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Human motion detection and notification system

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ABSTRACT

Video surveillance has become an important tool for organizations for maintaining its security and safety applications. This science has been evolving ever since. These systems are very important and find its applications finance, banks, and home. Traditional video surveillance will typically succeed close distance observance. Digital surveillance systems are replacing analog cameras which use coaxial cable for cost and performance reasons. The motion detector can capture any object moving in its surrounding area and continuously monitor the area for any changes. Security is a primary concern, and CCTV or security guards can be expensive. In this age of technology, we can use much cheaper alternatives for security monitoring. Automated Video Surveillance System has been developed to detect the motion in a live video stream environment. The System proposed is a software module that can be used in with any kind of camera or computer system. With this, any unlawful intrusion can be detected and notified. Motion Detection continuously scans a particular area for any presence of motion. It makes use of advance image processing and video processing for this purpose. The system acquires the video footage and does a real-time frame by frame analysis. Every frame is processed to find the details about the surrounding. This detail is then used to add details to the video footage through video processing.

Keywords— *Video surveillance, Automated video surveillance system, Motion detection, Advanced image processing*

1. INTRODUCTION

Human Motion Detection and Notification System is a custom implementation of the contemporary Digital Image Processing technology that today has led to a momentous paradigm shift in traditional analog image processing mechanism. Image Processing processes digital images which are a subcategory of digital signal and uses computer algorithms for the processing. Since a much wider range of algorithms is used in this method, the noise and signal distortions are highly minimized during the processing. Images are defined in two-dimensional space (can even be more) so Image Processing systems can be modelled in multidimensional systems.

Human Motion Detection and Notification System revolves around robust human tracking by using an appropriate algorithm to fit the expanding requirements and demands of improved surveillance techniques. It is architected to be both fast and reliable and aims at detecting human motion in a live video stream environment. Our architecture is extremely fast and the model processes images in real time at astounding 220 frames per second while still achieving seven times the mAP of other real-time detectors.

The present research is based on the following assumptions:

- A well-fixed camera – stability is a key if you want to isolate motion.
- Stable light, no flickering.
- Contrasting background.
- Camera having a high frame rate and good resolution.

Our System works in two mode the first mode is where the system scans for any motion in the surrounding and flags for any moving object and notifies the user via an email and screenshot, the second mode is where the system scans a particular area for the presence of any human being in the area, it does so by scanning humans in the frame presented by the camera. The frames are processed using Image processing and Video processing to add details to the image and scan the image. If a human is detected then motion is flagged and the user is notified by an email along with the screenshot.

2. OBJECTIVE

The objective of this paper is to provide a fully automated intrusion detection system. The system scans for intruders with the help of a fixed camera and it uses YOLO detection system to process the input image by resizing it into 448 x 448. It runs a single convolution network on this image and thresholds the resulting detections by model's confidence.

3. IMPLEMENTATION

First, we need to design and adaptive system which creates a reference background model that can deal with the changes in lighting, object occlusions and the changes that happen due to long term scenes. Noise cleansing also has to be done in the obtained image sequence so that object detection can be applied.

Followed, we can apply Human Modelling to recognise and monitor activities such as walking or running using YOLO algorithms [4]. The Techniques used to accomplish the above objectives are: Motions detection, tracking, human modelling, motion analysis and Image Processing.

