International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Improved Intelligence Surveillance System for Object Detection, Classification of Human Behaviour using GMM and Open CV

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Abstract: ***Real object motion detection has widely used in surveillance system such as intelligent security systems, airport security systems, video monitoring systems, etc. Object tracking is one of the most necessary steps for surveillance system. Moving object and background separation must be separated as much as clear. Motion detection is nothing but movement of objects. This pre processing can be done with the help of various techniques like GMM. A popular object segmentation strategy is background subtraction. While traditional methods of Segmentation using Thresholding, Background subtraction and Background estimation provide satisfactory results to detect single objects, noise is produced in case of multiple objects and in poor lighting conditions. In this paper we will be focusing on important features to build an advanced intelligent surveillance system and its architecture. To reduce the crime rate in any country advanced intelligent surveillance system required to automatically detect the illegal activities done by any criminal.***

Keywords: GMM, *Surveillance*, Thresholding, CCTV, Segmentation, *Loitering*, *ISS*

1. Introduction

In INDIA recently more focuses on public security because of increasing crime day by day. Like terrorists activity, rape, sexual harassment, murder, theft etc. As we know, after the criminal activity done, government deciding about to cover more public area covering with a CCTV cameras to improve the security. But in the traditional systems [1] a network of passive cameras able of only recording the moving images and converting it to video files are deployed at the site of prime importance. In case of accidents, terrorist attacks, theft, malicious activities such video data comes to be very important for analysis. But if traditional system is used we require to watch the video data again and again for long hours together because collected data is very large and we don't know the exact time when the malicious activity done. So that it is much necessary to build an intelligent surveillance system that would not only to provide a data as per traditional system but also assist us to detect malicious activities. Most colleagues are keeping faith on each other's and sharing their cabin or many things. But some of the criminal minded are doing malicious activities in absence of their co-workers. We can easily track and catch the activity when it happens with help of this intelligent system. In this system we added trip wire detection, face detection & capturing, loitering, abandoned bag detection likewise advance feature added. It would be so easy if system on its own recognizes some events as malicious and extract only those frames which are providing suspicious activity. The endless hours of watching the video can be avoided [4].

2. Background Subtraction

In this section, we had shown how to isolate objects or parts of objects from the rest of the image. In video security system, for example, the camera mostly looks out on the same boring background, which really isn't of interest. In CCTV camera recording scene when something is left in the scene that wasn't there before like a moving object. We want to isolate those events and to be able to ignore the endless hours when nothing is changing (i.e. background).

A binary image is a digital image that has only two possible values for each pixel [6-7]. Typically the two colors used for a binary image are black and white though any two colors can be used. The color used for the object(s) is the foreground color in the image while the rest of the image is the background color. Binary images are also known as *bi-level* or *two-level* images. i.e. each pixel is stored as a single bit (0 or 1). The names *black-and-white*, *B&W*, monochrome or monochromatic are often used for this concept, but may also designate any images that have only one sample per pixel, such as gray scale images.

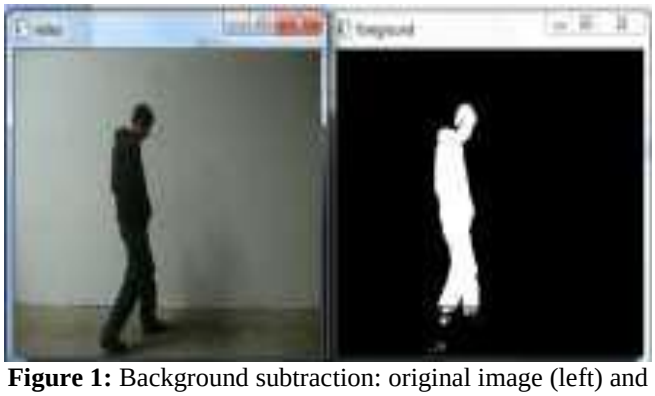

Figure 1: Background subtraction: original image (left) and foreground image (right)

Moving object detection in real time is a challenging task in visual surveillance systems. It often acts as an initial step for further processing such as classification of the detected moving object. In order to perform more sophisticated operations such as classification, we need to first develop an efficient and accurate method for detecting moving objects.

Background subtraction method is one of the simplest and popular method for moving object detection is which often uses background subtraction and modeling, but it takes more time to detect moving objects.

Temporal difference method is very simple method and it can easily detect objects in real time, but it does not provide robustness against illumination change. The foreground extraction problem is allocated with the change detection techniques, which can be pixel based or region based. Simple differencing is the most common technique by arguing that a change at a pixel location [6].

Thresholding is the very simple method of image segmentation to convert binary image from a gray scale image, thresholding can be used to create binary images from a gray scale image. When the thresholding process happened, individual pixels marked as "object" pixels from the image if their value is greater than preset threshold value and as "background" pixels otherwise. Above process is known as threshold above.

