Network Based Real Time Smart Alarming Video Surveillance System for Threat Detection

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***Abstract*— Object detection and tracking are vital and challenging tasks in many computer vision applications such as surveillance, vehicle navigation, and autonomous robot navigation. Moving Object detection and tracking are receiving a growing attention with the emergence of surveillance systems Surveillance is the monitoring of the behavior, activities or other changing information generally of people and object. Video surveillance is commonly used for event detection and human identification. But it is not simple as think to detect the event or tracking the object. Proposed system presents a new framework for smart threat detection with the assistance of video surveillance which captures live streaming from the camera and determine if any object is missing from the field of view. It then raises an alarm by sending an email to the authorised person just right after the object is missing from the field of view. The object is detected with the help of background subtraction and tracked using kalman filter and brought more accuracy on the object's image with the help of morphological operations.**

***Keywords*— Background subtraction, foreground detection and foreground mask, morphological operations, Blob analysis, Kalman filter, Alarm Generation.**

I. INTRODUCTION

Video Surveillance system has become an important aspect in security and a necessity to keep proper check against crime. There was a time when video surveillance was mostly used by the government and big companies only. But now the scenario has been changed. Now the use of surveillance camera has increased and it is increasing more and more. At everyplace, whether it's a restaurant, office, shops, educational institution, museums, department stores, schools, colleges or station, presence of video surveillance is almost obvious. This is because of the awareness of people to take precautions against crime than a cure and of technology being much more inexpensive. But the criminals are as aware as everyone else. So, to watch over from any unpredicted situations from occurring we need the surveillance system to be more accurate and advanced. That is how the idea of missing object detection through video surveillance came up. With the help of which we can identify if any object is missing from the field of view and then raises an alarm. It is challenging to detect an object in different environmental conditions. Here, the object will still be successfully detected in our project.

There are 3 key steps in video analysis:

- Detection of attention- grabbing moving objects.
- Tracking of moving objects from frame to frame.
- Analysis of object tracks to acknowledge their behavior.

A. Object Detection

Performance of an automated visual surveillance system significantly depends on its ability to find moving objects within the observed surrounding. A resulting action, such as tracking, analyzing the motion or distinguish objects, needs associate degree extraction of the foreground objects, creating moving object detection is a vital part of the system. So as to come to a decision on whether or not some regions during a frame are foreground or not there ought to be a model for the background intensities.

Object detection techniques consists of 2 main steps. Object detection techniques consists of 2 main steps. The primary step may be a preprocessing step that includes gray scaling, smoothing, and reducing image resolution then on. The second step is filtering to get rid of the image noise contained within the object. The filtering is performed by applying the morphology filter like dilation and erosion and eventually connected component labeling is performed on the filtered image.

B. Object Tracking

The goal of object tracking is to determine a correspondence between objects or object parts in consecutive frames and to extract temporal information concerning objects like trajectory, posture, speed and direction. Tracking detected objects frame by frame in close video may be vital and troublesome task.

An object level tracking algorithm is used in the proposed system . The knowledge extracted by this level of tracking is adequate for many of the smart surveillance applications. Approach is to make use of the object features such as size, center of mass and bounding box which are extracted in previous steps to determine a matching between objects in consecutive frames. By analyzing the object trajectory information, tracking system is ready to detect left and removed objects further.

C. Detecting Left and Removed Objects

The ability of detecting left and removed objects in a very scene is flatly important in some visual surveillance applications.3 steps in detecting left or removed objects are as follows:

1. Detecting a modification between the current image and therefore the reference background image by applying the adaptive background subtraction scheme.
2. Deciding that the detected region corresponds to a left or removed object by applying object tracking technique.

II. RESEARCH METHODOLOGY

This research is largely aimed for implementing a smart surveillance system that is capable of detecting any missing object left from the place. It also alarm the concerned person by sending an email to his email id. When the object is found to be missing in the Field of view, an automatic alarm is raised to aware the authority. The whole thesis is done in Matlab 2013b where the object detection is done by Background subtraction and the object tracking is done by Kalman filter. The image of the object is brought into more accuracy with the help of Morphological operations. To verify the completion of the project several videos have been made where the object is removed from the Field of View and check whether it sends the email to the concerned authority just after the object is missing . Most of the videos were made in different lighting condition to evaluate the role of lighting in the accuracy of detecting and tracking the missing object.

