



Indoor Surveillance System using Image Processing

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Abstract: Video surveillance has long been in use to monitor security sensitive areas such as banks, department stores, highways, crowded public places and borders. The purpose of this application is to detect a human intruder. This application will detect the occurrence of motion within the area under surveillance. Further, it will also detect if the motion is caused by a human intruder. This paper predominantly focuses on how motion and human can be detected. The study of these concepts has established a strong foundation on which the application has been architected.

Keywords: Differentiation; Vitruvius proportions; Ghosting effect; Blob; perturbations

I. Introduction

Insecurity and crime constitute some of the major problems facing the immediate society today. People live with a fear of being attacked by burglars, vandals and thieves. Today in the society security is one of the major issues and having a 24*7 human eye is just impossible. In order to be secured of safety, it has become a necessity to realize and manage smart surveillance system. Despite all the effort, resources and time that has been devoted to the development of tools that will reduce crime rates and make the world a safer place to live, these problems are still increasing substantially. These give rise to the need for an increasing development in the technology of motion sensors. Even with the introduction of these alarm systems which have reduced greatly the level of insecurity, there is still a problem of false alarm which needs to be minimized. Also, changes in illumination, noise, and compression artifacts make motion detection a challenging problem. In order to achieve robust detection, there is a need of a new technique i.e. using various image processing algorithms which will detect motion. This system will provide security and ensure alarms are activated only when an unauthorized person try to gain access to the protected area.

II. Existing Systems

A burglar alarm may be implemented using different methods. Two of them are:

- (a) Using Image Processing
- (b) Using Motion Sensors

A motion detector is an electronic device that detects the physical movement in a given area/ designated locations and it transforms motion into an electric signal. All motion sensors indicate the same thing; that some condition has changed. All sensors have some 'normal' state. Some sensors only report when the 'normal' status is disturbed, others also report when the condition reverts to 'normal'. [1]

However, there are a number of drawbacks associated with them. They are as follows: -

- It might not cover a full room.
- Things may trigger the motion detector that you don't want to.
- An outside detector mounted too close to a light that stays on at night, will be triggered continuously by bugs.
- The set shutoff time of the motion sensor may be too short (maybe only 30 seconds). For outside lights with a motion detector, if you want more "on time", it's best to buy a model with an adjustable shutoff time.
- The reliability of a motion sensor may also be affected by rapid environmental changes and direct sunlight. Also, things like a fireplace, and direct wind from an air conditioner or heater. This is because a PIR sensor actually detects changes in infrared energy, specifically, the "heat energy" emitted by normal human skin temperature.

All the above disadvantages can be overcome by using image processing.[2]

III. Human Detection Using Histograms

Once motion is detected using image processing, the next step is to detect if the motion is due to a human intruder. This can be done using histograms or using the optical flow algorithm. However, the method using histograms also have a number of drawbacks. They are as follows:-

- Higher cost.
- Less accurate.
- Comparatively higher CPU load.

- Requires a lot of processing time.

Thus, to avoid these drawbacks, the optical flow algorithm is used so as to detect the presence of a human intruder.

IV. Proposed System

In this paper a burglar alarm system is proposed. The main objective is to provide security to the user. For development of a burglar alarm using Image Processing, there are 2 major steps to be followed:

1. Motion Detection
2. Human Detection

A. Motion Detection using Image Processing

The surveillance system being designed is for a static background and for night time use. Since no motion is expected at night time, the first step is to detect if there is any motion in the area under surveillance. Initially, the software switches on the webcam in the video mode. A video is nothing but a stream of images. Now, the first step is to extract images from the video. The first image is stored as the background image.

