

Image Based Human Intruder Prevention System for Industry

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Abstract: The proposed system shows the design and development of human intruder prevention and alert system. This process is based on computer vision to detect human intruder and provide intelligent safety. The idea behind developing this system is that there are many security systems based vision with much functionality which continuously captures the video and leads to wastage of memory. In former security systems it captures video which will be used as evidence after the event is done, but the system which proposed not only capture video but also takes appropriate action to prevent the event. Without using motion sensors, camera will record live video whenever there is an intrusion in the limited area. The objective is to find intrusion objects efficiently and reduce false alarm. In this system, human recognition is accomplished by combining motion segmentation and whole body human detection and then intruder detection is known over the defined region.

Keywords: Intruder, Motion Detection, Safety, Security, Whole Body Human Recognition.

I. INTRODUCTION

The security and safety is one of the major concerns of any organization in present age. The countries put a lot of resources and accidents on border security and surveillance. With the need for 24 hours surveillance and security, the camera surveillance systems came into existence. These traditional camera systems lacked the intelligence of the humans. So, there is a need to combine both the intelligence of humans and the working efficiency of camera systems to come up with "Intelligent Camera systems". Here the camera will have an ability to detect the intruder and ensure requirement of less number of storage to cover a particular area. This paper describes such intelligent system which can be used into practical applications. Image processing is an important part of the entire operation. The efficiency of the algorithm used for image processing determines the efficiency of the entire system. The algorithm chosen to obtain the goal, the problems faced during its implementation and the possible improvements in it are discussed. Simulation results, conclusions and the future work will also discuss in the following.

II. RELATED WORKS

The rise in popularity of security systems has been fuelled by the availability of cameras and the ever increasing processing capacity of CPUs. Indeed, significant research work has been done in this field during the past two decades. The following is a brief review of some previous works about visual surveillance systems. Yuan et al. [4] proposed a distributed visual surveillance system by connecting the output from multiple cameras to a local area network. They used a simple background subtraction method to detect pedestrian and vehicles. However, their system could not recognise vehicles or pedestrian, it could only detect their

presence. The system was tested under controlled conditions which gave a detection accuracy of more than 95%. However, the authors conceded that the system will perform poorly under when it is raining, when there is little contrast between the objects of interest and the background or when there are many vehicles moving close to each other. Lee et al. [5] developed a real-time threat assessment system which could effectively distinguish between people, animals and vehicles but cannot recognise them. They used the contours of shapes obtained from each frame and compared it with that in their database in order to differentiate between people, animals and vehicles. An interesting work was done by See and Lee [8] in which they proposed to have a multi-modal home security system. They used a face recognition module to authenticate the user and a motion detection module to detect movement.

However, the outputs from these two systems were evaluated separately and were not integrated into a single system to detect intruders. Ansari et al. [9] described and implemented a sophisticated motion detection system using Matlab to detect motion from a video stream. The video is stored only when motion is detected. However, they do not have different levels of motion and owners are not given any warning messages. Nebel et al. [11] reviewed some of the state-of-the-art approaches for recognising human action from surveillance videos. They showed that even the best performing systems could only recognise a few distinct and basic actions with an accuracy of only 70% under controlled conditions. Thus, they argue that computer vision systems have not matured enough to be useful in human action recognition. Kosba et al. [12] designed and implemented a passive motion detection system which uses the signal

strength and waveform of wireless signals to detect motion instead of relying on visual systems. This system is better as it is not limited to line-of-sight vision and it works even in the presence of smoke and at night. The current system gives a detection accuracy of 93%. However, changes in the physical layout of the building and interference from other devices can have an impact of their accuracy. They are also investigating the effect of size, shape and motion pattern on the performance of their system.

III. DESIGN AND IMPLEMENTATION

The method proposed here is to design and implement high security system with intelligent safety conditions based on motion segmentation, whole body human detection and intruder detection. The overall system of human intruder prevention system is shown in figure1. This system uses the IP camera for human intruder detection. The camera provides real time video stream with the resolution of 640x480.

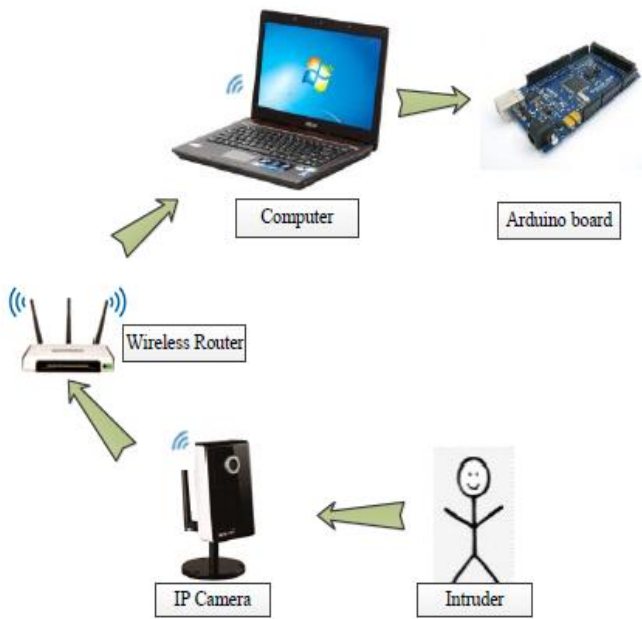


Figure1. Overall System of Image Based Human Intruder Prevention.

