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(54) **SYSTEM AND METHOD FOR MOBILE CHECK DEPOSIT ENABLING AUTO-CAPTURE FUNCTIONALITY VIA VIDEO FRAME PROCESSING**

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(Continued)

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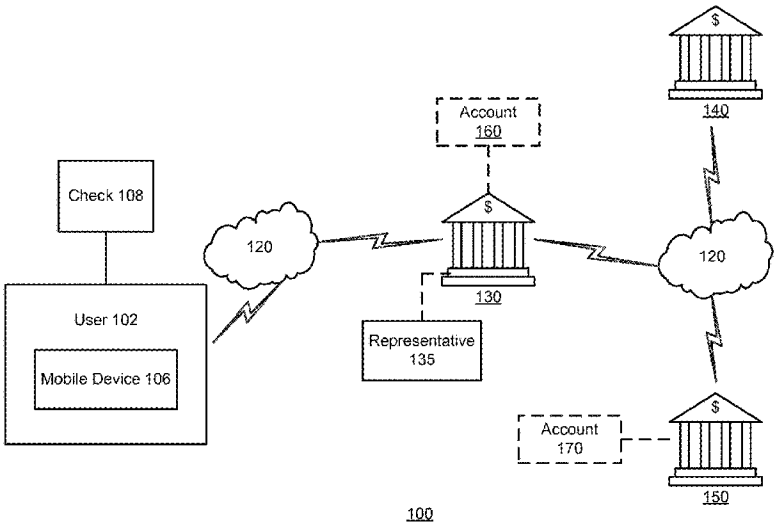
(57) **ABSTRACT**

An image of a check that is in the field of view of a camera is monitored prior to the image of the check being captured. The camera is associated with a mobile device. When the image of the check in the field of view passes monitoring criteria, an image may be taken by the camera and provided from the mobile device to a financial institution. The image capture may be performed automatically as soon as the image of the check is determined to pass the monitoring criteria. The check may be deposited in a user's bank account based on the image. Any technique for sending the image to the financial institution may be used. Feedback may be provided to the user of the camera regarding the image of the check in the field of view.

12 Claims, 8 Drawing Sheets



Related U.S. Application Data

continuation of application No. 17/161,235, filed on Jan. 28, 2021, now abandoned, which is a continuation of application No. 16/712,182, filed on Dec. 12, 2019, now Pat. No. 11,341,465, which is a continuation of application No. 16/280,455, filed on Feb. 20, 2019, now abandoned, which is a continuation of application No. 15/792,966, filed on Oct. 25, 2017, now Pat. No. 10,235,660, which is a continuation of application No. 15/392,950, filed on Dec. 28, 2016, now Pat. No. 9,818,090, which is a continuation of application No. 13/922,686, filed on Jun. 20, 2013, now Pat. No. 9,569,756, which is a continuation of application No. 12/545,127, filed on Aug. 21, 2009, now Pat. No. 8,977,571.

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See application file for complete search history.

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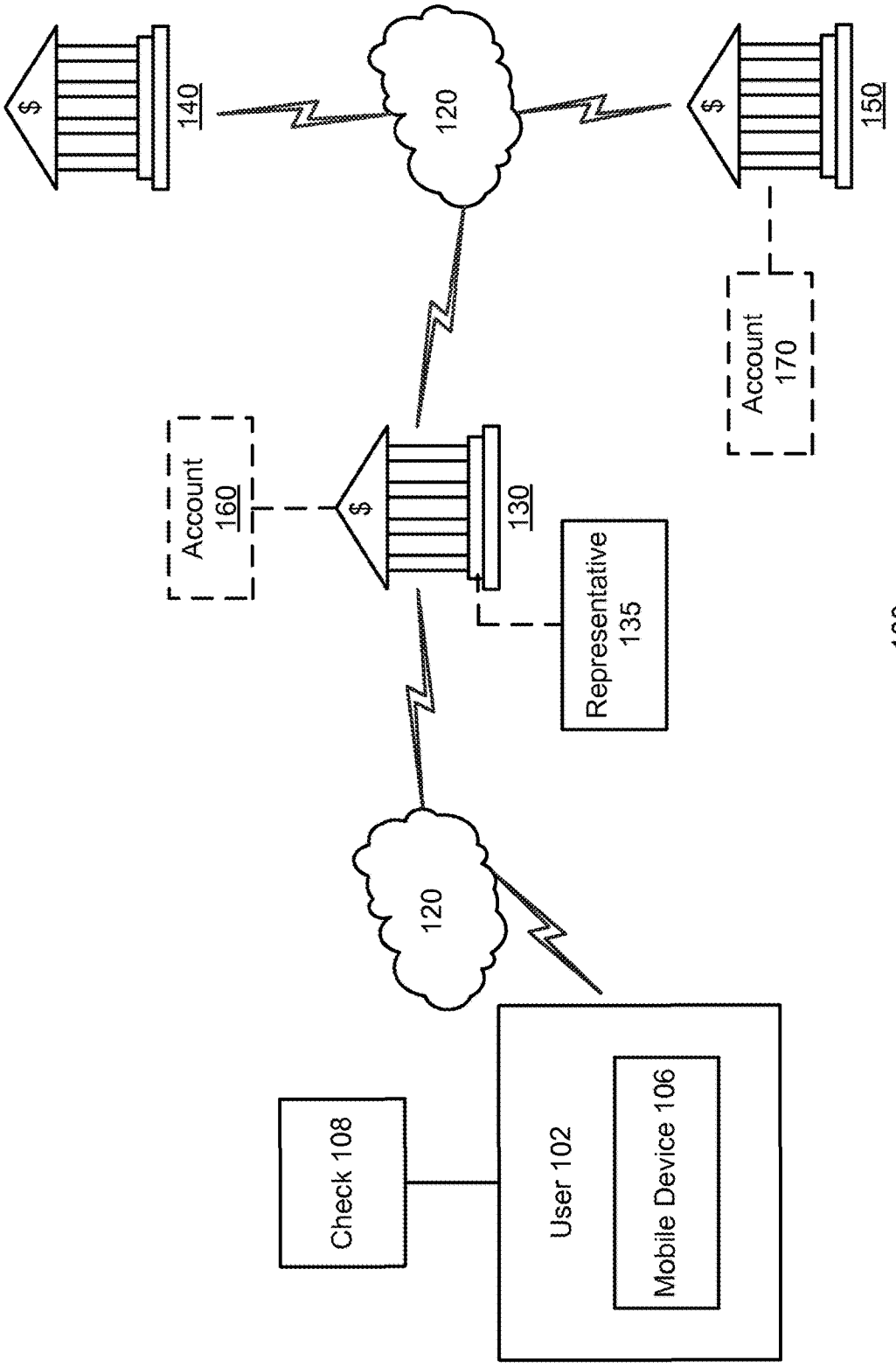

$
140
120
$
150
Account
170
Account
160
$
130
Representative
135
120
Check 108
User 102
Mobile Device 106
100

FIG. 1

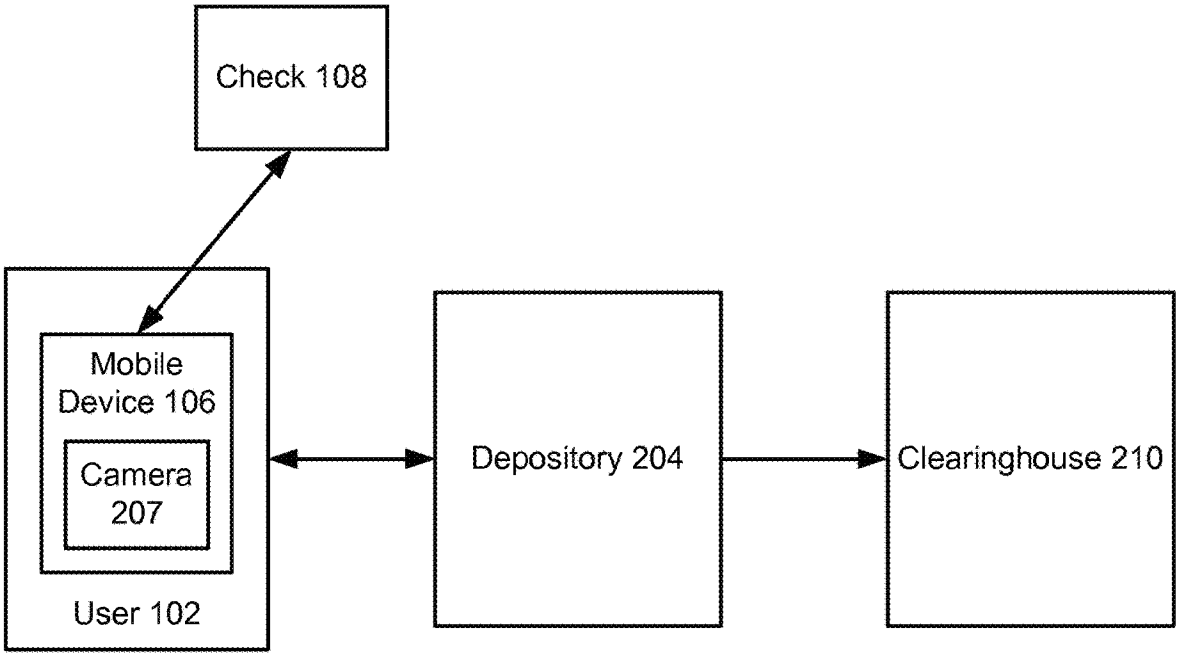

Check 108
Mobile Device 106
Camera 207
User 102
Depository 204
Clearinghouse 210
200

FIG. 2

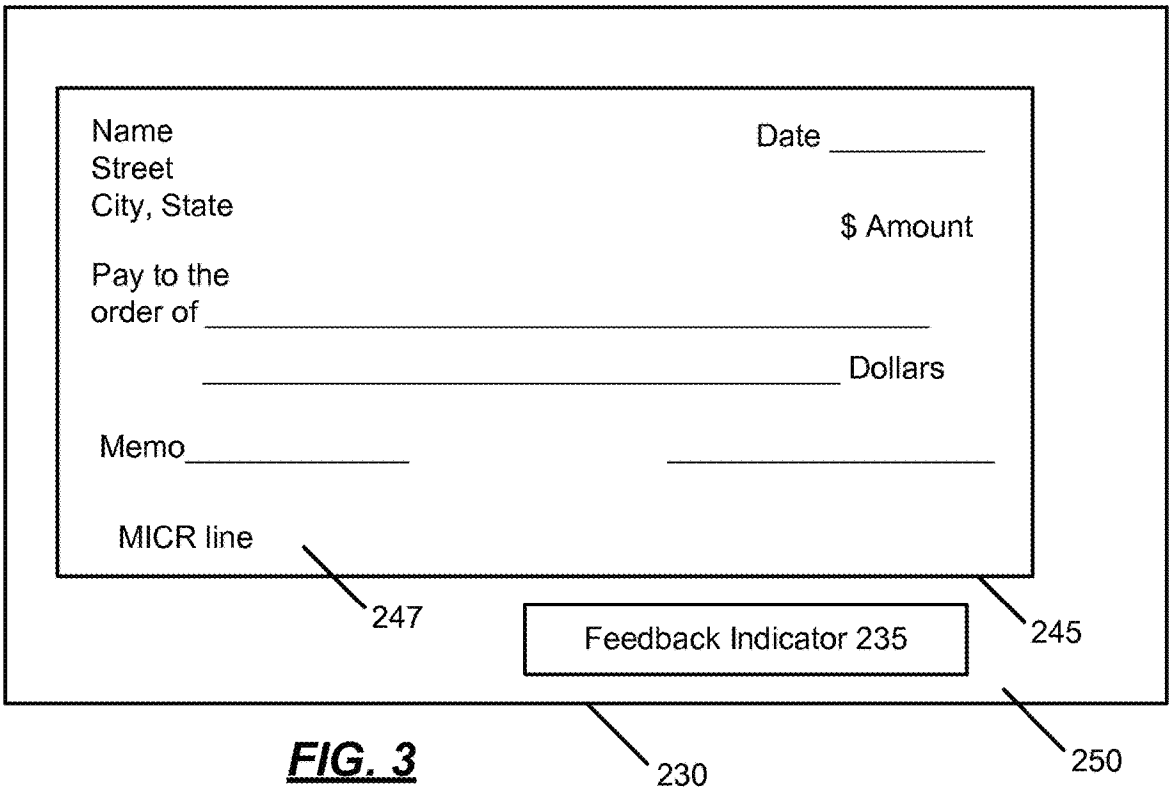

Name
Street
City, State
Date
$ Amount
Pay to the
order of
Dollars
Memo
MICR line
247
245
Feedback Indicator 235
230
250

