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Real Time Motion Detection Using Background Subtraction Method and Frame Difference

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Abstract: ***In today's competitive generation, the security concerns have grown rapidly. The latest technology used for security concerns is motion detection system. Motion detection is broadly used in many computer vision tasks like pose estimation, human tracking and face recognition. It is a basic part for many computer vision tasks. By using this technologies, it is possible to monitor and capture every motion by inch and second of the area of interest. As motion detection system is real time and it is implemented widely, system is used to detect any motion in a real time video and once motion has been detected in the real time, the warning system will activate by means of an alarm and capture the real time video. The methods employed to detect the motion are background subtraction method and frame difference method. The purposed method makes background image using 4 previous consecutive frames. This method detects the motion via a standard webcam in real-time YUY2_640x480 resolution.Experimental results showed that the proposed method is more robust in nature as it can avoid the noise in motion detection due to camera flicker and useful to reduce the number of false positive alarms.***

Keywords: Background subtraction method, frame difference, motion detection, consecutive frames, threshold comparison method.

1. Introduction

Motion detection means it's a process of detecting a change in position of an object relative to its surroundings or the change in the surroundings relative to an object. Motion detection can be achieved by both mechanical and electronic methods. When motion detection is accomplished by natural organisms, it is called motion perception. The main task of a motion detection system is to detect an "area of motion" present in an "area of environment being monitored". The area of motion here refers to the portion of the environment being monitored with activity due to the motions of moving objects. Motion detection is usually a software-based monitoring algorithm which, when it detects motions will indicate the surveillance camera to begin capturing the event or simply shows the motion detection using graphical method.

In video surveillance, motion detection relate to the capability of the surveillance system to detect motion and to capture the events. Motion detection is also called activity detection. An advanced method of motion detection surveillance system can examine the type of motion to see if it justifies an alarm.

A simple algorithm for motion detection by a fixed camera compares the current image with a reference image and simply counts the number of different pixels. Since images will naturally differ due to factors such as varying lighting, camera flicker, and CCD dark currents, pre-processing is useful to reduce the number of false positive alarms method has real-time detection speed and high detection accuracy, but needs long training time.

2. Objective

Optical motion detection [11] method uses infrared light or laser technology for motion detection. Devices, such as PIR motion detectors, have a sensor that detects a disturbance in the infrared spectrum, such as a person or an animal. Once detected, an electronic signal can activate an alarm or a camera that can capture an image or video of the motioner.

Background motion detection method is a simple method for motion detection by a fixed camera compares the current image with a reference image or background image pixel by pixel and simply counts the number of pixels with change more than the threshold value and thus motion is detected. Consecutive frame subtraction method simply compares the current image with previous image to find the change in value of pixels above threshold to detect the motion.

3. Motion Detector

A motion detector [12] is a device that detects moving objects, particularly people. A motion detector is often integrated as a component of a system that automatically performs a task or alerts a user of motion in an area. Motion detectors form a vital component of security, automated lighting control, home control, energy efficiency, and other useful systems. An electronic motion detector contains a motion sensor that transforms the detection of motion into an electric signal. This can be achieved by measuring optical changes in the field of view. Most inexpensive motion detectors can detect up to 15 feet (5 meters). Specialized systems are more expensive but have much longer ranges. Tomographic motion detection systems can cover much larger areas because the signals penetrate walls and obstructions.

A motion detector may be connected to a burglar alarm that is used to alert the home owner or security service after it detects motion. Such a detector may also trigger a red light camera. Motion detectors have found great application in domestic and commercial applications. Some of these applications include motion-activated outdoor lighting systems, motion sensor street lamps and motion sensor lanterns.

Figure 1: A motion detector attached to an outdoor, automatic light.

4. Methodology

This unit explains the method used for motion detection. A new approach is proposed which is a combination of both background subtraction method and consecutive frame subtraction method. As in this method background image is obtained by taking mean of previous consecutive frames and then this background image is compared pixel wise with current image to detect motion. Experimental results showed that the proposed method is more robust in nature as it can avoid the noise in motion detection and it's useful to reduce the number of false positive alarms. The methods used in detection of motion are background subtraction method, consecutive frames and threshold comparison method.

4.1 Pre-Processing

For Motion detection, a simple frame difference technique is used. The steps followed in this process are shown below:

- Firstly, need to interface a camera using MATLAB.
- Start the camera in background.
- Making a mean image from previous consecutive images.
- Compare the current image with mean image pixel by pixel.
- Next compare the pixel values with threshold value.
- If pixel value is greater than threshold value then, Motion is detected.
- If pixel value is less than threshold value then, Motion is not detected.
- If no motion is detected, again need to perform third point.(as above)
- Finally Motion detection is shown by graphical method or by an alarm.

