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Real Time Motion and Color Detection

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Abstract

When using HD video cameras in stores a large storage space is needed. The required storage space can be decreased using motion and a color detection algorithm that makes the camera records only when a motion or a lighting change occur. So, in this work a real time motion and color detection is presented based on the difference of two successive frames of images after dividing the image into blocks, different block sizes are tested (2×2, 4×4 , and 8×8).YCbCr color system is used for each case with different thresholds for Cb, Cr, and Y. Good results for the motion detection can be obtained using Cb, and Cr other than Y, since the coloring components of an image are exist in Cr, and Cb, which are important for motion detection. Additionally the components that produce or reflect bright light can be obtained from Y. Consequently the result of lightening change detection at different illumination conditions is better using Y more than Cb, and Cr. This means that the best result for both motion, and lighting change detection is obtained by combining the chrominance (Cb, Cr) and luminance (Y) components of a video. The data used in this work are collected in an indoor environment using a laptop webcam under different illumination conditions.

Introduction

Extracting moving objects from videos can be used in many applications like, people detection and identification [1,2] , target tracking [3,4],fire and flame detection [5], and many other applications.

In many applications, it is necessary to separate between motion and lighting changes, which mean that only motion information must be obtained without the effect of the lightening change[1].

In this work a real time motion and color detection algorithm is presented to solve the problem of using full HD (high definitions) security video cameras in stores. The algorithm used must be sensitive to lightning changes caused by (opening a door, or turning on alight), in addition to detecting motions, so once a motion detection or a lightening change occur, the recording process of the camera will start, otherwise the camera will not record anything,

Some researchers used only motion detection[1] , others combine motion and color detection [3,5], while other researchers used motion, color, and shape detection based on the suggested application [4]. This work, adopt a combination of motion and color detection, aiming to detect motion and lightening changes in stores.

Many motion detection algorithms has been proposed for different applications using two main algorithms, the first one is based on extracting a moving object by the difference of two successive frames[2,3,6]. The second algorithm adopt subtracting the static background from the current frame[7,8,9]. These methods work well for videos with static cameras [10]. While when videos have camera motions like [11], the background model is hard to be built, and therefore it is easier to use the difference of two successive frames.

The classification step is performed using different methods, like thresholding techniques, [12], and Bayesian framework[13], which are often used. Additionally the pixel-level and region-level labeling is used when a segmentation is used based on a motion[14].

In this work, the algorithm of extracting a moving object from the difference of two successive frames is proposed with a static camera in an indoor environment. The background technique is not robust, because when the position of the camera is changed the system must be reprogrammed for the new background, while for the used algorithm this process is done automatically. This algorithm is tested under different illumination conditions to detect lightening changes in addition to detecting motions. The thresholding technique with different thresholds for each color is tested for the classification part of the work.

The Proposed Algorithm

The proposed algorithm can be described by the block diagram shown in figure (1), this diagram is for Y component, the same diagram is used for Cb, and Cr .

