compressed video sequence, the electronic device comprising:

a processor;

memory in electronic communication with the processor;

instructions stored in the memory, the instructions being executable to:

receive a video sequence;

construct a prediction of an original video signal in a current frame from the video sequence;

form a residual frame by subtracting the prediction of the original video signal from the original video signal in the current frame;

apply a transform to the residual signal so as to convert the residual signal into a domain in which the residual signal is represented by a plurality of transform coefficients;

quantize the plurality of transform coefficients to generate a plurality of nonzero transform coefficients, wherein each of the nonzero transform coefficients has a value of nonzero and at least some of the nonzero transform coefficients are refinement coefficients, wherein each of the refinement coefficients has the value of nonzero prior to quantizing;

map each refinement coefficient to a ternary refinement symbol to generate a plurality of refinement symbols, wherein the ternary refinement symbol has three values and each refinement symbol has one of the three values;

group the refinement symbols in a certain coding order to generate a plurality of refinement symbol groups; and

code the refinement symbol groups using variable length codes.

19. The electronic device of claim 18, wherein the instructions are further executable to use a variable length coding table adaptively selected for different enhancement layers.

20. The electronic device of claim 18, wherein the electronic device is configured to interleave significant coefficients and refinement coefficients, and wherein the instructions are further executable to:

identify a video slice that includes a plurality of blocks;

scan the plurality of blocks before the grouping of the refinement coefficients;

determine an order with which the refinement coefficients will be coded; and

store the refinement coefficients in a queue according to the order that was determined.

21. A computer-readable medium comprising executable instructions for coding refinement coefficients in a signal-to-noise ratio (SNR) scalable enhancement layer of a compressed video sequence, the instructions comprising:

receiving a video sequence;

constructing a prediction of an original video signal in a current frame from the video sequence;

forming a residual signal by subtracting the prediction of the original video signal from the original video signal in the current frame;

applying a transform to the residual signal so as to convert the residual signal into a domain in which the residual signal is represented by a plurality of transform coefficients;

quantizing the plurality of transform coefficients to generate a plurality of nonzero transform coefficients, wherein each of the nonzero transform coefficients has a value of nonzero and at least some of the nonzero transform coefficients are refinement coefficients, wherein each of the refinement coefficients has the value of nonzero prior to quantizing;

mapping each refinement coefficient to a ternary refinement symbol to generate a plurality of refinement symbols, wherein the ternary refinement symbol has three values and each refinement symbol has one of the three values;

grouping the refinement symbols in a certain coding order to generate a plurality of refinement symbol groups; and

coding the refinement symbol groups using variable length codes.

22. A method for decoding refinement coefficients in an encoded video sequence comprising:

receiving an encoded video sequence;

decoding refinement symbols of the video sequence using a variable length coding table, wherein the refinement symbols were encoded using a plurality of refinement coefficients, wherein each refinement coefficient is mapped to a ternary refinement symbol to generate the refinement symbols, and wherein the ternary refinement symbol has three values and each refinement symbol has one of the three values;

decoding the refinement coefficients using the refinement symbols, wherein the refinement coefficients were grouped in a certain coding order and wherein the refinement coefficients are comprised within a plurality of transform coefficients;

dequantizing the plurality of transform coefficients to generate a refinement signal;

applying an inverse transform to the refinement signal; and

constructing a video sequence using the inverse transform of the refinement signal.

23. The method of claim 22, further comprising using different variable length coding tables adaptively selected for different enhancement layers.

24. The method of claim 22, wherein the encoded video stream includes interleaved significant symbols and refinement symbols, further comprising:

storing a location of the refinement coefficient being requested;

storing a sign of the corresponding base layer coefficient; and

incrementing a counter that relates to a number of requests made.

25. The method of claim 24, further comprising:

determining if the counter reaches a predefined count; and

invoking a read operation and causing normal variable length coding table decoding to obtain a group of refinement symbols.

26. The method of claim 25, further comprising storing the group of refinement symbols to the corresponding locations as previously stored.

27. The method of claim 22, further comprising performing a flushing operation.

28. The method of claim 27, wherein the flushing operation includes discarding padded symbols.

29. The method of claim 27, wherein the flushing operation includes using a variable length coding table which is selected based on the number of refinement coefficients to be processed in the flushing operation.

30. An electronic device that is configured to encode refinement coefficients in a signal-to-noise ratio (SNR) scalable enhancement layer of a compressed video sequence, the electronic device comprising:

means for receiving a video sequence;

means for constructing a prediction of an original video signal in a current frame from the video sequence;

means for forming a residual frame by subtracting the prediction of the original video signal from the original video signal in the current frame;

means for applying a transform to the residual signal so as to convert the residual signal into a domain in which the residual signal is represented by a plurality of transform coefficients;

means for quantizing the plurality of transform coefficients to generate a plurality of nonzero transform coefficients, wherein each of the nonzero transform coefficients has a value of nonzero and at least some of the nonzero transform coefficients are refinement coefficients, wherein each of the refinement coefficients has the value of nonzero prior to quantizing;

means for mapping each refinement the plurality of transform coefficients to a ternary refinement symbol to generate a plurality of refinement symbols, wherein the ternary refinement symbol has three values and each refinement symbol has one of the three values;

means for grouping the refinement symbols in a certain coding order to generate a plurality of refinement symbol groups; and

means for coding the refinement symbol groups using variable length codes.

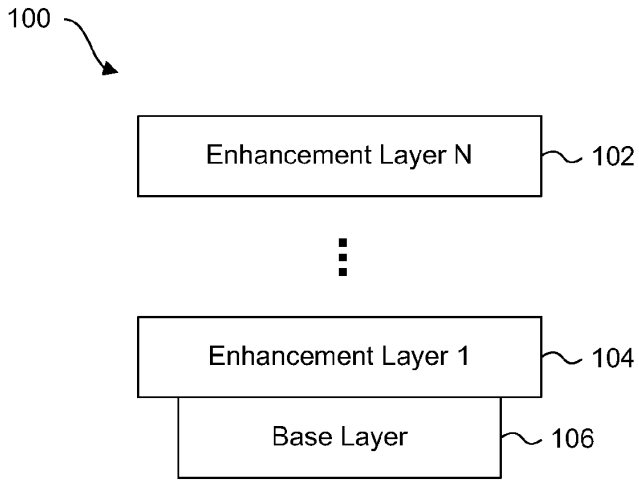

100
Enhancement Layer N
102
Enhancement Layer 1
104
Base Layer
106

FIG. 1

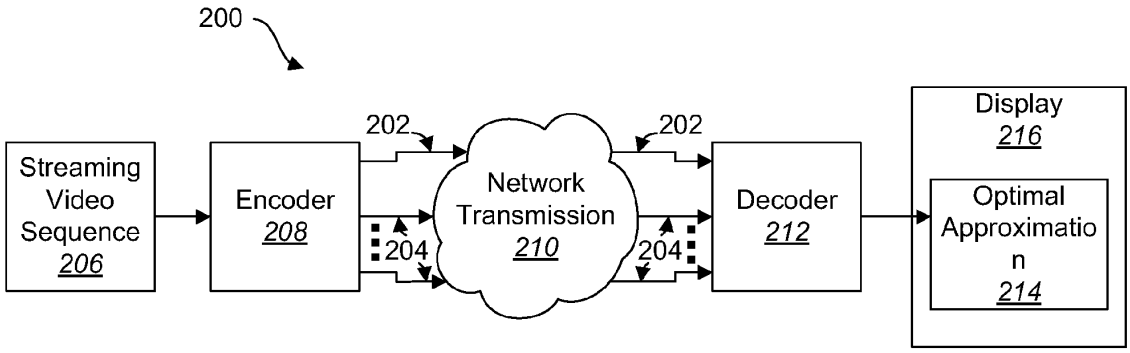

200
Streaming Video Sequence 206
Encoder 208
202
204
Network Transmission 210
202
204
Decoder 212
Display 216
Optimal Approximatio n 214