It is processed with the combination of motion detection and whole body human detection individually to detect human intruder in it. It takes a real time image frames from incoming video stream and then process a set of detected human intruder. This proposed system includes; Motion image segmentation: This step accepts a subtraction of current and background image frame by thresholding, a set of regions corresponding to motion areas in the image. This is achieved through temporal update background subtraction with Mixture of Gaussian (MOG) on the frames of image. Then, this step also takes motion mask by smooth(2) Whole body human detection: A set of gradient features vector are extracted from the motion mask and classified these features to recognize as human or other objects. Whole body human detection: A set of gradient features vector are extracted from the motion mask and classified these features to recognize as human or other objects.

Intruder detection: This step makes decision where the positions of human are closed to the hazard area. Once detect the human, this proposed system notice the human intruder. This step uses the current position of human compared with the defined hazard region. Finally, the set of candidates that are classified as humans is intruder. Figure 2 depicts the detection steps of proposed algorithm using Gaussian and blob filter.

IV. APPROACH

To implement this proposed system, open source computer vision (OPENCV) library is used in C# programming language with Emgu CV wrapper. As soon as the human intruder prevention system is started, the system continuously starts capturing images. In the monitoring mode, the camera monitors a specified area from an angle at a resolution of 640 x 480. In motion level exceeds a threshold value of 50%, the human detection module this triggered. The motion level is calculated by taking the difference between the current frame and the previous frame for each 100 minimum pixel area.

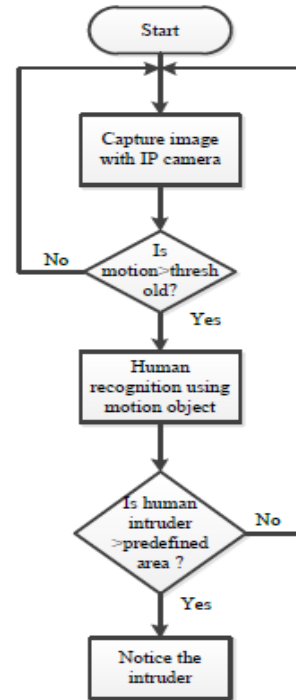


Figure2. Implementation of Human Intruder Prevention System.

If the motion is detected, the whole body human recognition algorithm will try to track and recognize the human by comparing it to the database of stored images. In this recognition module, the whole body human detection algorithm is used to detect the human. If the human arrived in the defined area, an alert will active. The goal of this proposed system is to efficient object detection and to develop intelligent surveillance system. Moreover, this method can do in live video streaming and more efficient than manpower surveillance.

A. Motion Segmentation

The goal of image segmentation is to separate background areas of the image from foreground regions of motion that

Image Based Human Intruder Prevention System for Industry

are interest point for human intruder detection. In this proposed system, the background scene of the system will remain stationary. This assumption necessitates that the camera be fixed and that lighting does not change suddenly. It is possible to achieve accurate image segmentation without this assumption, but such generality would require more computationally expensive algorithms. The choice of this algorithm is background subtraction, in which a model of the image background is computed over time. For any given frame of video, this background image can be subtracted from it. Those pixels with a result smaller threshold values are treated as background and those pixels with a larger result are treated as foreground. Thus, background image modeling is simple, efficient, and easy to implement. Acquiring the background model, on the other hand, is more complicated. The most straightforward approach would be to simply set up the camera, empty the scene of any moving objects, and take a snapshot. Although this approach is simple, it is always impractical in real scenes because backgrounds can change over time, it can be difficult to empty a scene and lighting can change subtly. A more practical approach is one that can adapt to a slowly changing background in real-time.

Consider the time-varying value of a pixel at position (x,y) of a grayscale video sequence. This value refers $V_{x,y}(t)$. So, the value as a random process of variable are expressed as $X_t, Y_t = V_{x,y}(t)$. Now, model the probability of observing the current pixel value can suppose as a mixture of K Gaussian distributions. This probability is expressed as

$$P(X_t, Y_t) = \sum_{i=1}^K \omega_i \eta(X_t, Y_t, \mu_i, \Sigma_i, t) \quad (1)$$

where ω is an estimate of the weight of the i th Gaussian, and η is the evaluation of a standard Gaussian with mean μ_i and covariance matrix Σ_i ;

$$\eta(X, \mu, \Sigma) = \frac{1}{(2\pi)^{\frac{n}{2}} \sqrt{|\Sigma|}} e^{-\frac{1}{2}(X-\mu)^T \Sigma^{-1} (X-\mu)}$$

Since the background is assumed to be static, the value of pixels which are part of the background can be represented by one or more Gaussians with a small variance due to image noise. Furthermore, in most scenes, the background will be visible more often than foreground at any given pixel, so the Gaussian with the largest weight ω is likely the background. These ideas now enable the following approach to background subtraction: For each pixel in a frame of video: Consider the last N values taken by the pixel find the K Gaussians and weights that best fit this sample of N values using Expectation Maximization (EM). Choose the Gaussian with the largest weight ω and store its mean as the value of the background image for that pixel. Subtract the background image from the frame. In the resulting difference image, any value larger than three standard deviations from the mean is considered foreground, and any other value is considered background. The final output of the segmentation step is a set of motion region. Each region is convolved with 3×3 Gaussian filter and blob detector. These filters help removing a number of regions that result from noisy data and are unlikely to correspond to a human part.



