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Use of Machine learning Classifier in Surveillance Systems

Kokate M.D. Chandwad, Nasik, India, mdkokate@rediffmail.com
Rahangdale K.V., Pune, India, komalvrahangdale@gmail.com
Wankhede V.A. , Chandwad, Nasik, wankhedeva@gmail.com

Abstract- **Nowadays, the increasing social threats and augmenting demand for video surveillance has become essential to bring efficient, fast detection and tracking video/image algorithms. Movement monitoring of a person, object is impetus behind this issue. In this paper, tracking of object is done using Kalman filtering and thereafter unknown person or known person face is detected and further monitorial processing is performed using GSM.**

Keywords — ***Kalman Filter, GMM, EKF, image detection, classifier; GSM module.***

I. INTRODUCTION

The surveillance system is a more efficient algorithm that consists of three intermediate steps, first is the development of a new image representation called "*integral image"* which allows feature selection to be easy and rapid. Second deals with the construction of classifiers that helps us to segregate desired features from the set of large number of features using a technique called *"AdaBoost"*. Third deals with the cascading of different classifiers which was introduced for further detailed selection of features and there by narrowing down our search and increasing speed of detection and tracking. This technique is expensive and more time consuming so, the operator role in monitoring section is costly for organization even then human error will be critical issue. Here, we have proposed to avoid man power requirement.

II. PROPOSED SYSTEM ON TRACKING OF EVENT AND FACE DETECTION

Many real time face detection and tracking systems have been appeared in literature [1].[2],[3],[4],[5].

In this proposed system, object detection, tracking and classification of features and identification are clearly extracted with less computations and complexity. MATLAB is used for detecting event and identification purpose.

Following processes have been are used in this approach.

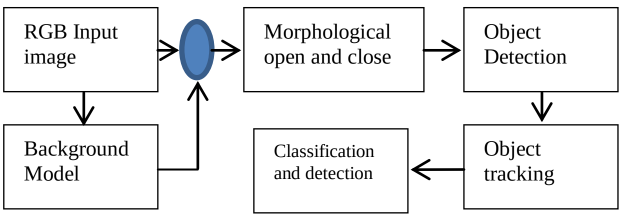

Fig.1 Block Diagram of Proposed System

A. GMM for low level preprocessing

Gaussian Mixture Model (GMM) is a composite distribution model where points are drawn form one of the K-means algorithm where each of points will have it's own probabilistic model which assumes all the data points generated from a mixture of finite number of normal distribution with unknown parameters. For clustering, K-means algorithms won't work for overlapped clusters. In GMM, clusters are modeled as Gaussian distributed and not just as mean like in K algorithm. The input video signal is extracted into frames, after that frame is applied to low level clustering scheme GMM which removes illumination and noises from frames using linear super position of Gaussian distribution [1],

$$P(x_t)=\sum_{i=1}^{k}\omega_{i,t}*\eta(x_{t,},\mu_{i,t}\,\Sigma_{i,t}) \qquad (1)$$

where k is number of Gaussian variables, typically k=1; $\omega_{i,t}$ is mixing coefficient, the weightage of each distribution, $\mu_{i,t}$ is the mean value of ith Gaussian in the mixture at time t and $\Sigma_{i,t}$ is the covariance matrix of ith Gaussian in the mixture at time t and η is a multivariate Gaussian probability density function [2]. The Gaussian mixture comes with different options to constrain the covariance of the difference classes estimated:

$$\eta(x_t,\mu,\Sigma)=\frac{1}{(2\Pi)^{n/2}\,|\Sigma|^{1/2}}*e^{\frac{1}{2}(x_t-\mu_t)^T\,\Sigma^{-1}(x_t-\mu_t)} \qquad (2)$$

We need to estimate mean and covariance. With same variance and independent Gaussian models, the covariance matric is

$$\Sigma_{k,t}=\alpha_k^2 I \qquad (3)$$

Match pixel value within standard deviation of distribution (=2.5), weight of the k distribution at time t, $\omega_{k,t}$ is as follow,

