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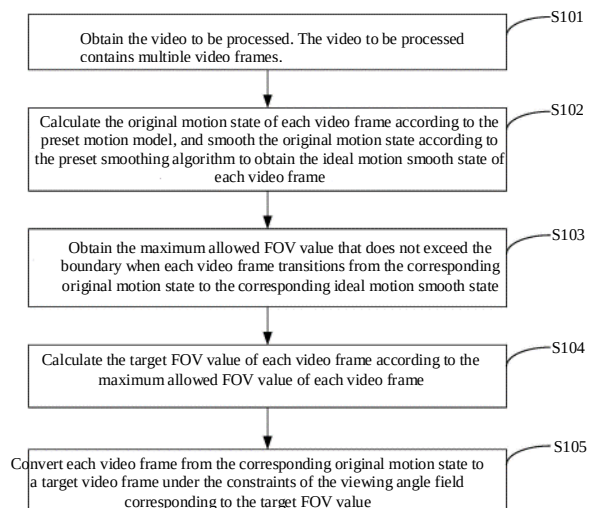
2 pages of claims, 6 pages of specifications, 2 pages of
drawings

(54) Title of Invention

A video processing method, device, computing
device and storage medium

(57) **Summary**

The present invention is applicable to the technical
field of video processing and provides a video
processing method, device, computing device and
storage medium. The method includes: Obtain the video
to be processed containing multiple video frames,
calculate the original motion state of each video frame
according to the preset motion model, and smooth the
original motion state according to the preset smoothing
algorithm to obtain the ideal motion smoothness of each
video frame status. Obtain the maximum allowed FOV
value that does not exceed the boundary when each
video frame transitions from the corresponding original
motion state to the corresponding ideal motion smooth
state. Calculate the target FOV value of each video
frame based on the maximum allowed FOV value of
each video frame. Convert each video frame from the
corresponding original motion state to the target video
frame under the viewing angle field limit corresponding
to the target FOV value, so that the anti-shake processed
video is as close as possible to the ideal motion
smoothed video. At the same time, it maximizes the
viewing angle field of the processed video image and
improves the anti-shake effect of the video.



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1. A video processing method, characterized in that the method includes the following steps:
Obtain a video to be processed, where the video to be processed includes multiple video frames;
Calculate the original motion state of each video frame according to the preset motion model, and smooth the original motion state according to the preset smoothing algorithm to obtain the ideal motion smooth state of each video frame;
Obtain the maximum allowed FOV value that does not exceed the boundary when each video frame transitions from the corresponding original motion state to the corresponding ideal motion smooth state;
Calculate the target FOV value of each video frame according to the maximum allowed FOV value of each video frame;
Convert each video frame from the corresponding original motion state to a target video frame under the constraints of the viewing angle field corresponding to the target FOV value;
The steps of calculating the target FOV value of each video frame based on the maximum allowed FOV value of each video frame include: Construct a maximum allowed FOV value histogram based on the maximum allowed FOV value of a preset number of video frames, based on the FOV value of the current video frame and the distribution of the maximum allowed FOV value in the maximum allowed FOV value histogram, determine the increase or decrease amount of the FOV value of the next video frame, and obtain the target FOV value of the next video frame of the current video frame;
According to the time advancement of the video to be processed, the maximum allowed FOV value histogram is slidably updated, and the FOV value of each video frame is dynamically modified to obtain the target FOV value of each video frame.
2. The method according to claim 1, characterized in that, after the step of calculating the target FOV value of each video frame, each video frame is converted from the corresponding original motion state to the viewing angle field limit corresponding to the target FOV value. Before the step of target video frame, also include:
Use a time domain or frequency domain low-pass filter to smooth the target FOV value of each video frame to obtain the smoothed target FOV value.
3. The method of claim 1, wherein the step of obtaining the maximum allowed FOV value that does not exceed the boundary when each video frame transitions from the corresponding original motion state to the corresponding ideal motion smooth state includes:
Determine whether each video frame exceeds the boundary when transitioning from the corresponding original motion state to the corresponding ideal motion smooth state;
When the boundary is exceeded, the FOV value of the current video frame is reduced until the maximum allowed FOV value that does not exceed the boundary when the current video frame transitions from the corresponding original motion state to the corresponding ideal motion smooth state is obtained;
When the boundary is not exceeded, the FOV value of the current video frame is increased until the maximum allowed FOV value of the current video frame that does not exceed the boundary when transitioning from the corresponding original motion state to the corresponding ideal motion smooth state is obtained.
4. The method of claim 1, wherein a histogram of the maximum allowed FOV values is constructed based on the maximum allowed FOV values of a preset number of video frames. Determine the amount of increase or decrease in the FOV value of the next video frame based on the distribution of the FOV value of the current video frame and the maximum allowed FOV value in the histogram of the maximum allowed FOV value. The steps of obtaining the target FOV value of the next video frame of the current video frame include:
If the current video frame is the first frame of the video to be processed, determine whether the preset FOV value of the current video frame is less than the difference between the maximum allowed FOV value of the current video frame and the preset angle margin. If so, the preset FOV value is set as the target FOV value of the current video frame; otherwise, the difference between the maximum allowed FOV value of the current video frame and the preset angle margin is set as the target FOV value of the current video frame.
5. A video processing method, characterized in that the method includes the following steps: Obtain a video to be processed, where the video to be processed includes multiple video frames;
Calculate the original motion state of each video frame according to the preset motion model, and smooth the original motion state according to the preset smoothing algorithm to obtain the ideal motion smooth state of each video frame;