FIG. 2

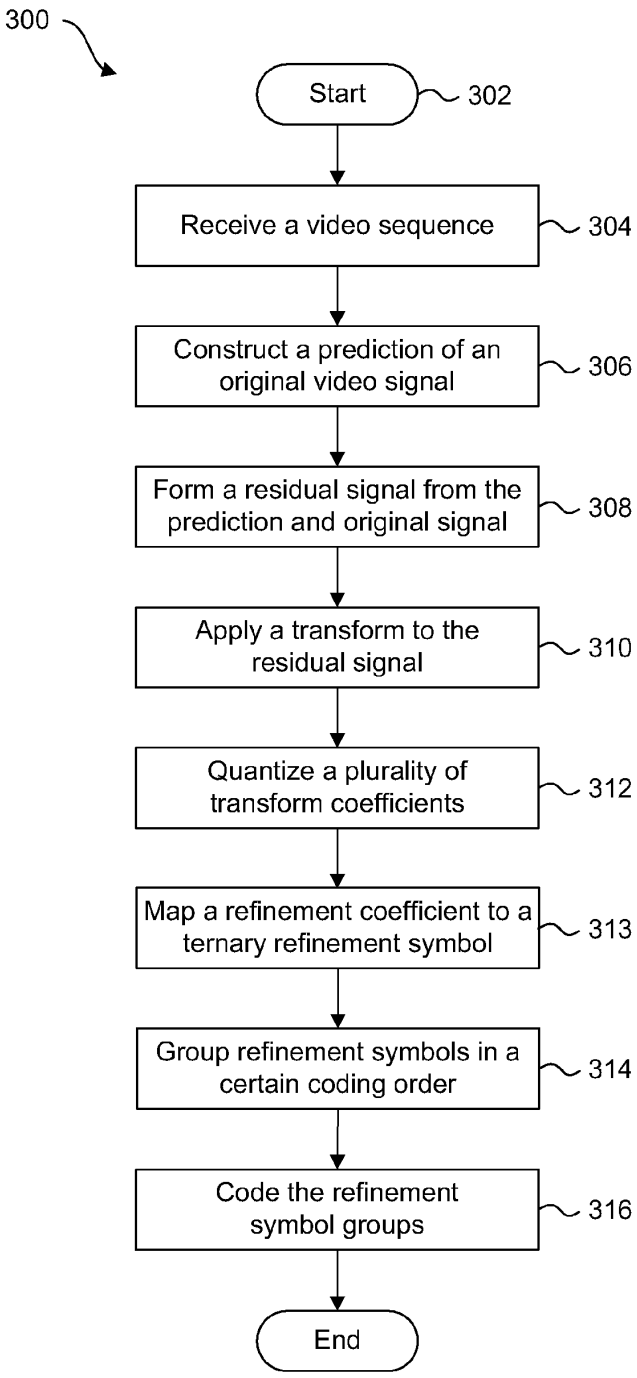

300
Start
302
Receive a video sequence
304
Construct a prediction of an original video signal
306
Form a residual signal from the prediction and original signal
308
Apply a transform to the residual signal
310
Quantize a plurality of transform coefficients
312
Map a refinement coefficient to a ternary refinement symbol
313
Group refinement symbols in a certain coding order
314
Code the refinement symbol groups
316
End

FIG. 3

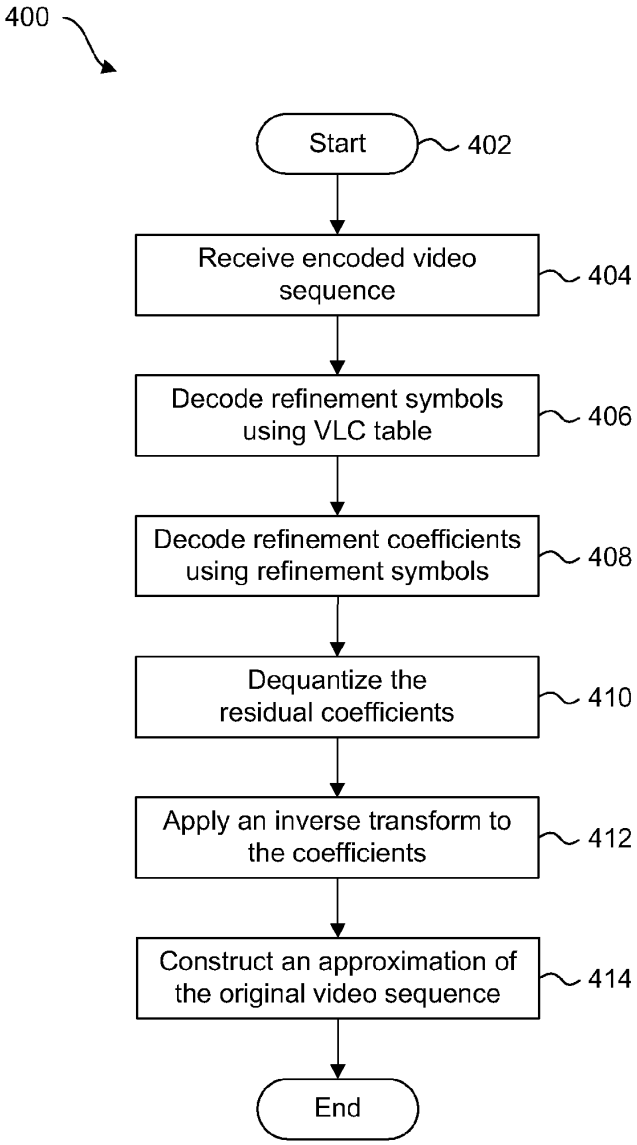

400
Start
402
Receive encoded video sequence
404
Decode refinement symbols using VLC table
406
Decode refinement coefficients using refinement symbols
408
Dequantize the residual coefficients
410
Apply an inverse transform to the coefficients
412
Construct an approximation of the original video sequence
414
End