The main focus of this paper is on making a background image from previous consecutive frames in real time by trigger method [1].The current image is compared pixel wise (pixel by pixel) or subtracted from background image to detect any motion. The image obtained after subtraction is called **Difference Image**. Values of pixels can be positive or negative in difference image. Therefore absolute of difference image is taken and then values of pixels in difference image is compared with threshold value, then if the pixel value is more than threshold value then it means there is motion in the area being monitored and motion is detected. This method continuously keep making background image using previous frames in real time.

To make it practical and useful warning system, graphical method is used. This approach will also show the number of objects detected in motion and percentage area of total area in which motion is present. This method (background image formation and motion detection process) happens in while loop because it has to continuously detects the motion in real time, it will not stop until required it to stop. This method will bring some robustness in motion detection because previous background subtraction method is very sensitive to the very little motion that can be called noise.

Two methods can be used for indication of motion detection, one by blowing alarm upon motion detection and second is the graphical method to take a record which shows number of objects in motion and percentage of area in which motion is present.

4.2 Approach

4.2.a Background Subtraction Method

Background subtraction [10], also known as Foreground Detection, is a technique in the fields of image processing and computer vision wherein an image's foreground is extracted for further processing (object recognition etc.). Generally an image's regions of interest are objects (humans, cars, text etc.) in its foreground. After the stage if image preprocessing (which may include image denoising etc.) object localization is required which may make use of this technique. Background subtraction is a widely used approach for detecting moving objects in videos from static cameras. The rationale in the approach is that of detecting the moving objects from the difference between the current frame and a reference frame, often called "background image", or "background model". Background subtraction is mostly done if the image in question is a part of a video stream.

In some cases , distance of the moving object also forms a basis for it to be considered a back ground, e.g if in a scene one person is close to the camera while there is a person far away is ignored due to its small size and the lack of information that it provides. Identifying moving objects from a video sequence is a fundamental and critical task in many computer-vision applications. A common approach is to perform background subtraction, which identifies moving objects from the portion of video frame that differs from the background model.

Background subtraction is a class of techniques for segmenting out objects of interest in a scene for applications such as surveillance. There are many challenges in developing a good background subtraction algorithm. First, it must be robust against changes in illumination. Second, it should avoid detecting non-stationary background objects and shadows cast by moving objects. A good background model should also react quickly to changes in background and adapt itself to accommodate changes occurring in the background such as moving of a stationary chair from one

place to another. It should also have a good foreground detection rate and the processing time for background subtraction should be real-time.

The purpose of our work is to obtain a real-time system which works well in indoor workspace kind of environment and is independent of camera placements, reflection, illumination, shadows, opening of doors and other similar scenarios which lead to errors in foreground extraction. The system should be robust to whatever it is presented with in its field of vision and should be able to cope with all the factors contributing to erroneous results.

A robust background subtraction algorithm should be able to handle lighting changes, repetitive motions from clutter and long-term scene changes. The following analyses make use of the function of V(x, y, t) as a video sequence where t is the time dimension, x and y are the pixel location variables, e.g. V(1, 2, 3) is the pixel intensity at (1, 2) pixel location of the image at t=3 in the video sequence.

A) Using Frame Differencing
Frame difference (absolute) at time t+1 is,

$$D(t+1) = |V(x, y, t+1) - V(x, y, t)|$$

The background is assumed to be the frame at time t. This difference image would only show some intensity for the pixel locations which have changed in the two frames. Though we have seemingly removed the background, this approach will only work for cases where all foreground pixels are moving and all background pixels are static.

A threshold "Th" is put on this difference image to improve the subtraction.

$$V(x, y, t) - V(x, y, t+1) > Th$$

(this means that the difference image's pixels intensities are 'thresholded' or filtered on the basis of value of Th).

The accuracy of this approach is dependent on speed of movement in the scene. Faster movements may require higher thresholds.

B) Mean Filter
For calculating the image containing only the background, a series of preceding images are averaged. For calculating the background image at the instant t,

$$B(x,y) = 1/N \sum_{t=1}^{N} V(x,y,t-1)$$

Where N is the number of preceding images taken for averaging. This averaging refers to averaging corresponding pixels in the given images. N would depend on the video speed (number of images per second in the video) and the amount of movement in the video. After calculating the background B(x, y) we can then subtract it from the images V(x, y, t) at time t = t and threshold it. Thus the foreground is

$$|V(x, y, t) - B(x, y)| > Th$$

Where Th is threshold.
Usage of global and time-independent Thresholds (same Th value for all pixels in the image) may limit the accuracy of the above two approaches.

5. Motion Detection And Frame Subtraction

5.1 Change in Pixel Values Indicates Motion

A simple method of subtracting one movie frame from another will provide information about which parts of the scene have changed (generally due to motion). This method was performed on each frame of the movie, with consecutive frames being subtracted from each other.