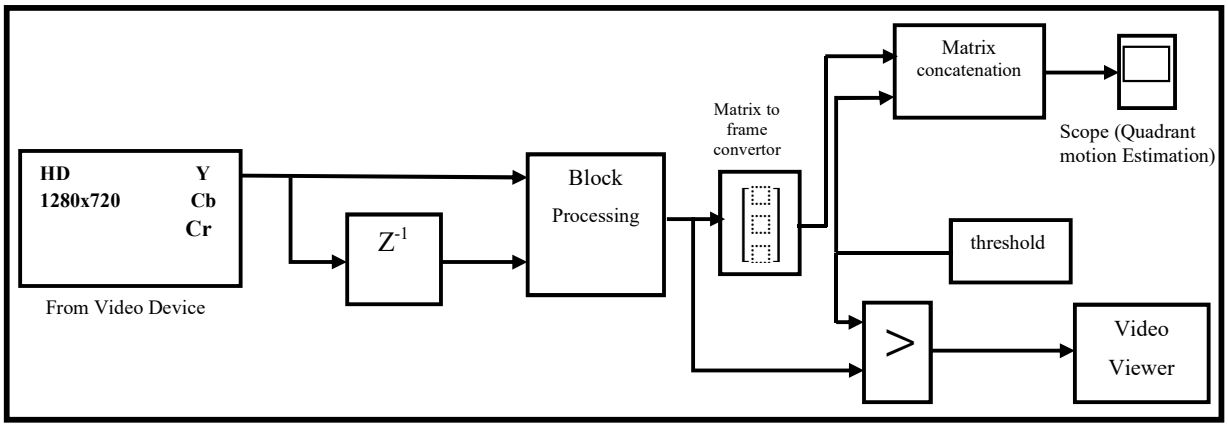

Figure 1: The block diagram of the proposed algorithm

The algorithm starts by capturing the live video from a webcam that provides a sequence of video frames in a specific speed (30 frames per second) , in two different resolutions (176×144), and full HD resolution (1280×720) .Then the current frame is compared with the previous one to detect motion (conducted in the block processing unit of the block diagram). The block processing unit extracts sub matrices of a specific size from each input frame to check the presence of any motion the live video. The block sizes that are tested in this work are (2×2, 4×4, and 8×8).

In order to decide whether or not a motion is present, the difference of two successive frames from the output of the block processing is compared with a specific threshold, if the difference is bellow this threshold, the two successive frames are considered the same, so no motion detection is obtained, and vice versa. The video viewer shows the video display of the detected motion lines for a specific color format (Y Cb Cr). In this work different threshold are tested for each color components. If motion is being detected, it is required to store such motion in order to be watch by the user later. This is also very important for the user to have a legal proof of robbery .

The matrix to frame convertor unit is responsible of converting the output matrices to a vector to facilitate the combination with the threshold by the matrix concatenation unit. The plot of the image color bars with the estimated threshold, is the result of the combining process that is displayed by the scope block.

The YCbCr color space is used in this work, this format is widely used for digital videos. In this format, luminance information is stored as a single component (Y), and chrominance information is stored as two color-difference components (Cb and Cr). Cb represents the difference between the blue component and a reference value. Cr represents the difference between the red component and a reference value, YCbCr color space components are related to the RGB color space components by equations 1,2, and 3. [15,2]

$$Y = 0.299\ R + 0.587G + 0.114B \quad \text{.....(1)}$$

$$Cb = m + 0.168736\ R + 0.331264\ G + 0.5B \quad \text{.....(2)}$$

$$Cr = m + 0.5\ R + 0.418688\ G + 0.081312\ B \quad \text{.....(3)}$$

Where m is a matrix with all pixel values as 128.

If Y component is dismissed, and only Cb, and Cr components are used, then the model becomes independent of the differences in lightening conditions, and the color space dimensions are reduced, since only two color components Cb and Cr are used for the classification process hence the computational load decreases. This model is very active for motion detection extracting the effect of lightening change. If Y component is taken into account, then detection due to lightening change can be obtained. In this work YCbCr are used in order to obtain detection of moving objects in addition to lightening change due to opening the door of the store to be protected, or turning on a light by some body.

Result and Discussion

The proposed algorithm is applied on different videos; the first video belongs to a person who is moving his head slightly to the left and right. The resolution is (176×144), and the algorithm is tested for different block sizes, using Y,Cr, and Cb color components separately. Figure (2) presents samples of the original video as well as the motion line images:

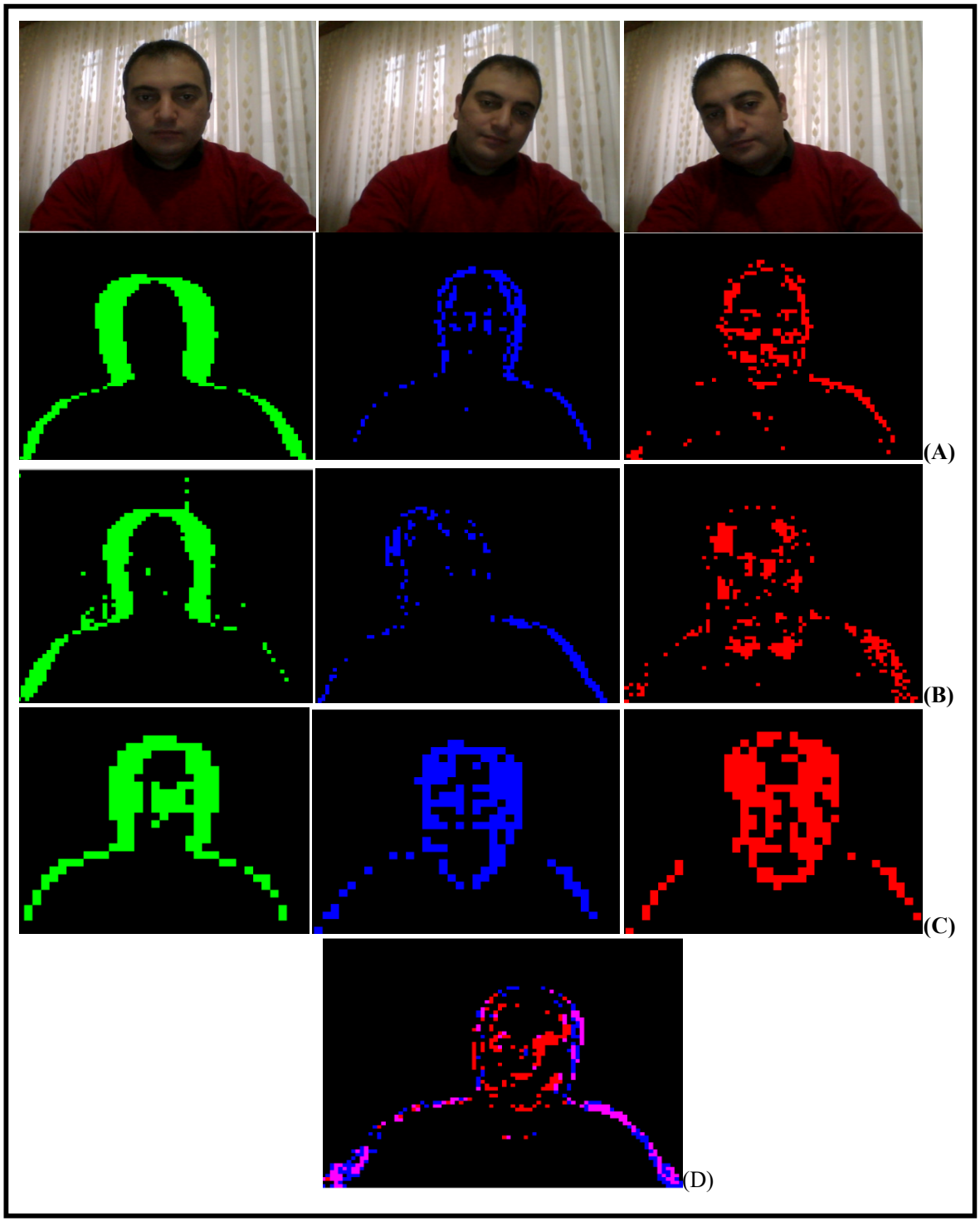

Figure 2: The results using resolution of (176×144), and (A):2×2 block size with Y,Cb, and Cr (from left to right). (B): 4×4 block size with Y,Cb, and Cr. (C): 8×8 block size with Y,Cb, and Cr. (D): 2×2 block size after coming Cr and Cb color components.

The use of (2×2) block size is much more sensitive in motion detection than the use of (4×4), and (8×8) for it provides more accurate representation of the video. The illumination condition in this video is constant.

Combining Cr, and Cb, looks more effective in motion detection. Is clear form figure (2) A, that the detection of motion lines is not as desired using Y color components even for 2×2 block size. However the use of 8×8 block size was not convincing for all colors(Y, Cb, and Cr) whether individually or a combination of them.

When using HD resolution (1280×720) , the result of motion detection is more accurate, especially when combining Cr, and Cb color components (the details of the face, and the motion lines are detected clearly), figure(3) D. While in the case of using Y the shadows are detected effectively, for example (both sides of nose), figure(3) C. By combining YCrCb the motion lines in addition to the brightness, shadows are detected clearly figure (3) E.