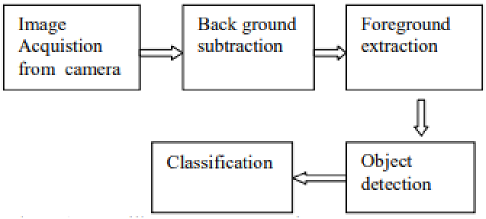


Fig. 1: Overview of the Surveillance System

3.1 Motion detection methods

3.1.1 Background subtraction*:* This method involves firstly the initialization of a background image and then the current frame (which contains the moving object) is subtracted from the background image. The difference in the help in the detection of the object. This method extracts the characteristics of the target data and is simple and easy to realize but suffers the limitation of being sensitive to the changes in the environment. That means it expects the background to be known. For different background objects, it poses a difficulty with the pixels which are distributed in the borders. The pixels are divided into a matrix of N x N blocks and every block is processed as a vector component [1]. Samples are collected over time to calculate them. Principal Component Analysis (PCA) model of each of the above-mentioned block [1]. The Pixels are then classified according to their difference which is above the threshold value of its PCA coefficients as either a background or a foreground image. Independent Component Analysis (ICA) approach which proves to be more robust to changes in indoor illumination is similar to the above-mentioned process. It uses a de-mixing vector and compares the new frame to extract or separate the foreground from the background [1].

Fig. 2: Input data

Fig. 3: Background subtracted image

Fig. 4: Tracking object

3.1.2 Frame differencing: This method quite is similar to background subtraction but is highly adaptive to changing the background or is good for dynamic scene changes. This method like background subtraction finds the difference between two-three consecutive frames and if the difference is larger than a particular threshold detects the moving object. Although it is easy and simple to implement, this algorithm fails to detect whole relevant pixels of the moving object, criteria which almost all the motion detect approaches should fulfil. Any such algorithm must be adaptive to sudden or dynamic background changes and should note the difference in lighting, motion changes, illumination changes, objects with high frequency and their respective geometries especially while working outdoors. The unfamiliar changes include camera oscillations, tress, birds, wind, sudden light changes and objects such as parked vehicles. One of the most difficult aspects of this field is to incorporate and implement these features in the camera itself so as to reduce the computational load and delays later [1].

Let Image be represented as F(x,y,t) and Background as K(x,y,t) at time t. Using Frame Differencing method, the relation between image and Background Image can be given as:

$$K(x,y,t) = F(x,y,t-1)$$

The background can thus be estimated if

$$|F(x,y,t) - F(x,y,t-1)| > \text{Threshold}$$

Median Filters uses the median of the previous frames as the Background model

$$K(x,y,t) = \text{median}\{F(x,y,t-i)\}$$

$$|F(x,y,t) - \text{median}\{F(x,y,t-i)\}| > \text{Thr}$$

Where i = {0,1…n-1}.

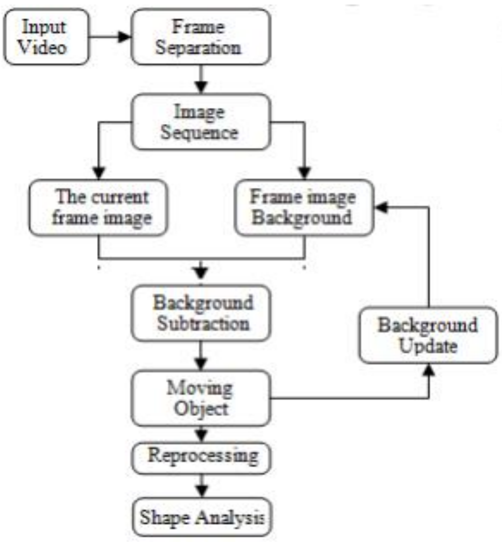


Fig. 5: Flow chart

3.1.3 Optical flow: This is used to detect the area of motion in the image sequences. It uses vector characteristics of the target which changes with time to accomplish the above mentioned. The algorithm gives excellent results in moving cameras but is complex to implement and require a lot of computation, which makes it difficult to use it in real-time video processing.[1] Artificial neural networks can also be used in this method to learn the movement patterns but this adds more complexity and computation.

3.1.4 YOLO: You only look once is an approach that employs a single neural network to predict the probabilities of the object classes. It's a state-of-art architecture which is extremely fast and processes images in real-time (approx.45 frame every second). Although the architecture is more prone to localizations errors, it is far less likely to predict false detections where nothing exists.