Obtain the maximum allowed FOV value that does not exceed the boundary when each video frame transitions from the corresponding original motion state to the corresponding ideal motion smooth state;
Calculate the target FOV value of each video frame according to the maximum allowed FOV value of each video frame;

Convert each video frame from the corresponding original motion state to a target video frame under the constraints of the viewing angle field corresponding to the target FOV value;

The steps of calculating the target FOV value of each video frame based on the maximum allowed FOV value of each video frame include:

Under the boundary condition $FOV_i < M\ FOV_i$, the global cost square is used to obtain the target FOV value of each video frame. FOV_i represents the FOV value corresponding to the i -th video frame of the video to be processed, and $M\ FOV_i$ represents the maximum allowed FOV value of the i -th video frame.

6. A video processing device, characterized by including:

A video acquisition unit, used to acquire a video to be processed, where the video to be processed includes multiple video frames;

A state smoothing unit, configured to calculate the original motion state of each video frame according to the preset motion model, and smooth the original motion state according to the preset smoothing algorithm to obtain the ideal motion smooth state of each video frame;

An allowed value acquisition unit configured to acquire the maximum allowed FOV value that does not exceed the boundary when each video frame transitions from the corresponding original motion state to the corresponding ideal motion smooth state;

A target value calculation unit configured to calculate the target FOV value of each video frame according to the maximum allowed FOV value of each video frame; and

A video conversion unit configured to convert each video frame from the corresponding original motion state to a target video frame under the viewing angle field restriction corresponding to the target FOV value;

When the target value calculation unit calculates the target FOV value of each video frame according to the maximum allowed FOV value of each video frame, it includes:

A histogram of the maximum allowed FOV values is constructed based on the maximum allowed FOV values of a preset number of video frames. Determine the amount of increase or decrease in the FOV value of the next video frame based on the distribution of the FOV value of the current video frame and the maximum allowed FOV value in the histogram of the maximum allowed FOV value. Obtain the target FOV value of the next video frame of the current video frame;

According to the time advancement of the video to be processed, the maximum allowed FOV value histogram is slidably updated, and the FOV value of each video frame is dynamically modified to obtain the target FOV value of each video frame.

7. The video processing device according to claim 6, further comprising:

The value smoothing unit, used to smooth the target FOV value of each video frame using a time domain or frequency domain low-pass filter to obtain the smoothed target FOV value.

8. A computing device, including a memory, a processor and a computer program stored in the memory and executable on the processor, characterized in that when the processor executes the computer program, the steps of the method according to any one of claims 1 to 5 are implemented.

9. A computer-readable storage medium stores a computer program, characterized in that when the computer program is executed by a processor, the steps of the method according to any one of claims 1 to 5 are implemented.

A video processing method, device, computing device and storage medium**Technical field**

[0001] The invention belongs to the technical field of video processing, and in particular relates to a video processing method, device, computing device and storage medium.

Background technique

[0002] In the video electronic image stabilization process, the existing technical solution is generally to first establish a motion model of the camera, and estimate the original motion state of the camera at different moments in the video based on the camera gyroscope (or visual characteristics) and the established motion model. Then according to the ideal motion smooth motion state obtained by the smoothing algorithm at different times, each frame of the video is converted from the image corresponding to the original motion state to the image corresponding to the ideal motion smooth state. However, for cameras with field of view (FOV) restrictions, it is necessary to obtain a boundary-limited motion state that allows the converted image to be successfully indexed in the original video image based on the original motion state, the ideal motion smoothing state, and the camera's FOV. Then the image is converted from the original motion state to the image of the camera's observation position in the boundary-limited motion state to achieve the purpose of electronic image stabilization.