FIG. 3

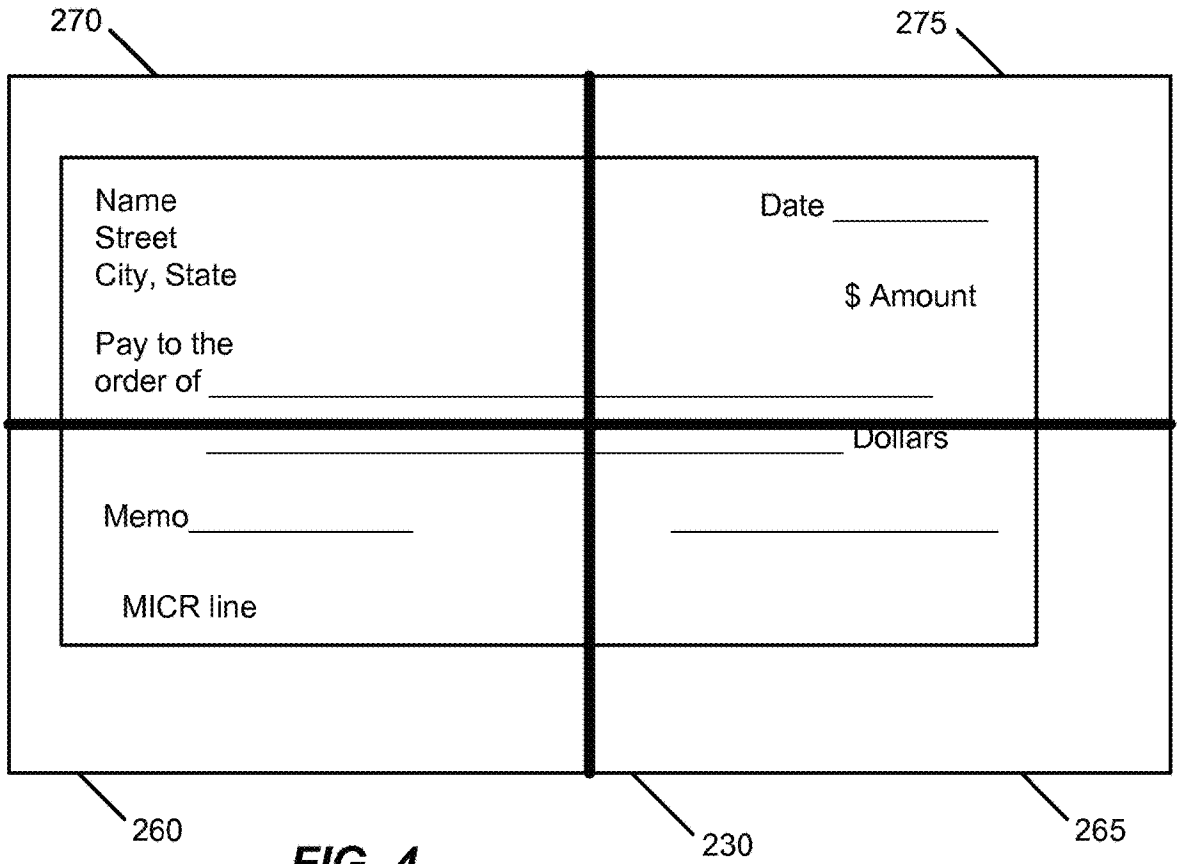
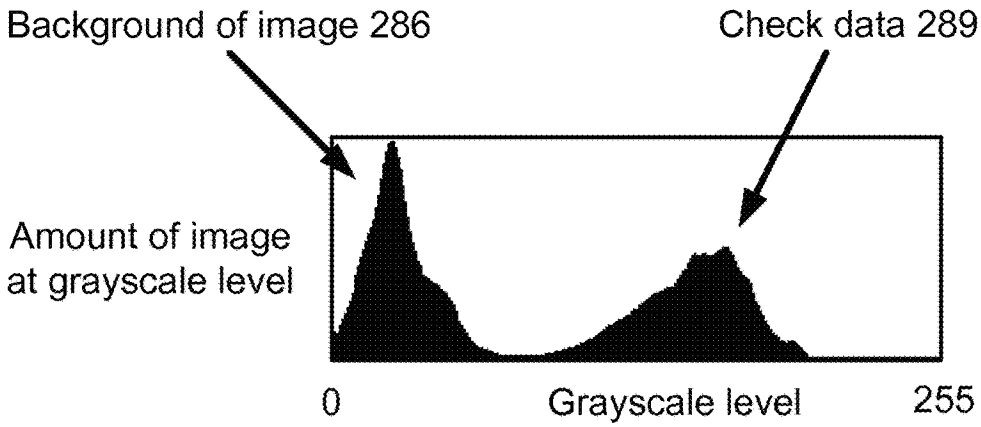
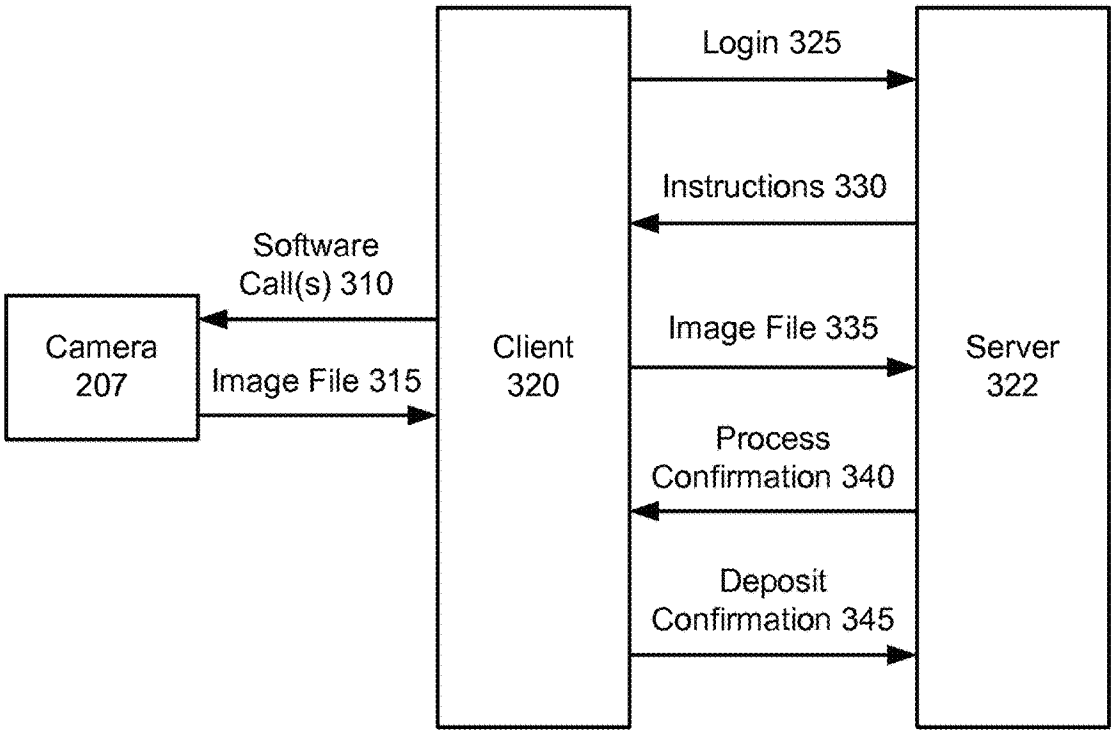

270
275
Name
Street
City, State
Date
$ Amount
Pay to the
order of
Dollars
Memo
MICR line
260
230
265

FIG. 4



280

FIG. 5



300

FIG. 6

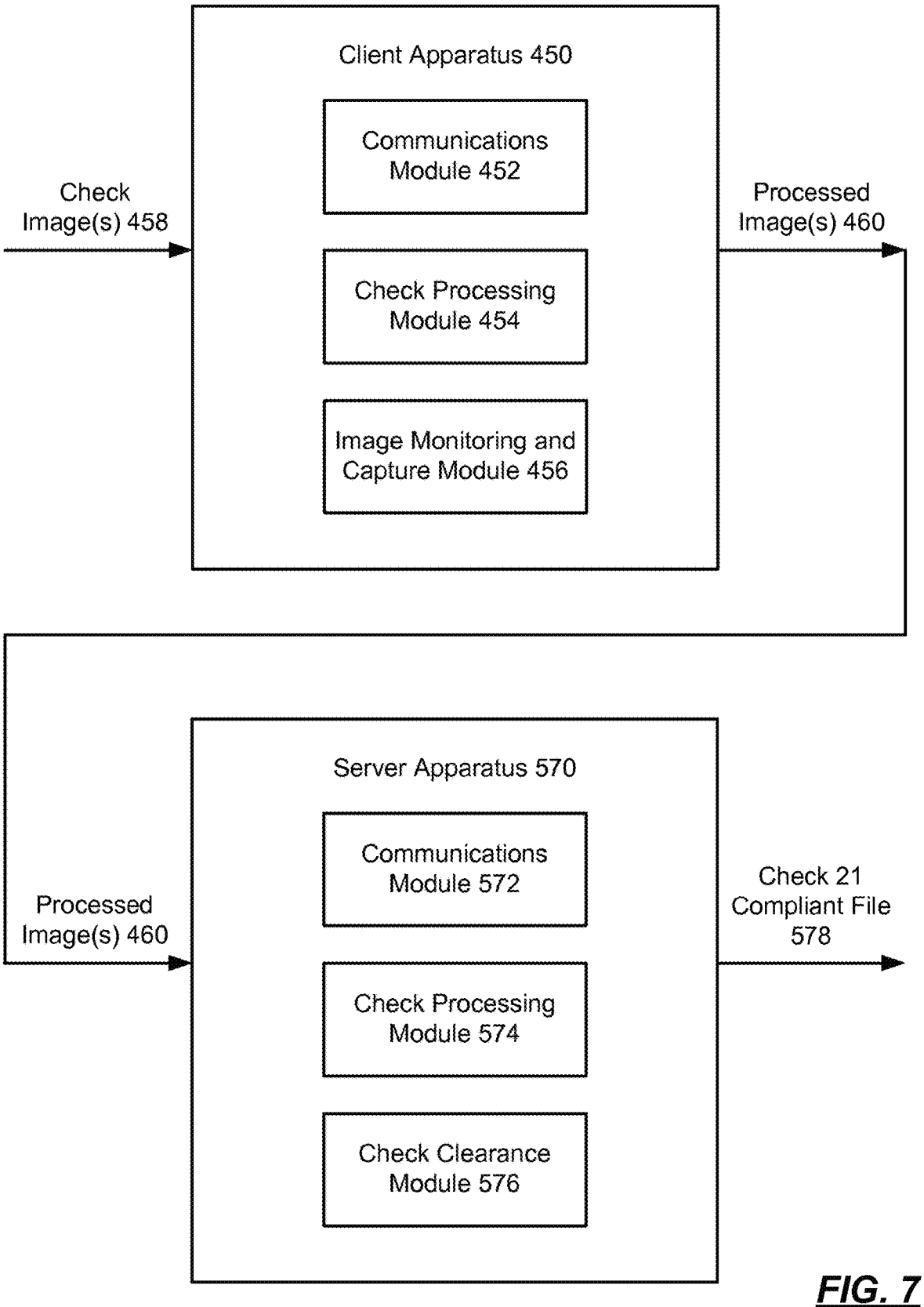
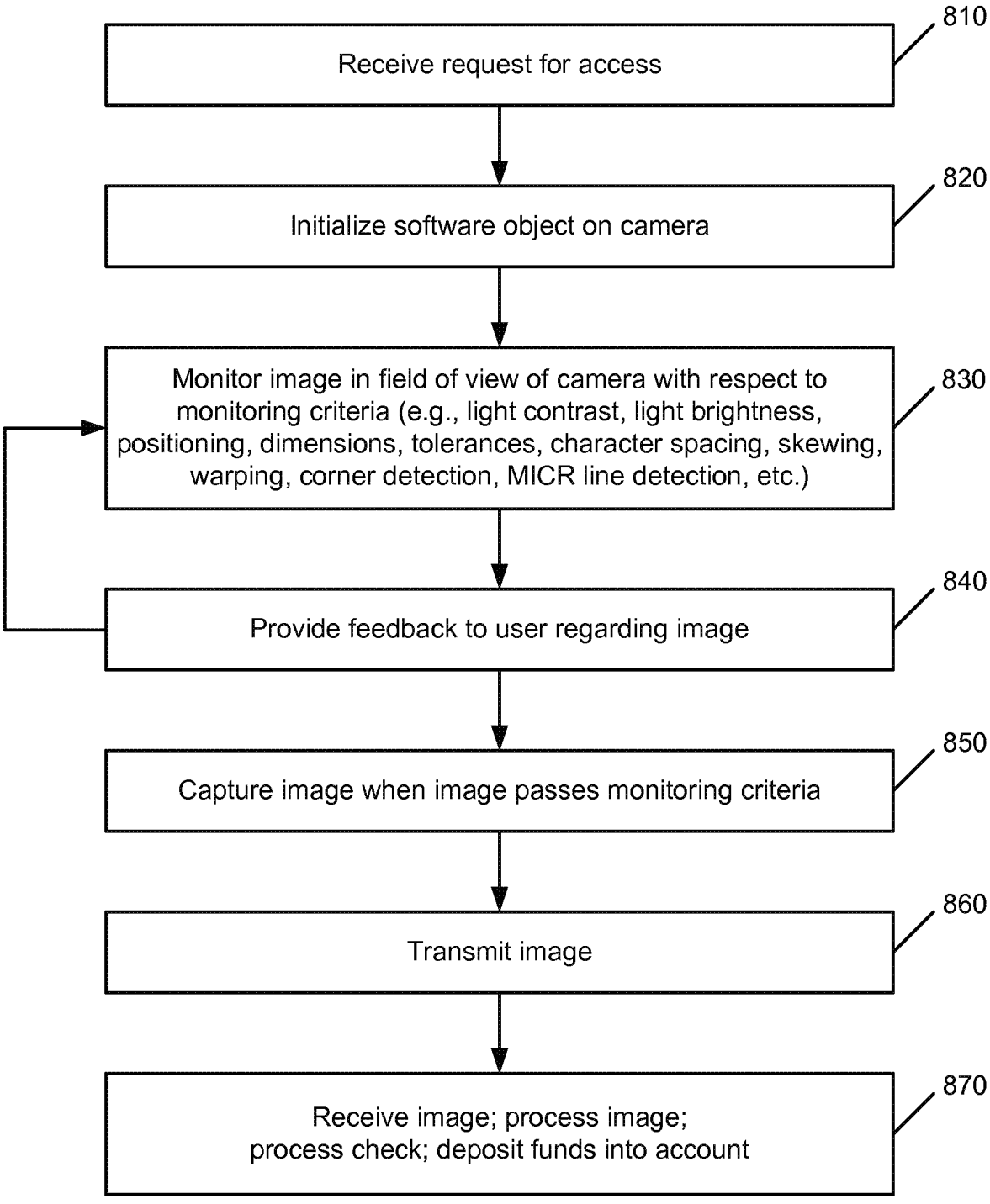