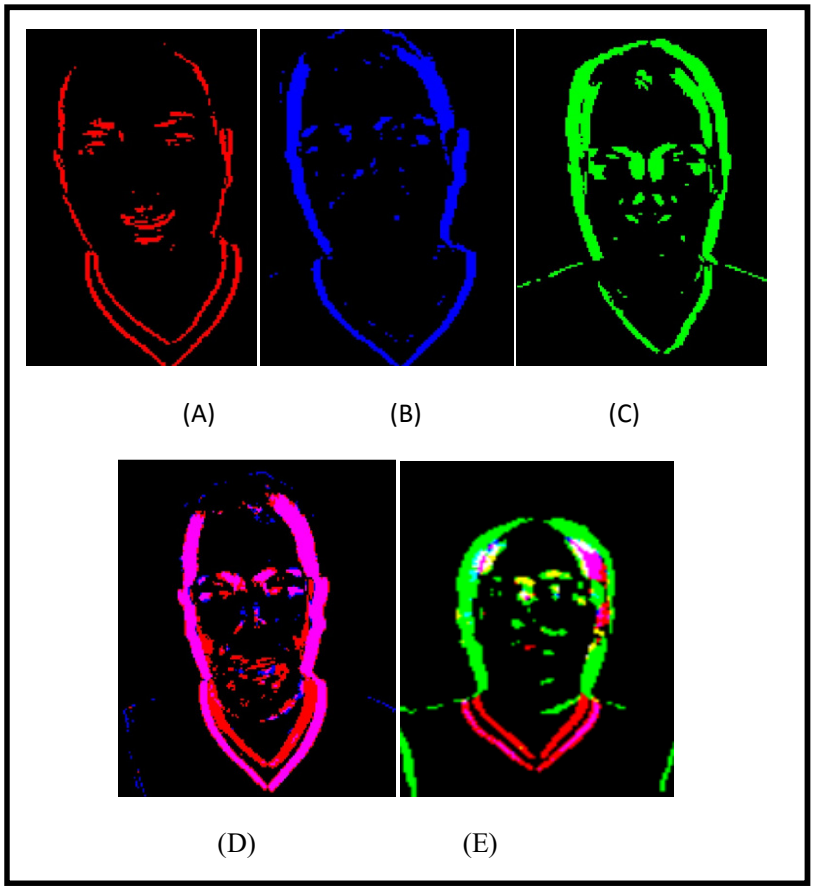

Figure 3: The results using resolution of (1280×720), 4×4 block size, and (A) Using Cr. (B) Using Cb. (C) Using Y. (D) Coming Cr and Cb color components to obtain the best motion detection result . (E) Combining Y, Cr, and Cb.

The processing speed of the proposed algorithm for real time is high, and the response of the system to any motion is immediate when using 4×4, and 8×8 block sizes even with HD resolution. While for 2×2 block size the detection process needs portions of second only .

The algorithm is applied with resolution of (176×144) on another video of a man interring a semi dark store-like place, moving around, and stopping. Different color components are used for different block sizes as shown in figure (4):

