Robust Human Body Tracking using PCA and SVM Classifier

Nirmala M, Hamsaveni N

Abstract*— *This paper deals with an intelligent image processing method for the video surveillance systems. We propose a technology detecting and tracking moving Human Body, which can be applied to consumer electronics such as home and business surveillance systems consisting of an internet protocol (IP) camera and a network video recorder (NVR). A real-time surveillance system needs to detect moving objects robustly against noises and environment. In the proposed system SVM classifies the data in a wide variety range of applications. SVM is powerful to approximate any training data and generalizes better on given datasets. Extended Kalman filter which makes the system more robust by tracking and reduce the noise introduced by inaccurate detections. Extended Kalman filter outperforms other state-of –the –art algorithms in terms of efficiency, robustness and accuracy.

Index Terms*— *Multiple moving object tracking, (IP) camera and a network video recorder (NVR)

I. INTRODUCTION

The traditional video surveillance systems have disadvantages in that a person should monitor the closed-circuit televisions (CCTV) or search the digital video recorders (DVR) when necessary. So the needs for the intelligent video surveillance systems which can monitor and respond to situations in real time have increased due to the high-cost and low-efficiency of the existing ones. In addition, the video surveillance systems using IP cameras have been widespread and NVR enables a person to keep watching anywhere. This paper deals with an intelligent image processing technology for home or business video surveillance systems. Human body tracking is currently widely used for intelligent video surveillance application. Video surveillance system is one of the most popular researches in computer vision. The rise in public concern about safety nowadays has gained many researchers attention to enhance the current video surveillance system. Intelligent Video Surveillance System (IVSS) is the most recent smart surveillance system which is capable to identify automated human activity and behavior from the video. The intelligent video surveillance system is a convergence technology including detecting and tracking objects, analyzing their movements, and responding to them .We propose a method detecting and tracking multiple moving objects, which includes the basic technologies of the intelligent video surveillance systems. To detect and track the specific moving objects only, it is important to eliminate the environmental disturbances such as light scattering, leaves, and birds and so on from input images. To do this, two methods are mainly used.

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Nirmala M, Pursing her Master Degree in Digital Electronics, S. J. B. Institute of Technology, Bangalore, India.

Hamsaveni N, Asso. Prof., in S. J. B. Institute of Technology, Bangalore, India.

One is to use the Bayesian method such as the particle filter (PF) or the extended Kalman filter (EKF). Extended Kalman filter has many uses, including applications in control, navigation, computer vision, and time series econometrics. It has features like prediction, measurement and correction.

