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A Study of Motion Detection Method for Smart Home System

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Abstract---Motion detection surveillance technology give ease for time-consuming reviewing process that a normal video surveillance system offers. By using motion detection, it save the monitoring time and cost. It has gained a lot of interests over the past few years. In this paper, a proposed motion detection surveillance system, through the study and evaluation of currently available different methods. The proposed system is efficient and convenient for both office and home uses as a smart home security system technology.

Keyword---Smart home system, Motion detection, Background Model, 2D correlation coefficient, GM filter

I. INTRODUCTION

In motion detection, there is process of detecting a change in various objects relative to its surroundings or change in surrounding relative to an object. There are many methods to obtain a motion detection using mechanical and electronic techniques. e.g. Infrared (Passive and active sensors), Optics (video and camera systems), Radio Frequency Energy (radar, microwave and tomographic motion detection), Sound (microphones and acoustic sensors), Vibration (triboelectric, seismic, and inertia-switch sensors), Magnetism (magnetic sensors and magnetometers).

The main focus of this paper is using this system as a part of smart home security system. Here, interested to build CCTV camera with their own feedback system which sense the motion by them self to alert using alarm. This system also use in such area where the suspicious motions are occurs. Like at night in bank, in museum, in jail. The region of interest in this case refers to portion of the environment with activity due to the motions of moving objects. The system captures images only when the motions exceed a certain threshold that is preset in the system. It thus reduces the volume of data that needs to be reviewed and is therefore a more convenient way of monitoring the environment, especially with the increasing demand for multi-camera. Also, it helps to save data space by not capturing static images which usually do not contain the object of interest. As part of the literature review in Section 2, we evaluated four popular motion detection surveillance products that are currently available in the market in terms of format and their features which are based on the features that are required of a surveillance system and the additional features that are required for the purpose of motion detection. Also in the literature review, the existing methods for motion detection are discussed. They include some of the popular methods, such as temporal difference [1][2] and background modeling [1][2][3][4], as well as methods that are not so widely used due to certain constraints, e.g. optical flow [5][6] and spatio-temporal entropy [7]. The proposed method for motion detection is determined in Section 2. Conclusion and future scope is described in section 3

TABLE I
COMMON FEATURES

GENERAL SETTINGS	Video Settings	• Auto start • Video compression • Frames/second • Alteration of frame size
	Audio settings	• Audio compression
	Camera settings	• Multi-camera
MONITOR SETTINGS	General	• Motion sensitivity • Delayed start • Highlight motion regions • scheduler
	Alert system	• FTP alert • Email alert • Sound alert • Program alert • SMS alert
SECURITY		• Password protection • Stealth mode
BROADCASTING		• Stream to internal web server • Remote access by different computers using the same software • HTTP server • HTML page generator • FTP upload
CUSTOMIZATION		• Language selection • Editing options

II. MOTION DETECTION

There are mainly two classes categorized for motion detection, i.e. pixel-based motion detection and region-based motion based algorithm. The pixel-based motion detection is based on binary difference by employing local model of intensity used in real time applications.the latter is based on the spatial dependencies of neighbouring pixel colours to provide result is more robust to false alarm. The region based motion detection algorithm include special point detection, block matching algorithm etc.

A. Temporal difference

In this technique, its compare consecutive frames on a pixel by pixel basis in a motion sequence where a threshold is applied which decide them as either stationary or motion. So if the motion is occur it only changes in boundaries area or pixels also it does not show relationship of neighboring pixel, making it more prone to false signaling [8]. This technique mostly used in biophysics especially in mind image study.

B. Background modeling

Background modeling method can be done by pixel based or region based. In background modeling, background image or main reference image is substrate by the given next image and if motion is occur in next image, it is detected. Gaussian distribution is used for this method which computes by comparing each pixel of background with foreground. Median measurement at each pixel can also be use. There are two popular methods for region based background modeling, the Eigen-space decomposition method, and the three tiered algorithm which process image at the pixel, region and frame level [8].