[0003] In boundary-constrained electronic image stabilization, there are inherent flaws in using a fixed FOV for the output video:

[0004] a.If the output video uses a large fixed FOV, when the degree of movement is relatively intense, since the boundary of the output anti-shake video image is relatively close to the boundary of the original image, the boundary-limited motion state at each moment is different from the ideal smooth motion state. The deviation is too large, resulting in poor anti-shake effect;

[0005] b.If the output video adopts a small fixed FOV, when the motion is relatively gentle, the anti-shake smoothing margin is too large (that is, the output video can adopt a larger FOV, which can make the motion state with boundary restrictions and the ideal motion smooth. state is closer or identical), resulting in a waste of FOV. Therefore, in reality, a compromise size FOV is often selected. However, when the movement is particularly intense, the above-mentioned problem a will occur, making the anti-shake effect less than optimal. When the movement is particularly gentle, the above-mentioned problem b will occur, so that the FOV utilization rate at this moment is not reached to the maximum.

Summary of the invention

[0006] The purpose of the present invention is to provide a video processing method, device, computing device and storage medium, aiming to solve the problem of poor anti-shake effect due to the inability of the existing technology to provide an effective video anti-shake processing method.

[0007] On the one hand, the present invention provides a video processing method, which method includes the following steps:

[0008] Obtain a video to be processed, where the video to be processed includes multiple video frames;

[0009] Calculate the original motion state of each video frame according to the preset motion model, and smooth the original motion state according to the preset smoothing algorithm to obtain the ideal motion smooth state of each video frame;

[0010] Obtain the maximum allowed FOV value that does not exceed the boundary when each video frame transitions from the corresponding original motion state to the corresponding ideal motion smooth state;

[0011] Calculate the target FOV value of each video frame according to the maximum allowed FOV value of each video frame;

[0012] Convert each video frame from the corresponding original motion state to a target video frame under the constraints of the viewing angle field corresponding to the target FOV value.

[0013] On the other hand, the present invention provides a video processing device, including:

[0014] A video acquisition unit, used to acquire a video to be processed, where the video to be processed includes multiple video frames;

- [0015] A state smoothing unit, configured to calculate the original motion state of each video frame according to the preset motion model, and smooth the original motion state according to the preset smoothing algorithm to obtain the ideal motion smooth state of each video frame;
- [0016] An allowed value acquisition unit configured to acquire the maximum allowed FOV value that does not exceed the boundary when each video frame transitions from the corresponding original motion state to the corresponding ideal motion smooth state;
- [0017] A target value calculation unit configured to calculate the target FOV value of each video frame according to the maximum allowed FOV value of each video frame; and
- [0018] A video conversion unit configured to convert each video frame from the corresponding original motion state to a target video frame under the viewing angle field restriction corresponding to the target FOV value.
- [0019] On the other hand, the present invention also provides a computing device, including a memory, a processor, and a computer program stored in the memory and executable on the processor. The processor implements the steps of the method as described above when executing the computer program.
- [0020] On the other hand, the present invention also provides a computer-readable storage medium, which stores a computer program. The computer program, when executed by a processor, implements the steps of the method as described above.
- [0021] The present invention calculates the original motion state of each video frame in the video to be processed according to the preset motion model, and smoothes the original motion state according to the preset smoothing algorithm to obtain the ideal motion smooth state of each video frame. Obtain the maximum allowable FOV value that does not exceed the boundary when each video frame transitions from the corresponding original motion state to the corresponding ideal motion smooth state, and calculate the target FOV value of each video frame based on the maximum allowable FOV value of each video frame. Convert each video frame from the corresponding original motion state to the target video frame under the viewing angle field limit corresponding to the target FOV value, so that the anti-shake processed video is as close as possible or even identical to the ideal motion-smoothed video. At the same time, the field of view of the video image after anti-shake processing is maximized, improving the anti-shake effect and FOV utilization.

Description of the drawings

- [0022] Figure 1 is an implementation flow chart of the video processing method provided by Embodiment 1 of the present invention;
- [0023] Figure 2 is a schematic structural diagram of a video processing device provided in Embodiment 2 of the present invention;
- [0024] Figure 3 is a schematic structural diagram of a computing device provided in Embodiment 3 of the present invention.