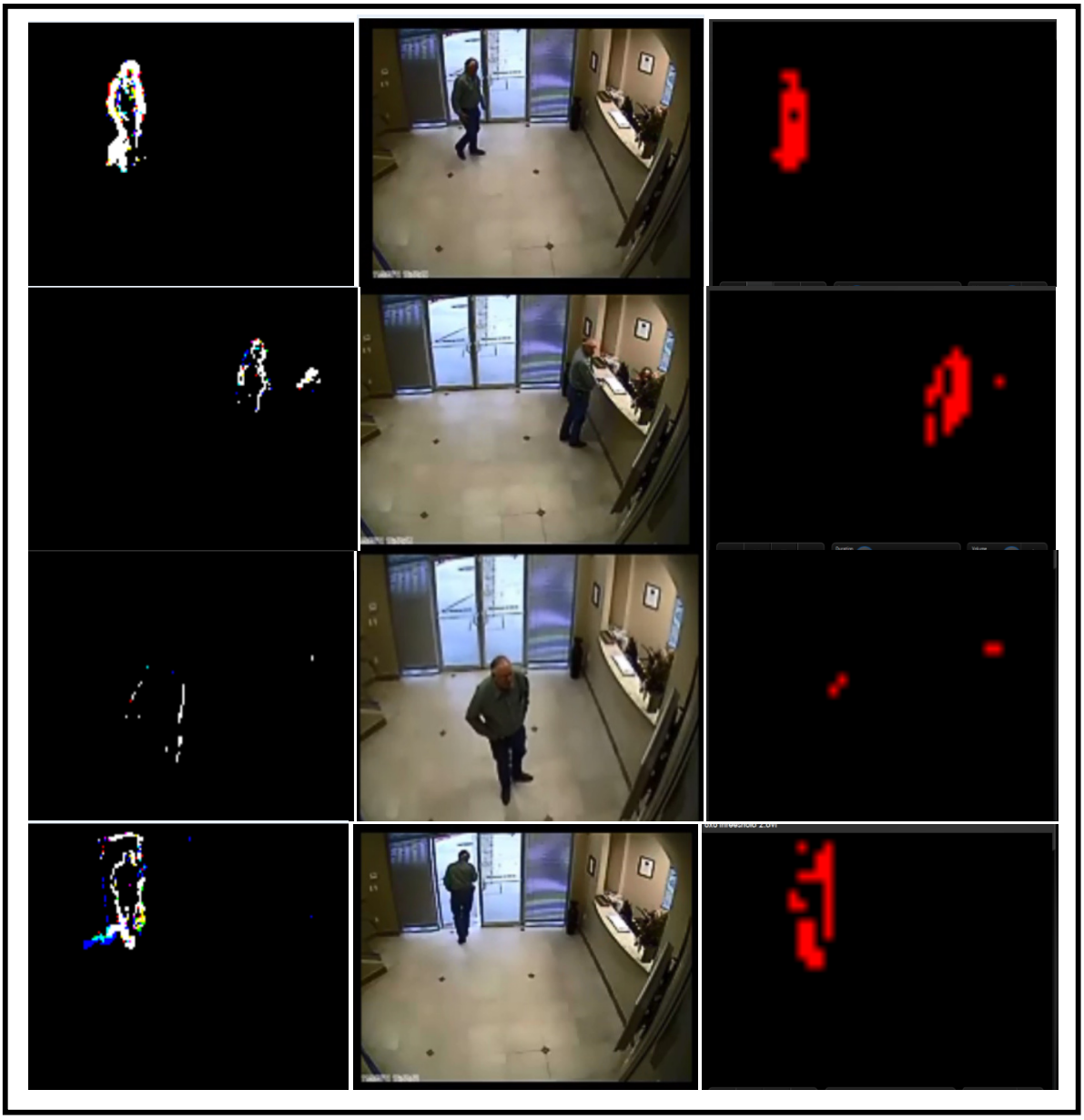

Figure 4: From left to right: The result of 2 ×2 bloke size after combing all the color components, the real video , and the result of 4×4 block size using only Cr color component.

Again the motion line image using 2×2 block size detects motion more effectively, and also when the man opened the door the difference of illumination conditions was also detected by combing all the color components (Y, Cb, and Cr).

The algorithm is applied on another video that contains different illumination conditions: Dark, fully light, and semi light. The output images using 2×2 bloke size, using all the color components including Y using resolution of (176×144) are shown in figure(5).