III. LITERATURE REVIEW

Lipton. J et al.(1998) [6] proposed an end-to-end method for extracting moving targets from a real-time video stream, classifying them into predefined categories according to image based properties, and then robustly tracking them. Moving targets are detected using the pixel wise difference between consecutive image frames. A classification metric is applied these targets with a temporal consistency constraint to classify them into three categories: human, vehicle or background clutter. Once classified, targets are tracked by a combination of temporal differencing and template matching frame. This method is very adaptive to dynamic environments, but generally does a poor job of extracting all the relevant pixels, e.g., there may be holes left inside moving entities. In order to overcome disadvantage of two-frames differencing, in some cases three-frames differencing is used.

Stauffer & Grimson et al.(1999) [7] proposed a a visual monitoring system that passively observes moving objects in a site and learns patterns of activity from those observations using Gaussian mixture model based on background model to detect the object.

Collins et al.(2000) [9] developed a hybrid method that combines three-frame differencing with an adaptive background subtraction model for their VSAM (Video Surveillance and Monitoring) project. . The hybrid algorithm successfully segments moving regions in video without the defects of temporal differencing and background subtraction.

Liu et al.(2001) [12] ,Proposed an approach to detect and track moving objects with a stationary camera. The mixture Gaussian model is used as an adaptive background updating method. Based on subtraction, foreground is separated from background, and then foreground objects are segmented with a modified binary connected component analysis. Kalman filtering is used in object tracking.

Yi˘githan Dedeo˘gl et al.(August, 2004) [1] proposed a smart visual surveillance system with real-time moving object detection, classification and tracking capabilities. The system operates on both colour and gray scale video imagery from a stationary camera. It can handle object detection in indoor and outdoor environments and under changing illumination conditions. The classification algorithm makes use of the shape of the detected objects and temporal tracking results to successfully categorize objects into pre-defined classes like human, human group and vehicle. The system is also able to detect the natural phenomenon fire in various scenes reliably. The proposed tracking algorithm successfully tracks video objects even in full occlusion cases. In addition to these, some important needs of a robust smart video surveillance system such as removing shadows, detecting sudden illumination changes and distinguishing left/removed objects are met.

Desa & Salih et al.(2004) [10], Some image processing concepts related to the study are first presented and improvement is proposed. They have obtained motion mask by applying background subtraction and consecutive frame differencing. They propose a reliable background update and noise reduction operator to facilitate the result of moving object extraction and a combination of background subtraction and frame difference that improved the previous results of background subtraction and frame difference. In object tracking methodology, this article will describe more about the region based tracking. Region-based tracking algorithms track objects according to variations of the image regions corresponding to the moving objects. For these algorithms, the background image is maintained dynamically and motion regions are usually detected by subtracting the background from the current image.

Cezar.J et al.(2005) [3] has proposed a small improvement to an existing background model, and incorporate a novel technique for shadow detection in greyscale video sequences. The proposed algorithm works well for both indoor and outdoor sequences, and does not require the use of colour cameras.

Sugandi et al.(2007) [8], proposed a new technique for object detection employing frame difference on low resolution image. Many tracking algorithms have better performance under a static background in indoor environment. It is, however, most of the tracking algorithms are applied in outdoor environment with noisy background instead of indoor environment. Since a low resolution image has a property that it can remove the small size pixels, it is adopted to solve the problem of the noisy background. In the tracking of a target object, many applications have problem when object occlude each other. A block matching technique based on peripheral increment sign correlation image is utilized to solve this problem. The identification of a target object is performed using color and spatial information of the target object.

Kalal. Z (April 2011) [4] proposed a novel tracking paradigm (TLD) that decomposes the visual tracking task into three sub-tasks: Tracking, Learning and Detection. The tracker follows the object from frame to frame. The detector localizes appearances that have been observed during tracking and corrects the tracker if necessary. Exploiting the spatio-temporal structure in the video sequence, the learning component estimates errors performed by the detector and updates it to avoid these errors in the future. In tracking, he develop a method for detection of tracking failures that we call Forward-Backward (FB) error. The FB error allows us to measure the reliability of point trajectories in video. In detection, He focus on supervised learning of object detectors from large data sets and develop a learning algorithm that optimally combines two popular learning approaches: boosting and bootstrapping. In learning, focus on incremental, real-time learning of object detectors from a video stream and develop a novel learning theory, P-N learning, which drives the learning process by a pair of ”experts” on estimation of detector errors: (i) P-expert estimates missed detections; (ii) N-expert estimates false alarms.