YOLO is said to have the following three advantages over the traditional methods:

- Firstly, YOLO is extremely fast since we frame detection as a regression problem so the need for a complex pipeline is eliminated. We directly train our neural networks on new images at test time to predict detections Moreover YOLO achieves twice as much as precisions as the classical detection methods.
- Secondly, YOLO globally reasons about the image before giving the predictions. YOLO sees the entire image during the training phase and so it encodes contextual information about the classes as well as their appearance.
- Thirdly, YOLO been trained on natural images and is tested on art works also, so the results provided by YOLO outperforms the other detection methods like DPM and R-CNN. That is YOLO is learned to give highly generalized representations of the detected objects [4].

4. EXPERIMENTAL RESULTS

Background Subtraction has been implemented using OpenCV software for the detection of moving object in the surveillance system. Here both current and the background image is compared and the subtracted image is displayed below. (figure). In the next figure, we see that an object has entered the fame and after background subtraction, the difference in the reference frame and the current frame is shown using white. The reference image is just the background image with the absence of the object [2].

The result of image sequences computed by the method here is in the following figures.

4.1 When there is no movement in the frames

When the object isn't present the figure shows that there is no significant difference between the pixels of the two images [2].

4.2 When there is movement in the frame

But when there is movement in the frame the difference in the pixels is shown using white colour.

Here a constant background image is used and hence the system isn't adaptive, to make the system adaptive the Frame differencing can be used. It takes into account the median of the previous few frames and then finds the difference [2].

YOLO, on the other hand, uses trained neural networks which can be used to identify individual objects. Compared to real-time systems YOLO is the fastest detection method on PASCAL, with 52.7% mAP, it is twice as accurate as prior Work on real-time decisions. YOLO give better results as it is trained on Picasso Dataset and People-art Dataset which even helps it to identify human feature from artworks