Detailed description

[0025] In order to make the purpose, technical solutions and advantages of the present invention more clear, the present invention will be further described in detail below with reference to the accompanying drawings and embodiments. It should be understood that the specific embodiments described here are only used to explain the present invention and are not intended to limit the present invention.

[0026] [0026] The specific implementation of the present invention will be described in detail below in conjunction with specific embodiments:

Embodiment I:

[0028] Figure 1 shows the implementation flow of the video processing method provided by Embodiment 1 of the present invention. For ease of explanation, only the parts related to the embodiment of the present invention are shown. The details are as follows:

[0029] In step S101, a video to be processed is obtained, and the video to be processed includes multiple video frames;

[0030] The embodiments of the present invention are suitable for anti-shake processing of videos. Specifically, they can be applied to anti-shake processing of videos on computing devices (for example, servers, personal computers). The video to be processed is captured by a shooting device. The shooting device can be any device that can obtain digital images, including but not limited to SLR cameras, mirrorless cameras, mobile phones with photo and video functions, action cameras, panoramic cameras, etc. In addition, the video to be processed can also be a video processed by any video processing method, and the video to be processed

includes multiple video frames.

[0031] In step S102, the original motion state of each video frame is calculated according to the preset motion model, and the original motion state is smoothed according to the preset smoothing algorithm to obtain the ideal motion smooth state of each video frame;

[0032] In the embodiment of the present invention, the preset motion model can be an attitude angle estimation model, and the original motion state and the ideal motion smoothing state can be represented by attitude data. For example, in attitude quaternion, the ideal motion smooth state is the ideal motion smooth state obtained by smoothing the original motion state. For example, low-pass filters such as mean filter and Gaussian filter can be used to filter the original motion state data to obtain ideal motion smooth state data.

[0033] In step S103, obtain the maximum allowed FOV value that does not exceed the boundary when each video frame transitions from the corresponding original motion state to the corresponding ideal motion smooth state;

[0034] In this embodiment of the present invention, for the video frames in the video to be processed, whether the video frame is out of bounds when transitioning from the original motion state to the ideal motion smooth state with the preset FOV value can be determined based on its corresponding original motion state and the converted ideal motion smooth state. Then adjust the FOV value of the video frame when it transitions from the corresponding original motion state to the corresponding ideal motion smooth state according to the judgment result, to maximize the use of the FOV of the original video frame during conversion, while ensuring that the video frame does not exceed the boundary when converting from the original motion state to the ideal motion smooth state. Thus, while maximizing the smoothing of the original motion state and improving the video anti-shake effect, the FOV of the converted video frames is increased. When judging whether the video frame is out of bounds when transitioning from the original motion state to the ideal motion smooth state with the preset FOV value, specifically, the pixel coordinate value of the image boundary of the video frame in the ideal motion smooth state can be compared with the pixel coordinate value of the image in the original motion state, and whether it is out of bounds can be determined based on the comparison result.

[0035] In a preferred embodiment, when obtaining the maximum allowable FOV value of the boundary that does not exceed the boundary when each video frame of the video to be processed is converted from the corresponding original motion state to the corresponding ideal motion smooth state, determine whether each video frame exceeds the boundary when transitioning from the corresponding original motion state to the corresponding ideal motion smooth state. When the boundary is exceeded, the FOV value of the current video frame is reduced until the maximum allowed FOV value of the current video frame that does not exceed the boundary when transitioning from the corresponding original motion state to the corresponding ideal motion smooth state is obtained. When the boundary is not exceeded, the FOV value of the current video frame is increased until the maximum allowed FOV value of the current video frame that does not exceed the boundary when transitioning from the corresponding original motion state to the corresponding ideal motion smooth state is obtained. Thus, while maximizing the smoothing of the original motion state and improving the effect of video anti-shake processing, the FOV of the converted video frames is increased. As an example, the maximum allowed FOV value can be searched by binary method. Specifically, set the upper limit value max and lower limit value min of the video frame FOV value, when the current video frame exceeds the boundary when transitioning from the original motion state to the ideal motion smooth state with the preset FOV value, the value of the upper limit max is set to the FOV value of the current video frame (preset FOV value). Take $\text{mid} = (\text{max} + \text{min}) / 2$. If mid is taken as the FOV value to convert the current video frame from the original motion state to the ideal motion smooth state and still exceeds the boundary, then let $\text{max} = \text{mid}$, otherwise $\text{min} = \text{mid}$, and so on until the boundary mid value that does not exceed the boundary is obtained when the current video frame is converted from the original motion state to the ideal motion smooth state. The boundary mid value is the maximum allowed FOV value of the current video frame. When the current video frame does not exceed the boundary when it transitions from the original motion state to the ideal motion smooth state with the preset FOV value, the value of the lower limit min is set to the FOV value of the current video frame (preset FOV value). Take $\text{mid} = (\text{max} + \text{min}) / 2$. If mid is taken as the FOV value to convert the current video frame from the original motion state to the ideal motion smooth state without exceeding the boundary, then let $\text{min} = \text{mid}$, otherwise $\text{max} = \text{mid}$, and so on until the boundary mid value that exceeds the boundary when the current video frame is converted from the original motion state to the ideal motion smooth state is obtained. The boundary mid value is the maximum allowed FOV value of the current video frame.