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$$\omega_{k,t} = (1-\alpha)\,\omega_{k,t-1} + \alpha\left(M_{k,t}\right) \quad (4)$$

where $M_{k,t}$ is 1 for matching and α is a learning rate. Now updated new Gaussian observation with the help of following iterations:

$$\mu_t = (1-\rho)\,\mu_{t-1} + \rho(Xt) \quad (5)$$
$$\sigma_t^2 = (1-\rho)\,\sigma_{t-1}^2 + \rho(X_t-\mu_t)^T(X_t-\mu_t)$$

$$\rho = \alpha\eta\left(X_t \setminus \mu_k, \sigma_k\right) \quad (6)$$

If no match is found for the new observed pixel, after that B distribution model chosen for T background is generally

$$B = \arg\min_b\left(\sum_{k=1}^{b}\omega_k \succ T\right) \quad (7)$$

B. Morphological Open and Close

Normally, morphological operations are performed to extract the significant features from image that are useful for image representation and description of region shapes [2],[11]. Morphological filters removes noise. Morphological opening is to remove noise in the foreground. i.e. morphological open is to remove shrink in opening time and at closing reconstruct all data and collect. Blob analysis has been used to compute their bounding boxes.

$$\prod_{\phi RC}(I_S) = \left\{\prod_{\phi RC\lambda} : \prod_{\phi RC\lambda} = \phi RC^{\lambda}(I_S)\,\forall\lambda\in[o,n]\right\} \quad (8)$$

L.H.S side is shown for closing profile after performing on image.

$$\Delta_{\gamma RC}(I_S) = \left\{\Delta_{\gamma RC\lambda} : \Delta_{\gamma RC\lambda} = \prod_{\gamma RC(\lambda-1)} - \prod_{\gamma RC\lambda}\,\forall\lambda\in[1,n]\right\} \quad (9)$$

L.H.S side is shown derivative opening profile and R.H.S shown subtraction of consecutives opening operations in images.

$$\Delta_{\gamma RC\lambda}(I_S) = \left\{\Delta_{\gamma RC\lambda} : \Delta_{\gamma RC\lambda} = \prod_{\gamma RC\lambda} - \prod_{\gamma RC(\lambda-1)}\,\forall\lambda\in[1,n]\right\} \quad (10)$$

L.H.S side of (10) show derivative closing profile and R.H.S show subtraction of consecutives closing operations in images.

C. Object Detection

Blob analysis is used for finding objects in frame and finding the center of mass [5],

- Compactness= $\frac{Area\ of blob}{width.height}$
- Center of mass

$$x_c = \frac{1}{N}\sum_{i=1}^{N} x_i \qquad y_c = \frac{1}{N}\sum_{i=1}^{N} y_i \quad (11)$$

Where, N is the total no. of pixels, Center of bounding circle is calculated,

$$x_{bc} = \frac{x_{\min} + x_{max}}{2} \quad (12)$$
$$y_{bc} = \frac{y_{\min} + y_{max}}{2}$$

III. KALMAN FILTER FOR OBJECT TRACKING

Tracking occluded objects is presented, which tracks multiple objects efficiently even if the background modeling is compromised at some instant. This paper is divided into four parts i.e. background modeling, extended Kalman filtering, dominant color information extraction and feature extraction. First of all, Standard Gaussian Mixture Model (StGMM) is applied to extract foreground. The proposed StGMM excludes the shadow and noise from the scene.

Expectation Maximization (EM) algorithm is use to assign data to cluster with some probability.

Secondly, to predict the state of nonlinear objects Extended Kalman Filter (EKF) is exploited. The overall performance of the tracking system can be reinforced using EKF if the object is not extracted in one or more frames.

Fig.2 Tracking a Person

Here the person picked up object in this case the object area is shows using background subtraction.

Fig.3 Helmet Detected Area

IV. CLASSIFYING ACTIVITIES

Model Training: Every model is trained to detect a specific type of object. The classification models trained with features extracted from a set of known images. These features are then fed into a learning algorithm to train the classification model. Classifying activities is in following–

a) Face detection
b) Face recognition
c) Person name or object is identify, if person unknown or known person face saved.

