ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 11, November 2013

# A Novel Approach of Detection of Moving Objects in a Video

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**Abstract**: In this paper, a novel approach is proposed for moving object detection and tracking. The main aim of this paper is to device a method by which moving objects can be detected in a video. A video stream is divided into several frames and our goal is achieved by identifying the moving portion which has changed over time. Here we used the temporal segmentation. In temporal segmentation, the absolute difference of two video image frames is segmented into changed and unchanged regions. We have divided the difference image frame into two clusters, one represents the changed region and the other represents the unchanged portion. Here changed region means moving object. We have achieved this by applying Genetic Algorithms (GA) using K-means clustering technique on the difference image frame. The proposed method is successfully tested over two video sequences.

**Keywords**: Genetic Algorithm, K-Means Algorithm, clustering, temporal segmentation, moving object detection, frame difference

## I. INTRODUCTION

Moving objects detection in video streams is a key fundamental and critical task in many computer vision and video processing applications [1, 2]; including video surveillance, as well as people tracking, gesture recognition in human-machine interface, traffic monitoring and so on. Visual surveillance primarily involves the human interpretation of image sequences through direct monitor inspection. Advanced visual surveillance of complex environments goes further and automates the detection of predefined alarm situations in a given context. The role of automatic computation in such systems is to support the human operator to perform different tasks, such as observing and detecting, interpreting and understanding, logging, giving alarms, and diagnosing false alarms. In many surveillance systems, most of activities of human operators staying in a control room are devoted to observe images provided by a set of cameras on several monitors. In moving object detection, first a reference frame is chosen from the video sequence. Reference frame can be any frame where no object is there in that particular frame, only background is present.

To detect the moving object, spatio-temporal spatial and temporal both segmentation are used in the literature. Markov Random Fields (MRF) models [3, 4, 5, 6, 7] are popularly used in the field of spatial segmentation of video.

Different optimization techniques like Iterated Conditional Mode (ICM) [9], Simulated Annealing (SA) [9], and Genetic Algorithm (GA) [6, 7, 8] are used for MAP (Maximum a posteriori probability) estimation of the MRF model. Iterated Conditional Mode is a fast method but may not give good results. Simulated Annealing gives better solutions but it is a very slow method. Genetic Algorithm also gives good results. Distributed Differential Evolution (DDE) algorithm [10] is also explored for MAP estimation of MRF model.

In this paper, to identify the moving object in a video sequence, we have used the temporal segmentation. The difference image frame has been found from the reference frame and the target frame. Then the difference image frame has been divided into two clusters, one cluster represents changed or moving region and the other represents unchanged or background region. From the K-means clustering algorithm [12], it is known that a good clustering algorithm is achieved by minimizing the within-cluster distance. So to minimize the within-cluster or intra-cluster distance, here we use the well known optimization technique Genetic Algorithm [11].

The organization of this paper is as follows. Section II represents the proposed technique for moving object detection. Section III represents the result analysis of our simulation. Conclusion is presented in section IV.

## II. PROPOSED TECHNIQUE

### A. *Difference image frame and creation of patterns*

We have worked on gray-level video sequence. From our video sequence, we have chosen the reference frame (where the object is not present). To detect the moving object, one target frame is taken. Now from these two frames by computing the absolute differencing, we have got the difference image frame. On the obtained image frame we have applied our algorithm. Suppose each frame

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

*International Journal of Advanced Research in Computer and Communication Engineering*
*Vol. 2, Issue 11, November 2013*

of the video has the dimension of M × N, so the difference image frame also has the same dimension.
Since we have used only gray-level video, so the intensity values of each pixel should be between 0 to 255. Instead of one single pixel value, here we have considered its 3×3 neighborhood pixel values for a particular pixel which is shown in Fig. 1. These nine intensity values form a pattern of the image. Thus total M × N patterns are there for a single image frame.

| | | |
|---|---|---|
| x[i-1,j-1] | x[i-1,j] | x[i-1,j+1] |
| x[i,j-1] | x[i,j] | x[i,j+1] |
| x[i+1,j-1] | x[i+1,j] | x[i+1,j+1] |

Fig. 1. The pixel x[i,j] with its neighboring pixels.

