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Browsed-back Post Event Analyzer

Ahmad Ali
Pakistan Institute of Engineering & Applied Sciences, Nilore, Islamabad.
ahmadali@pieas.edu.pk

Ilyas Butt
Queen Mary, University of London.
butt_elyas@hotmail.com

Asifullah Khan
Pakistan Institute of Engineering & Applied Sciences, Nilore, Islamabad.
asifullah@pieas.edu.pk

***Abstract* – Face recognition is considered as the integral part of the video surveillance or video security system. Most of the video surveillance systems recognize human on the basis of face, but the careful study shows that faces become vague from cameras either due to mask worn by terrorists or thieves, or due to distance from camera. This constraint makes thorny the investigation of an event after it has occurred. The objective of this paper is to propose a system that can recognize humans on the basis of their cloth color irrespective of their face ambiguity so that wearing of mask and distance of people from camera does not make any difference. The system is composed of two parts. One part detect the humans present in the video, segment the detected humans according to their trouser and shirt color and store the parameters of these clusters found with color based *K*-mean clustering. The second part is the query system. It provides an interface to the user to enter the query to get the required information from the video. By using this system we can convert a lot of available data (in the form of video) in to fruitful information. The system can also be used as image indexing with some modifications.**

***Index Terms* – Background subtraction, Mean shift, Event analyzer, *K*-means segmentation.**

I. Introduction

Today threat of terrorism has caught the world in its claws. Suicide attacks, bomb blasts, innocent killing are the headlines of almost every news channel. On 07-07-05, a series of four bomb attacks struck London's public transport system during the morning hours. Police investigators have identified four men as suicide bombers. Cameras were located on different locations for security purposes. However the investigation received a serious setback when it was discovered that the CCTV cameras on the bus that blew up were not working. [1, 2, 3] Terrorists' images were captured by a camera at one of the stations; Videos of 2000 cameras have been examined to track the bombers. It was quite difficult to search these four people from thousands of thousand images of 2000 cameras. Furthermore, the faces become vague due to images from distant camera. The present paper proposes a system, *Browsed-back Post Event Analyzer*, (BPEA) to recognize human on the basis of their cloth color irrespective of their face ambiguity so that wearing of mask or distance of people from camera does not make any difference. The project is divided into two parts. The 1st part is comprised of detection of humans from the images and segmentation of the humans on the basis of their cloth color. Second part is to design an interface that could search all the saved human images to yield required results specified through query. The query based system will enable us to query for particular information; for example, to answers the questions like described below:

- who are the people passed by wearing blue shirt and/or black trouser?
- Who are the people passed by between 3:00 p.m. to 5:00 p.m.?

A. Paper Organization

The rest of the paper is organized as follows. Section II briefly discusses the Grimson's background subtraction technique. Section III is about mean shift based human detection. Section IV discusses *K*-mean segmentation. Section V presents the system design of browsed-back post event analyzer. Section VI discusses results.

II. Background Subtraction

The capability of extracting the moving objects from a video sequence is typical a first step in visual surveillance. The common approach for detecting the movement in the given sequence is back ground subtraction. The word background refers to the part of the scene which appears to be static or semi-static and against which objects are represented or viewed. Concisely, we can say that background subtraction is a method of separating the interested objects (mostly moving) from the background. These separated objects are said to be the part of *Foreground.*

A. Overview of Grimson's background subtraction

According to the Grimson [4], each pixel is an independent statistical process, which may be combination of several processes. For explicit modeling, the values of all the pixels are considered as one particular type of distribution that is mixture of Gaussians. The persistence and variance of each Gaussian of mixture determine which pixel corresponds to background and which belongs to foreground. Pixel's color value from each of the associated *K* Gaussian distributions is calculated for each pixel at each frame. To update the model by Grimson's method, every new pixel *p* at the time *t* is checked against the existing *K* Gaussian distributions, until a match is found [7]. The match is the distribution with Mahalanobis distance less than a threshold. The mean and variance of unmatched distributions remain unchanged. For the matched distributions they are updated. The detail of updating the parameters is given in [7].