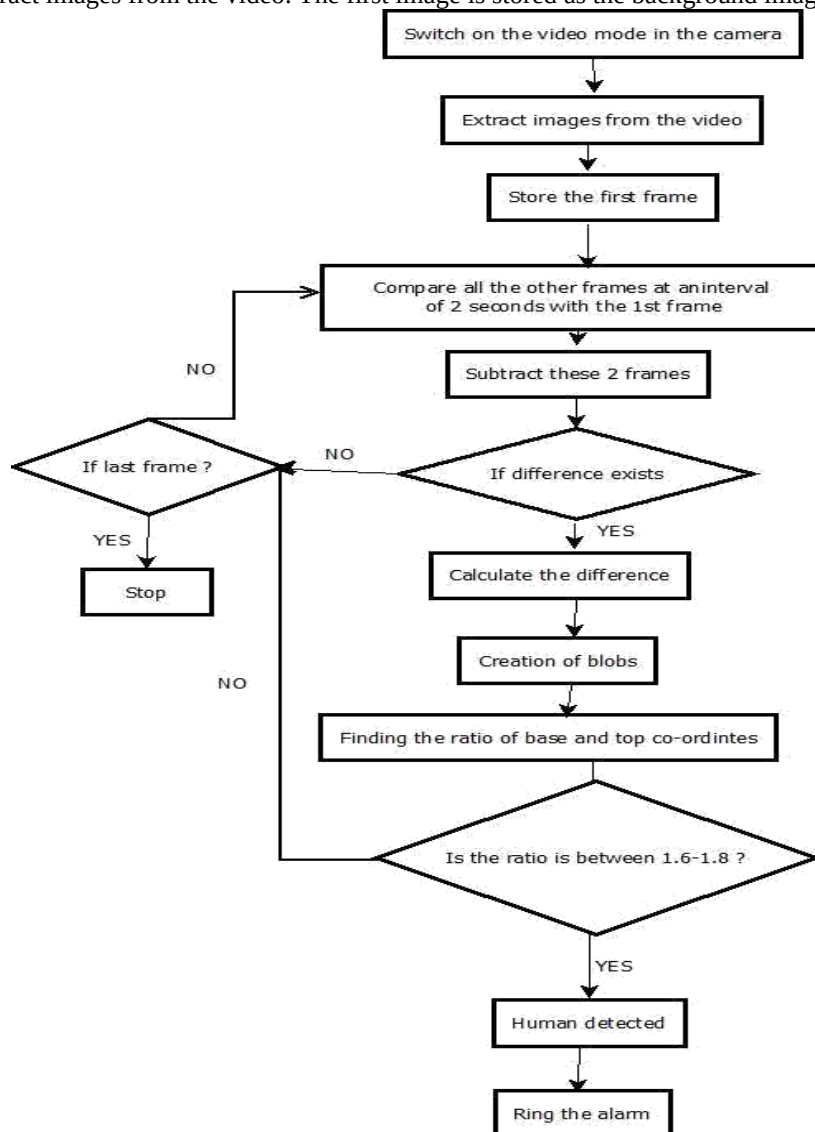


Figure 1 Flowchart of the design of the system

All other images following the first image are considered as the foreground images. A video has around 30 frames in every second. Since the pace of a human is not that fast, the frames are compared at an interval of every 2 seconds. Every 2 seconds, the captured image is captured with the background image. Image differentiation is performed on these two images, i.e. the background image is subtracted from the foreground image. The two images are compared pixel by pixel. Now, if there is a difference in the pixel values of the two images, the result of subtraction will be a non-zero value, else zero. Now if there is no motion in the frame, there will be no difference in the images. However, in case of motion, there will be a difference in the two images and hence, the pixel values will be different. Thus, the subtraction of the two images will yield a non-zero result. Thus, motion can be detected. The reason for comparing the images with the initial image and not with the

image captured just prior to the current image is that it may result in the ghosting effect. Now, consider a person enters the frame at instant t . Now, if the image that is captured at instant $t+1$ is compared with this image, the result will be an overlapped image of the person at instant t and at instant $t+1$. This makes it difficult to determine the exact position of the person. Such an effect is known as the ghosting effect. In order to avoid this, all the images are compared with the initial image that is static and has no motion.

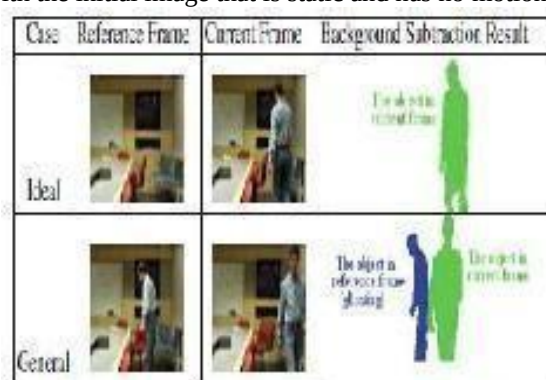


Figure 2: Difference in frames [3]

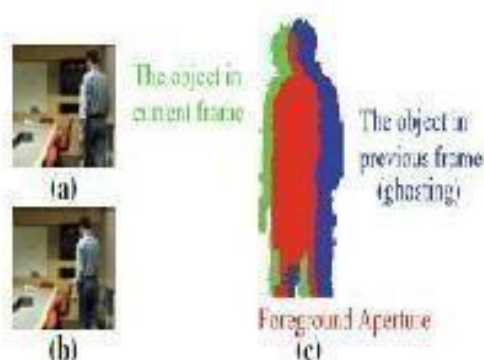


Figure 3: Ghosting effect [3]

Consider the example of a shop wherein the area facing the entrance is under surveillance. Now, during night time there will be no motion in this area. So the video captured by the webcam should ideally capture a series of images which are identical. Thus, when the subsequently captured images are compared with the first frame, the result should be a zero value. However, when there is motion, say at instant t , the image captured will be different from the initial one. Now, when this image is compared with the original background image, the result will be a difference of the pixel values of both images which will yield a non-zero value. This shows that there has been motion in the area under surveillance. [3]

B. Human Detection

B1. Scope of human detection

The needs of a human motion analysis system can be summarized in: Robustness, Accuracy and Speed. Using those three features, it is possible to make a basic description about the requirements for a proper algorithm or software.

