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KEY FRAME EXTRACTION OF LIVE VIDEO BASED ON OPTIMIZED FRAME DIFFERENCE USING CORTEX-A8

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ABSTRACT

In this paper, Key Frame Extraction of Live Video Based on Optimized Frame Difference Using Cortex- A8 system is designed, in which the embedded chip and the programming techniques are adopted. The central station which adopts Cortex-A8 chip as controller is the core of the whole system.Key frame extraction is a basic technology of live video retrieval and abstract establishing. Efficient key frame extraction technology can promote the development of widely used video browsing technology. In this paper, we first reviewed some commonly used key frame extraction techniques, and then proposed a key frame extraction technology based on optimized frame difference, which measures the similarity of two adjacent frames contents in terms of the information of frame difference, and extracts key frames after optimizing the frame difference using OpenCV software that was implemented on the CORTEX-A8 board. The experiment results are processed, compressed and sent to the monitor client by wireless network.

Keywords—key frame extraction; inter-frame difference; live video; OpenCV

I. INTRODUCTION

As the rapid development and wide application of computer and internet multimedia communication technology, the sharing of multimedia images, audios and videos data has become increasingly popular. Among all online and live data streams, video information is the most complicated. It is a critical problem to be solved that how to retrieve and manage live video streams effectively. Key frame (representative frame) is used to describe the key image of a video shot; it reflects the main content of a video shot. It is more effective to be used as video streams indexes than the original video streams. The extraction of key frames, on the one hand, the size of extracted key frames should be as small as possible, and the extraction algorithm should have low computation complexity in order to manage conventionally, thus the use of key frames reduces the amount of video data indexing.As the extraction of key frames has played such an important role in content based video streams' analysis, retrieval and inquiry that it attracts attention of an increasing number of researchers and achieves some research results.

II.THE REVIEW OF CLASSIC KEY FRAME

EXTRACTION METHOD

Commonly, some conservative methods are used to extract key frames such as preferring to extract more key frames to obtain important information of video streams. When extracting many key frames, the irrelevance between two adjacent frames is considered as the principle of key frame extraction.

1. VIDEO SHOT BASED METHOD

In the video shot based method, some classic methods include frame average method and histogram average method. The frame average method is to extract the average value in a specific location from the video shot, then select the frame whose pixel value mostly close to the average value as key frame, histogram average method is to compute the average value of the histogram of all frames in the video shot, then select the frame mostly close to the average histogram as key frame. According to above methods, Zhang et al.[1] proposed to make use of colour histogram to extract key frames. Yeung et al.[2] extracted key frames by means of computing the maximum distance of the feature space. These methods have the advantage of low computation complexity and easy computation, and extracted frames have average representative meaning. However, in these methods, the complexity of content in the current video shot is not considered and the number of key frames is limited as a fixed value and the content in the video shot with many changes cannot be completely described.

2. CONTENT ANALYSIS BASED METHOD

This method is to extract key frames based on the change of colour, texture and other visual information of each frame [3][4][5][6], when this information changes significantly, the current frame is key frame. The basic idea is that the first frame is selected as the new frame, and is viewed as reference frame, then the back frames are compared with the reference frame in order, the k-th frame do not become the new key frame until the distance between the k-th and (k-1)-th frame exceed a specific threshold. The frame difference (distance) between I f and j f is defined as the formula (1):

$$D(f_i, f_j) = \sum | f_i(x,y) - f_j(x,y) | \qquad (1)$$

This method can select corresponding key frames according to the change degree of content in the video shot. But its disadvantage is that it is not sensitive to the movement of video camera and cannot quantitatively indicate the changes of movement information, thus which will cause unstable key frame extraction.

3. MOTION-BASED ANALYSIS METHOD

Wolf [7] calculated the movement of a shot by analysing the optional flow, and selects the local minimum in the movement as key frames. The movement of a shot is defined as formula (2):

$$M(k) = \Sigma\Sigma | O_x(i, j, k) | + | O_y(i, j, k) | \quad (2)$$

Where $O_x(I,j,k)$ x is the intra-pixel(I,j) X component of optical flow, and $O_y(I,j,k)$ y is the intra pixel(I,j) Y-component of optical flow.

Wolf's motion –based method can select the appropriate number of key frames in the basis of the shot structure. The disadvantage is that the algorithm did not have strong robustness because it was depended on local information, and it did not pay enough attention to the content changes brought by the cumulative dynamic either.