[0036] In step S104, calculate the target FOV value of each video frame according to the maximum allowed FOV value of each video frame;

[0037] In the embodiment of the present invention, the target FOV value of each video frame is the expected FOV value when the video frame transitions from the corresponding original motion state to the corresponding ideal motion smooth state. The target FOV value of each video frame is less than the corresponding maximum allowed FOV value when the video frame is converted.

[0038] In one embodiment, when calculating the target FOV value of each video frame based on the maximum allowed FOV value of each video frame, a sliding window method is used to calculate the target FOV value of each video frame. Thus, the smoothness of adjacent video frames is maintained to the greatest extent when obtaining the corresponding target FOV value of each video frame. Preferably, when calculating the target FOV value of each video frame using a sliding window method, a maximum allowed FOV value histogram is constructed based on the maximum allowed FOV value of a preset number of video frames. Based on the FOV value of the current video frame and the distribution of the maximum allowed FOV value in the maximum allowed FOV value histogram, determine the increase or decrease of the FOV value of the next video frame, and obtain the target FOV value of the next video frame of the current video frame. According to the time advancement of the video frame of the video to be processed, the maximum allowed FOV value histogram is slidingly updated, and the maximum allowed FOV value of each video frame is dynamically modified to obtain the target FOV value of each video frame. Thus, the smoothness of adjacent video frames is maintained to the greatest extent when obtaining the target FOV value of each video frame. When using the sliding window method to calculate the target FOV value of each video frame, as an example, if the size of the sliding window is K, if the currently loaded K-frame video frame is frame 0 to K-1, then the FOV value of frame 1 is calculated through the FOV value of frame 0 and the maximum allowed FOV value of frame 0 to frame K-1. Then the window slides back one frame. At this time, the first frame becomes the current frame. The FOV of the second frame is calculated based on the FOV value of the first frame and the maximum allowed FOV value from the first frame to the Kth frame, and so on until the target FOV value of each video frame is obtained.

[0039] Specifically, after constructing the maximum allowed FOV value histogram based on the maximum allowed FOV value of a preset number of video frames. When determining the amount of increase or decrease in the FOV value of the next video frame based on the FOV value of the current video frame and the distribution of the maximum allowed FOV value in the maximum allowed FOV value histogram, if the current video frame is the first frame of the video to be processed, determine whether the preset FOV value of the current video frame is less than the difference between the maximum allowed FOV value of the current video frame and the preset angle margin.

If yes, the preset FOV value is set to the target FOV value of the current video frame. Otherwise, the difference between the maximum allowed FOV value of the current video frame and the preset angle margin is set as the target FOV value of the current video frame. This can more accurately determine the FOV value of the initial frame of the video to be processed, thereby improving the accuracy of the target FOV value of the subsequent video frame.

[0040] In another embodiment, when calculating the target FOV value of each video frame according to the maximum allowed FOV value of each video frame, under the boundary condition $FOV_i < M\ FOV_i$, the global cost square is used to obtain the target FOV value of each video frame, where FOV_i represents the FOV value of the i-th video frame of the video to be processed, and $M\ FOV_i$ represents the maximum allowed FOV value of the i-th video frame.

[0041] In step S105, convert each video frame from the corresponding original motion state to a target video frame under the constraints of the viewing angle field corresponding to the target FOV value.

[0042] In this embodiment of the present invention, after obtaining the target FOV value of each video frame, convert each video frame from the corresponding original motion state to the target video frame under the viewing angle field limit corresponding to the target FOV value to achieve anti-shake processing of the video to be processed. Thus, the video after anti-shake processing is as close as possible or even identical to the video after ideal motion smoothing, and at the same time, the viewing angle field of the processed video image is maximized, and the anti-shake processing effect of the video is improved.