### *B. K-Means Clustering [12]*

Suppose a data set, D, contains n objects in Euclidean space. Partitioning methods distribute the objects in D into k clusters, $C_1, \dots, C_k$, that is, $C_i \subset D$ and $C_i \cap C_j = \phi$ for $(1 \le i, j \le k)$. An objective function is used to assess the partitioning quality so that objects within a cluster are similar to one another but dissimilar to objects in other clusters. That is, the objective function aims for high intracluster similarity and low intercluster similarity.
A centroid-based partitioning technique uses the centroid of a cluster, $C_i$, to represent that cluster. The difference between an object $p \in C_i$ and $c_i$, the representative of the cluster, is measured by dist(p, $c_i$), where dist(x,y) is the Euclidean distance between two points x and y. The quality of cluster $C_i$ can be measured by the within cluster variation, which is the sum of squared error between all objects in $C_i$ and the centroid $c_i$, defined as

$$E = \sum_{i=1}^{k} \sum_{p \in C_i} dist(p, c_i)^2 \qquad \text{(i)}$$

where E is the sum of the squared error for all objects in the data set; p is the point in space representing a given object; and $c_i$ is the centroid of cluster $C_i$ (both p and $c_i$ are multidimensional). In other words, for each object in each cluster, the distance from the object to its cluster center is squared, and the distances are summed. This objective function tries to make the resulting k clusters as compact and as separate as possible. We can obtain good clusters by minimizing the equation (i).

### *C. Genetic Algorithm(GA)*

GA is a non-deterministic stochastic searching optimization method that utilizes the theories of evolution to solve a problem within a complex solution space [4]. They are based on natural selection discovered by Charles Darwin. They employ natural selection of fittest individuals as optimization problem solver. Optimization is performed through natural exchange of genetic material between parents. Off-springs are formed from parent genes. Fitness of offspring is evaluated. Best fit off-springs are selected and chosen for crossover and mutation.
A simple GA consists of five steps [13]:

1. Start with a randomly generated population of N chromosomes, where N is the size of population.
2. Calculate the fitness value of function φ(x) of each chromosome x in the population.
3. Repeat until N off-springs are created:
3.1. Probabilistically select a pair of chromosomes from current population using value of fitness function.
3.2. Produce an offspring $y_i$ using crossover and mutation operators, where i = 1, 2, up to N.
4. Replace current population with newly created one.
5. Go to step 2.

### *D. Chromosome Formation and Clustering*

For the difference image frame, each pixel that means its corresponding pattern is to be clustered into either changed (black) or unchanged (white) cluster. So two different patterns are taken randomly to form two cluster centroids. Each pattern has nine attributes, so the chromosome has 18 (2×9) attributes. Hence the chromosome formed here has two centroids like Fig. 2, where $x_{11}, x_{12}, \dots, x_{19}$ represents first centroid and $x_{21}, x_{22}, \dots, x_{29}$ represents second centroid. Each individual value of a chromosome is called a gene.

Chromosome

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $x_{11}$ | $x_{12}$ | … | $x_{19}$ | $x_{21}$ | $x_{22}$ | … | $x_{29}$ |

Centroid-1 Centroid-2

Fig. 2. Structure of a chromosome

After creating the chromosome, all the patterns of the image are now assigned to one of the two clusters, $C_i$ and $C_j$. A pattern p will be assigned to cluster $C_i$ if dist(p, $C_i$) < dist(p, $C_j$), otherwise it will be assigned to cluster $C_j$. dist(p, C) means the Euclidian distance between pattern p and the cluster centroid of cluster C. By this way all the patterns are clustered into two classes.