4. CLUSTER-BASED METHOD

It can be a good response to the main shot content when the cluster analysis method was applied to the key frame extraction. Algorithm idea is as follows: first initialize a cluster centre, and then determine the current frame is classified as this class or as a new class of cluster centres by calculating the distance between the current frame and the centre, and finally including all the frames which is nearest from the cluster centres as key frames. Hanjalic and Zhang[8] adopted cluster splitting algorithm with cluster efficiency analysis; the frame that is most closely to cluster centre is selected as key frame. joshi et al.[9] applied the fuzzy cluster method to a short video sequence with only gradient video shot, for each video shot, the frames in the centre will be selected as key frames. It is difficult for cluster algorithm to obtain general cluster parameters.

II. KEY FRAME EXTRACTION BASED ON OPTIMIZED FRAME DIFFERENCE

1. PROPOSED SYSTEM:

The proposed system is implemented on embedded device using Cortex-A8 board using OpenCV tool where the captured video is processed, from which key frames are extracted based on histogram difference algorithm. The existing algorithms are well processed under Mat lab whereas here the application is designed on board so that as per speed is concerned the histogram difference algorithm is developed for board purpose for extracting key frames and finally the receiver on connecting to the server observes those extracted key frames and do necessary actions.

1.1 HARDWARE DESIGN

The hardware system includes processor, video-capture devices, and router to receive key frame information through Wi-Fi. In this paper SAMSUNG S5PV210 CORTEX-A8 [10] processor is chosen to complete the core control; Logitech CMOS camera is used as a video-capture device; and the user's phone or PC connected to the wireless Internet to receive live Key frames. As shown in Figure 1, block diagram of the hardware design.

1.1.1. SAMSUNG S5PV210 PROCESSOR

The mini210 development board is a powerful cortex-A8 board offering a comprehensive solution integrating both hardware and software. It is designed, developed and distributed by friendly ARM. It uses Samsung's S5PV210 microprocessor whose maximum frequency is up to 1GHz. The S5PV210 integrates the powerVR SGX540 graphic engine, supports 3D and can drive video playing on screens up to 1080P. The Mini210 inherits all the features and benefits of our popular Mini2440 and Mini6410 excelling in quality and easy to use with low cost. It is equipped with a 5" LCD,512M DDR2, 1G SLC NAND flash, SD Wi-Fi, D type WM8960 audio which supports 8Ω 1W speakers. In addition it has a miniHDMI output, USB2.0 camera and 8x8 matrix key boards. It also supports power idle mode. These features make it easily and widely used in MID development, Android notepads, auto electronic devices, industrial applications, GPS systems and multimedia systems. It is very easy and convenient for users to refresh the system with various OS via a TF card with our specially developed super boot.

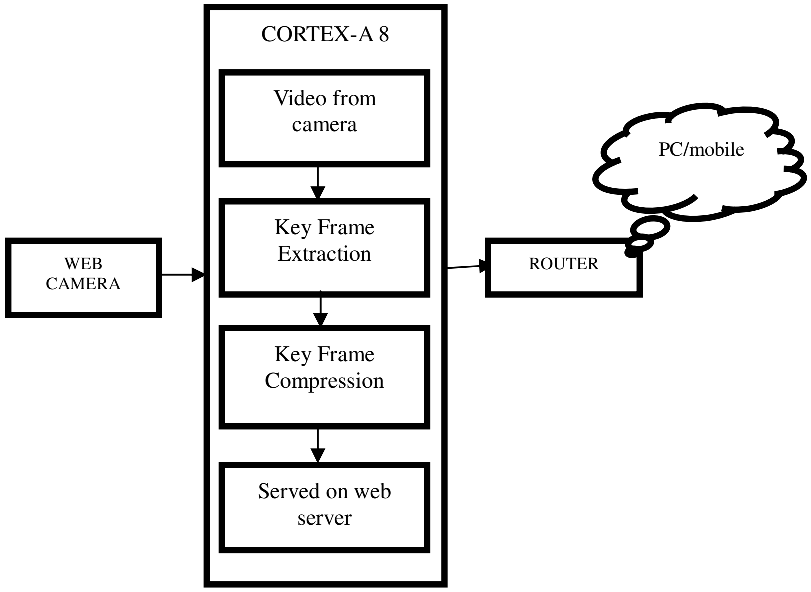

Figure 1. Block diagram of the hardware design

1.1.2. WEB CAMERA

Logic tech camera with 1.3 million pixels is selected in the built system. Particularly in poor light, the speed of CMOS camera is slower, but its price very low, and CMOS has power consumption only when the circuit is connected, it is generally used low-end cameras, digital cameras and toys. There is a 20P plug with 2mm pitch in ARM used as extension to connect the camera. These web cameras continuously monitor the room and send the video.