[0043] Before converting each video frame from the corresponding original motion state to the target video frame under the constraints of the viewing field corresponding to the target FOV value, use a filter to smooth all target FOV values obtained through step S104 to obtain the smoothed target FOV value, so as to

achieve global smoothing of the target FOV values corresponding to all video frames in the video to be processed, and improve the anti-shake effect of the video to be processed. Preferably, a time domain or frequency domain low-pass filter is used to smooth all target FOV values obtained in step S104 to obtain a smoothed target FOV value, thereby achieving global smoothing of the target FOV values corresponding to all video frames in the video to be processed, and improving the anti-shake effect of the video to be processed.

[0044] The embodiment of the present invention calculates the original motion state of each video frame in the video to be processed according to the preset motion model, and smoothes the original motion state according to the preset smoothing algorithm to obtain the ideal motion smooth state of each video frame. Obtain the maximum allowable FOV value that does not exceed the boundary when each video frame transitions from the corresponding original motion state to the corresponding ideal motion smooth state, and calculate the target FOV value of each video frame based on the maximum allowable FOV value of each video frame. Convert each video frame from the corresponding original motion state to the target video frame under the viewing angle field limit corresponding to the target FOV value, so that the anti-shake processed video is as close as possible or even identical to the ideal motion-smoothed video. At the same time, it maximizes the viewing angle field of the processed video image and improves the anti-shake effect of the video.

[0045] Embodiment II:

[0046] Figure 2 shows the structure of a video processing device provided in Embodiment 2 of the present invention. For ease of explanation, only the parts related to the embodiment of the present invention are shown, including:

[0047] The video acquisition unit 21, used to acquire the video to be processed, where the video to be processed contains multiple video frames;

[0048] A state smoothing unit 22, configured to calculate the original motion state of each video frame according to the preset motion model, and smooth the original motion state according to the preset smoothing algorithm to obtain the ideal motion smooth state of each video frame;

[0049] An allowed value acquisition unit 23 configured to acquire the maximum allowed FOV value that does not exceed the boundary when each video frame transitions from the corresponding original motion state to the corresponding ideal motion smooth state;

[0050] A target value calculation unit 24 configured to calculate the target FOV value of each video frame according to the maximum allowed FOV value of each video frame; and

[0051] A video conversion unit 25 configured to convert each video frame from the corresponding original motion state to a target video frame under the viewing angle field restriction corresponding to the target FOV value.

[0052] Further, the video processing device also includes:

[0053] The value smoothing unit, used to smooth the target FOV value of each video frame using a time domain or frequency domain low-pass filter to obtain the smoothed target FOV value.

[0054] In the embodiment of the present invention, each unit of the video processing device can be implemented by a corresponding hardware or software unit. Each unit may be an independent software or hardware unit, or may be integrated into one software or hardware unit. This is not intended to limit the present invention. For the specific implementation of each unit, please refer to the description of Embodiment 1, which will not be described again here.

[0055] Embodiment III:

[0056] Figure 3 shows the structure of a computing device provided in Embodiment 3 of the present invention. For convenience of explanation, only the parts related to the embodiment of the present invention are shown.

[0057] The computing device 3 of the embodiment of the present invention includes a processor 30, a memory 31, and a computer program 32 stored in the memory 31 and executable on the processor 30. When the processor 30 executes the computer program 32, it implements the steps in the above method embodiment, such as steps S101 to S105 shown in Figure 1. Alternatively, when the processor 30 executes the computer program 32, it implements the functions of each unit in the above device embodiment, such as the functions of the units 21 to 25 shown in Figure 2.

[0058] The present invention calculates the original motion state of each video frame in the video to be processed according to the preset motion model, and smoothes the original motion state according to the preset smoothing algorithm to obtain the ideal motion smooth state of each video frame. Obtain the maximum allowable FOV value that does not exceed the boundary when each video frame transitions from the

corresponding original motion state to the corresponding ideal motion smooth state, and calculate the target FOV value of each video frame based on the maximum allowable FOV value of each video frame. Convert each video frame from the corresponding original motion state to the target video frame under the viewing angle field limit corresponding to the target FOV value, so that the anti-shake processed video is as close as possible or even identical to the ideal motion-smoothed video. At the same time, the field of view of the video image after anti-shake processing is maximized, improving the anti-shake effect and FOV utilization.