5.2 Frame Subtraction

First, the scene is converted to an array of pixel values. These pixel values are the averaged Red, Green, and Blue (RGB) values for each pixel. The pixel values of the previous frame are then subtracted from the current frame's pixel values, and the absolute value of the values is taken. The result is an array of values that represent how much each pixel has changed between the two frames, with higher values representing more change. The amount of change in a region of pixels can be interpreted as the amount of motion that is taking place in that region. These data can then be used to determine where in the scene the most motion is taking place.

6. Experimental Setup

To fulfill our aim, we have used strong computing software called **MATLAB** [3]

6.1 Acquisition Setup

MATLAB is an integrated technical computing environment that combines numeric computation, advanced graphics and visualization, and a high level programming language. The Matlab programming language is used to store data in the form of matrices. Matlab can provide quick interface with data matrices. The software provides for frame acquisition from hardware devices such as web cams or digital cameras as long as the devices are correctly initialized by the programmer. In order to allow quick setup with the image acquisition devices, Matlab Function directory provides a host of predefined functions by which the user can inquire about the various different devices currently connected and then setup the required device with Matlab so that it can acquire and store data at run time.

Advantage of Matlab [2]: Matlab is an interpreted language for numerical computation. It allows one to perform numerical calculations, and visualize the results without the need for complicated and time consuming programming. Matlab allows its users to accurately solve problems, produce graphics easily and Produce code efficiently.

Disadvantage of Matlab [2]: The only problem with Matlab is that since Matlab is an interpreted language, it can be slow, and poor programming practices can make it unacceptably slow. If the processing power of the computing machine is low the Matlab software takes time to load and execute any code making the code execute very slowly.

Reason for Selection [2]: We used Matlab to develop our work, because Matlab provides Image Acquisition and Image Processing Toolboxes which facilitate us in creating a good GUI and an excellent code.

Approach: Using a video input object, live data is acquired and analyzed to calculate any motion between two adjacent image frames. Any motion in the image stream is plotted in a MATLAB figure window.

7. Experimental Results and Analysis

The graphical user interfaces developed shows the effectiveness of the surveillance method in the work. This has got many features which are discussed below.

Features included: We have included various important features in our work

- We have developed a GUI in our code which allows a user to use our software with ease and efficiently.
- Our software can be integrated and used with any company manufactured web cam.
- We have provided the user a facility to use any audio (.Wave) file as alarm signal.
- If the user wants he can use the software without the alarm audio signal.
- The user can store the recorded video after the motion has been detected on any place in the hard disk.
- We have used icons instead of usual buttons in our GUI to make a layman user more comfortable in using our software.
- Only one instance of our software can run at a single time hence reducing confusion due to multiple instances of same software running.

Where 640×480 resolution which is acceptable for real-time scenarios. In addition, this method shows the number of objects in motion detected if there are many and it also shows the percentage of total area in which motion is present. According to the real world experiments motion detection and graphical method used for taking record is taken in the experiment in real time.