FIG. 4

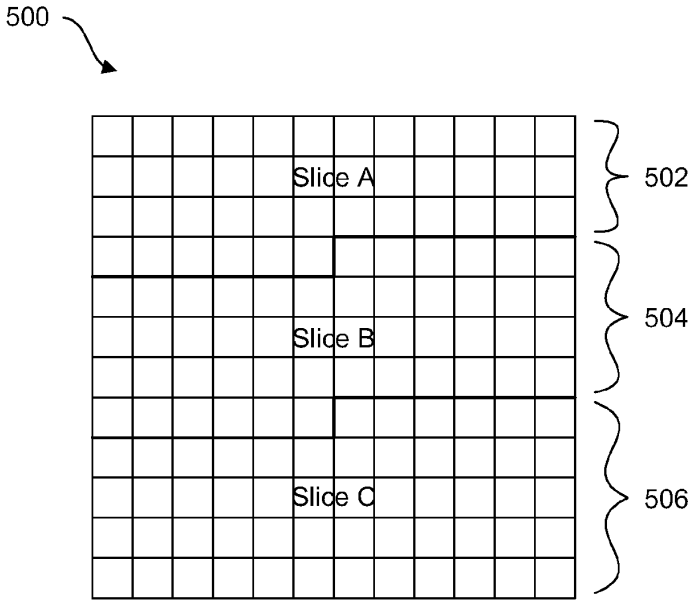


FIG. 5

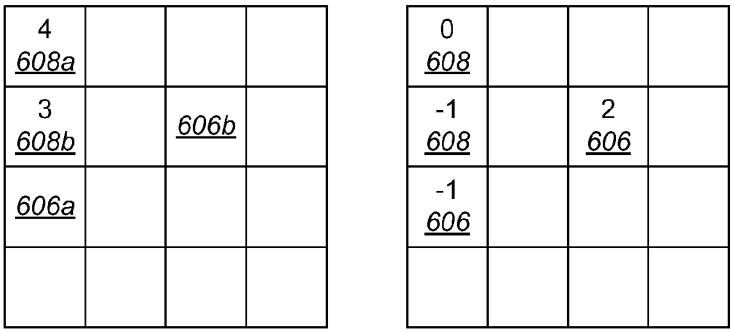
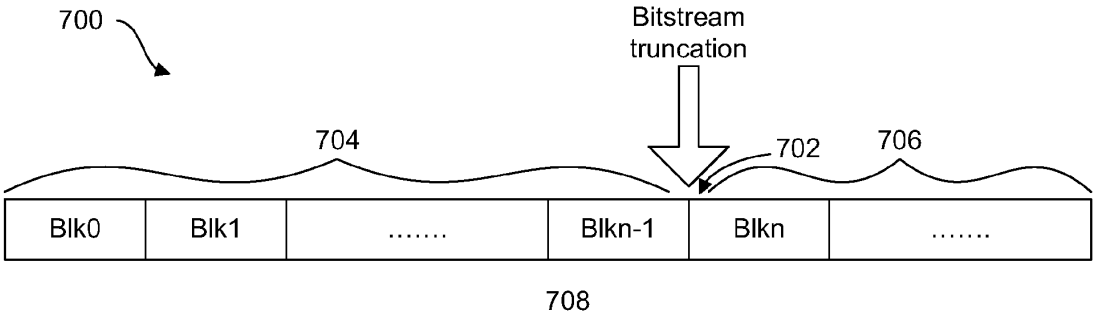


FIG. 6


700
Bitstream truncation
704
702
706
Blk0
Blk1
.....
Blkn-1
Blkn
.....
708

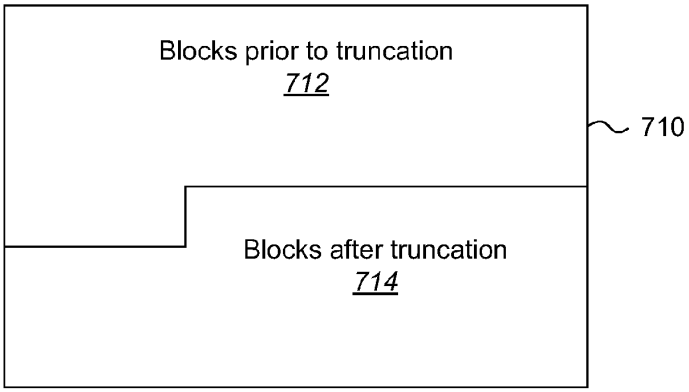

Blocks prior to truncation
712
710
Blocks after truncation
714

FIG. 7

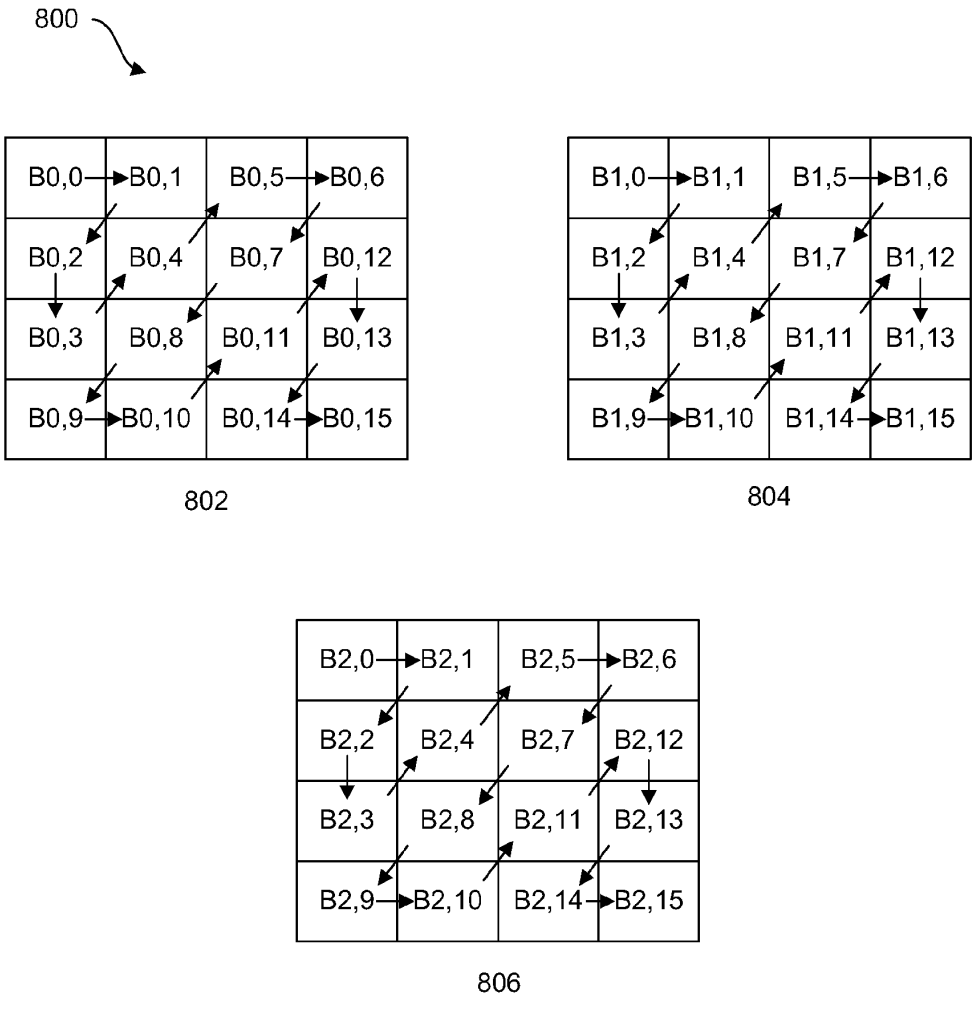

800
B0,0
B0,1
B0,5
B0,6
B0,2
B0,4
B0,7
B0,12
B0,3
B0,8
B0,11
B0,13
B0,9
B0,10
B0,14
B0,15
802
B1,0
B1,1
B1,5
B1,6
B1,2
B1,4
B1,7
B1,12
B1,3
B1,8
B1,11
B1,13
B1,9
B1,10
B1,14
B1,15
804
B2,0
B2,1
B2,5
B2,6
B2,2
B2,4
B2,7
B2,12
B2,3
B2,8
B2,11
B2,13
B2,9
B2,10
B2,14
B2,15
806