[0059] The computing device in the embodiment of the present invention may be a server or a personal computer or other device with specific computing capabilities. The steps implemented when the processor 30 in the computing device 3 executes the computer program 32 to implement the above method may refer to the description of the foregoing method embodiments, and will not be described again here.

[0060] Embodiment IV:

[0061] In an embodiment of the present invention, a computer-readable storage medium is provided. The computer-readable storage medium stores a computer program. When the computer program is executed by a processor, the steps in the above method embodiments are implemented. For example, steps S101 to S105 shown in Figure 1. Alternatively, when executed by the processor, the computer program implements the functions of each unit in the above device embodiment, such as the functions of units 21 to 25 shown in Figure 2.

[0062] Computer-readable storage media in embodiments of the present invention may include any entity or device or recording medium capable of carrying computer program code, such as ROM/RAM, magnetic disk, optical disk, flash memory and other memories.

[0063] The above are only preferred embodiments of the present invention and are not intended to limit the present invention. Any modifications, equivalent substitutions and improvements made within the spirit and principles of the present invention shall be included in the protection scope of the present invention.

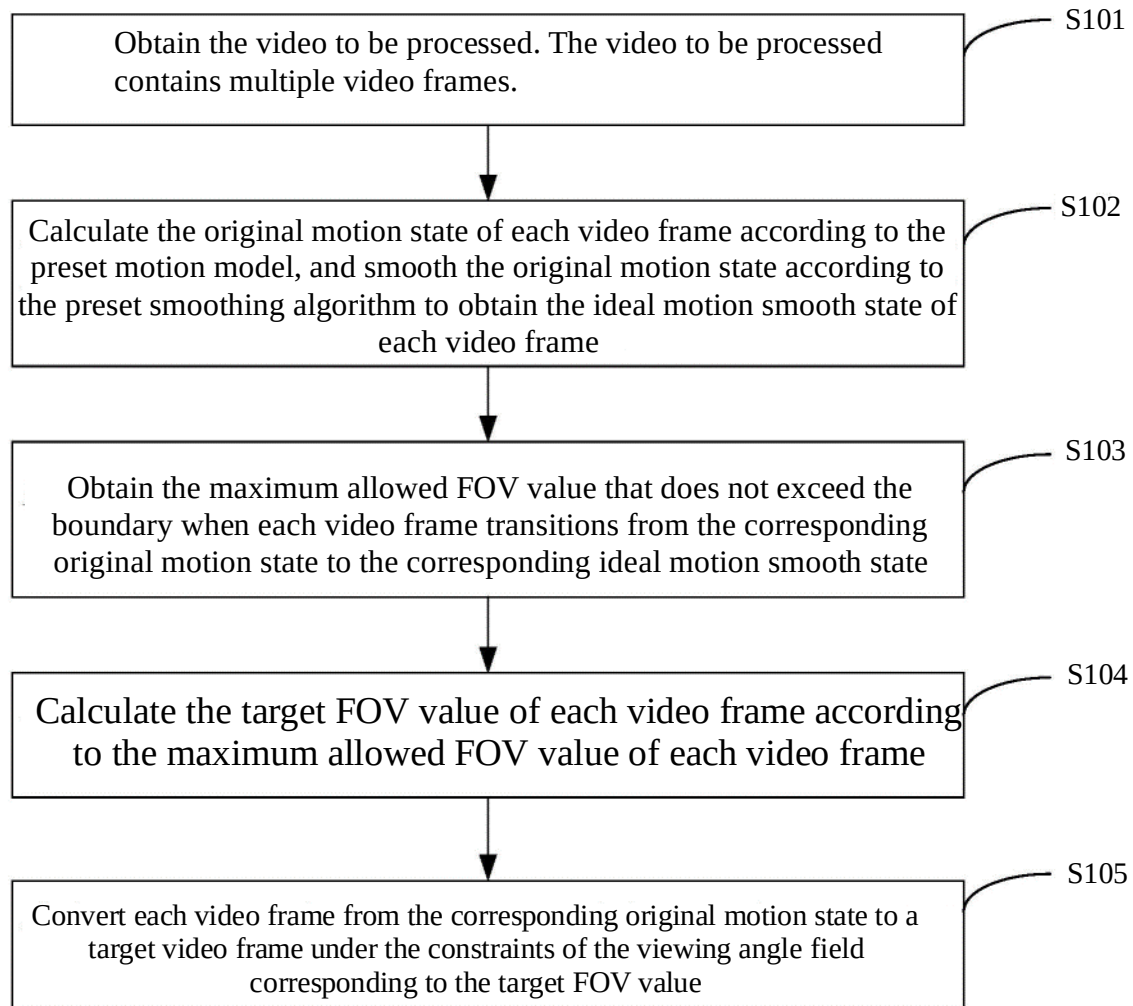


Figure 1

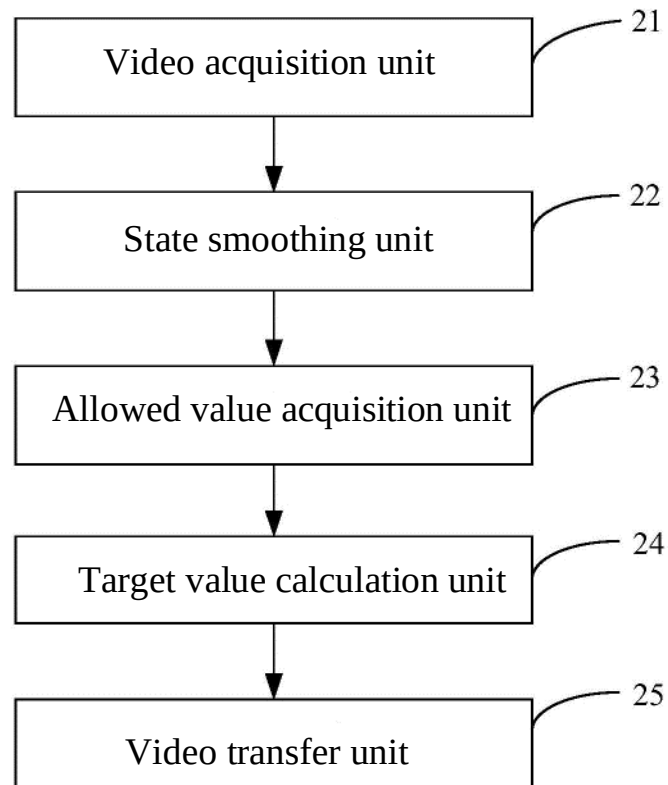


Figure 2

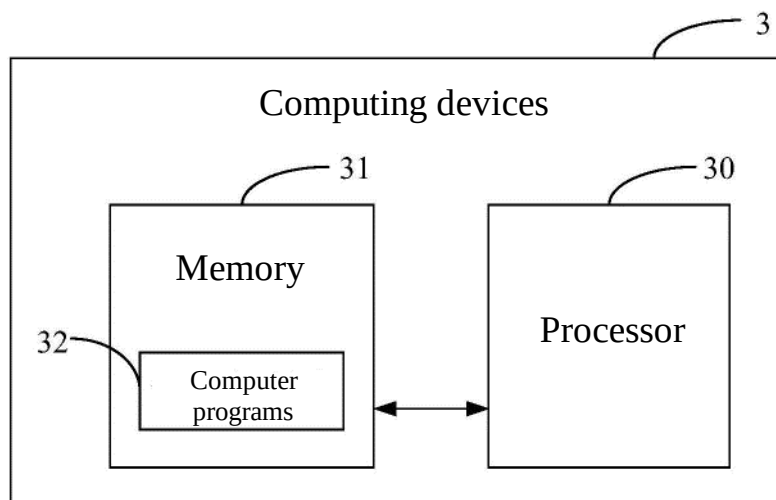


Figure 3

City of New York, State of New York, County of New York

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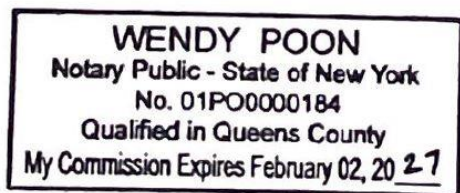


Jacqueline Yorke

Sworn to before me this
October 1, 2024



Signature, Notary Public

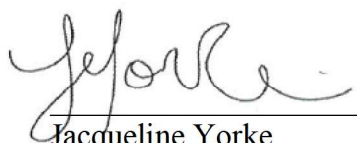


Stamp, Notary Public



City of New York, State of New York, County of New York

I, Jacqueline Yorke, hereby declare that all statements made herein of my own knowledge are true and that all statements made on the information and belief are believed to be true; I declare under penalty of perjury that the foregoing is true and correct, and understand that willful false statements and the like are punishable by fine or imprisonment, or both pursuant to 18 U.S.C. 1001.



Jacqueline Yorke
Date: October 16, 2024