Client Apparatus 450
Communications Module 452
Check Processing Module 454
Image Monitoring and Capture Module 456
Check Image(s) 458
Processed Image(s) 460
Server Apparatus 570
Communications Module 572
Check Processing Module 574
Check Clearance Module 576
Processed Image(s) 460
Check 21 Compliant File 578

FIG. 7


Receive request for access
810
Initialize software object on camera
820
Monitor image in field of view of camera with respect to monitoring criteria (e.g., light contrast, light brightness, positioning, dimensions, tolerances, character spacing, skewing, warping, corner detection, MICR line detection, etc.)
830
Provide feedback to user regarding image
840
Capture image when image passes monitoring criteria
850
Transmit image
860
Receive image; process image; process check; deposit funds into account
870

800

FIG. 8

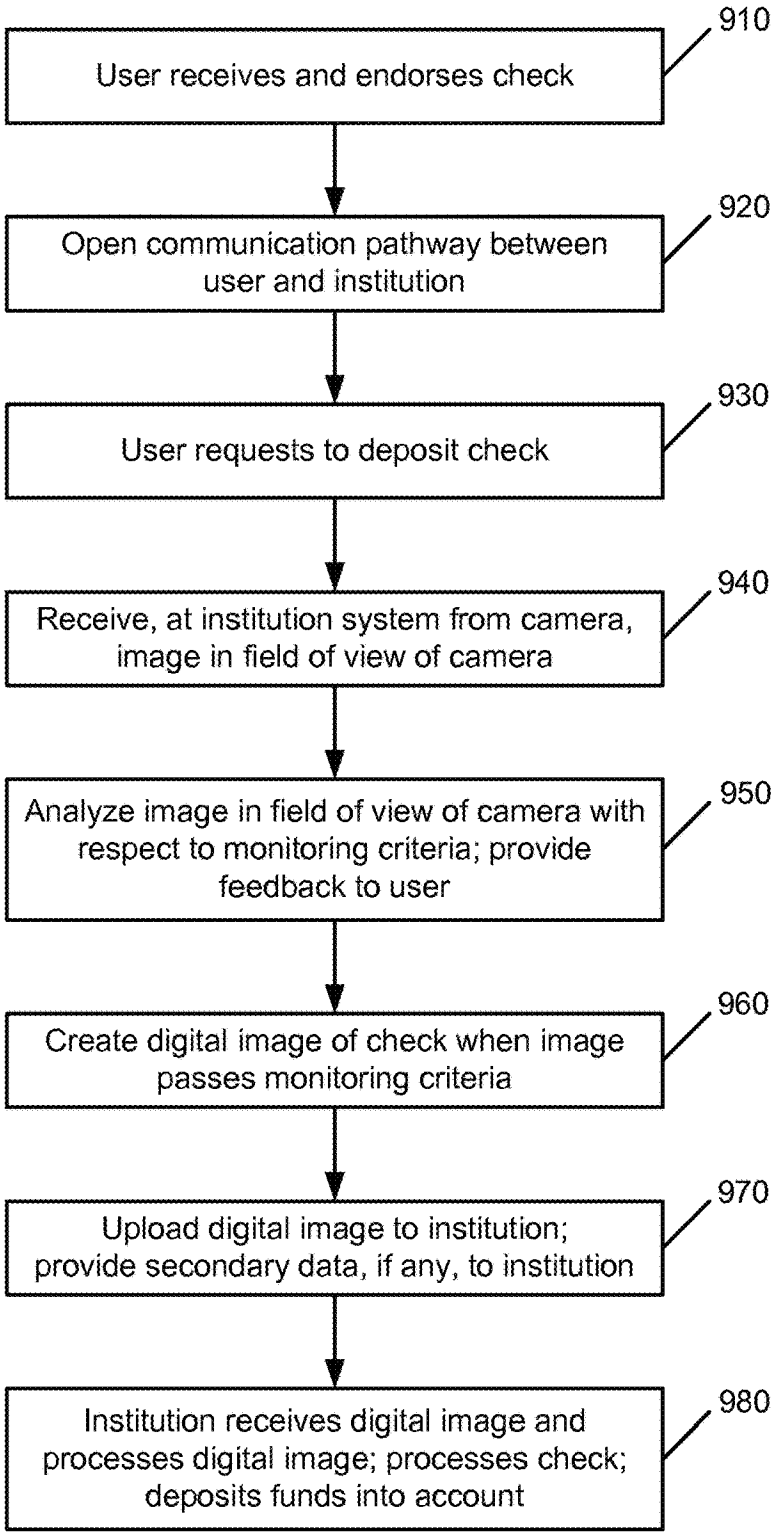

910
User receives and endorses check
920
Open communication pathway between user and institution
930
User requests to deposit check
940
Receive, at institution system from camera, image in field of view of camera
950
Analyze image in field of view of camera with respect to monitoring criteria; provide feedback to user
960
Create digital image of check when image passes monitoring criteria
970
Upload digital image to institution; provide secondary data, if any, to institution
980
Institution receives digital image and processes digital image; processes check; deposits funds into account
900

FIG. 9

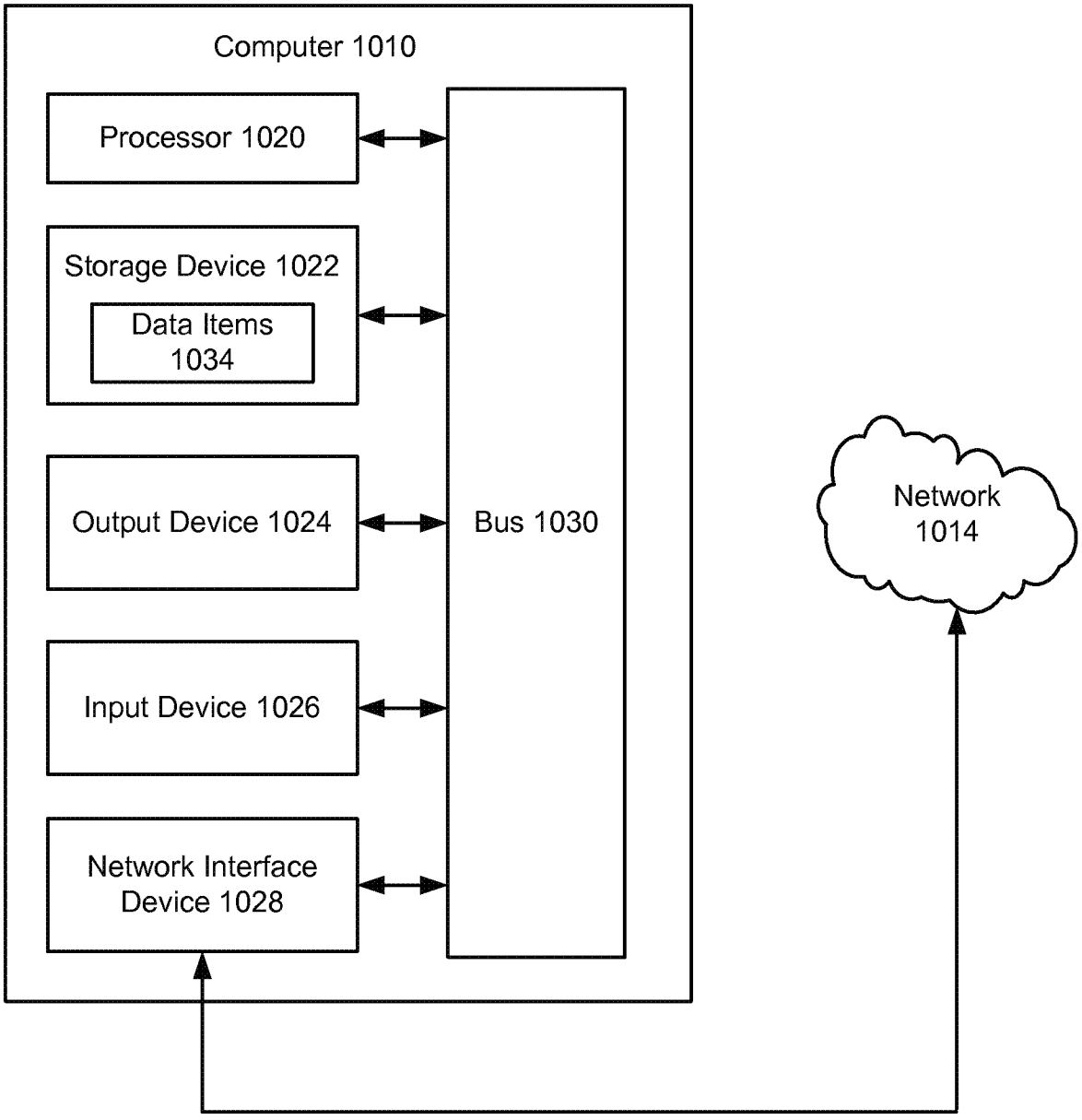

Computer 1010
Processor 1020
Storage Device 1022
Data Items 1034
Output Device 1024
Input Device 1026
Network Interface Device 1028
Bus 1030
Network 1014
1000

FIG. 10

SYSTEM AND METHOD FOR MOBILE CHECK DEPOSIT ENABLING AUTO-CAPTURE FUNCTIONALITY VIA VIDEO FRAME PROCESSING

BACKGROUND

Checks typically provide a safe and convenient method for an individual such as a payor to transfer funds to a payee. To use a check, the individual usually opens a checking account, or other similar account, at a financial institution and deposits funds, which are then available for later withdrawal. To transfer funds with a check, the payor usually designates a payee and an amount payable on the check. In addition, the payor often signs the check. Once the check has been signed, it is usually deemed negotiable, meaning the check may be validly transferred to the payee upon delivery. By signing and transferring the check to the payee, the payor authorizes funds to be withdrawn from the payor's account on behalf of the payee.