G. Mallikarjuna Rao, Dr. Ch. Satyanarayana (April, 2014) [5] proposed the tracking of single object in a sequence of frames either from a live camera or a previously saved video. A moving object is detected frame-by-frame with high accuracy and efficiency using Median approximation technique. As soon as the object has been detected, the same is tracked by kalman filter estimation technique along with a more accurate Template Matching algorithm. The system handles entry and exit of an object. Such a tracking scheme is cost effective and it can be used as an automated video conferencing system and also has application as a surveillance tool.

IV. System Implementation

- Object Detection with Background Subtraction
- Assigning Field Of View(FOV)
- Foreground Detection And Foreground mask
- Using Morphology to eliminate gaps between pixels of any detected object for more accuracy and smoothens of the object.
- Blob Analysis
- Using Kalman filter to track object in the frame
- Send the mail to authority when moving object leaves the Field Of View.

A. Background Subtraction

Background subtraction plays a vital role within the field of object detection. There are numerous of proposed algorithms for background subtraction, as an example, Mean filter, Gaussian Average, Frame difference model. Background subtraction could be a common and wide used technique for foreground detection and foreground mask (namely, a binary image having the pixels belonging to moving objects in the video) by working of static cameras. So as the name suggests, Background subtraction calculates the foreground mask executing a subtraction between the current frame and a background model, containing the static part of the scene or, additionally normally, everything which can be thought of as background given the characteristics of the observed scene[6].

The detection of moving objects uses a background subtraction algorithm based on Gaussian mixture models to induce the foreground mask.

B. Foreground Detection And Foreground Mask

The foreground detection is employed to segment moving objects from the background. It outputs a binary mask, where the pixel value of 1 corresponds to the foreground and therefore the value of 0 corresponds to the background.

Foreground detection is done using Gaussian mixture model.

Algorithm of Gaussian Mixture Model:

In order to present a far better understanding of the algorithm used for background subtraction the subsequent steps were adopted to realize the required results:

1. Firstly, we compare each input pixels to the mean 'µ' of the associated components. If the value of a pixel is near to a selected component's mean, then that component is taken in to account as the matched component. So as to be a matched component, the difference between the pixel and mean must be less than compared to the component's standard deviation scaled by factor D in the algorithm.
2. Secondly, update the Gaussian weight, mean and standard deviation (variance) to give the new obtained pixel value. In relation to non-matched components the weights 'w' decreases whereas the mean and standard deviation stay the same. It is dependent upon the learning component 'p' in relation to how fast they change.
3. Thirdly, determine which components are parts of the background model. For this a threshold value is applied to the component weights 'w'.
4. Fourthly, in the final step determine the foreground pixels. Here the pixels that are determined as foreground don’t match with any components identified to be the background.[2]

C. Morphology

Morphological filtering of a binary image is conducted by considering compound operations like opening and closing as filters. They will act as filters of shape. As an example, opening with a disc structuring element smoothes corners from the inside, and closing with a disc smoothes corners from the outside. However jointly these operations will filter out from an image any details that are smaller in size than the structuring element, e.g. opening is filtering the binary image at a scale outlined by the size of the structuring element. Solely those portions of the image which fit the structuring element are passed by the filter; smaller structures are blocked and excluded from the output image. The size of the structuring element is most important to eliminate noisy details but not to damage objects of interest[4].

D. Blob Analysis

For image process, a blob is outlined as a region of connected pixels. Blob analysis is that the identification and study of those regions in an image. The algorithms make out pixels by their value and place them in one of every of 2 categories: the foreground (typically pixels with a non-zero value) or the background (pixels with a zero value).

E. Detection Of Moving Object Using Kalman Filter

The association of detections to the same object entirely based on motion. The motion of each track is calculated by a Kalman filter. The filter is employed to predict the track' s location in every frame, and determine the chances of each detection being assigned to every track[5].

Track maintenance becomes an vital side. In every frame, some detections may be assigned to tracks, while other detections and tracks could stay unassigned. The assigned tracks are updated using the related detections. The unassigned tracks are marked invisible. An unassigned detection begins a brand new track.

Every track keeps count of the number of consecutive frames, wherever it remained unassigned. If the count exceeds a specific threshold, system assumes that the object leave the field of view and it deletes the track.

F. Object Leaves The Field Of View

The field of view (also called the field of vision, abbreviated FOV) is the range of the observable world that is seen at any given moment. Field of view is the area of the scrutiny captured on the camera's imager. The size of the field of view is rely on the size of the camera's imager directly. After the moving object leaves the field of view system sends the alarming email to the authority.

V. Results And Discussion

A real time video player application (Object Monitoring _System) is implemented in Matlab 2013b. The video player can play real time video and send an alarming mail to the mail id entered in the system so that immediate and quick action can be taken against crime.