FIG. 8

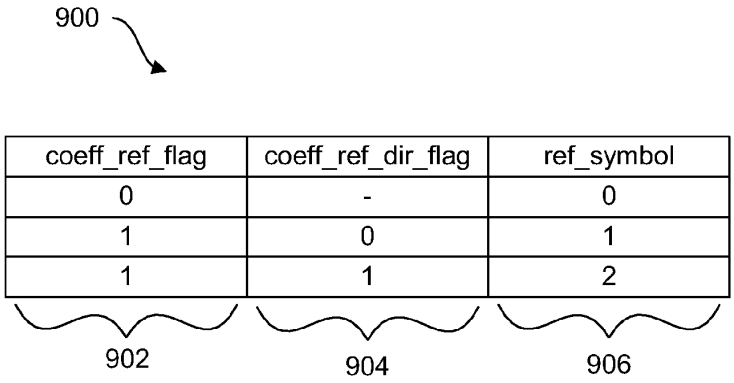

900
coeff_ref_flag
coeff_ref_dir_flag
ref_symbol
0
-
0
1
0
1
1
1
2
902
904
906

FIG. 9

1000

1002 1004 1006

Refinement Symbol Group	Code length	Code Word
0,0,0	1	1
0,0,1	4	0011
0,0,2	5	00101
0,1,0	3	011
0,1,1	6	000101
0,1,2	8	00000101
0,2,0	5	00100
0,2,1	7	0000101
0,2,2	9	000000101
1,0,0	3	010
1,0,1	6	000100
1,0,2	8	00000100
1,1,0	6	000011
1,1,1	9	000000100
1,1,2	10	0000000011
1,2,0	7	0000100
1,2,1	10	0000000010
1,2,2	12	000000000011
2,0,0	5	00011
2,0,1	7	0000011
2,0,2	9	000000011
2,1,0	8	00000011
2,1,1	10	0000000001
2,1,2	12	000000000010
2,2,0	9	000000010
2,2,1	12	000000000001
2,2,2	12	000000000000

FIG. 10

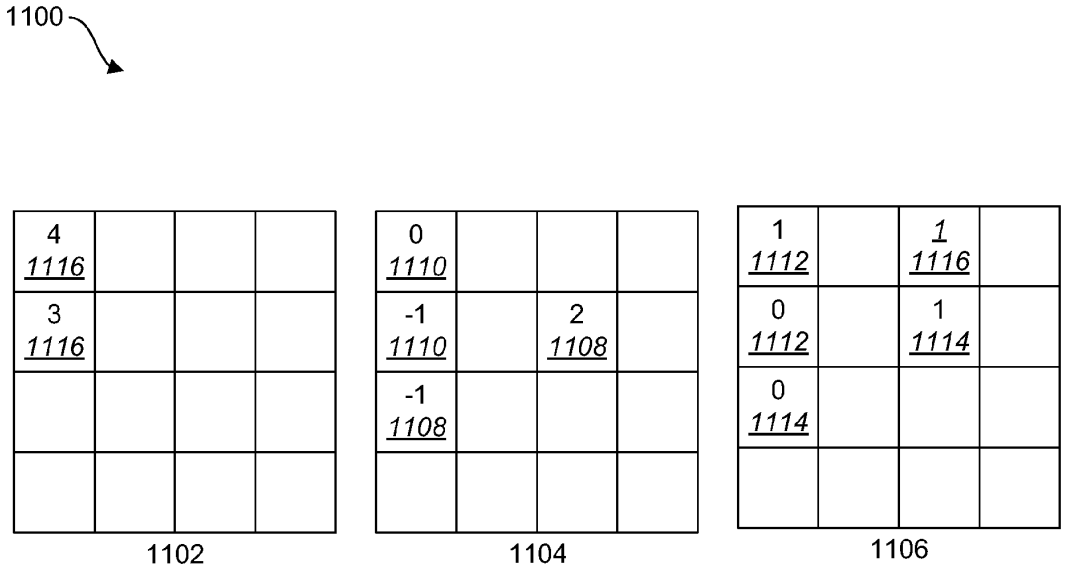

1100
4
1116
3
1116
1102
0
1110
-1
1110
-1
1108
2
1108
1104
1
1112
0
1112
0
1114
1
1116
1
1114
1106