While a check may provide a payor with a convenient and secure form of payment, receiving a check may put certain burdens on the payee, such as the time and effort required to deposit the check. For example, depositing a check typically involves going to a local bank branch and physically presenting the check to a bank teller. To reduce such burdens for the payee, systems and methods have been developed to enable the remote deposit of checks. For example, the payee may capture a digital image of a check using a mobile device. The financial institution may then receive from the payee the digital image of the check. The financial institution may then use the digital image to credit funds to the payee. However, such a technique requires the efficient and accurate detection and extraction of the information pertaining to a check in the digital image. Capturing a digital image at a mobile device that allows for subsequent detection and extraction of the information from the digital image is difficult.

SUMMARY

An image of a check that is in the field of view of a camera is monitored prior to the image of the check being captured. The camera is associated with a mobile device. The monitoring may be performed by the camera, the mobile device, and/or a financial institution that is in communication with the mobile device. When the image of the check in the field of view passes monitoring criteria, an image may be taken by the camera and provided from the mobile device to a financial institution. The check may be deposited in a user's bank account based on the image. Any technique for sending the image to the financial institution may be used.

In an implementation, the image capture may be performed automatically by the camera, the mobile device, and/or the financial institution as soon as the image of the check is determined to pass the monitoring criteria. In an implementation, feedback may be provided to the user of the camera regarding the image of the check in the field of view. The user may reposition the check and/or the camera, for example, responsive to the feedback. Alternatively, the user may capture an image of the check responsive to the feedback.

This summary is provided to introduce a selection of concepts in a simplified form that are further described below in the detailed description. This summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing summary, as well as the following detailed description of illustrative embodiments, is better understood when read in conjunction with the appended drawings. For the purpose of illustrating the embodiments, there are shown in the drawings example constructions of the embodiments; however, the embodiments are not limited to the specific methods and instrumentalities disclosed. In the drawings:

FIG. **1** is a block diagram of an implementation of a system in which example embodiments and aspects may be implemented;

FIG. **2** shows a high-level block diagram of an implementation of a system that may be used for the deposit of a check;

FIG. **3** is a diagram of an example image comprising a check image, a background image, and feedback;

FIG. **4** is a diagram of an example image divided into segments that may be used for monitoring the image;

FIG. **5** is a diagram of an example histogram for a segment of an image comprising check data and background data;

FIG. **6** shows a data flow diagram of a system for the deposit of a check, in accordance with an example embodiment;

FIG. **7** shows a block diagram of a client apparatus and a server apparatus for the deposit of a check, in accordance with an example embodiment;

FIG. **8** is an operational flow of an implementation of a method that may be used for deposit of a check using image monitoring of the check;

FIG. **9** is an operational flow of another implementation of a method that may be used for deposit of a check using image monitoring of the check; and

FIG. **10** is a block diagram of an example computing environment in which example embodiments and aspects may be implemented.

DETAILED DESCRIPTION

In the following detailed description of example embodiments, reference is made to the accompanying drawings, which form a part hereof and in which is shown, by way of illustration, specific embodiments in which the example methods, apparatuses, and systems may be practiced. It is to be understood that other embodiments may be used and structural changes may be made without departing from the scope of this description.

FIG. **1** is a block diagram of an implementation of a system **100** in which example embodiments and aspects may be implemented. System **100** may include an account owner, referred to herein as a user **102**, and financial institutions **130**, **140**, and **150**, which may be any type of entity capable of processing a transaction involving a negotiable instrument. For example, financial institutions **130**, **140**, and **150** may be a retail bank, an investment bank, an investment company, a regional branch of the Federal Reserve, a clearinghouse bank, and/or a correspondent bank.

A negotiable instrument typically includes a type of contract that obligates one party to pay a specified sum of money to another party. Negotiable instrument as used herein is an unconditioned writing that promises or orders payment of a fixed amount of money. One example of a negotiable instrument is a check. The check may be taken by

the receiving party and deposited into an account at a financial institution of the receiving party. The receiving party may endorse the check and then present it for deposit at a bank branch, via an automated teller machine (ATM), or by using remote deposit. Other examples of negotiable instruments include money orders, cashier's checks, drafts, bills of exchange, promissory notes, and the like. A money order is a trusted financial instrument that is a payment order for a pre-specified amount of money. A cashier's check (also known as a bank check, official check, teller's check, bank draft or treasurer's check) is a check guaranteed by a bank and may be purchased from a bank.

The user **102** may be an individual or entity who owns account **160** that may be held at financial institution **130**. Account **160** may be any type of deposit account for depositing funds, such as a savings account, a checking account, a brokerage account, and the like. The user **102** may deposit a check **108** or other negotiable instrument in the account **160** either electronically or physically. The financial institution **130** may process and/or clear the check **108** or other negotiable instrument. The user **102** may communicate with financial institution **130** by way of communications network **120** such as an intranet, the Internet, a local area network (LAN), a wide area network (WAN), a wireless fidelity (WiFi) network, a public switched telephone network (PSTN), a cellular network, a voice over Internet protocol (VoIP) network, and the like. The user **102** may communicate with financial institution **130** by phone, email, instant messaging, text messaging, web chat, facsimile, mail, and the like. Financial institutions **130**, **140**, and **150** also may communicate with each other by way of communications network **120**.

In an implementation, the user **102** may receive payment from another individual such as a payor in the form of a check **108** or other negotiable instrument that is drawn from account **170** at financial institution **150**. The user **102** may endorse the check **108** (e.g., sign the back of the check **108**) and indicate an account number on the check **108** for depositing the funds. It is noted that although examples described herein may refer to a check, the techniques and systems described herein are contemplated for, and may be used for, deposit of any negotiable instrument. Similarly, the techniques and systems described herein are contemplated for and may be used with any form or document whose image may be captured with a camera or other imaging device of a mobile device for subsequent storage and/or processing.

As described further herein, a digital image of a check or other negotiable instrument may be provided from a user to a financial institution, and the digital image may be processed and funds associated with the check or negotiable instrument in the digital image may be deposited in a user's bank account. The user **102** may deposit the check **108** into account **160** by making a digital image of the check **108** and sending the image file containing the digital image to financial institution **130**. For example, after endorsing the check **108**, the user **102** may use a mobile device **106** that comprises a camera to convert the check **108** into a digital image by taking a picture of the front and/or back of the check **108**. The mobile device **106** may be a mobile phone (also known as a wireless phone or a cellular phone), a personal digital assistant (PDA), or any handheld computing device, for example. Aspects of an example mobile device are described with respect to FIG. **10**.

To increase the likelihood of capturing a digital image of the check **108** that may be readable and processed such that the check **108** can be cleared, the image is monitored for compliance with one or more monitoring criteria, prior to the image of the check **108** being captured. The monitoring criteria may be directed to proper lighting and/or framing of the check **108** in an image of the check **108** that will be captured and presented for clearing of the check **108**. An application may monitor whether the check **108** is sufficiently within the frame of the camera and has a high enough quality for subsequent processing. The monitoring is performed with respect to the image as it appears in the field of view of the camera of the mobile device **106**. The field of view is that part of the world that is visible through the camera at a particular position and orientation in space; objects outside the field of view when the image is captured are not recorded in the image. The monitoring criteria may be based on one or more of light contrast on the image, light brightness of the image, positioning of the image, dimensions, tolerances, character spacing, skewing, warping, corner detection, and MICR (magnetic ink character recognition) line detection, as described further herein. In an implementation, one or more histograms may be determined using the image being monitored. The histograms may be used in conjunction with monitoring criteria, as described further herein.

The monitoring may be performed by the camera, the mobile device **106**, and/or a financial institution that is in communication with the mobile device **106**. When the image of the check **108** in the field of view passes the monitoring criteria, an image may be taken by the camera and provided from the mobile device **106** to a financial institution. By ensuring that the image of the check passes monitoring criteria during pre-image capture monitoring, the number of non-conforming images of checks is reduced during presentment of the images to a financial institution for processing and clearing. In an implementation, feedback may be provided to the user **102** regarding the image of the check in the field of view. Based on the feedback, the user **102** may reposition the check **108** and/or the camera, for example, or may capture an image of the check **108**.

In an implementation, the image capture may be performed automatically by the camera, the mobile device **106**, and/or the financial institution as soon as the image of the check **108** is determined to pass the monitoring criteria. Alternatively, the user **102** may manually instruct the camera to perform the image capture (e.g., by pressing a button the camera or the mobile device **106**) after the user **102** receives an indication or other feedback that the image passes the monitoring criteria.

In an implementation, the user **102** may send the digital image(s) to financial institution **130** using the mobile device **106**. Any technique for sending a digital image to financial institution **130** may be used, such as providing a digital image to a website associated with financial institution **130** from storage, emailing a digital image to financial institution **130**, or sending a digital image in a text message or instant message, for example.

Financial institution **130** may receive a digital image representing the check **108** and may use any known image processing software or other application(s) to obtain the relevant data of the check **108** from the digital image. Financial institution **130** may determine whether the financial information associated therewith may be valid. For example, financial institution **130** may include any combination of systems and subsystems such as electronic devices including, but not limited to, computers, servers, databases, or the like. The electronic devices may include any combination of hardware components such as processors, databases, storage drives, registers, cache, random access

memory (RAM) chips, data buses, or the like and/or software components such as operating systems, database management applications, or the like. According to an embodiment, the electronic devices may include a network-based server that may process the financial information and may receive the digital image from the user **102**.

The electronic devices may receive the digital image and may perform an analysis on the quality of the digital image, the readability of the data contained therein, or the like. For example, the electronic devices may determine whether the account number, amount payable, and the like may be readable such that it may be parsed or otherwise obtained and processed by the financial institution to credit an account **160** associated with the user **102** and debit an account associated with the payor. In an implementation, a representative **135** of financial institution **130** may provide assistance to the user **102** and may provide assistance in determining whether the financial information may be readable and/or of a good enough quality to be processed.

Upon receipt and approval of the digital image, financial institution **130** may credit the funds to account **160**. Financial institution **130** may clear the check **108** by presenting a digital image of the check **108** captured from the digital image to an intermediary bank, such as a regional branch of the Federal Reserve, a correspondent bank, and/or a clearinghouse bank. For example, the check **108** may be cleared by presenting the digital image to financial institution **140**, which may be a regional branch of the Federal Reserve, along with a request for payment. Financial institutions **130** and **150** may have accounts at the regional branch of the Federal Reserve. Financial institution **130** may create a substitute check using the image provided by the user **102** and present the substitute check to financial institution **140** for further processing. Upon receiving the substitute check, financial institution **140** may identify financial institution **150** as the paying bank (e.g., the bank from which the check **108** is drawn). This may be accomplished using a nine digit routing number located on the bottom left hand corner of the check. A unique routing number is typically assigned to every financial institution in the United States. Financial institution **140** may present the substitute check to financial institution **150** and request that the check be paid. If financial institution **150** verifies the check (i.e., agrees to honor the check), financial institution **140** may then settle the check by debiting funds from financial institution **150** and crediting funds to financial institution **130**. Financial institution **150** may then debit funds from account **170**.

It will be appreciated that the preceding examples are for purposes of illustration and explanation only, and that an embodiment is not limited to such examples. For example, financial institution **150** may be a correspondent bank (i.e., engaged in a partnership with financial institution **130**). Thus, financial institution **130** may bypass the regional branch of the Federal Reserve and clear the check directly with financial institution **150**. In addition, account **160** and account **170** may both be held at financial institution **130**, in which case the check **108** may be cleared internally.

In an implementation, the mobile device **106** may comprise a video source such as a video camera, a web camera, or a video-enabled phone, for example, to obtain a video of the check **108**. A frame of the video may be obtained and monitored with respect to monitoring criteria, as described further herein. The mobile device **106** and/or the institution may obtain the frame and monitor the frame, depending on an implementation. Generation of a live video of a check **108** is not limited to a video camera, a web camera, and a video-enabled phone, and it is contemplated that any device that is capable of generating a live video may be used to make a video of the check **108** which may be monitored in real-time with respect to monitoring criteria. Additional devices that may be used in the generation and/or transmission of a live video include a web-enabled video computing device, a mobile phone, a camcorder, and a computer camera, for example.