3. Intelligence Surveillance System

In the following architecture shown how camera capturing frames for video and how our intelligence system detects human normal behaviors and malicious intents. If any suspicious frame or activity done by human this system has been trace it and start the alarm to control crime. This system is working definitely reduce the crime rate in India. With this improved system we can stop the terrorist attack before it happened.

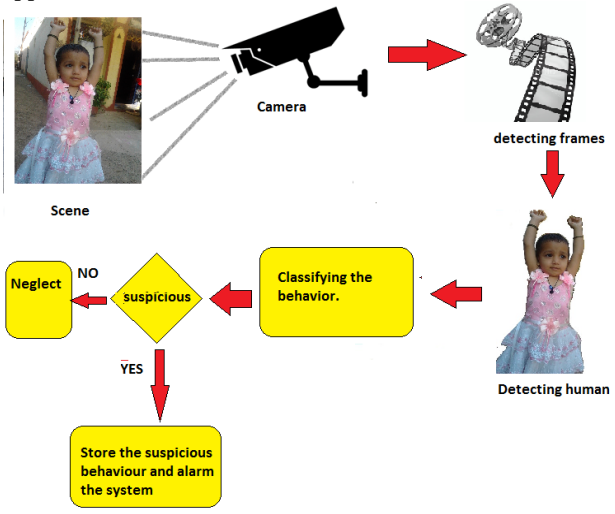

Figure 2: Generalized architecture of ISS system

A. Implementation Procedure

Step 1: This routine will detect each frame at real time from a video sequence and present its status in form of matrix, its frame no, pixels, color content and sample rate, etc. Mainly due to durability and simplicity of its use we will be opting for Gaussian models for background subtraction.

Step 2: This will detect and remove background features to detect the object in the scene. Algorithms like GMM based will be a tool for such removal. As shown in fig.3 we need to remove unwanted background and separate foreground data containing moving objects. Then we apply segmentation algorithms to separate moving objects from background.

Step 3: Non-human objects are to be deleted and human objects are to be maintained in frames. Once we get a human object in frame we can track the motion of such object in subsequent frames.

Step 4: After this we draw a bounding rectangle around the counter and save its center of mass.

Step 5: Now we can track motion of moving object using the center of mass.

Step 6: If the center of mass crosses a threshold report the event as suspicious by giving an alert with an alarm.

Step 7: In case of such event save the suspicious frame, extract the intruder photo and store his face and data.

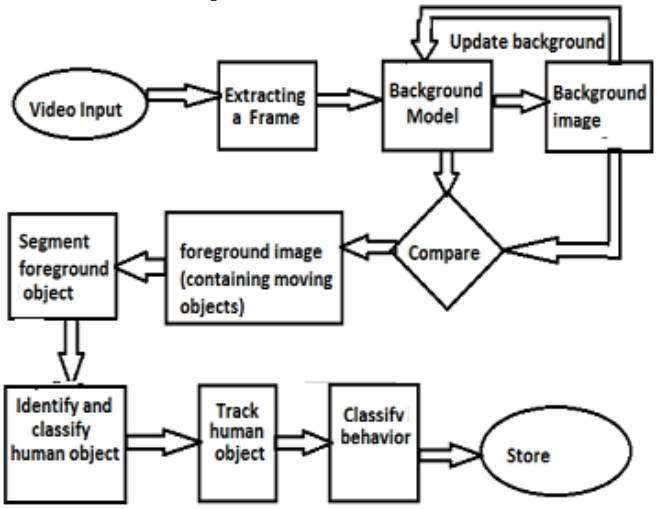

Figure 3: Architecture of ISS system.

Loitering: A person has been standing or roaming at a one place more than required time and / or for more time than a preset threshold in our system.

Figure 4: Suspicious person loitering for a long period of time.

In the above figure shown a single person or no interaction (see Fig. 4) consists of behaviors that can be defined only by considering person(s), which are not interacting with any other person or vehicle. The person may be planning to do some kind of malicious activity that will be much harmful to the society or it may be possible he is there for any positive

activity. But precaution is better than cure our system will detect the person and take action like a criminal activity.

To maintain the peace in the society this kind of surveillance system is much more useful. For example, loitering, crowd counting, crowd flow (behavior) analysis, and person talking on a cell phone. Loitering is defined as the presence of an individual in an area for a period of time longer than a given time threshold. Methods for automatically detecting loitering in real time would enable deployed security to investigate sus- picious individuals or to target loitering stations for future investigation. Loitering is of very easy way to public transit systems since it is a common regular way of drug dealers, beggars, and muggers, among others. In this survey, loitering refers to a behavior that exclusively involves a human [6].