1.1.3 ROUTER

Router is a device that forwards the data packets between computer networks. Router is connected to S5PV210 CORTEX-A8 board through Ethernet cable. Using Wi-Fi we can stream the live Key frames through mobile or PC.

1.2. SOFTWARE DESIGN

The system selected Linux operating system [11] as software platform; the code for the application is developed in C language and run using OpenCV libraries. The main functions are capturing the video, processing the video, Key frame extraction from the live video. Flow chart of key frame extraction is shown in figure 2.

Steps:

I. Collect the frames from input video
II. Convert frame color from RGB to HSV
III. Compute histogram for each channel (H-H, S-S, V-V)
IV. Normalize the histogram.
V. Compare histogram difference using chi-square method

$$d(H_1, H_2) = \sum_I \frac{(H_1(I) - H_2(I))^2}{H_1(I)}$$

VI. If histogram difference is greater than threshold value, then save it as a key frame otherwise discard that image.

1.2.1. BUILDING AND CROSS COMPILING OF OPENCV

OpenCV [12] is a collection of software algorithms put together in a library that to be used by industry and academics for computer vision applications and research, Using this libraries we design applications. To build OpenCV we need to install some libraries, Using below command we can install those libraries sudo

Apt-get install libjpeg-dev libjasper-dev libtiff4-dev libpng12-dev libpango1.0-dev libcairo2-dev libgdk-pixbuf2.0-dev libgtk2.0-dev cmake cmake-gui

After installing those libraries Download OpenCV source and configure the OPENCV using below commands:

cmake-gui make make install

Cross-Compile OpenCV and its libraries, to run on boards.

OpenCV cross compiling steps:

1. Set up the compiler tool chain.
2. Build v4l-utils
3. Configure OpenCV
4. Build and install OpenCV

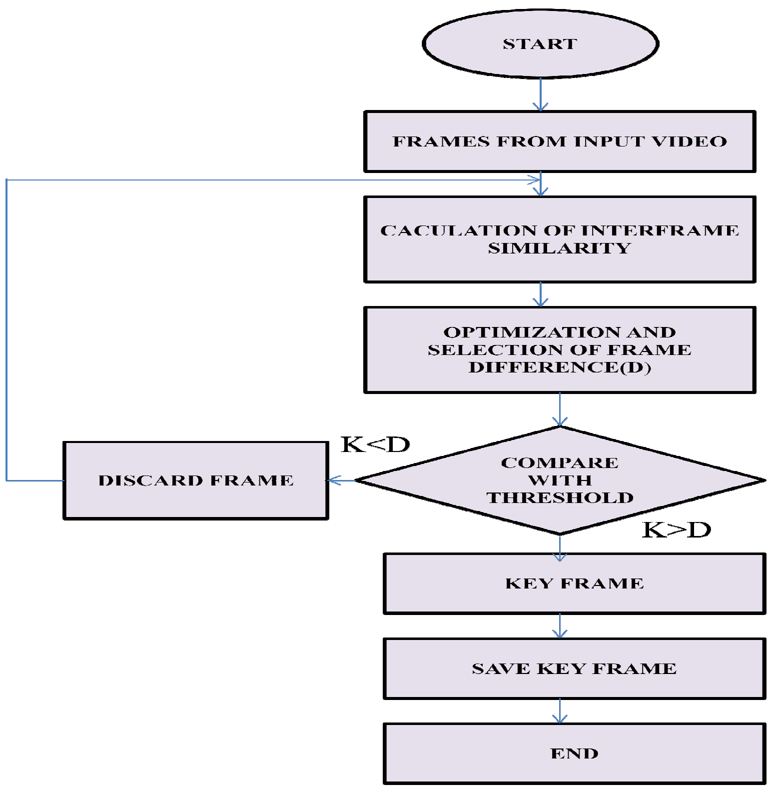

Figure 2: Flow chart of key frame extraction

III. EXPERIMENTAL SETUP AND OBTAINED RESULT

At first the parameters related to the video sequences are considered as listed in table 1 then based on that for an amount of time interval the obtained key frames from above mentioned steps are noted based on the appropriate threshold as listed in table 2.