FIG. **2** shows a high-level block diagram of an implementation of a system **200** that may be used for the deposit of a check, such as the check **108**. As described further herein, the user **102** may deposit the funds of the check **108** using the camera functionality in the mobile device **106**. In the example of one person giving a check to another person, this would enable the receiving party to deposit the funds at that time, without physically visiting an ATM or a bank branch.

In an implementation, the mobile device **106** may comprise a camera **207**, such as a digital camera. Such a mobile device may be called a camera phone. The mobile device **106**, through the camera **207**, has the ability to take or capture a picture or digital image of the check **108** or other negotiable instrument. The camera **207** may take an image of the front of the check **108**. Alternatively, the camera **207** may take an image of both the front and the back of the check **108**. The back of the check may provide endorsement verification, such as the signature of the person or party the check is made out to.

In an implementation, prior to an image in the field of view of the camera **207** being captured by the camera **207**, the image may be monitored with respect to monitoring criteria, e.g., using a software application running on the mobile device **106**. Feedback based on the monitoring of the image may be provided to the user **102** to assist the user **102** in positioning the check **108** so that the image of the check **108** may be captured in such a manner that it may be more easily processed and cleared during subsequent operations, such as those involving one or more financial institutions.

A depository **204** may include a bank in which the user **102** has a deposit account; however, the present disclosure is not limited to just banks. Alternatively, a third party may act as the depository **204** providing functionality to a plurality of users without regard to the bank at which they have deposit accounts, or whether their individual bank allows for the methods and systems described herein. The depository **204**, in an implementation, after receiving the image(s) of the check **108** from the user **102**, may use a clearinghouse **210** to perform the check clearing operations. As described with respect to the system **100** of FIG. **1**, check clearing operations are used by banks to do the final settlement of the check **108**, such as removing funds from the account of the payor and transferring those funds to the user's bank. The user's bank may choose to make the funds available to the user **102** immediately and take on the risk that the check **108** does not clear. However, for various reasons, the bank may only make those funds available to the user **102** after the check **108** finally clears.

In an implementation, the user **102** may place the check **108** on a background and generate a digital image comprising an image of the check (e.g., a check image) and a portion of the background (e.g., a background image) using the camera **207**. Any background may be used, although a dark background or a consistently colored background may provide more optimal results. It is noted that although examples and implementations described herein may refer to a check image and check data, the term "check image" may refer to any foreground image in a digital image (as opposed to the background image) and the term "check data" may refer to

any foreground data in a digital image (as opposed to background dara). Thus, the "check image" and the "check data" may refer to the foreground image and foreground data in implementations involving any negotiable instrument, form, or document.

In an implementation, the image being monitored in the field of view of the camera **207** comprises check data and background data. The check data pertains to the check image and the background data pertains to the background image (e.g., the background on which the check image is disposed).

FIG. **3** is a diagram of an example image **230** comprising a check image **247**, a background image **250**, and a feedback indicator **235** providing feedback to the user **102**. The image **230** may be generated by an imaging device associated with the mobile device **106**, such as the camera **207**. An edge **245** separates the check image **247** from the background image **250**. The edge **257** may be detected using any known technique(s). The image **230** may be provided in the field of view of the camera **207** prior to and during image capture of the check **108**. The user **102** may adjust the camera **207**, the check **108**, and/or any light source so that the image **230** passes one or more monitoring criteria. For example, a light source from a specific angle can lead to poor light contrast. Light contrast may be a monitoring criterion, and poor light contrast may be corrected easily by moving the lens of the camera **207** to a different perspective, thereby allowing the image to pass the monitoring criterion.

Feedback regarding the image **230** in the field of view with respect to the monitoring criteria may be generated and provided to the user **102**. In an implementation, the feedback may be provided visually, such as by text (e.g., "go closer", "go farther", "move the check to the right", "put the check on a darker background", "tilt the camera down", "take the picture now", etc.), arrows, or other visual indicators or cues (e.g., green lights, red lights, etc.) overlaid on the image **230**, shown as feedback indicator **235**. Alternatively or additionally, feedback may be provided to the user **102** aurally, such as through a speaker associated with the mobile device **106**. The feedback may advise the user **102** to move the camera **207** or the check **108** or adjust the lighting or the background, for example. The feedback may also advise the user **102** when the image **230** passes the one or more monitoring criteria and to capture the image of the check **108**.

One of the monitoring criteria may be based on the positioning of the check **180** in the image **230**. The positioning of the check **108** may be determined from the image **230** and compared with predetermined dimensions (e.g., of a typical personal check, of a typical business check) and tolerances. If the dimensions are within a certain acceptable tolerance, then it may be determined that the check **108** is properly positioned. Such feedback may be generated and provided to the user **102**.

In an implementation, the positioning of the check **108** in the image **230** may be compared with an alignment guide (which may or may not be visible to the user **102** in the field of view of the camera **207**). For example, measurements may be made by a processor in the camera **207**, the mobile device **106**, or a computing device at the financial institution to determine the check's position with respect to the alignment guide. The measurements may be compared to predetermined measurements or values to determine whether the check's positioning in the image **230** is proper or sufficient for further processing of the image. Edge detection and/or corner detection may be used in such measurements (e.g., in measuring the distance from the check **108** in the image **230** to the alignment guide). Any known technique(s) for edge detection and/or corner detection may be used. In an implementation, corner detection itself may be a monitoring criterion, such that if corner detection of the check **108** in the image **230** is achieved, then it may be concluded that the image **230** may be properly processed and cleared by a depository (I.e., the image **230** passes the monitoring criteria).

The alignment guide may be overlaid on the camera feed of the mobile device **106**, in an implementation. The alignment guide may take any shape such as a bounding rectangle or other bounding box or shape, horizontal and/or vertical bars, parallel lines, etc., for example. With a bounding rectangle, for example, used as the alignment guide, aligning the check **108**, thereby passing this monitoring criterion, means enclosing the check **108** within the bounding rectangle. If the check **108** is outside of the alignment guide in the image **230**, feedback may be generated and provided to the user **102** regarding this monitoring criterion with instructions for moving the check **108** or the camera **207** in order to properly align the check **108** in the field of view.

The operator of the camera **207** may introduce distortions in the image due to a perspective problem, specifically an angling of the camera vertically over the check, and the top of the check is smaller than the bottom, or the reverse. Monitoring criteria may also be directed to determining whether the image is skewed or warped. Skewing occurs when the check **208** is rotated from the horizontal in the image **230**. By measuring the distance from the edge(s) of the check **208** in the image to an alignment guide or the edge of the field of view, it may be determined whether the check **208** is skewed (e.g., by comparing the distances to one another, by comparing the distances to predetermined values, etc.). If skewing is present in the image **230**, feedback may be generated and provided to the user **102** with instructions for moving the check **108** or the camera **207** in order to properly align the check **108** in the field of view with respect to the horizontal.

Warping, as used herein, is meant to denote that the check **108** is tilted forward or back with respect to a plane that is perpendicular to a line drawn from the camera lens to the center of the check **108**. Warping, or tilting, of the image may lead to incorrect optical detection of the check **108**. In an implementation, a processor in the camera **207**, the mobile device **106**, or a computing device at the financial institution may determine whether warping is present in the image, and if so, may generate and provide feedback to the user **102**. Such feedback may comprise instructions to the user **102** for moving the check **108** or the camera **207** such that the check **108** would appear to be perpendicular to an imaginary line drawn from the center of the camera lens to the center of the check **108** itself (e.g., dewarping instructions).

If user involvement is tolerated, the user may be queried to supply or identify one or more corners of the check **108** in the image **230**. The perimeter of the check **108** may be determined using this information. Additionally, this information may be used for monitoring the image **230** for distortions.

In an implementation, a monitoring criterion may be whether the MICR line can be detected and/or read. Any known MICR line detection technique(s) may be used by the camera **207**, the mobile device **106**, and/or the financial institution (e.g., using an image processor, for example) to detect the MICR line on the check **108** in the image **230**. If the MICR line can be detected, it may be determined that the image **230** may be captured and sent to the financial institution for processing and clearing of the check **108** (i.e., the image passes the monitoring criterion directed to MICR line

detection). If the MICR line cannot be detected, feedback may be provided to the user **102**, such as to reposition the check **108** and/or the camera **207** (I.e., the image fails to pass the monitoring criterion, perhaps because the image is out focus or the lighting is inadequate, for example).

In an implementation, spacing between certain characters, points, or features (e.g., MICR number, "$" sign, signature line, courtesy amount line, legal amount line, etc.) may be determined and used as a monitoring criterion. For example, if the MICR line can be detected, then the spacing between the numbers in the MICR line may be determined using any known measuring and/or image processing technique(s). If the spacing is outside of a certain range corresponding to valid spacing between number in a MICR line, then it may be determined that the image **230** may be not properly processed if captured by the camera **207**. In such a case, feedback may be generated and provided to the user **102**, such as to reposition the check **108** and/or the camera **207**.

Another monitoring criterion may be based on the light in the image **230**, such as the light contrast and/or light brightness found on the image **230**, such as in various regions of the image **230**. For example, if the light contrast between the check image **247** and the background image **250** is less than a predetermined amount, then it may be determined that the image **230** may be not properly processed if captured by the camera **207**. In such a case, instead of capturing the image **230**, feedback may be generated and provided to the user **102** to adjust the camera **207**, the check **108**, and/or the lighting in order to bring the image **230** into compliance with the monitoring criteria.

As another example, the light brightness on various regions of the image may be determined and compared to each other and/or may be compared to a predetermined threshold. If the difference between the light brightness of the various regions is less than a predetermined amount (e.g., the light brightness does not vary significantly among the regions) or if the light brightness is less than a predetermined threshold, then it may be determined that the image **230** may be properly processed if captured by the camera **207**. Otherwise, feedback may be generated and provided to the user **102** to adjust the camera **207**, the check **108**, and/or the lighting in order to change the light brightness on the image **230**.

In an implementation, one or more histograms may be generated based on the image **230** and used in the determination of light contrast and/or light brightness monitoring criteria. A histogram is a well known graph and may be used to display where all of the brightness levels contained in an image are found, from the darkest to the brightest. These values may be provided across the bottom of the graph from left (darkest) to right (brightest). The vertical axis (the height of points on the graph) shows how much of the image is found at any particular brightness level.

Histograms may be used to monitor whether the light on the image **230** is uniform, not too bright, etc. For example, the mobile device **106** can monitor the histogram of the image **230** to ensure that there is a large contrast between the background image **250** and the check image **247**. Feedback may be provided to the user **102** as to how to move or adjust the camera, lighting, etc. in order to get a good image for subsequent processing (i.e., how to get an image that passes the monitoring criteria).

In an implementation, the image **230** may be divided into segments, such as those shown in FIG. **4**. FIG. **4** is a diagram of the example image **230** of FIG. **3** divided into segments **260**, **265**, **270**, **275** that may be used for monitoring the image **230**. Although four segments are shown in FIG. **4**, any number of segments may be used with techniques described herein. Although the segments **260**, **265**, **270**, **275** are formed by dividing the image **250** into quadrants, the segments may be formed by any techniques, take any shape, and have any area, subject to a constraint that each segment comprises a portion of the check data **247** and a portion of the background data **250** separated by a portion of the edge **245**. In this manner, distinct areas of density corresponding to the background of the image and the check data of the image may be provided in a histogram.

FIG. **5** is a diagram of an example histogram **280** for a segment of an image comprising check data and background data. The horizontal axis of the histogram **280** represents the grayscale level between 0 and 255, where 0 represents true black and 255 represents true white. The vertical axis represents the amount of the image at a particular grayscale level of the horizontal axis. Any known technique for generating a histogram for an image (such as a grayscale image of the image **230**) may be used. The histogram **280** shows two distinct areas of density (i.e., two distinct density distributions). The density area **286** closer to the grayscale level of zero corresponds to the background of the image, and the density area **289** closer to the grayscale level of 255 corresponds to the check data.