4. Mathematical Model

A. Gaussian models

The main idea is to of actually fitting one Gaussian distribution (μ, σ) over the histogram. This was supposed to give the Background PDF. This Background PDF was to be updated from time to time for suppressing background changes. Generalized Gaussian Family model is most representative background model. Background was modeled as pixel variation in a static scene over time with GGF distribution defined.

This was supposed to give the Background PDF. This Background PDF was to be updated from time to time for suppressing background changes. So this update was given by running average as follows:

$$\mu_{t+1} = \alpha F_t + (1-\alpha)\mu_t$$
$$\sigma^2_{t+1} = \alpha(F_t - \mu_t)^2 + (1-\alpha)\sigma^2_t$$

In testing | F -μ| > Th, Th which is threshold can be chosen as kσ . But the problem was that it never comes up with multimodal distributions. In order to do this a mixture of K Gaussians model was proposed by Stauffer and Grimson in 1999. The main parameters were (μi, σi, ωi).

1. GGF model: Generalized Gaussian Family model:
This is most representative background model. GGF model was proposed by H.Kim, R. Sakamoto. Background was modeled as pixel variation in a static scene over time with GGF distribution defined as follows.[1]

$$p(x:\rho) = \frac{\rho\gamma}{2\Gamma(1/\rho)}\exp(-\gamma^{\rho}|x-\mu|^{\rho}) \text{ with } \gamma = \frac{1}{\sigma}\left(\frac{\Gamma(3/\rho)}{\Gamma(1/\rho)}\right)^{1/2} \quad (1)$$

where s is a gamma function and is a variance of the distribution. In above equation (1), represents a Gaussian distribution while represents a Laplace distribution. The models for each pixel in the background are decided by calculating excess kurtosis g2 of the first m frames. Excess kurtosis measures whether the data are peaked or flat relative to a normal distribution and calculated using (2), where n is the number of samples and m is the mean. The excess kurtosis of Gaussian and Laplace distributions is 0 and 3, respectively.

$$g_2 = \frac{n\sum_{i=1}^{n}(x_i-\mu)^4}{\left(\sum_{i=1}^{n}(x_i=\mu)^2\right)^2} - 3 \quad (2)$$

Background subtraction: First, the initial region classification is performed by subtracting the intensity components of the current frame from the background model. Classify the initial object region into three categories using two thresholds based on background subtraction BD, as in (3). LI and LB indicate the luminance components of pixel p in the current frame and the background model, respectively, and b is a scale parameter of the background model:

$$BD(p) = |L_I(p) - L_B(p)|$$

$$\begin{cases} BD(p) < K_1 b(p) & \Rightarrow \text{background} \\ K_1 b(p) \le BD(p) \le K_2 b(p) & \Rightarrow \text{suspicious} \\ K_2 b(p) \le BD(p) & \Rightarrow \text{foreground} \end{cases} \quad (3)$$

Then refine the suspicious regions from the initial classification by using a hue component because the shadow or lighting changes the color property of the background much less than the luminance. Apply (3) to the hue component in a similar manner with a single parameter, K3, and classify the suspicious regions into the background and foreground regions. Thresholds K1–K3 are determined by training data with the following condition.

$$(K_1, K_2, K_3) = \arg\min_{K_1,K_2,K_3}\begin{pmatrix}\beta \times \text{false negative error} \\ +\text{false positive error}\end{pmatrix} \quad (4)$$

2. MOG model- Mixture of Gaussian :
In Mixture of Gaussian (MOG) background is termed as parametric frame of values where each pixel is represented with number of Gaussian Functions as Probability Distribution function as in equation 1 below.

$$F(i_t = \mu) = \sum_{i=1}^{k} \omega_{i,t} \cdot \eta(\mu, \sigma) \quad 1$$

where,
η = the *i-th* Gaussian component
μ = intensity mean
σ = standard deviation
$\omega_{i,t}$ = portion of the data accounted by *i-th* component

In addition, for MoG approach, only pixel that is within a scaling factor of background standard deviation is considered as part of background. This can be determined by comparing the pixel value with Gaussian component tracking [9]

Advantages

1. This model has low rate of complexity, memory consumption and suitable for outdoor environments.
2. It can handle multimodal distributions.

3. It can separate and suppress non stationary object that classify as noise such as moving leaves , sky, etc,
4. Shadow effect can be minimized.
5. Changing parameters can give us better results according to our needs.