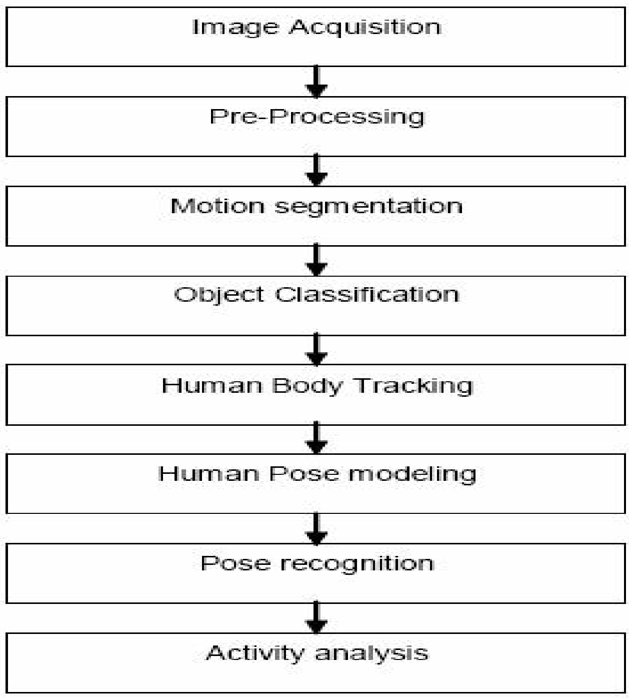

Fig. 1 System Model of the Video Surveillance System

Fig 1 shows Human body modeling which identifies the body positions and activities in video sequences. The proposed model is as shown in Fig 1. The frame work of the system starts with the acquiring of video images by means of camera and pre-processing has to be done on them for enhancing the quality of frames in the sequences. The video frames have a lot of noise due to camera, illumination and reflections etc. This can be removed and quality of images can be enhanced with the help of preprocessing stages. The suitable steps should be carried out in this stage. The next stage is motion segmentation which separates foreground images from background images and it is followed by Object classification, Tracking and Human pose modeling. At the end, the activity analysis will be processed. Massimo Piccardi reviewed about eight background subtraction techniques used for object tracking in video surveillance ranging from simple approaches, used for maximizing speed and restraining the memory requirements, to more complicated approaches, used for accomplishing the highest possible accuracy under any potential circumstances. All approaches intended for real-time performance. The techniques reviewed are: Running Gaussian average, Temporal median filter, Mixture of Gaussians, Kernel density estimation (KDE), Sequential KD approximation, Cooccurence of image variations and

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Eigen backgrounds technique. This paper describes an algorithm to detect and track moving human body from the camera calibration parameters and Mat-lab software. This paper is organized as follows, in section II, the structure of the proposed filterbank is presented. In section III, a design example is shown. In section IV, expected results are shown and lastly in section V, conclusion of the paper is drawn.

II. PROPOSED SYSTEM

Human detection in a smart surveillance system aims at making distinctions among moving objects in a video sequence. The successful interpretations of higher level human motions greatly rely on the precision of human detection. In the proposed system SVM Classifier and Extended Kalman Filter is used for detection and tracking of human body. General block diagram of the proposed design is shown in Fig. 2. Object detection in a video sequence is the method of detecting the moving objects in the frame sequence using digital image processing techniques. Background subtraction is the most commonly used technique for object detection. Background subtraction techniques for object detection from video sequence use the concept of subtracting the background model or a reference model from the current image. The methods considered in tracking of objects use various techniques for building the background model. It has been found that the methods require different time for execution and their performance differs in speed and memory requirements. The techniques involved in these algorithms are based on the intensity values of the pixels constituting the image. The background and illumination changes of the image influence the intensity values to a great extent, ultimately affecting the overall performance. An architectural view of the proposed design is shown in Fig. 3.which consists of PCA, SVM Classifier, Extended Kalman Filter blocks.