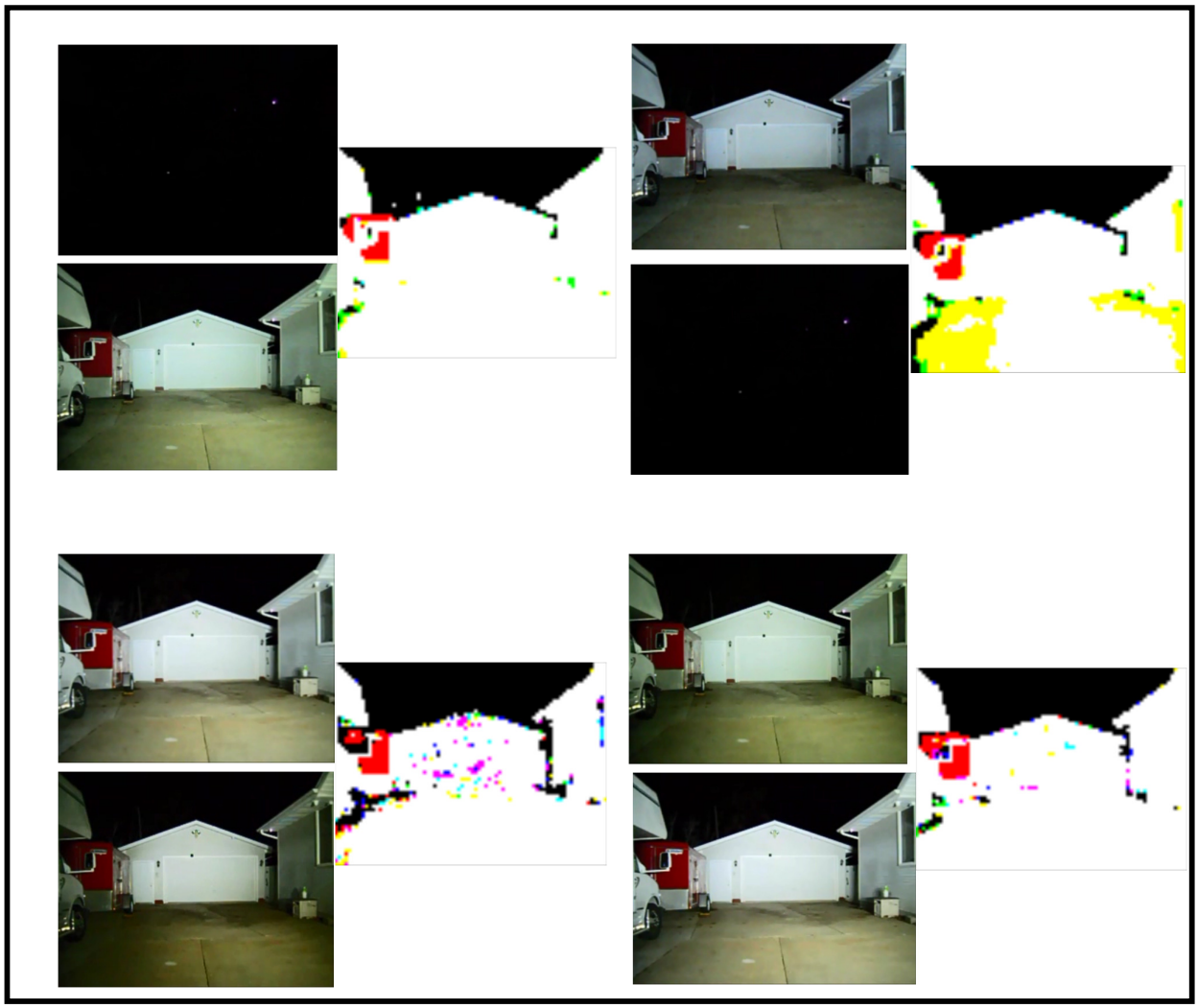

Figure 5: The results at different illumination conditions using 2×2 block size after combing all the color components.

Different thresholds are used for each color components. Figures (6,7, and 8) show the thresholds combined with the color bars when applying the algorithm on the video described in figure (2), the block size is 2×2 , for Cr,Cb, and Y component respectively. For motion detection Cr and Cb are of prime importance other than Y, for they represent color components as shown in figures (6,7).While figure (8) shows the brightness and light reflecting information of the video that can be obtained from Y components, which is very important for detecting lightening changes. The more convinced results are obtained with a threshold of 0.12 for Cr, and Cb components, and 0.5 for Y components as shown in figures (5,6,7) respectively.

The color components (Y, Cr, and Cb) of the video described in figure (5), that represents different illumination conditions are shown in figure (9), the threshold value is 0.5 for Y, Cb, and Cr components. The

high amplitude coefficients indicate the transition from one-illumination conditions to another; the higher is the amplitude the wider is the illumination difference.

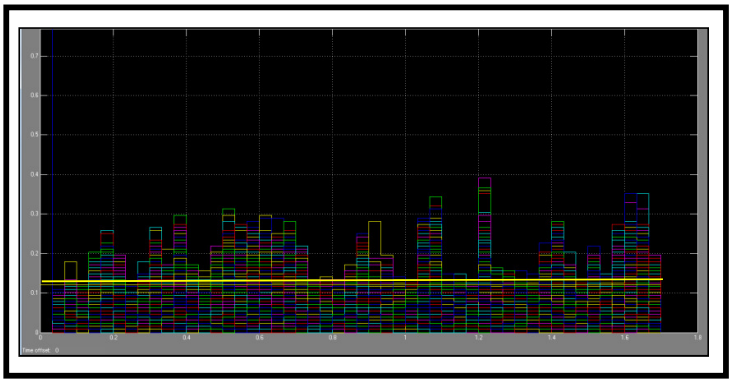

Figure 6:The Cr color components with threshold of 0.12.