8. Results

The results of Motion Detection in real time video are shown in below figures

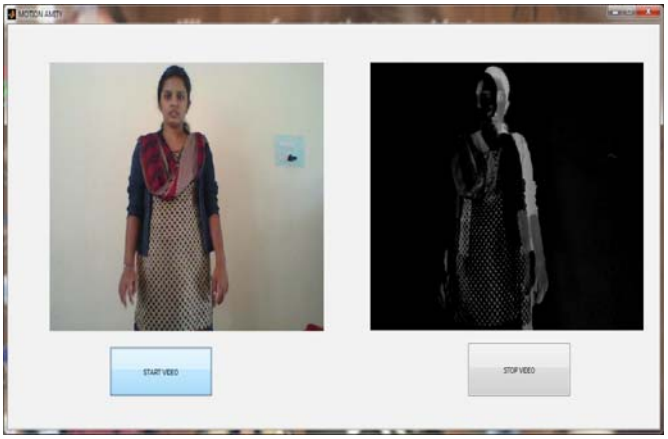

Figure 2: Result of Motion Detection in real time

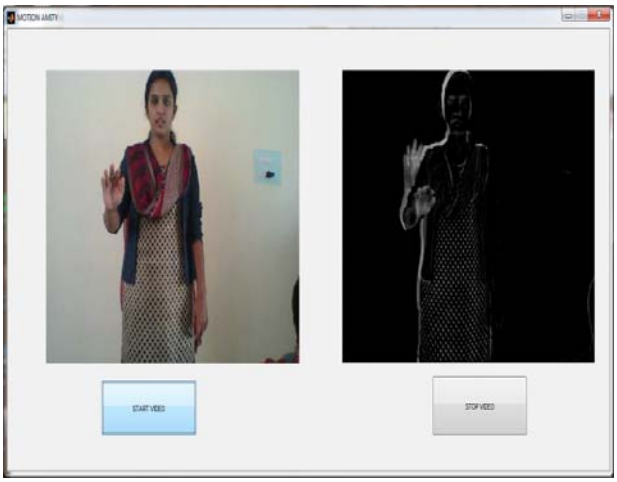

Figure 3: Result of Motion Detection in real time

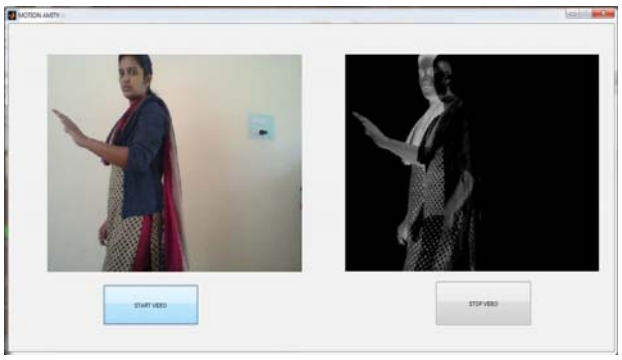

Figure 4: Result of Motion Detection in real time

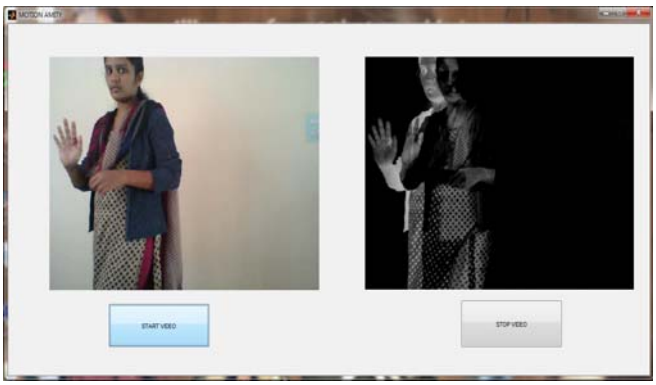

Figure 5: Result of Motion Detection in real time

White regions indicate more change in pixel values. Very little change has occurred in much of the scene. Only the

movement of the main character has resulted in a large amount of change in pixel values.

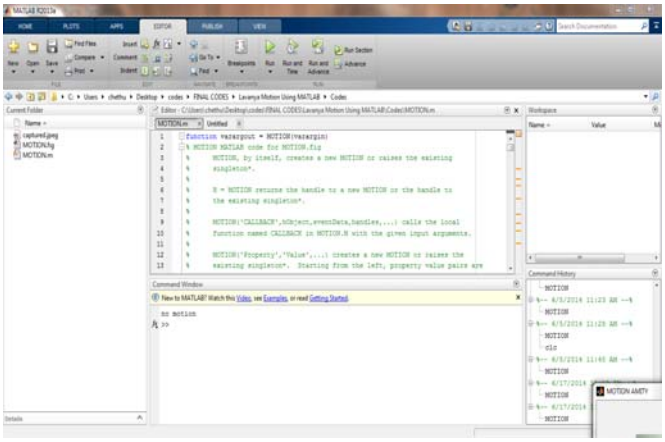

Figure 6: Indication of no Motion Detected

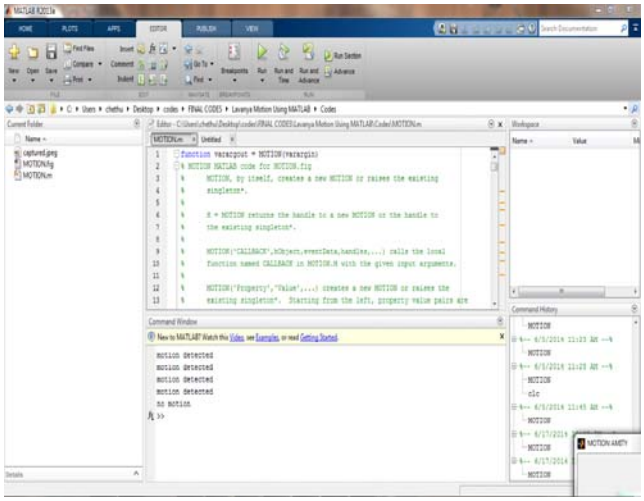

Figure 7: Indication of Motion Detection

9. Conclusion

In this paper, a new method is purposed to detect motion using the algorithm. A video monitoring & detection system was thus developed successfully. The system mainly provides an efficient method for surveillance purposes and is aimed to be highly beneficial for any person or organization. The proposed method is adjustable to the camera movements which were shown as detected motion in other approaches because of their over sensitivity. Experimental results showed that the proposed method is more robust in nature as it can avoid the noise in motion detection. Therefore this method is useful to reduce the number of false positive alarms.

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