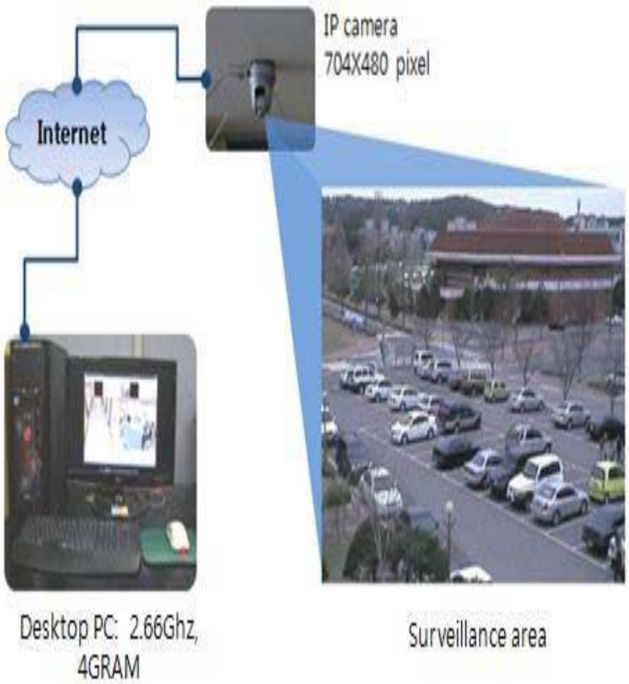

Fig. 2 General Block Diagram of the Proposed Design

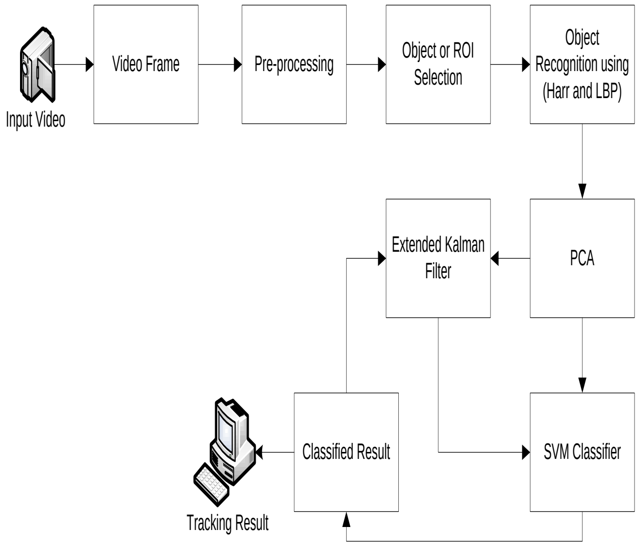

Fig. 3 Architecture of the Proposed Design

A. PCA Block

The Principal Component Analysis (PCA) is one of the most successful techniques that have been used in image recognition and compression. PCA is a statistical method under the broad title of factor analysis. The purpose of PCA is to reduce the large dimensionality of the data space (observed variables) to the smaller intrinsic dimensionality of feature space (independent variables), which are needed to describe the data economically. This is the case when there is a strong correlation between observed variables. The jobs which PCA can do are prediction, redundancy removal, feature extraction, data compression, etc. Because PCA is a classical technique which can do something in the linear domain, applications having linear models are suitable, such as signal processing, image processing, system and control theory, communications, etc. The main idea of using PCA for face recognition is to express the large 1-D vector of pixels constructed from 2-D facial image into the compact principal components of the feature space. This can be called eigen space projection. Eigen space is calculated by identifying the eigenvectors of the covariance matrix derived from a set of facial images (vectors).

B. Support Vector Machine Classifier

Several detectors are used in generic object modeling architecture which includes pixel-processing elements and classification systems. They have used a generic architecture as envisaged where detectors can exchange both features extracted at the pixel level and classification results.

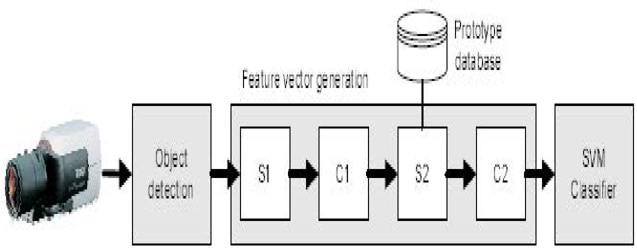

Fig. 4 Block Diagram for Object Classification in Camera Image

In an approach for video surveillance detection of irregular events based on target trajectory analysis is presented. The methodology pursues a sequence: Detection, Tracking and

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Identification. The detection step is done by using the color constancy principle using an adaptive background subtraction technique with shadow elimination model. The tracking uses a direct and inverse matrix matching process. In the identification stage local motion properties are expressed by elliptic Fourier descriptors.

C. Extended Kalman Filter

The Kalman filter dynamics results from the consecutive cycles of prediction and filtering. The dynamics of these cycles is derived and interpreted in the framework of Gaussian probability density functions. Under additional conditions on the system dynamics, the Kalman filter dynamics converges to a steady-state filter and the steady-state gain is derived. The innovation process associated with the filter, that represents the novel information conveyed to the state estimate by the last system measurement, is introduced. The filter dynamics is interpreted in terms of the error ellipsoids associated with theGaussian involved in the filter dynamics. The optimal non-linear filter propagates these non-Gaussian functions and evaluates their mean, which represents an high computational burden. A non optimal approach to solve the problem, in the frame of linear filters, is the Extended Kalman filter (EKF). The EKF implements a Kalman filter for a system dynamics that results from the linearization of the original non-linear filter dynamics around the previous state estimates. The Extended Kalman filter (EKF) gives an approximation of the optimal estimate. The non-linearities of the system's dynamics are approximated by a linearized version of the non-linear system model around the last state estimate. For this approximation to be valid, this linearization should be a good approximation of the non-linear model in all the uncertainty domain associated with the state estimate.

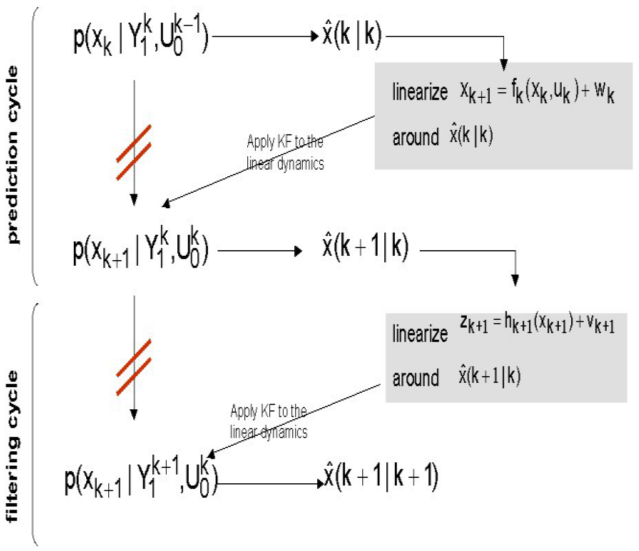


Fig. 5 Extented Kalman filter dynamic concept

One iteration of the EKF is composed by the following consecutive steps:

1. Consider the last filtered state estimate $\hat{x}(k|k)$,
2. Linearize the system dynamics, $x_{k+1} = f(x_k) + w_k$ around $\hat{x}(k|k)$,
3. Apply the prediction step of the Kalman filter to the linearized system dynamics just obtained, yielding $\hat{x}(k+1|k)$ and $P(k+1|k)$,
4. Linearize the observation dynamics, $y_k = h(x_k) + v_k$ around $\hat{x}(k+1|k)$,
5. Apply the filtering or update cycle of the Kalman filter to the linearized observation dynamics, yielding $\hat{x}(k+1|k+1)$ and $P(k+1|k+1)$.

Let $F(k)$ and $H(k)$ be the Jacobian matrices of $f(.)$ and $h(.)$, denoted by

$$F(k) = \nabla f_k \mid_{\hat{x}(k|k)}$$
$$H(k+1) = \nabla h \mid_{\hat{x}(k+1|k)}$$

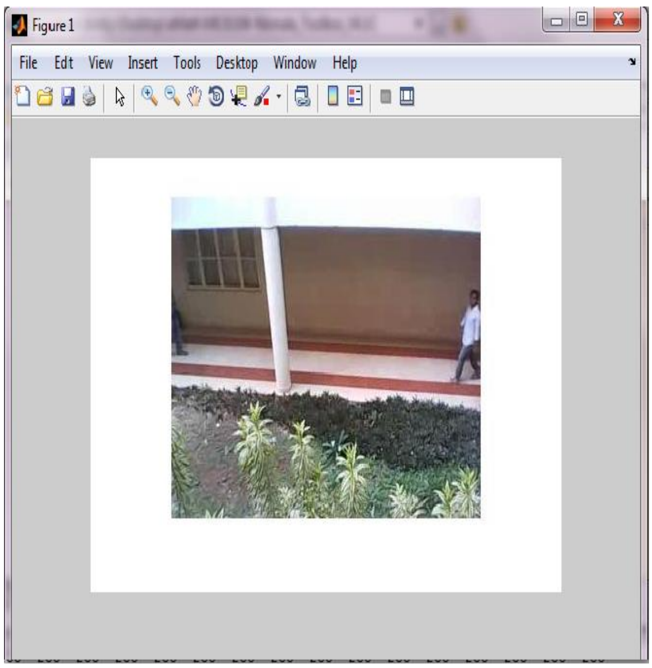
III. ABBREVATIONS

In the paper , SVM Classifier where SVM used for Support Vector Machine , PCA used for Principle Component Analysis, EKF for Extended Kalman Filter, NVR used for Network Video Recorder.

IV. EXPECTED EXPERIMENTAL RESULTS

Detecting human beings accurately in a surveillance video is one of the major topics of vision research due to its wide range of applications. It is challenging to process the image obtained from a surveillance video as it has low resolution. A review of the available detection techniques is presented. The detection process occurs in two steps: object detection and object classification. In this paper, human detection and tracking is done by principle component analysis and SVM Classier. Extended Kalman filters helps for prediction , measurement and correctness of the image.