B. Open Source Technology

OpenCV is a collection of freely available C/C++ libraries specially meant for image processing and computer vision applications. The library is written in C and C++ and runs under Linux, Windows and Mac OS X. There is active development on interfaces for Python, Ruby, Matlab, and other languages. OpenCV was designed for computational efficiency and with a strong focus on real time applications. OpenCV is written in optimized C and can take advantage of multicore processors .
One of OpenCV's goals is to provide a simple-to-use computer vision infrastructure that helps people build fairly sophisticated vision applications quickly. The OpenCV library contains over 500 functions that span many areas in vision, including factory product inspection, medical imaging, security, user interface, camera calibration, stereo vision, and robotics. Because computer vision and machine learning oft en go hand-inhand, OpenCV also contains a full, general-purpose Machine Learning Library (MLL). This sublibrary is focused on statistical pattern recognition and clustering. The MLL is highly useful for the vision tasks that are at the core of OpenCV's mission, but it is general enough to be used for any machine learning problem [7].

1. Face detection

If face is detectable we will detect and save it too. This suspicious frame, intruders and face data can be used for future use (fig 5). The face data is detectable using HAAR classifiers provided by opencv library. The HAAR classifier used is haarcascade_frontalface_alt2.xml file which can detect frontal faces in an image. Whenever a face is detected we draw a rectangle around it and save it.

Figure 5: Faces are detected and rectangles are drawn bounding the faces.

2. Advantages:

1. It is completely free of cost
2. We will boost our quality of project anytime
3. In open source, you modify code to suit your needs, within your budget.
4. We will ensure continuity
5. There are concerns about open source and security. With an abundance of open source community members, bugs are found and fixed early.
6. We can upgrade our product within our budget anytime that provide no real value.

5. Future Scope

This system is not compatible with light fluctuate in future with more image processing plus advance library functions in openCv this problem can be overcome. We can apply this same logic on vehicle toll plaza system where come vehicles are not doing normal activities with not paying toll or any accident. We can minimize the crime public hub by crowd counting system.

6. Acknowledgment

I would like to thank all those people whose support and cooperation has been an invaluable asset during the course of this paper. I would also like to thank my Guide **Prof. P. R. Barapatre** for guiding me throughout this paper and giving it the present shape. It would have been impossible to complete the paper without their support, valuable suggestions, criticism, encouragement and guidance.

I am also grateful for all other teaching and nonteaching staff members of the SKN SIT, Computer Engineering for directly or indirectly helping us for the completion of this project and the resources provided.

7. Conclusion

This paper and the study of related topic will further benefit us in developing our system successfully. Hopefully I expect this system will minimize the crime rate in India. Using this system people should feel safe to survive in any place any time.
Thus we have successfully defined our problem statement to develop an advanced Intelligent Surveillance System to detect abnormal malicious intents doing by intruders. We have identified the necessary steps and modules to achieve our proposed system. In the light of the study we have anticipated various algorithms and work done in the fields of image processing and video processing. We have identified important and core technologies as Image segmentation, Background removal, Object classification, motion tracking and behavior analysis and have studied each technology with its recent developments. It automatically detects the malicious activity and start the alarm so that it will be giving an alert kind of alarm to capture the criminal and minimize the crime.

References

[1] Integrating Color and Shape-Texture Features for Adaptive Real-time Object Tracking" by Junqiu WANG and Yasushi YAGI.
[2] "Improved Adaptive Gaussian Mixture Model for Background Subtraction" by Zoran Zivkovic ICPR, 2004.

[3] "Intelligent System for detecting, Modeling, Classification of human behavior using image processing, machine vision and OpenCV" Niraj .B. Gadhe, Prof: Dr. B .K . Lande, Prof: Dr. B.B.Meshram, ISSN: 2278 – 1323, Volume 1, Issue 4, June 2012.
[4] "An Efficient Real Time Moving Object Detection Method for Video Surveillance System"Pranab Kumar Dhar, Mohammad Ibrahim Khan, Image Processing and Pattern Recognition Vol. 5, No. 3, September, 2012.
[5] A. D. Sappa and F. Dornaika, "An Edge-Based Approach to Motion Detection", V. N. Alexandrov, G. D. van Albada, P. M. A. Sloot and J. J. Dongarra, (eds.) LNCS, vol. 3991, **(2006)**, pp. 563–570. Springer, Heidelberg.
[6] "Performance Comparison of Moving Object Detection Techniques in Video Surveillance System" Dr. Dheeraj Agrawal, Nitin Meena, IJES , ISSN: 2319 – 1813 ISBN: 2319 – 1805, 20th January 2013.
[7] Book on " Learning Open Cv – Computer vision with Open CV library" by Gary Bradski and Adrian Kaebler – o'reilly
[8] Dar-Shyang Lee, Member, IEEE ―Effective Gaussian Mixture Learning for Video Background Subtraction ― in Ieee Transactions On Pattern Analysis And Machine Intelligence, Vol. 27, No. 5, May 2005.
[9] Gaussian Mixture Models, Yogesh Raja - Shaogang Gong , Department Of Computer Science, Queen Mary And Westfield College, England.
[10] www.wikipedia.org