FIG. 11

12/15

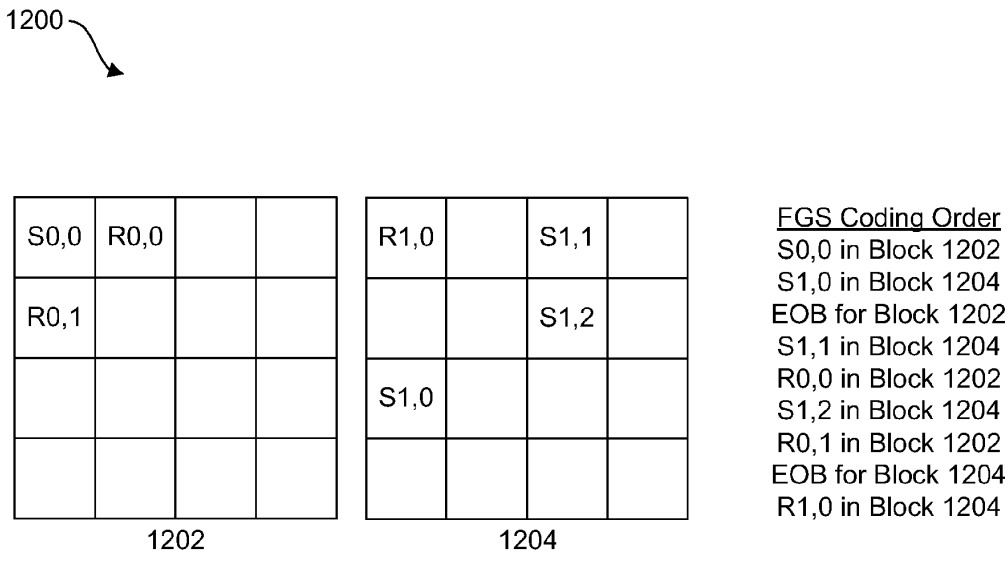


FIG. 12

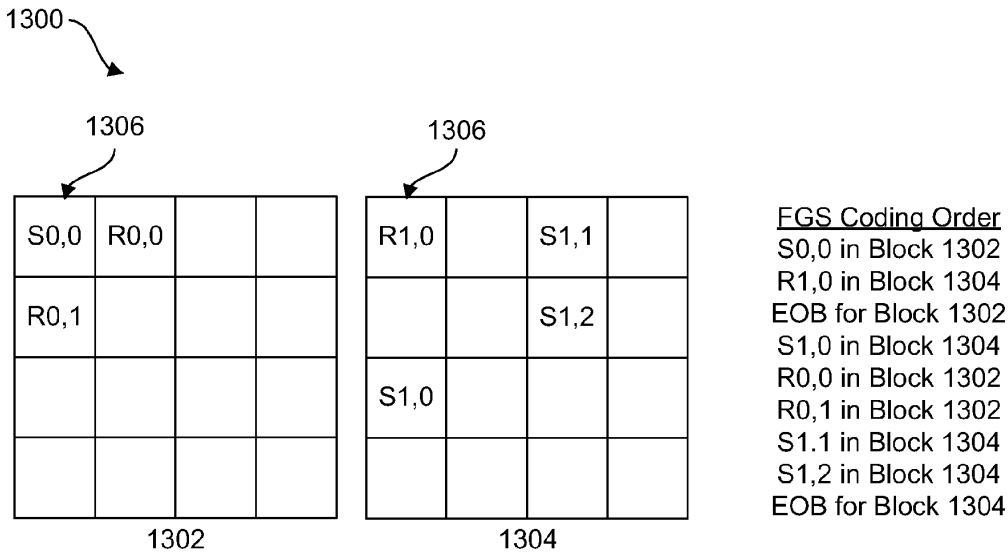


FIG. 13

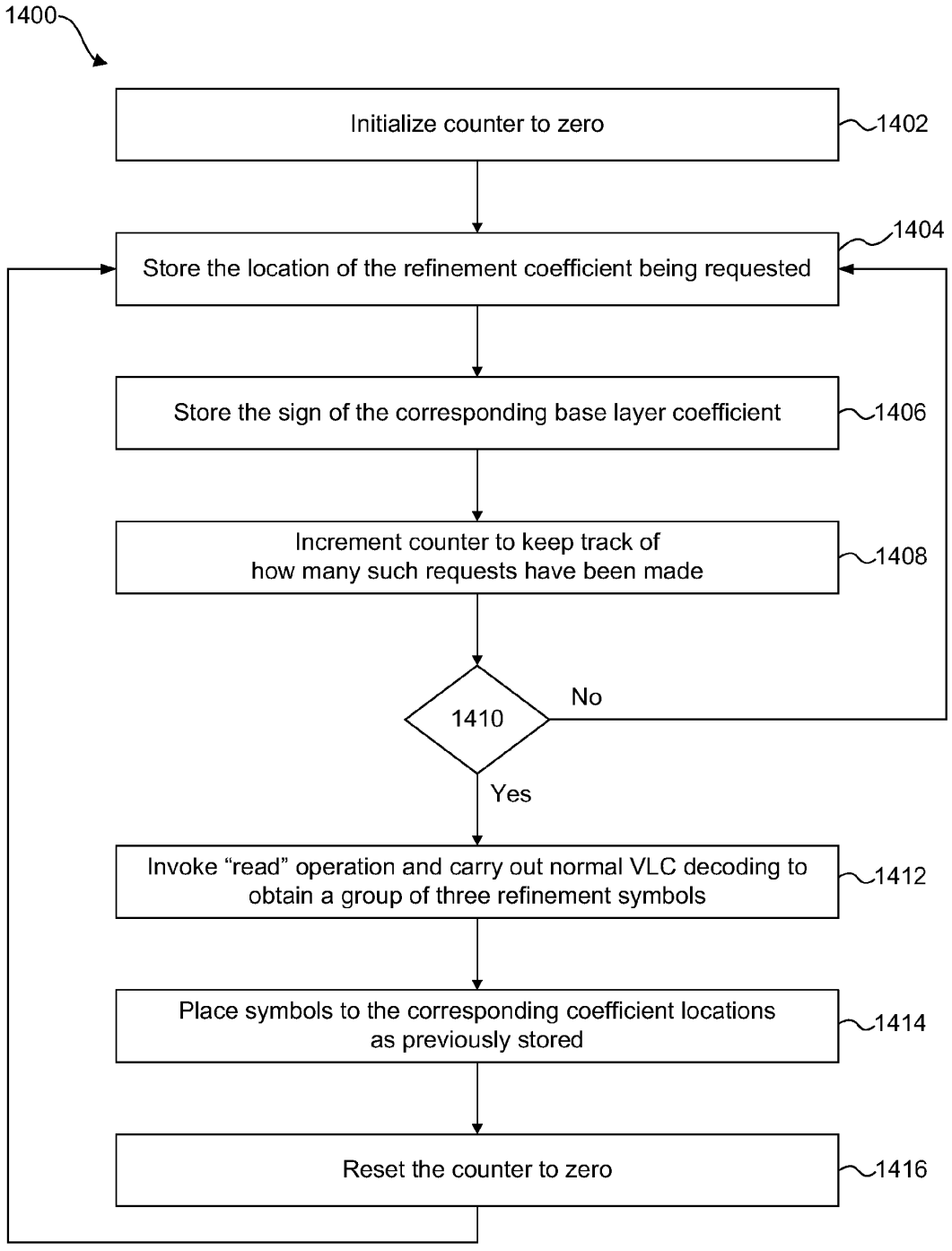

1400
Initialize counter to zero
1402
Store the location of the refinement coefficient being requested
1404
Store the sign of the corresponding base layer coefficient
1406
Increment counter to keep track of how many such requests have been made
1408
1410
No
Yes
Invoke "read" operation and carry out normal VLC decoding to obtain a group of three refinement symbols
1412
Place symbols to the corresponding coefficient locations as previously stored
1414
Reset the counter to zero
1416

FIG. 14

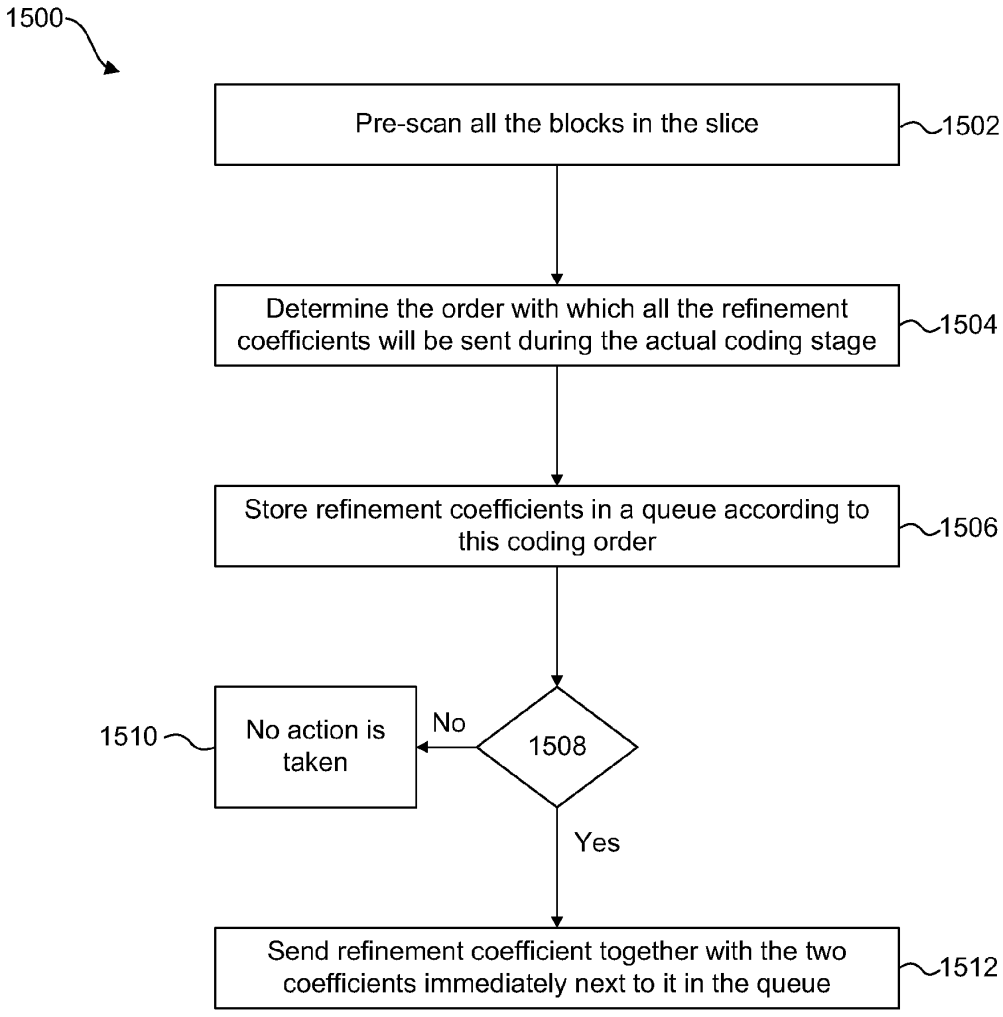

1500
Pre-scan all the blocks in the slice
1502
Determine the order with which all the refinement coefficients will be sent during the actual coding stage
1504
Store refinement coefficients in a queue according to this coding order
1506
1508
No
1510
No action is taken
Yes
Send refinement coefficient together with the two coefficients immediately next to it in the queue
1512