Camera: The camera is not calibrated. The camera is situated in a fixed position and do not have to be affected by any kind of vibrations.

Scenario: The scenario is indoor. Due to design requirements, is preferable to avoid major illumination changes, hence the environment is indoor.

Detected objects / Persons: The target persons' height has to appear completely in the scene as the ultimate measurement is the height. In addition, in a sub-stage of this software there is a filter which works using human shape proportions, so it is necessary to have the complete shape of the person in the image. It is not necessary to have a person in movement because the detection is based on frame differencing, comparing every frame with the background scenario, which is previously computed.

After it has been found out that motion has occurred, the next step is to find out the reason behind the motion, i.e. whether the motion is because of a human intruder. There is a possibility that the motion detected can be because of any object falling or curtains flying or any other such reason. So to find out whether the motion occurred is because of an intruder, the second step is human detection.

This system uses the optical flow algorithm for human detection.

Once the motion regions are detected it is possible that several sorts of moving objects can be distinguished, i.e. persons, animals, cars, etc. Objects are classified based on the shape of the motion regions. That information can be related to the surface, aspect ratio or the diffusion of the shape. It is a common practice to consider a square box around the region of interest in order to work with the surface or with the width/length ratio of the box. This technique makes use of shape-based object classification based on human shape proportions. The frame achieved from the human differentiation technique is the input to this algorithm.

This algorithm gives two outputs. The principal one is the coordinates of the detected object. With the coordinates, the aforementioned measuring system will be able to calculate the height by itself. The other output is the video sequence with the detected person bounded by a rectangle; which provides visual feedback to the user.

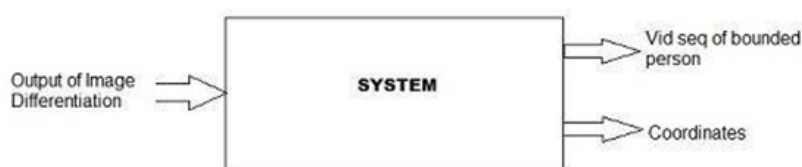


Figure 4: System inputs, outputs and perturbations. [4]

The goal of this application is to build a real-time human detection algorithm which could be for further estimation of human height. The algorithm will be able to have any kind of video inputs. An important assumption is that the algorithm should work with any standard webcams. Furthermore, it is assumed that indoor scenes are being analyzed and there is no need of camera calibration.

B2. Object classification

Once the motion regions are detected it is possible that several sorts of moving objects can be distinguished, i.e. persons, animals, cars, etc. Even though false positives due to noise could appear. Methods to implement moving object classification: shape based and motion based classification.

Shape-based: Objects are classified based on the shape of the motion regions. That information can be related to the surface, aspect ratio or the diffusion of the shape. It is a common practice to consider a square box around the region of interest in order to work with the surface or with the width/length ratio of the box. That is how it is going to be done in this project.

This technique makes use of shape-based object classification based on human shape proportions.

Basic Steps:

(a) Getting blobs of the objects

Now, the system draws a rectangle which, allegedly, fits a human body silhouette i.e. the blob. The base and the top coordinates of the detected object are estimated.

With these coordinates, a person's height is estimated.

An average height to width ratio of the object is found out.

(b) Blob Generation.

This is a simple technique which consists on filling up the complete shape of the moving object from the detected blobs using the classic procedures of morphological processing, such as dilation and erosion. Those blobs are coming from the result of differencing the background and the current frame i.e. from the motion detection algorithm.



Figure 5: Window showing the blob of a person. [4]

Now a rectangle is drawn which completely inscribes the blob in it. [4]

B3. Deciding Stage

Using the measurements of the rectangle, the base and top co-ordinates are found out. Using these base and top co-ordinates, the height of the blob is found out. Now in general, according to the Vitruvius' proportions the ratio between the height and width of a human is 1.7. So the ratio of height and width of the blob is found out. If the ratio lies between the range 1.6 -1.8, then detected, if not then the motion is not because of an

intruder. If human is detected, then the alarm rings, if not then the remaining frames are compared again with the first frame, and the entire procedure repeats till the video is on.

V. Conclusion

Using sensors for motion detection is not completely reliable as it has a higher probability of raising false alarms and also inefficient functioning. Whereas in the proposed system, motion detection using image processing is much faster and cost effective. Effective storage and transmission, availability in any desired format, noise free processing are the advantages of using image processing for motion detection.

Also for Human Detection, traditional HOG cannot describe the body detail in larger image region. It also requires a lot of processing time. The information is often noisy. Another disadvantage is that as the final descriptor vector grows larger, the time for extracting and training using a given class increases. But, the Optical flow method of the proposed system deals with vibrations and illumination changes. The problem of detecting the silhouette of a person correctly and distinguishing it from windows and doors is solved by checking the human proportion constrains and it is based on the number of pixels in movement which are inside the detected rectangle. It also helps save a lot of computational time.

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