The density distribution for each segment (or for the entire image **230**) may be analyzed to determine whether the light contrast and/or light brightness is appropriate for processing and clearing of the check **108** in the image **230** (and thus passes that monitoring criterion) or whether the light contrast and/or light brightness does not pass the monitoring criterion and the camera **207**, the check **108**, and/or the light source should be adjusted or repositioned. For example, the density distributions for the segments may be compared with each other and/or may be compared to predetermined values or levels. If the differences are less than a predetermined difference amount, such as less than 1 percent different, less than 5 percent different, etc., then the image **230** may be captured and sent to the financial institution for processing. Otherwise, feedback may be generated and provided to the user **102** to reposition the camera **207**, the check **108**, and/or the light source.

When the image **230** passes the monitoring criteria (e.g., is positioned properly with respect to an alignment guide, is not warped, is not skewed, has adequate light brightness and/or light contrast, etc.), the image **230** may be captured either automatically (e.g., by the camera or the mobile device under direction of an application running on the camera **207** or the mobile device **106** or the financial institution) or manually (e.g., by the user **102** pressing a button or making a selection on the camera **207** or the mobile device **106**). The digital image thus captured may be provided from the mobile device **106** to a financial institution. The check **108** may be deposited in a user's bank account based on the digital image. Any technique for sending the digital image to the financial institution may be used.

FIG. **6** shows a data flow diagram **300** of a system for the deposit of a check, in accordance with an example embodiment. In the data flow diagram **300**, a client **320** is one example of the mobile device **106** of the user **102** described with respect to the systems **100** and **200** of FIGS. **1** and **2**, respectively. In an implementation, a server **322** may be a software component operable by the depository **204** of FIG. **2**. The client **320** may log in to a remote deposit system executed on the server **322**. The login **325** may serve to authenticate the user **102** as an authorized consumer of the depository **204**.

The server **322**, in one example, may send instructions **330** to the client **320** that execute an application on the client **320**. This may include instructions that cause a software object, which may have been previously downloaded and installed (e.g., pre-installed) on the client **320**, to be executed on the client **320**. The software object may analyze the image in the field of view of a digital camera (e.g., the image **230** shown in the field of view of the camera **207** associated with the mobile device **106**) with respect to one or more monitoring criteria and may generate and provide feedback to the user regarding the monitoring criteria and/or instructions for capturing an image of the check **108**.

In another example, the instructions **330** may include a wholly self-contained application that when delivered to the client **320** will execute and perform one or more operations described herein, such as those directed to analyzing the image in the field of view of the camera **207** with respect to monitoring criteria and providing feedback to the user **102**. In either example, the software object may be configured to make one or more software calls **310** to the camera **207**. This may be through specific software instructions to the camera **207**. In other words, the camera's functionality may not be abstracted through any software library. In such an example, software code may be written and delivered to every different camera-equipped mobile phone.

In an alternate example, the software object may operate through a software abstraction layer, such as an application programming interface (API). The software object developer may only insert code into the software object to call one or more APIs exposed by the software operating the mobile device **106**. One example of such software is Windows Mobile by Microsoft Corporation. In the context of a Windows Mobile device, the Windows Mobile operating system (OS) has one or more APIs exposed to application developers that will translate instructions from applications into instructions operable by the camera **207** on the mobile device **106**. A mobile operating system, also known as a mobile platform or a handheld operating system, is the operating system that controls a mobile device. Other mobiles OSs include Symbian OS, iPhone OS, Palm OS, BlackBerry OS, and Android.

The software object may cause the camera **207** to analyze an image in the field of view with respect to monitoring criteria, provide feedback, and/or take a picture or capture one or more images of the check **108** being deposited. These images may be captured sequentially, e.g., pursuant to the user **102** flipping the check **108** over after an image of the front of the check **108** has been captured after passing the monitoring criteria. However, each side of the check **108** may be captured by the camera **207** using similar API calls. The images may be stored in an image file **315**.

Once the images of one or both sides of the check **108** pass the monitoring criteria and are captured by the camera **207**, the image file **315** may be operated on by the software object of the client **320**. These operations may include any of the following: deskewing, dewarping, magnetic ink character recognition, cropping (either automatically, or having the user **102** manually identify the corners and/or edges of the check **108** for example), reducing the resolution of the image, number detection, character recognition, and the like.

With respect to number and character recognition, commercial check scanners have used characteristics of the MICR encoding to detect information about the check, such as the bank's routing number and the account number. However, the characteristics that these scanners have used are the magnetic characteristic of the ink itself and these scanners have used methods similar to those of magnetic audio tape readers. In an implementation, a software object of the client **320** may optically recognize the characters on the MICR line, as a consumer mobile device such as the mobile device **106** will lack the magnetic reading ability of a commercial check scanner.

The image may be also down converted into a grayscale or black and white image, such as either in Joint Photographic Experts Group (JPEG) compliant format or in tabbed image file format (TIFF) for example. In an alternate example, the image may be formatted as a Scalable Vector Graphics (SVG) image. One of the benefits of an SVG file is a large size advantage over JPEG. In the former example, the image at some point before entry into the clearing system may be converted to TIFF format. This may be performed at the mobile device **106**, wherein the camera **207** captures the image in TIFF format. However, the camera **207** of the mobile device **106** may capture the image in JPEG format, which may then be converted into TIFF either at the mobile device **106** or at the server **322**. In the latter example, this may use the transmission of the TIFF image across a communications network which may be more advantageous as TIFF images are typically smaller in file size for the same size of picture as a JPEG formatted image.

The software object on the client **320** may operate by performing one or more of the operations described herein and then transmitting an image file **335** (e.g., based on image file **315** that has been processed) to the server **322** after the user **102** confirms that they do wish to deposit the check **108**. Alternately, the software object may capture the image of the check **108** and transmit that image to the server **322** that in turn may perform those operations, verifies that the image quality is within acceptable thresholds, and communicates that verification back to the client **320**, which can then instruct the user **102** to take a picture of the other side of the check **108**. In this example, the image transmitted to the server **322** may be in any format, such as JPEG or TIFF, insofar as the server software has the ability to convert that image into a Check 21 compliant format. Alternately, the bank may output an X9.37 file to the clearing system. The Check Clearing for the 21st Century Act (or Check 21 Act) is a United States federal law that allows the recipient of a paper check to create a digital version, thereby eliminating the need for further handling of the physical document. The Check 21 standard for electronic exchange is defined in the standard DSTU X9.37-2003 ("X9.37"). It is a binary interchange format.

The server **322** may confirm (e.g., using a process confirmation **340**) with the user **102** the transmission, reception, and processing of each side of the check **108** separately, or may confirm both sides at the same time. On the server side, more operations may be performed, such as signature verification. Where to perform these operations may be determined by the processing power of the mobile device **106** itself, which is typically limited in computational power. However, the present discussion is not limited in any way by discussion of where certain operations are described as operating. The operations of detecting and verifying information may be performed by the client **320** before the information is transmitted along with the image in the image file **335** to the server **322**. Alternately, the software object(s) operating on the mobile device **106** may perform no operation other then capturing images of the front and back of the check **108** after passing the monitoring criteria, receiving confirmation that the user **102** wishes to proceed, and transmitting those images to the server **322**, wherein the server **322** performs those operations.

In an implementation, after the image file **335** has been received by the server **322**, the server **322** may send a process confirmation **340** to the client **320**. The process confirmation **340** may request instructions from the client **320** to continue proceeding with the deposit now that the server **322** has received the image file **335**. In response, the client **320** may send a deposit confirmation **345** to the server **322**, instructing the server **322** to process the deposit of the check based on the image file **335** that had been received by the server **322**.

FIG. **7** shows a block diagram of a client apparatus **450** and a server apparatus **570** for the deposit of a check, in accordance with an example embodiment. The client apparatus **450** may include one or more software objects operating on a mobile device **106**, such as described above. The client apparatus **450** may include a communications module **452**, a check processing module **454**, and an image monitoring and capture module **456**. The client apparatus **450** may receive, in one example, one or more check images **458** as an input and output one or more processed images **460**.

In an implementation, the check images **458** may be received following a software call from the check processing module **454** to the image monitoring and capture module **456**. In such an implementation, the image monitoring and capture module **456** may include the camera **207** contained within the mobile device **106**. Alternately, the camera **207** may be detachably coupled to the mobile device **106** such as through a secure digital (SD) slot or over any suitable communications bus, such as USB (universal serial bus).

In an implementation, the image monitoring and capture module **456** may obtain an image and send the image to a financial institution (e.g., financial institution **130**, the server **322**, the server apparatus **570**, etc.) for processing. In an implementation, the client apparatus **450** may comprise a browser such as a web browser, for accessing a website on the Internet or other network associated with a financial institution. The user may access the website and select a "monitor and capture image" link or similar icon, button or link, for example, displayed on the browser. Such a selection may call the image monitoring and capture module **456** on the client apparatus **450**.

The communications module **452** may be configured, in one example, to receive and send data signals over a suitable communications network. This may include, without limitation, GSM/GPR3, HSDPA, CDMA, TDMA, 802.11, 802.16 and the like. While the bandwidth available to the mobile device **106** may be an implementation concern such discussion is outside the scope of the present discussion and any suitable wireless communications network is considered to be within the scope of the present discussion. With respect to the present discussion, the communications module **452** may receive one or more processed check images **460** from the check processing module **454** and may transmit them over the suitable communications network to the depository **204**, as described herein.

The check processing module **454** may be configured, in one example, to cause the image monitoring and capture module **456** to monitor an image of at least one side of a check provided in a field of view of the camera **207** and then capture the image after it passes monitoring criteria. Compliance with the monitoring criteria is intended to ensure that the image of the check is suitable for one or more processing tasks. For instance, if the check is rotated 45 degrees clockwise when captured, the check processing module **454** or a software object operated on the server **322** described above may be unable to optically detect information on the check.

The check processing module **454** may perform one or more cleaning or processing operations on the captured image of the check. Such cleaning of processing may include dewarping and/or deskewing (if not part of the monitoring criteria, in an implementation), for example. Cleaning or processing may include down-converting the image received from the image capture module to a suitable size, such as 200 dots per inch (OPI) resolution or in a resolution range such as 200 DPI to 400 DPI, 300 DPI to 500 DPI, etc., and/or converting the image to grayscale or black and white. Such operation(s) may reduce the file size of the check image. Alternatively, the check processing module **454** may send instructions to the image monitoring and capture module **456** to cause the image monitoring and capture module **456** to capture an image of the check at a suitable resolution. The check processing module **454** may additionally perform any of the following operations, in further examples: convert from JPEG to TIFF, detect check information, perform signature detection on the image of the check, and the like. The check processing module **454** may, alternatively, send the captured check image to the server described herein for such processing, and receive confirmation that the operations were completed before further operations can proceed.

The size of the file sent between the mobile device and the server may be small. This runs counter with respect to automatic check detection against a background. If captured in color, the contrast between check and background becomes easier. However, the processed image sent over the communications network may need to be smaller, and if the detection operation is performed by the server, it may be advantageous to convert the captured image to grayscale, or even black and white, before transmission to the server. Grayscale images are compliant with the Check 21 Act.

While "flat" is a fairly well known term to users, each user's appreciation of flat with respect to the camera lens of the camera **207** associated with the mobile device **106** may result in a problem with needing to align the check image programmatically or risk rejecting a large number of check images. As the image captured is a set of pixels, a tilted image will result in a jagged polygon rather than a perfect rectangle. Using convex hull algorithms, the check processing modules may create a smooth polygon around the boundary and remove the concavity of the check image. Alternatively, a rotating calipers algorithm may be used to determine the tightest fitting rectangle around the check boundary, which can then be used to determine the angle of it, with that angle being used to align the check properly.

The server apparatus **570** may include one or more software objects operating on a server operated by the depository **204**. Aspects of an example server apparatus are described with respect to FIG. **10**. The server apparatus **570** may include a communications module **572**, a check processing module **574**, and a check clearance module **576**. The server apparatus **570** may receive one or more processed images **460** from a mobile device **106** or a client apparatus **450** as an input and may output a file such as a Check 21 compliant file **578**. The Check 21 compliant file **578** may be a file or entry in a record set that is compliant with the clearinghouse rules set forth in the Check 21 Act and may include outputting an X9.37 file, in one example.

The communications module **572** may be configured to receive a wireless communication from the mobile device **106** over any suitable communications network, such as those described above. The communications module **572** may additionally receive a communication over a different communications network than the mobile device **106** com-

municated on, such as receiving the communication over a TCP/IP (Transmission Control Protocol/Internet Protocol) connection from the user's communication provider.