C. Optical Flow

It is 2-D velocity field stimulated in an image due to the projection of moving objects onto the image plane. Each shows the velocity of each pixel in the image. And assume that uniform illumination is present. Some approaches towards computing optical flow include gradient technique [6] which relates optical flow to spatial and temporal image derivatives, and the token matching or correlation method which matches windows surrounding a pixel from frame to frame, with the best match determining the displacement of the pixel from one frame to another [8]. However, only small movements can be accurately detected in the gradient technique due to the Taylor's approximation of the gradient constraint equation. As for the correlation method, matching in the presence of rotation is computationally expensive and window will be distorted if motion is not constant[8].

D. Spatio-Temporal Entropy

It works on the assumption that pixels' state change brought about by noises would be in a small range while those brought about by motion would be large[8]. Accumulating window is used to show relationship between pixels. Thus the diversity of state at each pixel is used to characterize the intensity of motion at its position. Using multiple frames' information this method avoids error accumulation. It is less computationally complex. However, nearly all motion detection methods work on the assumption of stationary capturing devices and objects are moving against a fixed background. It is impossible to predict all types of noises, thus accuracy of detection is most of the times being compromised. Though masking of such areas is available in most motion detection software, it will prevent objects of interest from being detected[8].

III. PROPOSED MOTION DETECTION METHOD

The architecture of our method is shown in Fig. 1 As described in the the figure, the detection procedure contains a web-cam, processing module taking charge of extracting the regions of moving area and a audio device module to alarm alert. The detection procedure is described as follows

A. GM filter

There are many smoothing filter used for remove the noise in image. Generally there are seven basic filter are mainly used which are convolution filter, Gaussian filter, first derivative GF, second derivative GF etc. Here we used a Gaussian filter, Gaussian filter removes high frequency components from the image. In 2D GM filter can derive as,

$$G(x, y) = e^{-\frac{x^2+y^2}{2\sigma^2}}$$

Where, G is the operand, x and y are two axes value, and σ constant variable, larger the value of σ removes more details. In our application more detail is not essential. Using these filter we remove noise and more data, which also save the storage space.

B. 2D Correlation Coefficient Method

This method used for check the similarity between two images. This method works pixel based comparison. The value of coefficient is between [0 1]. If the coefficient value is 0 its show both images are different in each pixel value at same location. If the coefficient value is 1 its show both images are same in each pixel value at same location. The formula used for the 2D correlation coefficient is shown below,

$$r = \frac{\sum_m \sum_n (A_{mn} - \bar{A})(B_{mn} - \bar{B})}{\sqrt{(\sum_m \sum_n (A_{mn} - \bar{A})^2)(\sum_m \sum_n (B_{mn} - \bar{B})^2)}}$$

Here, Compute the correlation coefficient between A and B, where A and B are matrices or vectors of the same size. Where $\bar{A}$= mean2(A), and $\bar{B}$ = mean2(B). A and B can be numeric or logical. The return value, r, is a scalar.