FIG. 15

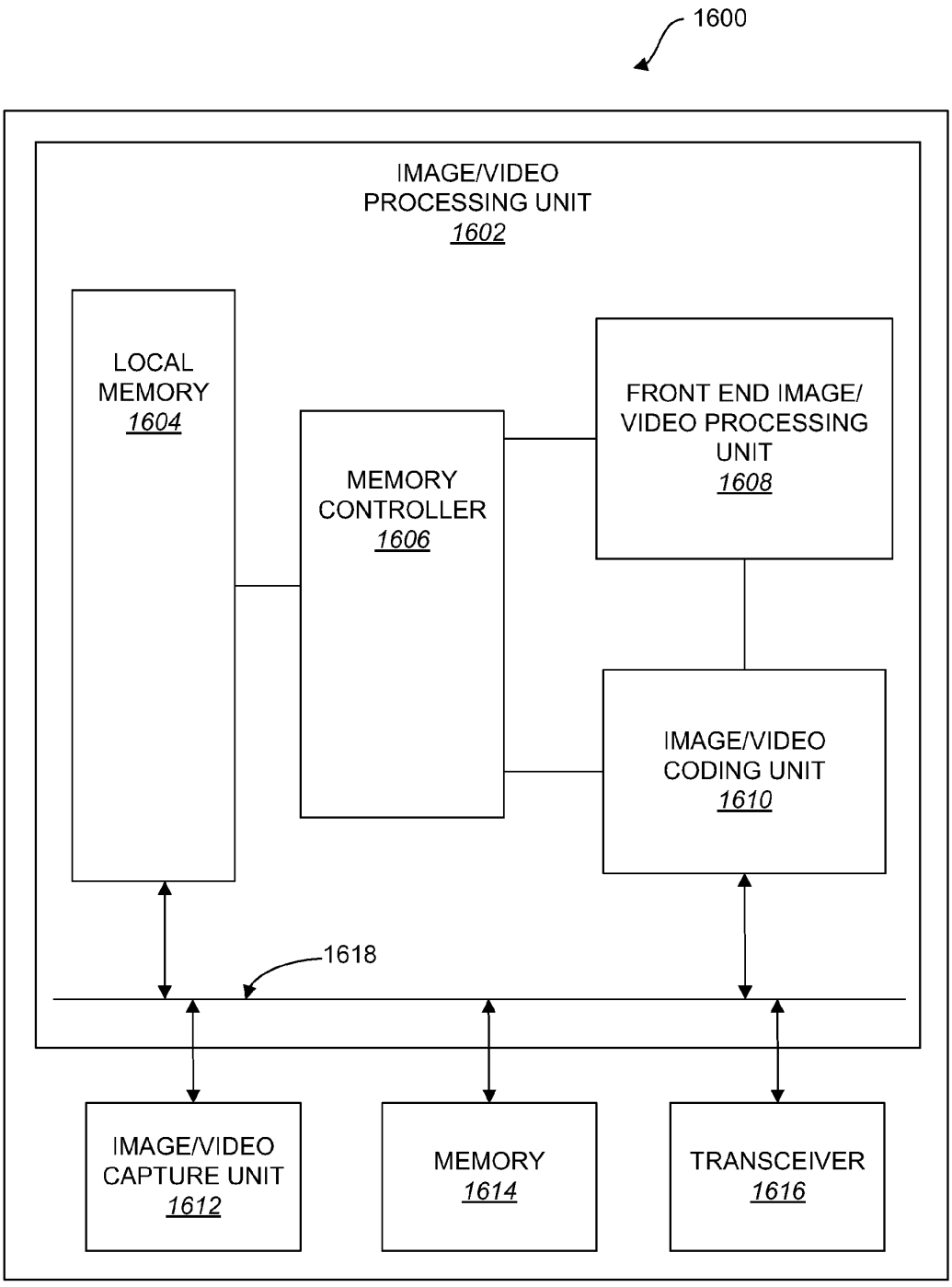

1600
IMAGE/VIDEO PROCESSING UNIT 1602
LOCAL MEMORY 1604
MEMORY CONTROLLER 1606
FRONT END IMAGE/ VIDEO PROCESSING UNIT 1608
IMAGE/VIDEO CODING UNIT 1610
1618
IMAGE/VIDEO CAPTURE UNIT 1612
MEMORY 1614
TRANSCEIVER 1616

FIG. 16

Electronic Patent Application Fee Transmittal

Application Number:	13192111
Filing Date:	27-Jul-2011
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING
First Named Inventor/Applicant Name:	Jani LAINEMA
Filer:	Grant Allen Gildehaus/Emma Pham
Attorney Docket Number:	042933/442419

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt	
EFS ID:	21290402
Application Number:	13192111
International Application Number:	
Confirmation Number:	5397
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING
First Named Inventor/Applicant Name:	Jani LAINEMA
Customer Number:	10949
Filer:	Grant Allen Gildehaus/Emma Pham
Filer Authorized By:	Grant Allen Gildehaus
Attorney Docket Number:	042933/442419
Receipt Date:	23-JAN-2015
Filing Date:	27-JUL-2011
Time Stamp:	12:49:46
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
RAM confirmation Number	11155
Deposit Account	160605
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees) Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)	

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		IDS.pdf	243299 362bf25359026f500bc7298dee05eb3d1dfd91d2	yes	3
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Transmittal Letter		1	2	
	Information Disclosure Statement (IDS) Form (SB08)		3	3	
Warnings:					
Information:					
2	Foreign Reference	CA1.pdf	2012156 4643cd98b506221918ad4220b00050343ae96dbe	no	54
Warnings:					
Information:					
3	Non Patent Literature	CA2.pdf	157483 6e16aae25cc74872acce8ce09cece9edbae0d8a1	no	5
Warnings:					
The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing					
Information:					
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Information:					
		Total Files Size (in bytes):	2443725		

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Attorney's Docket No. 042933/442419

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Jani Lainema	Confirmation No.:	5397
Appl. No.:	13/192,111	Group Art Unit:	2485
Filed:	July 27, 2011	Examiner:	Francis Geroleo

For: METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. § 1.97(d)

This Information Disclosure Statement is being filed after a Notice of Allowance under 37 C.F.R. § 1.311, but before payment of the Issue Fee. The Notice of Allowance was mailed on January 21, 2015.

Attached is a list of documents on form PTO-1449 along with any cited foreign patent documents and non-patent literature documents in accordance with 37 CFR 1.98(a)(2). Also enclosed is a translation or a concise explanation of each non-English language document.

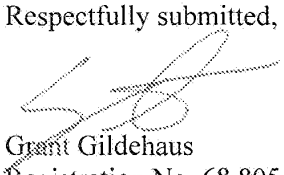
By identifying the listed documents, Applicant in no way makes any admission as to the prior art status of the listed documents, but is instead identifying the listed documents for the sake of full disclosure.