S. No	Parameters	specifications
1.	Video length (assumption)	60 sec
2.	Frame rate	25Fps
3.	Resolution	352x288=101376
4.	Number of Frames	60x25=1500
5.	Bit rate(compressed)	60x512kbps=30720kbps=30.720Mbps

Table 1: experimental setup

S.N0	Threshold (k)	Actual Key Frames	Detected Key Frames	Transmission bandwidth (Mbps)
1.	K=1	10	19	19x512kbps=9.7
2.	K=5	10	15	15x512kbps=7.6
3.	K=10	10	10	10x512kbps=5.1
4.	K=15	10	7	7x512kbps=3.58

Table 2: Result Analysis

Here the key frames are changing according to threshold value, for higher threshold we will get less key frames and vice-versa, so based on application we can make a relevant threshold so that we can save the transmission bandwidth accordingly.

1. KEY FRAME RESULTS

The below shown figure 3 represents the key frames which are extracted from live video using CORTEX-A8 board and served on web server, by using IP address we can browse that key frames hyperlinks, by clicking on the hyperlink we will get the key frame that is shown in figure 4 and figure 5 shows the final output key frames stored in SD card.

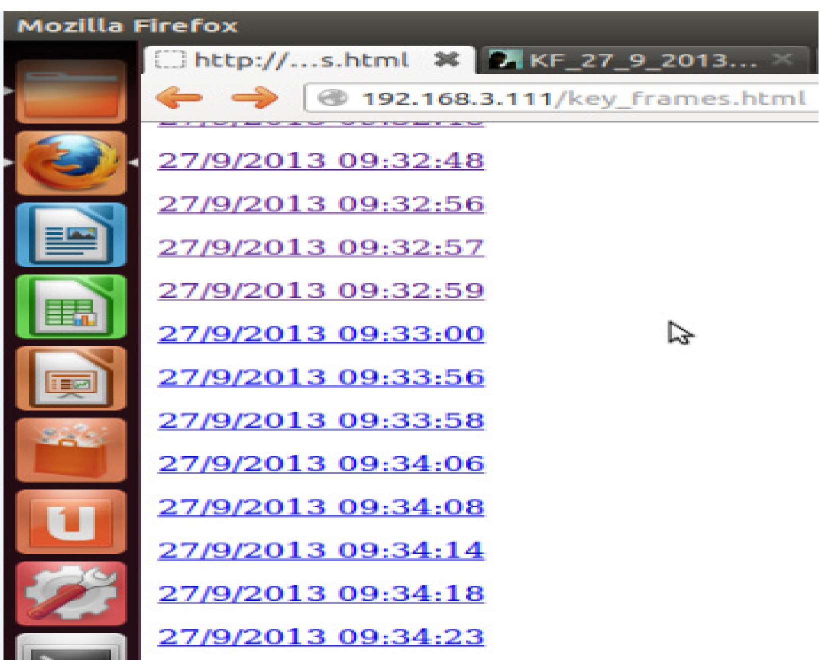

Figure 3. Output of Key Frames

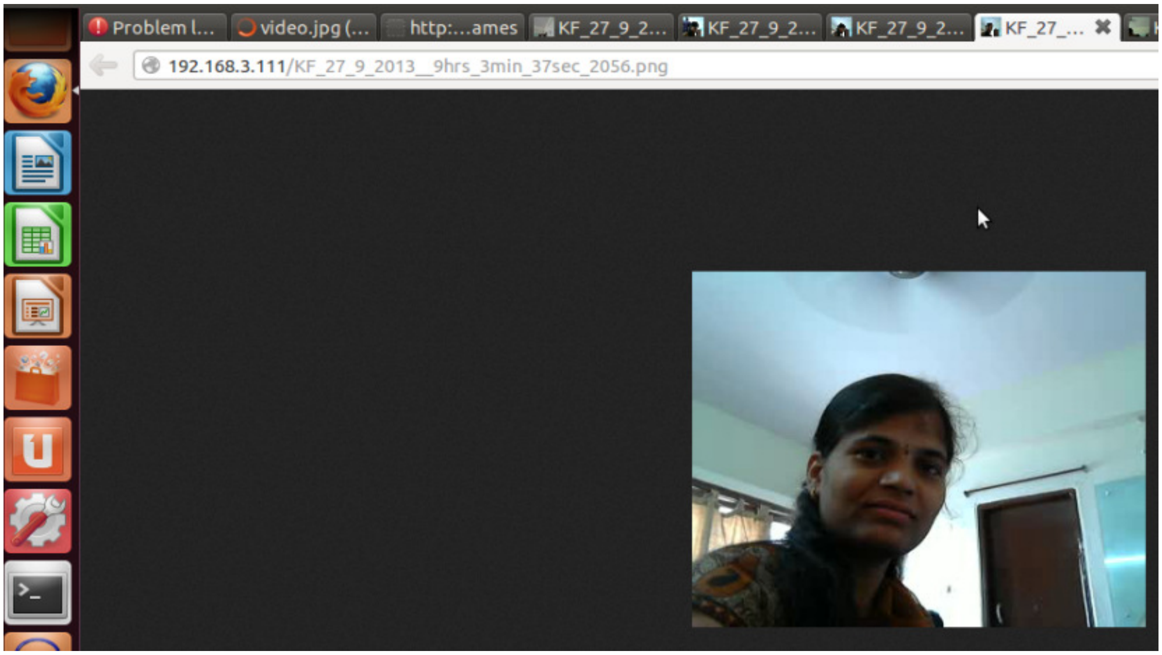

Figure 4: key frame related to hyper link 27/9/2013 09: 34:37

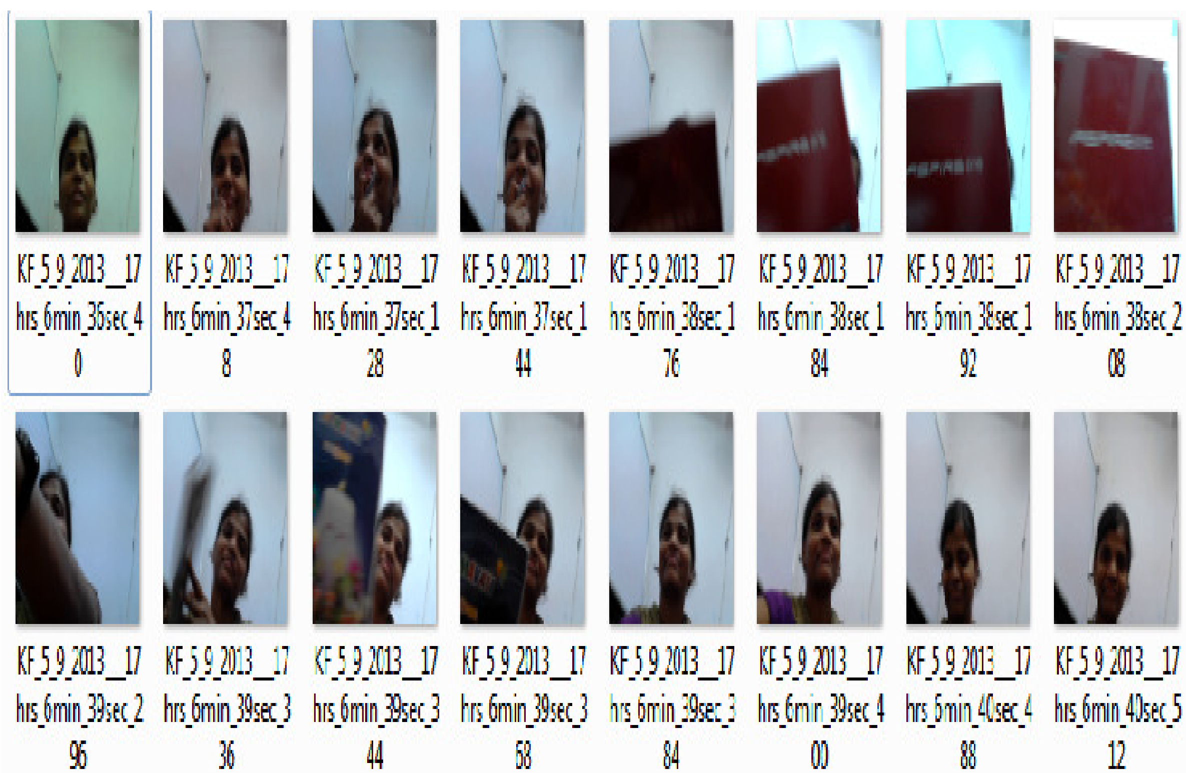

Figure 5: Final output key frames

IV. CONCLUSION

In this paper Key Frame Extraction of Live Video Based on Optimized Frame Difference Using Cortex-A8 system is tested successfully.The proposed key frame extraction algorithm is mainly used to describe the contents of the entire process of a shot. However, the key frames of a particular event are often taken into account. The experimental result shows that the key information of live video are extracted efficiently resulting in saving transmission bandwidth.

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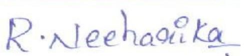

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