III. Human Detection

Detection of humans is an extensively investigated topic in the field of automated visual surveillance and tracking systems [6]. The task of reliable detection of human becomes highly complex for crowded scenarios due to partial or complete occlusion between individual human. Existence of human face, torso, hand, and limb or skin color in the color histogram

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of the moving blob make the detection process more robust. Human skin color detection can be carried out in various color spaces including the red, green, and blue (RGB) color space, luminance and color difference or chrominance (YUV), and hue, saturation (HSV) color spaces.

A. Overview of Mean Shift Approach

The mean shift algorithm is a nonparametric technique to locate density extrema or modes of a given distribution by an iterative procedure [5, 6].The mean shift can outline regions belonging to high density modes within a complex feature space. The method is conceptually very simple being based on the same idea of iteratively shifting a fixed size window to the average of the data points within the window. The term *mode-seeking* refers to finding the locations where high density changes occurred. *The objective of implementing Mean Shift algorithm is to find a location in a window where a human can be centrally localized.* The detail of human detection via mean shift can be found in [6]. Instead of using simple image subtraction, we have used the method of Grimson's background subtraction [4] to get difference image and after that we have applied technique mentioned [6] to detect humans.

IV. Segmentation

The division of an image according to different textures or objects present in it or with respect to certain criteria is called segmentation. It is an important part for our system, i.e., BPEA. We will have to segment the detected human according to the color of its trouser or shirt. We will use color base *K*-mean clustering/segmentation for this sake.

A. Overview of K-means segmentation

K-means is computationally efficient algorithm. It is easily implementable and it can be easily used in image segmentation. It is one of the simplest unsupervised learning algorithms. *K* is the required number of clusters and it is kept fixed before the start of the segmentation process. The algorithm starts by defining the *K* centroids. The algorithm associates each data point present in the given data set to its nearest centroid. This process is continued until all data points are associated to atleast one cluster. The next step of the algorithm involves updating the centroids according their associated data points. Now the same process is repeated and centroids are iteratively updated. The iterative process remains continued until there is significant change in centroids positions. The algorithm is also significantly sensitive to the initial randomly selected cluster centers. The *K*-means algorithm can be run multiple times to reduce this effect.

B. Color based segmentation using K-means approach

Our goal is to segment the detected human image using *K*-means Segmentation. Firstly we have to define *K*. How many colors do we see in the image if you ignore variations in brightness? Notice how easily you can visually distinguish these colors from one another. For our simplicity, we consider that human is wearing uniform color trouser and shirt, which allow us maximum $K = 3$ i.e. one segment for background, one for shirt and the other for trouser. Applying *K*-means segmentation for a color based images as defined in Section IV (A). It finds partitions with respect to their colors, such that object within each segment is as close to each other as possible, and as far from objects in other segments as possible.

V. System Design

BPEA is comprised of two systems. One is event recording system. It stores the description of different events, occurring in the video, in the data base. The events of considerations are the humans in video. The description involves detected human(s)'s trouser and shirt color. System completes its processing after performing multiple operations. Grimson's background subtraction method is applied on a recorded movie. Now these images are processed and applied Mean Shift (Fast Mean Shift) to detect human(s), when a possible human is detected it is segmented using *K*-means segmentation (color based). As the requirement of the system is to extract shirt and trouser colors of each human so each detected human image is segmented in three different parts i.e. shirt trouser and background. Mean and variance of trouser and shirt colors are saved to data base and this process goes on. The above description of BPEA can be seen pictorially in Figure 1. The second part of BPEA is the query based system. It uses a Graphical User Interface to retrieve results depending upon the query run. The graphical interface allows user to select multiple colors for trouser, shirt and a logical operations Or/And between these colors. The search process is also facilitated with time limits to search people with some specific trouser and shirt color within a specified time span. For example:

- Who are the people passed by wearing blue shirt And/Or black trouser between 3:00PM to 4:00PM?

The time information can be given as we know the starting time of recording and frame rate of the camera. From this information we can get the time of certain event happening in the video.Selected colors are converted to their respective RGB values. The correlation values (sum of squared difference) of specified shirt color and trouser color are computed to their respective shirt and trouser colors saved in data base. The correlation less a threshold is considered as a match.