Before Detection



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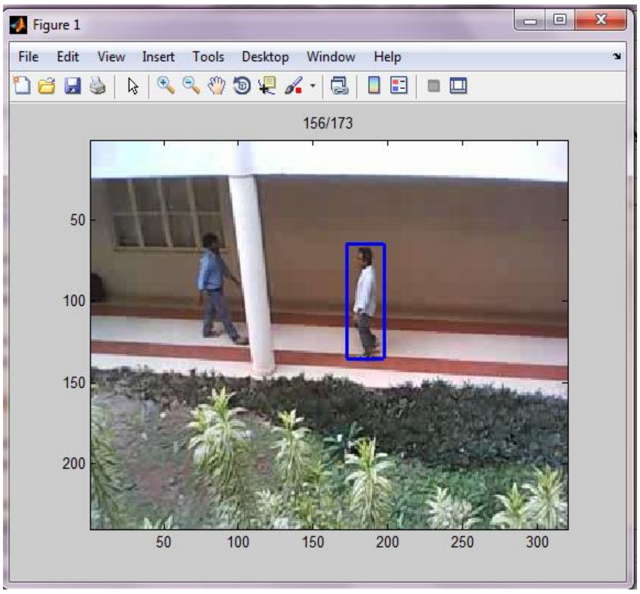
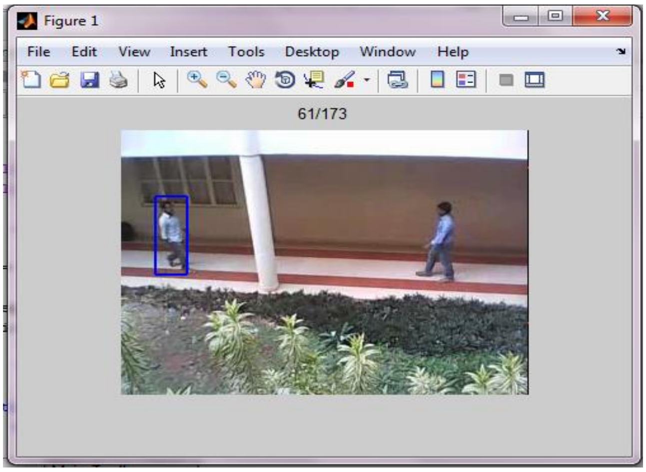
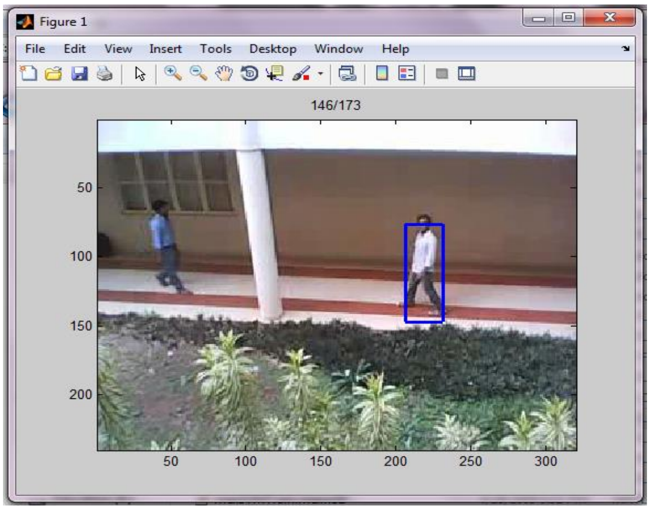
After Detection



The factors that led to the keen interest in this paper was that, it helps to detect and track objects in a moving environment, group of objects/humans are considered with a fixed camera which cannot cover wide area under coverage in the existing system.





V. Conclusion and Future Scope

In this system, a technology has been proposed for detecting and tracking a moving human body, among group of people which can be applied to consumer electronics such as home, business surveillance systems and also to detect and track a particular person consisting of IP camera and NVR. The robustness and the speed of the proposed method were verified through the experiments. Because of the robustness against the environmental influences, the proposed method can be used regardless of the place where a camera is installed. Because of the high-speed of the image processing, the proposed method can be applicable to the real-time surveillance system. At this time the method is intended for a fixed camera.A disc ussion is made to point the future work needed to improve the human detection process in surveillance videos. These include exploiting a multi-view approach and adopting an improved model for detecting and tracking a multiple or single humans. Further research for a pan-tilt-zoom (PTZ) camera is under consideration, which makes it possible to monitor a wide area with the minimal number of cameras. In this system fixed background is used as fixed camera has been used, but for further research moving camera can be used for different backgrounds which vary the features of the trained object. In this system only humans are detected & tracked using principle component analysis and SVM Classifier, but for further improvement different algorithms rather than SVM classifier and PCA can be used for detection and tracking of moving objects.

VI. Acknowledgment

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Nirmala M, Presently Pursing her Master Degree in Digital Electronics from S .J. B. Institute of Tchnology , Bangalore, India. She is B.Tech. From BITM, VTU, University in Electronics and Communication. Her Major Research Work Interests in Image Processing.

Hamsaveni N, Presently working as Associate Professor in S J B Institute of Technology, Bangalore, India. Her major research work interests in Image Processing.

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