In accordance with the requirements of 37 C.F.R. § 1.97(d)(2), the following statement as specified in 37 C.F.R. § 1.97(e) is made:

Each item of information contained in this statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three (3) months prior to the filing of this statement.

The $180.00 fee specified in 37 C.F.R. § 1.17(p) is being paid at the time of e-filing. The Commissioner is authorized to charge any additional fee, or credit any refund, to our Deposit Account No. 16-0605.

Respectfully submitted,



Grant Gildehaus
Registration No. 68,805

CUSTOMER NO. 10949
ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
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Fax Charlotte Office (704) 444-1111

Snap - Exhibit 1002
Snap v. Nokia - IPR2025-01345
Page 350 of 378

Substitute for form 1449/PTO (Revised 07/2007)				Complete if Known	
				Application Number	13/192,111
				Filing Date	July 27, 2011
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				First Named Inventor	Jani Lainema
				Art Unit	2485
(Use as many sheets as necessary)				Examiner Name	Francis Geroleo
Sheet	*1*	of	1	Attorney Docket Number	042933/442419

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
	1	Office Action from Korean Patent Application 2013-7005051, dated November 27, 2014	YES

Examiner Signature		Date Considered	

**Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

CLT#35336117v1

Submitted January 29, 2015

Electronic Patent Application Fee Transmittal	
Application Number:	13192111
Filing Date:	27-Jul-2011
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING
First Named Inventor/Applicant Name:	Jani LAINEMA
Filer:	Jonathan Abbott Thomas/Lisa Rone
Attorney Docket Number:	042933/442419
Filed as Large Entity	
Filing Fees for **Utility under 35 USC 111(a)**	

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt	
EFS ID:	21342761
Application Number:	13192111
International Application Number:	
Confirmation Number:	5397
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING
First Named Inventor/Applicant Name:	Jani LAINEMA
Customer Number:	10949
Filer:	Jonathan Abbott Thomas/Lisa Rone
Filer Authorized By:	Jonathan Abbott Thomas
Attorney Docket Number:	042933/442419
Receipt Date:	29-JAN-2015
Filing Date:	27-JUL-2011
Time Stamp:	13:09:23
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
RAM confirmation Number	10567
Deposit Account	160605
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		442419-IDS2.PDF	389371 52a6ea905797e06b4b69a308202acfbeff087ff6	yes	3
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Transmittal Letter		1	2	
	Information Disclosure Statement (IDS) Form (SB08)		3	3	
Warnings:					
Information:					
2	Non Patent Literature	442419-KR_OA.PDF	130884 ff762bd1fb3dd29311c587c90479711fba94afcf	no	4
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30788 a02312c1007d6d2dd1ab9ba1794da960ed6c63c2	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	551043		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Attorney's Docket No. 042933/442419

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Jani Lainema	Confirmation No.:	5397
Appl. No.:	13/192,111	Group Art Unit:	2485
Filed:	July 27, 2011	Examiner:	Francis Geroleo

For: METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. § 1.97(d)

This Information Disclosure Statement is being filed after a Notice of Allowance under 37 C.F.R. § 1.311, but before payment of the Issue Fee. The Notice of Allowance was mailed on January 21, 2015.

Attached is a list of documents on form PTO-1449 along with any cited foreign patent documents and non-patent literature documents in accordance with 37 CFR 1.98(a)(2). Also enclosed is a translation or a concise explanation of each non-English language document.

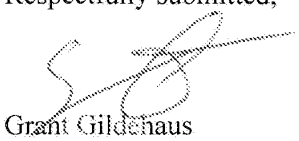
By identifying the listed documents, Applicant in no way makes any admission as to the prior art status of the listed documents, but is instead identifying the listed documents for the sake of full disclosure.

In accordance with the requirements of 37 C.F.R. § 1.97(d)(2), the following statement as specified in 37 C.F.R. § 1.97(e) is made:

Each item of information contained in this statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three (3) months prior to the filing of this statement.

The $180.00 fee specified in 37 C.F.R. § 1.17(p) is being paid at the time of e-filing. The Commissioner is authorized to charge any additional fee, or credit any refund, to our Deposit Account No. 16-0605.

Respectfully submitted,



Grant Gildenaus
Registration No. 68,805

CUSTOMER NO. 10949
ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000
Fax Charlotte Office (704) 444-1111

Snap - Exhibit 1002
Snap v. Nokia - IPR2025-01345
Page 358 of 378

Substitute for form 1449/PTO (Revised 07/2007)				Complete if Known	
				Application Number	13/192,111
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Filing Date	July 27, 2011
				First Named Inventor	Jani Lainema
(Use as many sheets as necessary)				Art Unit	2485
				Examiner Name	Francis Geroleo
Sheet	*1*	of	1	Attorney Docket Number	042933/442419

U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No.	Document Number Number - Kind Code (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages of Relevant Figures Appear
		US			
		US			
		US			
		US			

FOREIGN PATENT DOCUMENTS

Examiner Initials	Cite No.	Foreign Patent Document Country Code - Number Kind Code (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	English Language Translation Attached
		CA 2,643,705	10-04-2007	Ye et al.		
		***Abstract Only**				

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
		Office Action from Canadian Application 2,806,523, dated December 17, 2014	

Examiner Signature	/Francis G Geroleo/	Date Considered	03/11/2015

**Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

CLT#35185700v1

Submitted January 23, 2015

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /F.G.G./

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/192,111	07/27/2011	Jani LAINEMA	042933/442419	5397

10949 7590 03/19/2015

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

EXAMINER	
GEROLEO, FRANCIS	

ART UNIT	PAPER NUMBER
2485	

NOTIFICATION DATE	DELIVERY MODE
03/19/2015	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

usptomail@alston.com

UNITED STATES DEPARTMENT OF COMMERCE
U.S. Patent and Trademark Office
Address : COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450

APPLICATION NO./ CONTROL NO.	FILING DATE	FIRST NAMED INVENTOR / PATENT IN REEXAMINATION	ATTORNEY DOCKET NO.
13/192,111	27 July, 2011	LAINEMA ET AL.	042933/442419

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

EXAMINER	
FRANCIS G. GEROLEO	
ART UNIT	PAPER
2485	20150311

DATE MAILED:

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner for Patents

Applicant's Information Disclosure Statement (IDS) forms, filed on 1/23/15 and 1/29/15, have been reviewed and considered and IDS have been entered (please see attached).