VI. Experiment Results and Conclusion

We have presented a new way of searching people on the basis of their cloth color. The proposed system was tested on number of data sets. Results are presented for one image sequences depicting partially crowded scenes as shown in Figure 1. It also shows the steps involve in recording an event by BPEA. Figure 2 shows the query system of BPEA. We can query to the BPEA for detection humans in the video according to its trouser and/or shirt color. We can also detect these human in the video within certain time pocket. Figure 3 shows the results of query mentioned in Figure 2. Detection results in terms of detection rates and false detection are shown in Table1. Some missed detections occur when the human's clothing has colors similar to the background. The

relatively high false positive rates stem from the fact, that the difference image often contains motion clutter in form of slightly swaying stationary humans, reflections or shadows leading to occasional false detection. The proposed system was implemented in MATLAB and results were carried out on a 2.8 GHz PC.

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Table 1 Detection performance of the proposed system given for a range of image sequences.

Image Sequences	Sequence 1	Sequence 2
No. of frames	900	450
Valid Human detection	81%	83%
False Human detection	19%	17%
Valid Color based segmentation	76%	75%
Valid Human retrieval on color selected by user	65%	72%

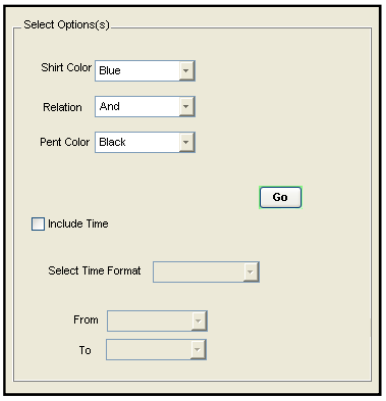

Figure 2 Sample query given to system

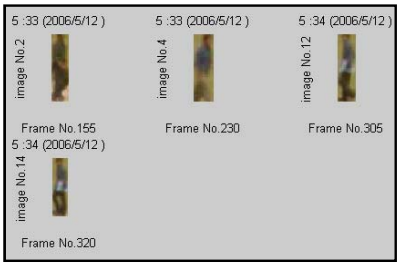

Figure 3: Result shown by system according to query given in Figure 2. Search for people with Blue shirt and Black trouser)

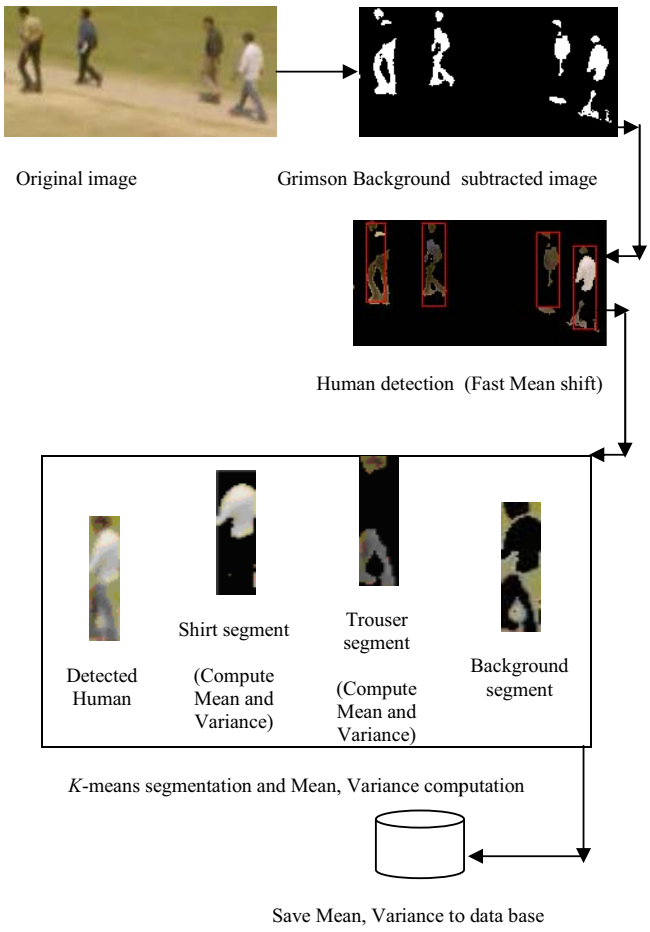

Figure 1. System Flow Diagram

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