The check processing module **574** may be configured, in one example, to perform one or more check processing operations on the processed image(s) **460** that are received. In an implementation, these operations may include any of the operations described herein with respect to the check processing module **454**. The operation of signature verification may be performed by the check processing module **574** of the server apparatus **570** as the server apparatus **570** may interface with other systems of the depository **204** that may maintain previously verified signature samples of the user **102**. Performing signature verification at the client apparatus **450** may be computationally unfeasible; additionally, there may be a security risk if the signature sample is stored on the user's own device.

A cropped grayscale image may be sent to the server apparatus **570**. The server apparatus **570** may extract information via a TIFF conversion and determine the DPI and re-scale to the proper DPI (e.g., convert to TIFF and detect the DPI that was used in the grayscale image). In an implementation, DPI detection may run on the client apparatus **450**.

The check clearance module **576** may be configured, in one example, to receive a file from the check processing module **574** and may communicate with a check clearinghouse such that a Check 21 compliant file may be delivered to the check clearinghouse and funds may be received by the depository **204**. The availability of the funds to the user **102** may be delayed by this operation such that the user **102** only has access to those funds when the depository **204** receives confirmation that the check has cleared.

FIG. **8** is an operational flow of an implementation of a method **800** that may be used for deposit of a check using image monitoring of the check. At **810**, a request for access may be received from a user (e.g., the user **102**). The user may request access to a deposit system operated by a depository (e.g., the depository **204**) by way of a mobile device (e.g., the mobile device **106**) such as a cellular phone, a PDA, a handheld computing device, etc. operated by the user. The access may be through some sort of user login, in some examples. The deposit system may be configured to receive a deposit of a negotiable instrument, such as a check, money order, cashier's check, etc. from the user and clear the negotiable instrument in a suitable clearinghouse system.

At **820**, the system may initialize a software object on the mobile device. This may include sending instructions to the mobile device intended to execute a previously installed (i.e., pre-installed) software object. Alternatively, the system may send a software object to the mobile device that may execute the software object, carry out operations described herein by use of the software object, and terminate the software object. In an implementation, the system may instruct a camera associated with the mobile device to monitor and capture an image of the negotiable instrument in conjunction with monitoring criteria.

The user may use the camera to obtain an image in the field of view of the camera, and at **830**, the image in the field of view of the camera may be monitored with respect to one or more monitoring criteria, such as those described above. The monitoring may be performed by the camera, the mobile device, and/or a computing device associated with the depository, for example. The monitoring may be performed pursuant to instructions received at the camera or mobile device from the deposit system operated by a depository, the server **322**, or the server apparatus **570**, for example. In an implementation, the results of the monitoring may indicate that the camera and/or the check should be repositioned and/or the light source should be adjusted prior to an image capture in order to capture an image of the check that may be processed properly, e.g., to have the data from the check obtained without error from the image, so that that check can be cleared.

At **840**, feedback based on the results may be generated and provided visually and/or aurally to the user via the camera and/or the mobile device. In an implementation, the feedback may be provided if the image fails to pass the monitoring criteria. The feedback may comprise instructions or guidance for the user to follow to obtain an image of the check in the field of view of the camera that will pass the monitoring criteria. Processing may continue at **830** with the image that is currently in the field of view of the camera (after the user has received and acted on the feedback) being monitored with respect to the monitoring criteria.

When the image in the field of view passes the monitoring criteria as determined at **830**, the image in the field of view may be captured by the camera at **850**. This may be accomplished through the software object accessing a camera associated with the mobile device (e.g., either comprised within the mobile device or separate from the mobile device). This may be done through an API exposed by the OS of the mobile device, or may be through software code customized for a specific phone and specific camera. With respect to the former, a developer of the software object may write code to the camera API(s), which may be specific to the OS and without regard to the camera on the device. The user may initiate the capture of the image (e.g., by pressing a button on the camera or the mobile device) or the image may be captured automatically, without user intervention, as soon as the image in the field of view is determined to have passed the monitoring criteria. In this manner, the occurrence of non-conforming images downstream (e.g., at a depository or financial institution) is reduced, and there is a high confidence that the image will be properly processed downstream.

In an implementation, when the image in the field of view is determined to pass the monitoring criteria, feedback may be generated and provided to the user indicating so. The feedback may instruct the user to capture the image now (e.g., by pressing a button on the camera or mobile device) or may advise the user that the image has been captured, for example.

At **860**, the captured image may be transmitted to the depository, e.g. as a digital image file. At **870**, the depository may receive the image of the check (along with financial information pertaining to the account for depositing funds, for example) and may process the image. Processing of the digital image file may include retrieving financial information regarding the check. The financial information may comprise the MICR number, the routing number, an amount, etc. Any known image processing technology may be used, such as edge detection, filtering to remove imagery except the check image or check data in the received digital image file, image sharpening, and technologies to distinguish between the front and the back sides of the check. The depository may identify and/or remove at least a portion of data that is extraneous to the check, such as background data.

After retrieving the financial information from the check in an electronic data representation form, the depository may determine whether the financial information such as the amount payable to the user, the account associated with the user to deposit funds, an account associated with a payor to

debit funds, and an institution associated with the payor, etc., may be valid. For example, the depository may include electronic devices such as computers, servers, databases, or the like that may be in communication with each other. The electronic devices may receive an electronic data representation and may perform an analysis on the quality of the data representation, the readability of the data representation, or the like. For example, the electronic devices may determine whether the account number, amount payable, or the like may be readable such that they may be parsed and processed by the depository to credit an account associated with the user.

If the financial information is determined to be valid, the electronic data representation may be processed by the depository, thereby depositing the money in the user's account. If the financial information is determined to be invalid, then the user may be advised. For example, the depository may transmit an email, a web message, an instant message, or the like to the user indicating that the financial information associated with the electronic data representation may be invalid. The user may determine how to proceed by selecting an option on the web message, replying to the email, or the like.

Thus, in an implementation, instructions on how the user would like to proceed may be requested from the user, such as whether the user would like to try the deposit again (e.g., make another image of the check that pass the monitoring criteria and send it to the depository) or whether the user would like assistance from a representative, for example. The user may indicate how they would like to proceed. If the user would like assistance, the financial information may be transferred to a representative for further review. The representative may review the financial information associated with the electronic data representation to determine whether to allow the electronic data representation to be processed by the depository. If so, the electronic data representation of the financial information may be processed by the depository, thereby depositing the check in the user's account. The depository may send a notice to the user via email, facsimile, instant message, or mail, for example, that the check has been deposited into the selected account.

FIG. **9** is an operational flow of another implementation of a method **900** that may be used for deposit of a check using image monitoring of the check. A user (e.g., the user **102**) may receive and endorse a check (e.g., the check **108**) at **910**, and open a communication pathway with an institution (e.g., the financial institution **130**) at **920**. In an implementation, the user may open a communication pathway with the institution by logging into a website of the institution, for example, There may be several ways in which a communication pathway may be established, including, but not limited to, an Internet connection via a website of the institution. The user may access the website and log into the website using credentials, such as, but not limited to, a username and a password.

At **930**, the user may send a request to deposit the check and may select an account in which to deposit the check. In an implementation, the user may select a "deposit check" option provided on the website, and may enter details such as check amount, date, the account the check funds should be deposited in, comments, etc.

At **940**, an image in the field of view of the camera may be obtained and provided, via the communication pathway, to the institution. A still image may be provided or a video may be provided, such as a video stream generated by the camera.

At **950**, the institution may receive the image or video stream and may analyze the image or a frame of the video stream with respect to one or more monitoring criteria, such as those described above. Feedback pertaining to the image with respect to the monitoring criteria may be generated and provided to the user over the communication pathway. Based on the feedback, the user may adjust the position the camera and/or the check and/or may adjust the light source until the image in the field of view of the camera is determined by the institution to pass the monitoring criteria.

When the image in the field of view passes the monitoring criteria, the image in the field of view may be captured (e.g., automatically without user intervention or pursuant to the user pressing a button) by the camera at **960**, thereby creating a digital image of the check. In an implementation, the user may instruct the camera (e.g., by pressing a button on the camera or the mobile device) to create the digital image. In another implementation, the camera may automatically create the digital image as soon as the image of the check passes the monitoring criteria. In this manner, the user may point the camera at the check such that the image of the check appears in the field of view, and after image has been determined to pass the monitoring criteria, a digital image of the check may be created without further user intervention. Depending on the implementation, one or more digital images of the check (e.g., corresponding to the front and back of the check) may be created using such techniques.

At **970**, the digital image(s) may be uploaded to the institution using any known image upload process. In an implementation, the upload may be augmented by secondary data which may be information relating to the deposit of the check, such as an account number and a deposit amount, for example. At **980**, when the institution has received the digital images (e.g., of the front and back sides of the check), the institution may process the digital images to obtain an image of the check and to deposit the funds of the check in the user's account, as described herein. It is contemplated that processing such as grayscale conversion, image cropping, image compression, edge and/or corner detection, etc. may be implemented in the method **900**. Such operations may be performed on one or more digital images created by the camera and may be performed on the image(s) by the mobile device and/or by the institution, as described further above.

Although the examples described herein may refer to uploading of images of checks to an institution, it is contemplated that any negotiable instrument or image (e.g., vehicle accident pictures provided to an insurance company) may be processed and/or transmitted using the techniques described herein. Additionally, one or more of the techniques described herein may be performed by the institution instead of the mobile device of the user.

FIG. **10** is a block diagram of an example computing environment in which example embodiments and aspects may be implemented. The computing system environment is only one example of a suitable computing environment and is not intended to suggest any limitation as to the scope of use or functionality. Numerous other general purpose or special purpose computing system environments or configurations may be used. Examples of well known computing systems, environments, and/or configurations that may be suitable for use include, but are not limited to, personal computers (PCs), server computers, handheld or laptop devices, multiprocessor systems, microprocessor-based systems, network PCS, minicomputers, mainframe computers,

embedded systems, distributed computing environments that include any of the above systems or devices, and the like.

Computer-executable instructions, such as program modules, being executed by a computer may be used. Generally, program modules include routines, programs, objects, components, data structures, etc. that perform particular tasks or implement particular abstract data types. Distributed computing environments may be used where tasks are performed by remote processing devices that are linked through a communications network or other data transmission medium. In a distributed computing environment, program modules and other data may be located in both local and remote computer storage media including memory storage devices.

With reference to FIG. **10**, a system **1000** includes a computer **1010** connected to a network **1014**. The computer **1010** includes a processor **1020**, a storage device **1022**, an output device **1024**, an input device **1026**, and a network interface device **1028**, all connected via a bus **1030**. The processor **1020** represents a central processing unit of any type of architecture, such as a CISC (Complex Instruction Set Computing), RISC (Reduced Instruction Set Computing), VLIW (Very Long Instruction Word), or a hybrid architecture, although any appropriate processor may be used. The processor **1020** executes instructions and includes that portion of the computer **1010** that controls the operation of the entire computer. Although not depicted in FIG. **10**, the processor **1020** typically includes a control unit that organizes data and program storage in memory and transfers data and other information between the various parts of the computer **1010**. The processor **1020** receives input data from the input device **1026** and the network **1014** reads and stores code and data in the storage device **1022** and presents data to the output device **1024**. Although the computer **1010** is shown to contain only a single processor **1020** and a single bus **1030**, the disclosed embodiment applies equally to computers that may have multiple processors and to computers that may have multiple busses with some or all performing different functions in different ways.

The storage device **1022** represents one or more mechanisms for storing data. For example, the storage device **1022** may include read-only memory (ROM), RAM, magnetic disk storage media, optical storage media, flash memory devices, and/or other machine-readable media. In other embodiments, any appropriate type of storage device may be used. Although only one storage device **1022** is shown, multiple storage devices and multiple types of storage devices may be present. Further, although the computer **1010** is drawn to contain the storage device **1022**, it may be distributed across other computers, for example on a server.

The storage device **1022** includes a controller (not shown in FIG. **10**) and data items **1034**. The controller includes instructions capable of being executed on the processor **1020** to carry out functions previously described herein with reference to FIGS. **1-9**. In another embodiment, some or all of the functions are carried out via hardware in lieu of a processor-based system. In one embodiment, the controller is a web browser, but in other embodiments the controller may be a database system, a file system, an electronic mail system, a media manager, an image manager, or may include any other functions capable of accessing data items. The storage device **1022** may also contain additional software and data (not shown), which is not necessary to understand the invention. Although the controller and the data items **1034** are shown to be within the storage device **1022** in the computer **1010**, some or all of them may be distributed across other systems, for example on a server and accessed via the network **1014**.