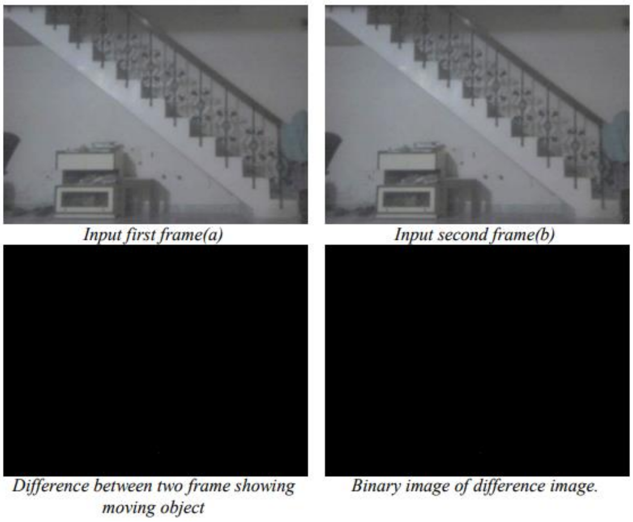


Fig. 6: When there is no movement in the frames

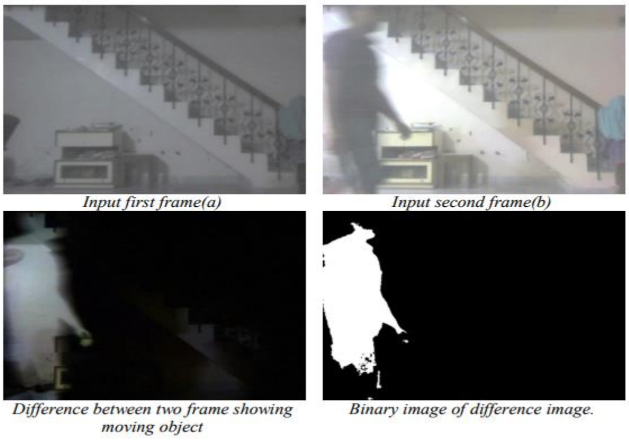
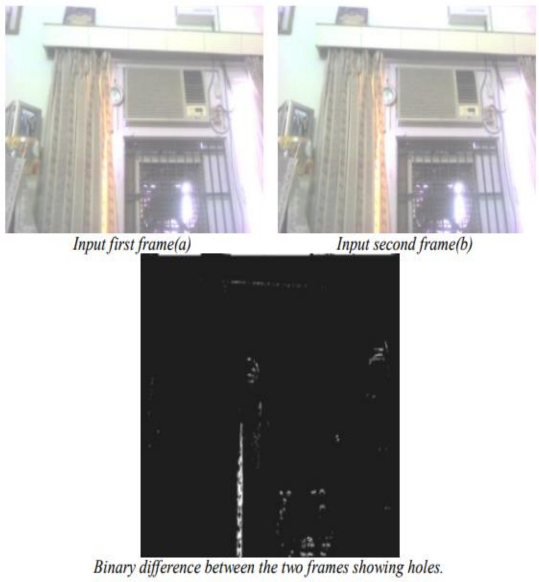


Fig. 7: When there is movement in the frames

5. LIMITATIONS

Frame differencing method also detects motion which is due to the movement of air. Due to air movement, the camera doesn't remain static and hence the angle or the angle of focus changes. This results in object detection and shows holes in the binary output image even if there is no real object. [2].



Background Subtraction is easier to implement but it's adaptive to background changes. Optical flow has a good performance but is very complex and requires more computations, making it unsuitable for real-time use.

YOLO spatial constraints on bounding boxes limit the number of objects that can be predicted by it. YOLO also struggles to generalise newer or unfamiliar aspect rations or configurations [4].

Moreover, non-human objects are thus detected and thus generate false alerts. The system must only concentrate on only the human. Thus a proper shape analysis should be done and the object shout is judge according to the height/width ratios after the background subtraction has been done. For reduction of noises (such as video vibrations) Gaussian blur can be employed to extract only the required areas or pixels. As depicted in the image below.

OpenCV for Video Tracking and Motion Detection: OpenCV is a computer library developed by Intel in 1999. It contains functions useful for real-time computer vision.

The basic interface for OpenCV is developed using C++ but it also binds MATLAB, JAVA and Python. It finds its application human facial recognition, gesture recognition and motion tracking.

Fig. 8: Original video

Fig. 9: Background elimination

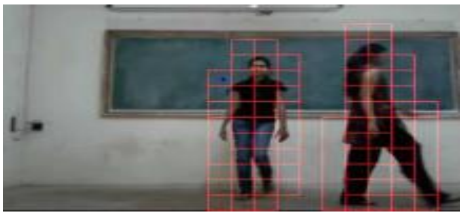


Fig. 10: Human detected

Few of the libraries involved in motion detection are:
OpenCV 1.0 has the following important modules:
1) CxCore: Contains basic functions like Data types.
2) CV: Contains modules on image processing and computer vision (structure analysis, motion analysis pattern recognition and etc.)
3) CvAux: Some experimental functions (View Morphing, Three-dimensional Tracking, PCA, HMM).
4) HighGUI: This contains the GUI function for storing and recall of the video data.
5) CvCam: This is the Camera Interface (this will be removed completely after OpenCV 1.0)

6. FUTURE SCOPE

The Future scope for the discussed topic is to understand the human motions in a better and more detailed way including not only the whole body characteristics but the motion of individual body parts. Improved data-logging and retrieval mechanisms to support the system 24/7. Moreover, delays and computational time need to be reduced to make the predictions faster to suit the need of real-time video surveillance [3].

Better control of the camera and better focusing power can help in enabling the smoothing of the image. Thus the tracking of the object and its classification can be enhanced. In cases of high zooming, the vibration of the video is a major issue, thus video stabilising algorithms which are not too heavy on the system needs to be develop.

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