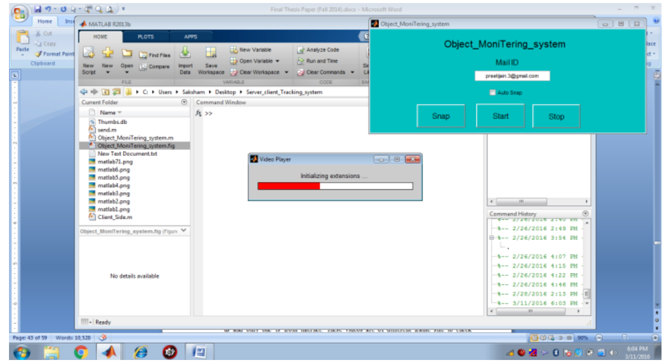

Fig. 1. Initialization of the camera

The camera is installed and initialized to capture the video of the place where the threat of crime is high. Camera is stationary in the system. Field of View depends on the type of camera, its angle and capacity.

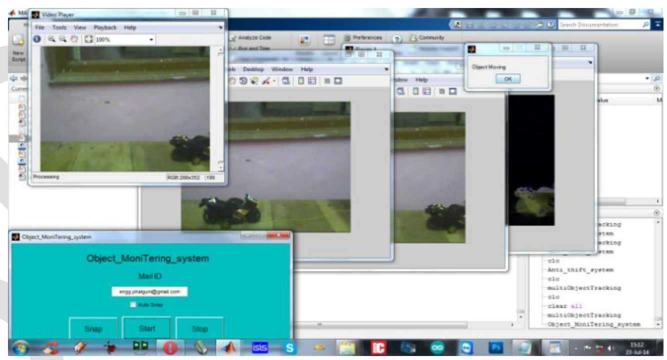

Fig. 2. Movement of Object

In above figure object is moved towards right which is shown in figure 2 of the system and a dialog box of object moving appears on the system.

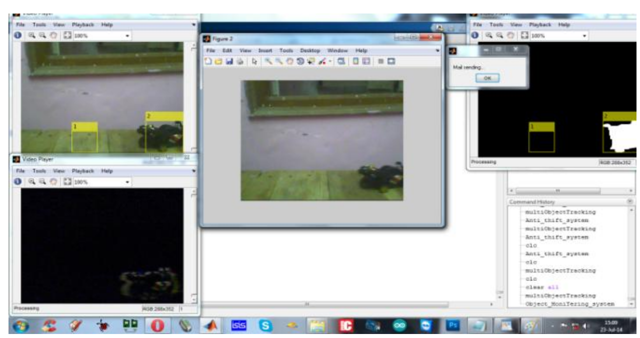

Fig. 3.Detection of Moving Object

Fig 3. shows the movement of object in a bounded box from bounded box 1 to bounded box 2. Video player of the system is showing the object after tracking through kalman filter and morphological operations. As the object is removed from the FOV a dialog box (Mail Sending) appears on the screen.

VI. CONCLUSIONS

The objective has been to detect moving objects in real time video and thereafter, decide on objects of particular interest which would be tracked and then perform the network based alarm operation though email. I have implement the Video surveillance system in Matlab 2013b. Object detection in video image obtained from single camera with static background that means fixing camera at a particular place. In this thesis, I have tried different videos with fixed camera with a single object and multiple objects to see if it is able to track objects. There are many methods available for object detection and object tracking. Here for object detection we have used the background subtraction to get foreground mask of the moving object, kalman filter is used for object tracking, morphological operations are done to remove noise, and finally a mail is send immediately after the object is moved out of the FOV(Field of view). All this gave satisfactory results in sufficiently reducing the noise while detecting moving objects. The approach seems to have efficient practical applications. But in some cases it gives unwanted noise. It give noise in poorly-lighted conditions such as night-time, and in different environmental conditions such as illumination changes, shadows and waving tree branches in the wind. I have compared proposed method with existing methods and prove that rather than simply tracking the object I have modified it by implementing the network based alarm system through email so that necessary and immediate action can be taken as soon as possible.

VII. FUTURE WORK

Future work will be directed towards achieving the following issues:

- Object classifications
- Improved data logging and retrieval
- mechanisms to support 24*7 system operations.
- Better understanding of object motion including segmentation and tracking of articulated body parts.
- Better camera control to enable smooth object
- tracking at high zoom, even in case, video is vibrating
- Video stabilization algorithm is required.

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