The output device **1024** is that part of the computer **1010** that displays output to the user. The output device **1024** may be a liquid crystal display (LCD) well-known in the art of computer hardware. In other embodiments, the output device **1024** may be replaced with a gas or plasma-based flat panel display or a traditional cathode-ray tube (CRT) display. In still other embodiments, any appropriate display device may be used. Although only one output device **1024** is shown, in other embodiments any number of output devices of different types, or of the same type, may be present. In an embodiment, the output device **1024** displays a user interface. The input device **1026** may be a keyboard, mouse or other pointing device, trackball, touchpad, touch screen, keypad, microphone, voice recognition device, or any other appropriate mechanism for the user to input data to the computer **1010** and manipulate the user interface previously discussed. Although only one input device **1026** is shown, in another embodiment any number and type of input devices may be present.

The network interface device **1028** provides connectivity from the computer **1010** to the network **1014** through any suitable communications protocol. The network interface device **1028** sends and receives data items from the network **1014**. The bus **1030** may represent one or more busses, e.g., USB, PCI, ISA (Industry Standard Architecture), X-Bus, EISA (Extended Industry Standard Architecture), or any other appropriate bus and/or bridge (also called a bus controller).

The computer **1010** may be implemented using any suitable hardware and/or software, such as a personal computer or other electronic computing device. Portable computers, laptop or notebook computers, PDAs, pocket computers, appliances, telephones, and mainframe computers are examples of other possible configurations of the computer **1010**. For example, other peripheral devices such as audio adapters or chip programming devices, such as EPROM (Erasable Programmable Read-Only Memory) programming devices may be used in addition to, or in place of, the hardware already depicted.

The network **1014** may be any suitable network and may support any appropriate protocol suitable for communication to the computer **1010**. In an embodiment, the network **1014** may support wireless communications. In another embodiment, the network **1014** may support hard-wired communications, such as a telephone line or cable. In another embodiment, the network **1014** may support the Ethernet IEEE (Institute of Electrical and Electronics Engineers) 802.3x specification. In another embodiment, the network **1014** may be the Internet and may support IP (Internet Protocol). In another embodiment, the network **1014** may be a LAN or a WAN. In another embodiment, the network **1014** may be a hotspot service provider network. In another embodiment, the network **1014** may be an intranet. In another embodiment, the network **1014** may be a GPRS (General Packet Radio Service) network. In another embodiment, the network **1014** may be any appropriate cellular data network or cell-based radio network technology. In another embodiment, the network **1014** may be an IEEE 802.11 wireless network. In still another embodiment, the network **1014** may be any suitable network or combination of networks. Although one network **1014** is shown, in other embodiments any number of networks (of the same or different types) may be present.

It should be understood that the various techniques described herein may be implemented in connection with hardware or software or, where appropriate, with a combination of both. Thus, the methods and apparatus of the presently disclosed subject matter, or certain aspects or portions thereof, may take the form of program code (i.e., instructions) embodied in tangible media, such as floppy diskettes, CD-ROMs, hard drives, or any other machine-readable storage medium wherein, when the program code is loaded into and executed by a machine, such as a computer, the machine becomes an apparatus for practicing the presently disclosed subject matter. In the case of program code execution on programmable computers, the computing device generally includes a processor, a storage medium readable by the processor (including volatile and non-volatile memory and/or storage elements), at least one input device, and at least one output device. One or more programs may implement or use the processes described in connection with the presently disclosed subject matter, e.g., through the use of an API, reusable controls, or the like. Such programs may be implemented in a high level procedural or object-oriented programming language to communicate with a computer system. However, the program(s) can be implemented in assembly or machine language, if desired. In any case, the language may be a compiled or interpreted language and it may be combined with hardware implementations.

Although exemplary embodiments may refer to using aspects of the presently disclosed subject matter in the context of one or more stand-alone computer systems, the subject matter is not so limited, but rather may be implemented in connection with any computing environment, such as a network or distributed computing environment. Still further, aspects of the presently disclosed subject matter may be implemented in or across a plurality of processing chips or devices, and storage may similarly be effected across a plurality of devices. Such devices might include personal computers, network servers, and handheld devices, for example. Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

What is claimed:

1. A method enabling mobile check deposit auto-capture functionality via video frame processing, the method comprising:

providing an app for download to a mobile device of a user, the user's mobile device including a camera and a memory storing a software abstraction layer for controlling the camera, the app associated with a bank to control check deposit by controlling the camera through the software abstraction layer, wherein the app, when downloaded to the user's mobile device and executed by the user's mobile device, is configured to cause the user's mobile device to perform operations comprising:

providing instructions to the user for capturing an image of a check;

generating a live video of the check in a field of view of the camera, the downloaded app causing the live video to be generated by controlling the camera through the software abstraction layer;

overlaying an alignment guide on the live video of the check in the field of view of the camera;

monitoring the live video of the check in the field of view of the camera with respect to at least one monitoring criterion;

determining that a video frame of the live video of the check satisfies the at least one monitoring criterion and then automatically capturing the video frame;

when the video frame of the live video of the check in the field of view of the camera is determined to satisfy the at least one monitoring criterion, providing feedback advising the user that the check has been captured;

using a wireless network, transmitting a digital image of the check from the user's mobile device and submitting the check for mobile check deposit in the bank after automatically capturing the video frame, wherein the digital image is the captured video frame or is based on the captured video frame; and

before the submitting, confirming that the mobile check deposit can go forward after optical character recognition is performed on the check in the digital image, a magnetic ink character recognition (MICR) line on the check in the digital image is recognized, and an amount payable on the check in the digital image is validated;

receiving the digital image of the check transmitted by the user's mobile device;

processing the digital image of the check including performing optical character recognition on the check in the digital image and verifying that the digital image of the check is acceptable for mobile check deposit, wherein the app, when downloaded and executed by the user's mobile device, is configured to cause the user's mobile device to perform additional operations including receiving an indication of a result of the processing before confirming that the mobile check deposit can go forward; and

updating, by a computer, a balance of an account at a financial institution of the user to reflect an amount of funds associated with the check submitted for mobile check deposit by the user's mobile device, after the submitting the check for mobile check deposit in the bank, the confirming that the mobile check deposit can go forward, and the verifying that the digital image of the check is acceptable for mobile check deposit.

2. The method of claim **1**, wherein the digital image is a modified version of the captured video frame.

3. The method of claim **1**, wherein the wireless network is a cellular network.

4. A method enabling mobile check deposit auto-capture functionality via video frame processing, the method comprising:

monitoring a live video of a check in a field of view of a camera with respect to at least one monitoring criterion, wherein the live video is generated by a mobile device of a user, the user's mobile device including the camera and a downloaded app, the downloaded app associated with a bank to control check deposit by controlling the camera, the downloaded app, when executed by the user's mobile device, being configured to cause the user's mobile device to perform operations comprising:

providing instructions to the user for capturing an image of the check;

generating the live video of the check in the field of view of the camera, the downloaded app causing the live video to be generated by controlling the camera;

overlaying an alignment guide on the live video of the check in the field of view of the camera; and

using a wireless network, submitting the check for mobile check deposit in the bank after a frame of the live video of the check in the field of view of the camera is automatically captured;

determining that a video frame of the live video of the check satisfies the at least one monitoring criterion and then automatically capturing the video frame;

when the video frame of the live video of the check in the field of view of the camera is determined to satisfy the at least one monitoring criterion, providing feedback advising the user that the check has been captured;

processing a digital image of the check including performing optical character recognition and verifying that the digital image of the check is acceptable for mobile check deposit, the digital image of the check being the captured video frame or being based on the captured video frame;

confirming that the mobile check deposit can go forward after optical character recognition is performed on the check in the digital image, a magnetic ink character recognition (MICR) line on the check in the digital image is recognized, and an amount payable on the check in the digital image is validated; and

updating, by a bank computer, a balance of an account at a financial institution of the user to reflect an amount of funds associated with the check submitted for mobile check deposit by the user's mobile device, after the check is submitted for mobile check deposit in the bank, confirming that the mobile check deposit can go forward, and verifying that the digital image of the check is acceptable for mobile check deposit.

5. The method of claim **4**, wherein one or more of one or more computers, remote from the user's mobile device, performs the monitoring, the determining, or both the monitoring and the determining, and wherein the one or more computers include the bank computer.

6. The method of claim **5**, wherein the downloaded app, when executed by the user's mobile device, is configured to cause the user's mobile device to perform additional operations comprising transmitting, using the wireless network, the live video of the check in the field of view of the camera.

7. The method of claim **4**, wherein the wireless network is a cellular network.

8. A method enabling mobile check deposit auto-capture functionality via video frame processing, the method comprising:

providing an app for download to a mobile device of a user, the user's mobile device including a camera and a memory storing a software abstraction layer, the app associated with a bank to control check deposit by controlling the camera through the software abstraction layer, wherein the app, when downloaded to the user's mobile device and executed by the user's mobile device, is configured to cause the user's mobile device to perform operations comprising:

providing instructions to the user for capturing an image of a check;

generating a live video of the check in a field of view of the camera, the downloaded app causing the live video to be generated by controlling the camera through the software abstraction layer;

monitoring the live video of the check in the field of view of the camera with respect to at least one monitoring criterion;

determining that a video frame of the live video of the check satisfies the at least one monitoring criterion and then automatically capturing the video frame;

when the video frame of the live video of the check in the field of view of the camera is determined to satisfy the at least one monitoring criterion, providing feedback advising the user that the check has been captured;

using a wireless network, transmitting a digital image of the check from the user's mobile device and submitting the check for mobile check deposit in the bank after automatically capturing the video frame, wherein the digital image is the captured video frame or is based on the captured video frame; and

before the submitting, confirming that the mobile check deposit can go forward after optical character recognition is performed on the check, a magnetic ink character recognition (MICR) line on the check is recognized, and an amount payable on the check is validated; and

updating, by a computer, a balance of an account at a financial institution of the user to reflect an amount of funds associated with the check submitted for mobile check deposit by the user's mobile device, after the submitting the check for mobile check deposit and the confirming that the mobile check deposit can go forward.

9. The method of claim **8**, wherein the digital image is a modified version of the captured video frame.

10. The method of claim **8**, wherein the wireless network is a cellular network.

11. A method enabling mobile check deposit auto-capture functionality via video frame processing, the method comprising:

receiving an image of a check, wherein the image of the check is provided for mobile check deposit in a bank by a mobile device of a user, the user's mobile device including a camera and a memory storing a software abstraction layer and a downloaded app, the downloaded app associated with the bank to control check deposit by controlling the camera through the software abstraction layer, and the downloaded app, when executed by the user's mobile device, being configured to cause the user's mobile device to perform operations comprising:

providing instructions to the user for capturing the check;

generating a live video of the check in a field of view of the camera, the downloaded app causing the live video to be generated by controlling the camera through the software abstraction layer;

monitoring the live video of the check in the field of view of the camera with respect to at least one monitoring criterion;

determining that a video frame of the live video of the check satisfies the at least one monitoring criterion and then automatically capturing the video frame;

when the video frame of the live video of the check in the field of view of the camera is determined to satisfy the at least one monitoring criterion, providing feedback advising the user that the check has been captured;

using a wireless network, transmitting a digital image of the check from the user's mobile device and submitting the check for mobile check deposit in the bank after automatically capturing the video frame, wherein the digital image is the captured video frame or is based on the captured video frame; and

before the submitting, confirming that the mobile check deposit can go forward after optical character rec-

ognition is performed on the check, a magnetic ink character recognition (MICR) line on the check is recognized, and an amount payable on the check is validated;

performing image processing operations on the image of the check, the image processing operations including performing optical character recognition and verifying that the image of the check is acceptable for mobile check deposit, wherein the image of the check is the digital image transmitted by the user's mobile device or is based on the digital image transmitted by the user's mobile device; and

updating, by a computer, a balance of an account at a financial institution of the user to reflect an amount of funds associated with the check submitted for mobile check deposit by the user's mobile device, after the submitting the check for mobile check deposit in the bank, the confirming that the mobile check deposit can go forward, and the verifying that the image of the check is acceptable for mobile check deposit.

12. The method of claim **11**, wherein the wireless network is a cellular network.

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