/Jayanti K Patel/ Supervisory Patent Examiner, Art Unit 2485	/FRANCIS G GEROLEO/ Examiner, Art Unit 2485

PTO-90C (Rev.04-03)

Substitute for form 1449/PTO (Revised 07/2007)				Complete if Known	
				Application Number	13/192,111
				Filing Date	July 27, 2011
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				First Named Inventor	Jani Lainema
				Art Unit	2485
(Use as many sheets as necessary)				Examiner Name	Francis Geroleo
Sheet	*1*	of	1	Attorney Docket Number	042933/442419

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
	1	Office Action from Korean Patent Application 2013-7005051, dated November 27, 2014	YES

Examiner Signature	/Francis G Geroleo/	Date Considered	03/11/2015

**Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

CLT#35336117v1

Submitted January 29, 2015

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /F.G.G./

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

10949 7590 01/21/2015
Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/192,111	07/27/2011	Jani LAINEMA	042933/442419	5397

TITLE OF INVENTION: METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	04/21/2015

EXAMINER	ART UNIT	CLASS-SUBCLASS
GEROLEO, FRANCIS	2485	375-240080

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Alston & Bird LLP
2
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Nokia Corporation
(B) RESIDENCE: (CITY and STATE OR COUNTRY): Espoo, Finland

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
- ☒ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ☐ A check is enclosed.
- ☐ Payment by credit card. Form PTO-2038 is attached.
- ☒ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number 16-0605 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ☐ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ☐ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ☐ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Grant Gildehaus/ Date April 15, 2015
Typed or printed name Grant Gildehaus Registration No. 68,805

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Snap - Exhibit 1002
Snap v. Nokia - IPR2025-01345
Page 363 of 378

Electronic Patent Application Fee Transmittal

Application Number:	13192111
Filing Date:	27-Jul-2011
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING
First Named Inventor/Applicant Name:	Jani LAINEMA
Filer:	Jonathan Abbott Thomas/Lisa Rone
Attorney Docket Number:	042933/442419

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl Issue Fee	1501	1	960	960

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**960**

Electronic Acknowledgement Receipt	
EFS ID:	22068854
Application Number:	13192111
International Application Number:	
Confirmation Number:	5397
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING
First Named Inventor/Applicant Name:	Jani LAINEMA
Customer Number:	10949
Filer:	Jonathan Abbott Thomas/Lisa Rone
Filer Authorized By:	Jonathan Abbott Thomas
Attorney Docket Number:	042933/442419
Receipt Date:	15-APR-2015
Filing Date:	27-JUL-2011
Time Stamp:	14:20:45
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$960
RAM confirmation Number	356
Deposit Account	160605
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	442419-IssueFee.pdf	256117 8eca19d6bbd2b8362ef492630bd7ac5404848206	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30799 fe768cdf3712ee3be136c4c61c49085540f2dfed	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	286916		

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<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/192,111	05/19/2015	9036701	042933/442419	5397

10949 7590 04/29/2015

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 276 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Jani LAINEMA, Tampere, FINLAND;
Kemal UGUR, Tampere, FINLAND;
Antti Olli HALLAPURO, Tampere, FINLAND;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

ALSTON&BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000

704-444-1000
Fax: 704-444-1111
www.alston.com

Guy R. Gosnell

Email: guy.gosnell@alston.com

January 28, 2016

Certificate of Correction Branch
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Re: U.S. Patent No. 9,036,701; Issued: May 19, 2015
Application No. 13/192,111; Filing Date: July 27, 2011
Title: Method and Apparatus for Providing Complexity Balanced Entropy Coding
Our File 042933/442419

Dear Sir or Madam:

It is respectfully requested that a Certificate of Correction be issued for the above-identified patent.

Specifically, during prosecution of this application an amendment was filed on December 2, 2014, introducing the addition of the following phrase at the end of the third paragraph in each of independent Claims 1, 8, and 15:

> "...which occur greater than the frequency of occurrence threshold are categorized into the first category and syntax elements which occur less than the frequency of occurrence are categorized into the second category"

In this amendment, applicants' attorney inadvertently transposed the wording of "first category" and "second category". The phrase added by amendment should have read:

> "...which occur greater than the frequency of occurrence threshold are categorized into the second category and syntax elements which occur less than the frequency of occurrence are categorized into the first category"

Support confirming the inadvertent transposition of "first category" and "second category" can be found in the specification at column 9, lines 51-63.

Snap - Exhibit 1002
Snap v. Nokia - IPR2025-01345
Page 369 of 378

A Certificate of Correction setting forth the requested corrections to Claims 1, 8, and 15 is being filed simultaneously herewith, along with the required Certificate of Correction fee of $100.

Sincerely,

Guy R. Gosnell
Reg. No. 34,610

Enclosure
LEGAL02/36155646v1

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 9,036,701 B2 Page 1 of 1

APPLICATION NO. : 13/192,111

ISSUE DATE : May 19, 2015

INVENTOR(S) : Lainema et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the claims:

Column 14,
Lines 14 and 57, "first category" should read --second category--.
Lines 16 and 59, "second category" should read --first category--.

Column 16,
Line 5, "first category" should read --second category--;
Line 7, "second category" should read --first category--.

MAILING ADDRESS OF SENDER

ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000

Electronic Patent Application Fee Transmittal

Application Number:	13192111
Filing Date:	27-Jul-2011
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING
First Named Inventor/Applicant Name:	Jani LAINEMA
Filer:	Jonathan Abbott Thomas/Marigrace Faulkner
Attorney Docket Number:	042933/442419

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Certificate of Correction	1811	1	100	100

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**100**

Electronic Acknowledgement Receipt	
EFS ID:	24762989
Application Number:	13192111
International Application Number:	
Confirmation Number:	5397
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING COMPLEXITY BALANCED ENTROPY CODING
First Named Inventor/Applicant Name:	Jani LAINEMA
Customer Number:	10949
Filer:	Jonathan Abbott Thomas/Marigrace Faulkner
Filer Authorized By:	Jonathan Abbott Thomas
Attorney Docket Number:	042933/442419
Receipt Date:	29-JAN-2016
Filing Date:	27-JUL-2011
Time Stamp:	11:51:48
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$100
RAM confirmation Number	11623
Deposit Account	160605
Authorized User	ALSTON & BIRD, LLP
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Certificate of Correction	coc442419wFEE.PDF	87824 95c0dafc24fac7c5ed78f7a887a87534a23ef51f	no	3
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30600 f7d41c99e097c6c706eb362c9729032f2f10895c	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	118424		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/192,111	07/27/2011	Jani LAINEMA	042933/442419	5397

10949 7590 03/14/2016

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

EXAMINER	
GEROLEO, FRANCIS	

ART UNIT	PAPER NUMBER
2485	

NOTIFICATION DATE	DELIVERY MODE
03/14/2016	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

usptomail@alston.com

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
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Alexandria, VA 22313-1450
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Patent No. 9036701
Issued Date: 19 May, 2015
Appl. No: 13/192,111
Filed.: 27 July 2011

PART (A) RESPONSE FOR CERTIFICATES OF CORRECTION

This is a decision on the Certificate of Correction request filed 29 January 2016.

The request for issuance of Certificate of Correction for the above-identified correction(s) under the provisions of 37 CFR 1.322 and/or 1.323 is hereby:

(Check one)
☒ Approved ☐ Approved in Part ☐ Denied

Comments:

PART (B) PETITION UNDER 37 CFR 1.324 OR 37 CFR 1.48

This is a decision on the petition filed to correct inventorship under 37 CFR 1.324.

This is a decision on the request under 37 CFR 1.48, petition filed . In view of the fact that the patent has already issued, the request under 37 CFR 1.48 has been treated as a petition to correct inventorship under 37 CFR 1.324.

The petition is hereby: ☒ Granted ☐ Dismissed

The patented filed is being forwarded to Certificate of Corrections Branch for issuance of a certificate naming only the actual inventor or inventors.

/Jayanti K Patel/
Supervisory Patent Examiner, Art Unit 2485
Technology Center 2400
Phone: 5712722400

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,036,701 B2
APPLICATION NO. : 13/192111
DATED : May 19, 2015
INVENTOR(S) : Lainema et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the claims:

Column 14,
Lines 14 and 57, "first category" should read --second category--.
Lines 16 and 59, "second category" should read --first category--.

Column 16,
Line 5, "first category" should read --second category--.
Line 7, "second category" should read --first category--.

Signed and Sealed this
Fifth Day of April, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office