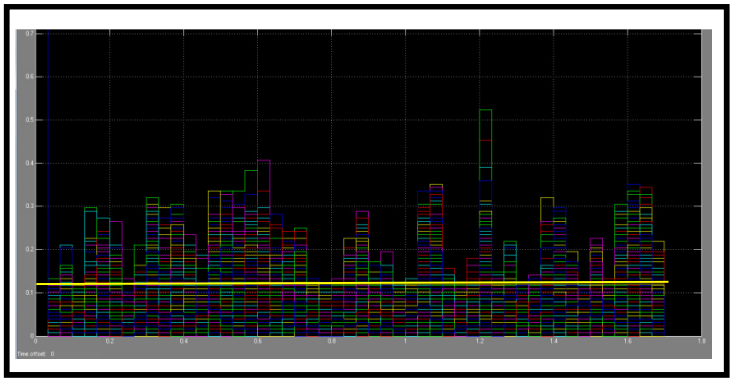

Figure 7:The Cb color components with threshold of 0.12.

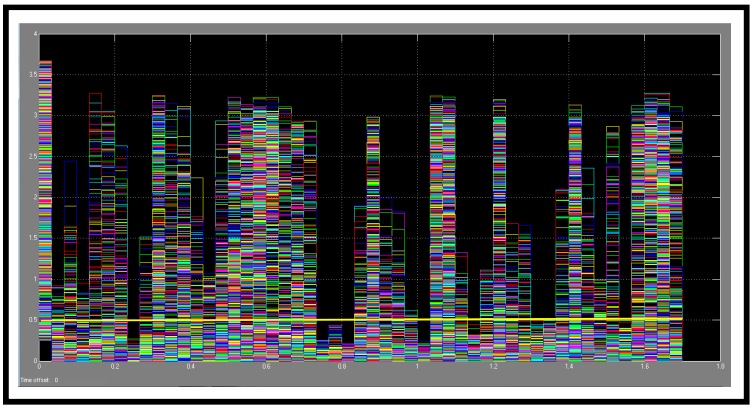

Figure 8:The Y color components with threshold of 0.5.

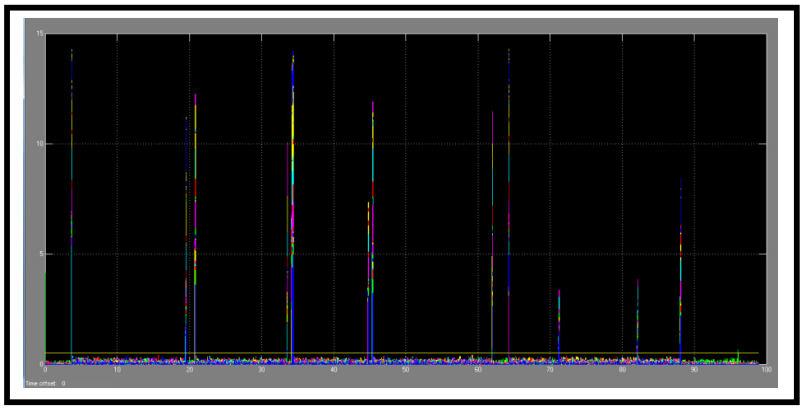

Figure 9:The(Y, Cr, and Cb) color components at different illumination conditions with threshold of 0.5 for all color components.

Conclusions.

The proposed algorithm was active for motion detection using Cr, and Cb color components, more than the use of Y, since the coloring components of an image are concentrated in Cb, and Cr, while the components that produce or reflect bright light is obtained from Y, which is an indication of lightening change more than motion existence. It is concluded that the more effective motion, and lightening change detection is obtained when combing Cr, Cb, and Y, as a consequent of having information about brightness in Y and coloring in Cr, and Cb. So the proposed motion and color detection algorithm is active for lightening changes, in spite of slightly illumination condition changes.

In choosing the block sizes; 2×2 block size records better motion line images than 4×4, and 8×8 block sizes, since the resolution of images is better. However the processing delay time increases slightly when using a 2×2 block size, that is because the data size from the images will be larger.

The resolution of the used camera is of prime importance, the detection results using HD resolution of (1280×720) is much more better than lower resolution (176×144), and the processing time for real time is high (immediate) even for HD resolution .

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