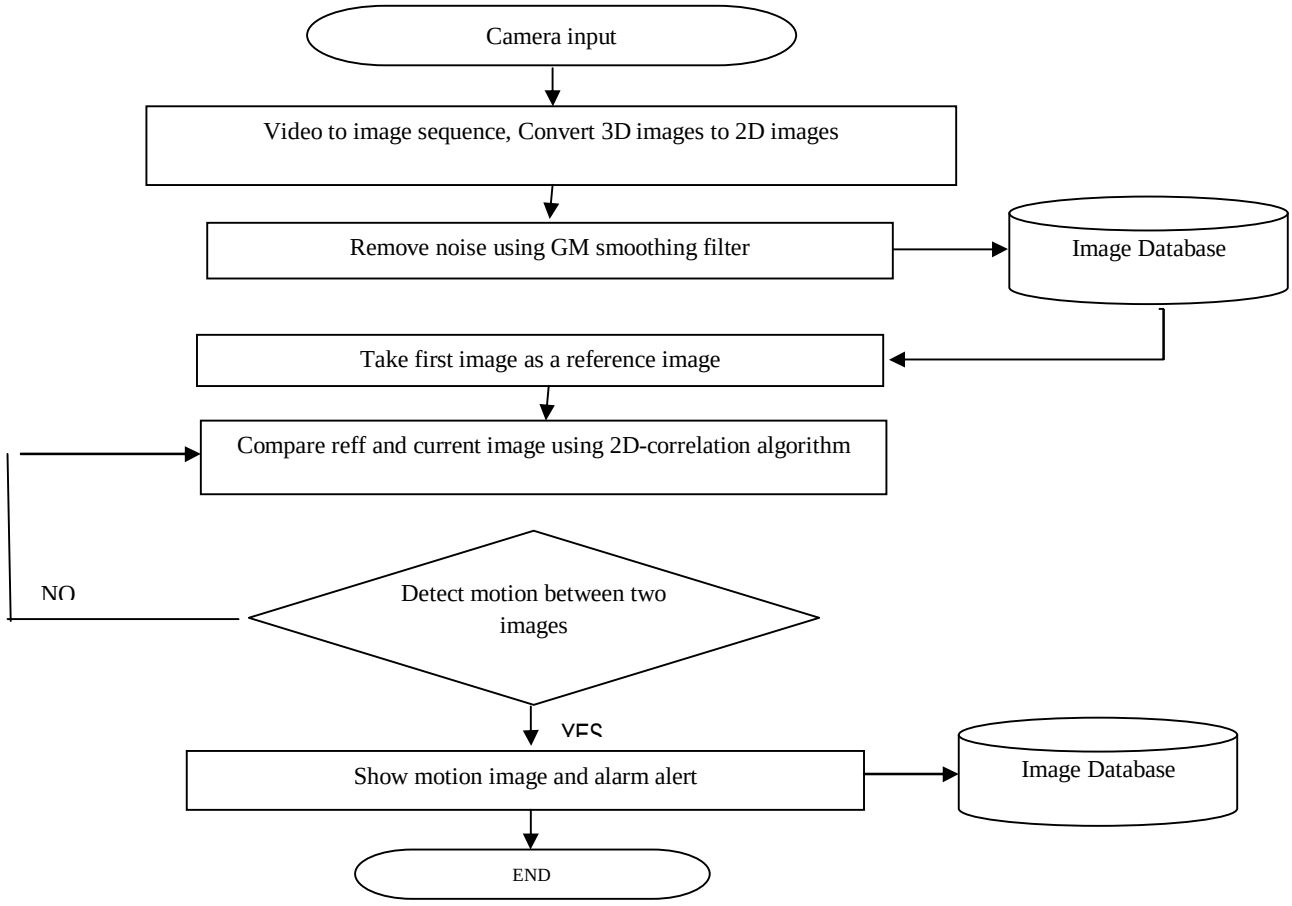

Fig.1 Proposed method for motion detection

Here we show result of our proposed method, the correlation coefficient between fig (a) and fig(b) is 0.91.

Fig. (a) - Reference image Fig.(b) - Random image from video Fig.(c) Background model

In this technique used simple 2D correlation coefficient, which gives faster result compare to other motion tracking algorithm, we can compare 100 frames within a 10-12 second. Using different scenario like waving tree, lightswitch on-off, different time of day, we have to set different coefficient ratio for getting 97% accuracy.By using this technique, it may be give false alert, but its not skip the right indication of motion. Comparing this technique to other, this is less time consuming process.

IV. CONCLUSIONS

Efficient and convenient motion detection surveillance is proposed in this work. The system captures images only when the motions exceed a certain threshold that is preset in the system. It thus reduces the volume of data that needs to be reviewed and is therefore a more convenient way of monitoring the environment, especially with the increasing demand for multi-camera. Also, it helps to save data space by not capturing static images which usually do not contain the object of interest. It is applicable for both office and home uses. After successfully implementing the project, it can be apply for the motion detection for smart home security system which would be very much helpful in auto theft detection for security purpose. It can also be useful in bank, museum and street at mid-night. As a future work we can improve the alert system, instead of alarm we can use SMS alert, email alert with the moving object. There is less(3%) chances to skip any detection. There is may be some false detection due to the illumination effects, which can be overcome for the better performance.

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