(a)Input Image (b)Motion Segmentation
Figure 3. Difference Poses of Human Showing Motion.

B. Whole Body Human Detection

In this paper, whole body human is recognized using Histogram of Oriented Gradients (HOG) feature detector and Support Vector Machine (SVM) classifier. Normalize gamma and color Weight vote into spatial and orientation cells Compute gradients Linear SVM Human / No Human Collect HOG over detection window Input Image

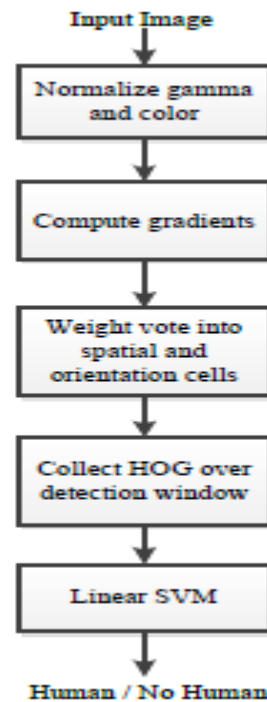


Figure4. Flowchart of pedestrian detection system.

HOG is based on evaluating a dense grid of normalised local histograms of image gradient orientations over the image windows. The hypothesis is that local object appearance and shape can often be characterised rather well by the distribution of local intensity gradient or edge orientations, even without precise knowledge of the corresponding gradient or edge positions. The method uses a dense grid of HOG, computed over blocks of size 16×16 pixels to represent a detection window. Each detection window is divided into cells of size 8×8 pixels and each group of 2×2 cells is integrated into a block in a sliding fashion, so blocks overlap each other. Each cell consists of a

9-bin HOG and each block contains a concatenated vector of all its cells. Each block is thus represented by a 36 - D feature vector that is normalized. Each 64×128 detection window is represented by 7×15 blocks, giving a total of 3780 features per detection window. These features are then used to train a linear SVM classifier. After training, pedestrian classifier has been got.



Figure5. Pedestrian Detection using HOG and SVM.

C. Human Intruder Detection

This step includes the classification of human according to their current position who is intruder or not intruder to the hazard area.



(a)



(b)

Figure 6: Final Detection Steps of Human Intruder.

V. EVALUATION OF RESULTS

This proposed system is tested in different light conditions. Motion capture in lighting conditions is more responsive than normal motion capture. Nevertheless, the system is able to detect motion under both conditions. Thirteen different

persons were asked to walk in front of the camera, one at a time. All of them were detected. However, the recognition rate was between only 62%. Furthermore, recognition works only up to a distance of 7m. For detection, the moving object/person can be up 12m. The system is designed to capture 30 frames per second (fps). These frame numbers is sufficient and allow selection of useful frames to be retrieved and analysed. These frames are also used to build the video, for streaming purposes. However, a fast internet connection of is required to have a quick response. For the system to operate in real-time, images are at a resolution of 640 x 480 pixels.

This allows for fast processing at 30fps. Small file size also allows for faster uploads and downloads. When the person enters the field of view, the system starts to detect human from the starting point, i.e., from a distance of 12 metres. This can be seen green rectangle from the first frame, indicating motion. Moreover, it can also be seen in red rectangle in defined hazard region. If the human is recognised, no action is necessary. However, if the human is not recognised the system will capture the frames and continue detect in the same manner. Visual surveillance systems have many advantages. Firstly, these systems are not obstructive. Secondly, authentication and tracking can be done automatically from a distance. Thirdly, the setup requires simple low-cost cameras and a computer. Sensor-based systems, in contrast, usually rely on some sort of contact to detect movement. Furthermore, many surveillance applications depend on one feature only whereas this system uses gradient features which make it even more robust, reliable and effective.

VI. CONCLUSION

In this proposed system, an intelligent human intruder prevention system significantly is contributed to situation awareness. Such systems transform video surveillance from data acquisition tool to information and intelligence acquisition systems. It provides smart surveillance systems with the ability to react in real-time. The system senses false alarm as well as the intrusion and notice intruder person so that action can be taken in response to the intrusion. The motion detector uses background subtraction to estimate the motion and then reduce process computation time with a certain risk level. The whole body human recognition distinguishes human intruder and other moving objects in order to eliminate false alerts. The system has been tested in real-life scenarios and it is a low-cost industry surveillance system shows good performance in different lighting condition. The system can be improved by omni-directional cameras so that one is present in wider area. However, additional work is required processing stage before motion detection and whole body human recognition module to increase its recognition ratio and to make it less sensitive to variations in light intensity.

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Image Based Human Intruder Prevention System for Industry

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