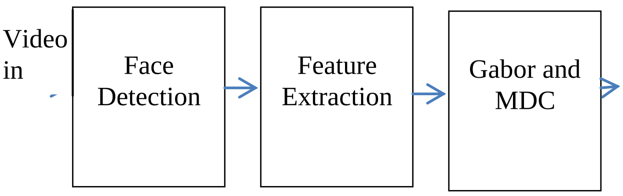

Fig.4 Classifying Activities

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a) Face Detection-

The Viola-Jones Algorithm is used for face detection; this algorithm works using Haar-like features [6], [7]. These features are basically black and white rectangles that the algorithm hunts for in an image. The algorithm adds the number of pixels of the rectangles to a box depending on whether it is contained in a threshold or not.

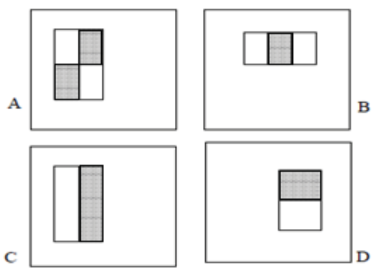

Fig.5 Rectangles in Face Detection

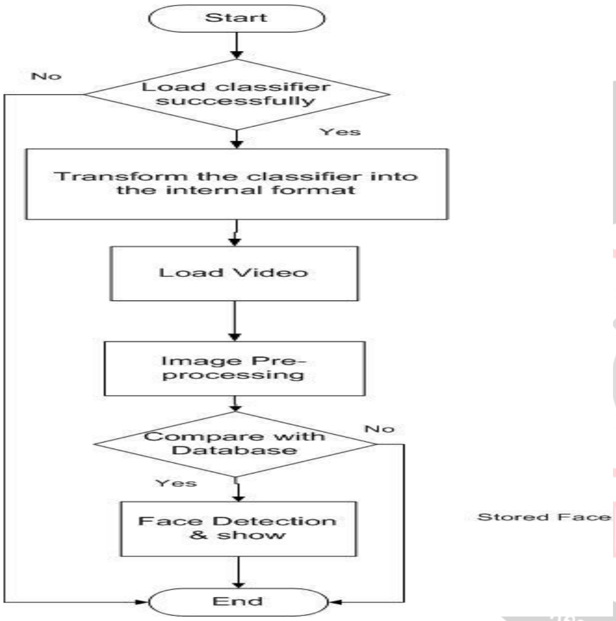

Fig.6 Face Detection Flowchart

The face detection scheme is utilized in smart cars for security purpose [8].

b) Face Recognition-

The face recognition is a process of identifying identity of an individual using his face as input.

In this paper, Gabor filter available in MATLAB has been used for face detection. The Gabor features can be derived by applying signal processing technics both in time and frequency domain. If we specify wavelength orientation vectors, *gabor* function in MATLAB reruns array of objects, that contains specific combination of frequency and time. The Minimum distance Classifier (MDC) as shown in fig 4 optimizes colour spaces.[9]

Fig.7 Face Stored In Database

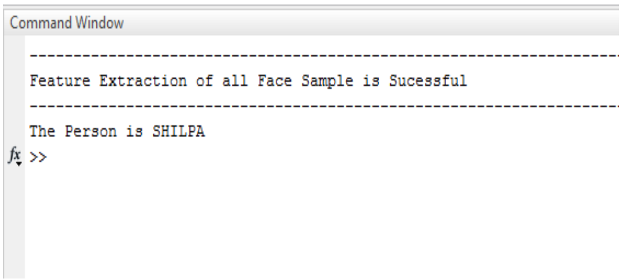

Fig.8 Detected Result

In [10] an application for counting people in masses through a single fixed camera is discussed.

c) *Identification [GSM Model]*

GSM model is used for sending message to destination after tracking and face detection process is completed [11].

To achieve important information of indoor system, one GSM module is added into the security system. The module quickly sends SMS messages to appointed mobile phone or SMS server and the owner can be informed accordingly. If another unknown person is obtained in surveillance area that picked up any object so his /her face is saved in system and the face data is also sent to an information server.

V. CONCLUSION

Proposed model of GMM takes the less computational time with less man power and is more reliable. It has four different covariance types. These types have their own degree of freedom in the shape of the clusters. It will not bias the means towards zero. But when someone has insufficiently many points per mixture, estimating the covariance matrices become very difficult, and algorithm is known to diverge and find solutions with infinite likelihood unless one regularizes the covariance artificially.

In future, this event detection system can be used for surveillance, where viewing all footage is not possible when suspicious activity takes place.

GSM module is used for sending message to owner of indoor surveillance area.

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