### *E. Fitness function*

After clustering has been done using the initial cluster centroids, the fitness values of all the chromosomes are calculated by the following formula:

$$E = \sum_{i=1}^{k} \sum_{p \in C_i} dist(p, c_i)^2$$

where k is the total number of clusters, $c_i$ represents the cluster centroid of cluster $C_i$, p denotes the pattern, and dist(p, $c_i$) represents the Euclidian distance between pattern p and cluster centroid $c_i$. Since a good cluster can be found when the intra cluster distance is minimum. So, we try to minimize the fitness value of all the chromosomes.
After getting the fitness value for all the chromosomes we have applied the operators of Genetic Algorithms. This process is continued until we get a stable result.
In this way, we have clustered the difference frame image into two different clusters. The black cluster represents the object part and the white cluster represents the background

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

*International Journal of Advanced Research in Computer and Communication Engineering*
*Vol. 2, Issue 11, November 2013*

portion. So we can easily identify the object in the target frame. The flowchart of the proposed algorithm is shown in Fig. 3.

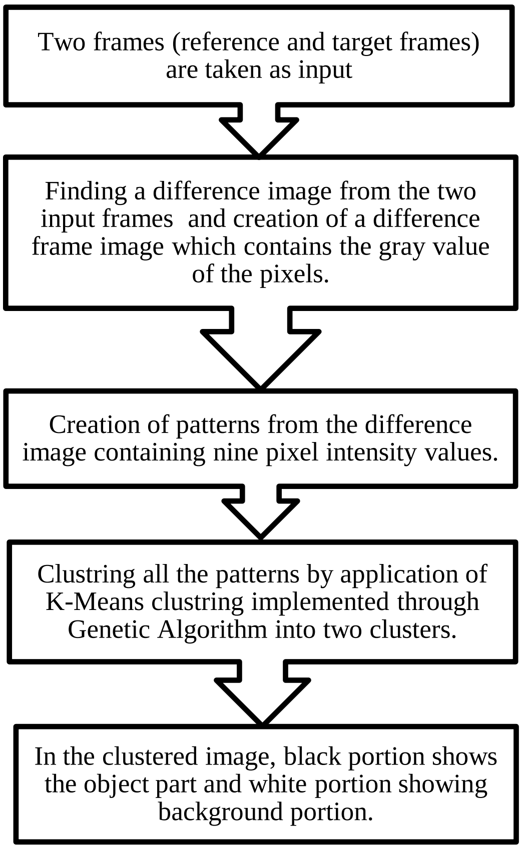


Fig. 3. Flowchart of the proposed moving object detection method

## III. EXPERIMENTAL RESULTS

For simulation we have used two video sequences, the Hall-monitor video and the Bowing video. Both these video sequences are captured by fixed camera. In the videos, between two consecutive frames the amount of changes is very less. That's why we have considered the target frames within a particular interval of time to have a reasonable amount of change.

For Hall-monitor video sequence, we have taken $3^{rd}$ frame as the reference frame which is shown in Fig. 4(a). The original target frames ($40^{th}$, $130^{th}$, $150^{th}$ and $190^{th}$) are shown in Fig. 4(b) – 4(e). And their corresponding outputs using our

Fig. 4(a)

Fig. 4(b)

Fig. 4(f)

Fig. 4(c)

Fig. 4(g)

Fig. 4(d)

Fig. 4(h)

Fig. 4(e)

Fig. 4(i)

Fig. 4. Hall-monitor video. (a) Reference frame ($3^{rd}$ frame). (b) – (e) Original target frames (frames $40^{th}$, $130^{th}$, $150^{th}$ and $190^{th}$). (f) – (i) Output generated by proposed method.

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*International Journal of Advanced Research in Computer and Communication Engineering*
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Fig. 5(a)

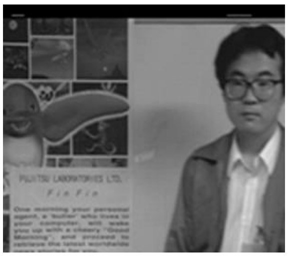

Fig. 5(b)

Fig. 5(f)

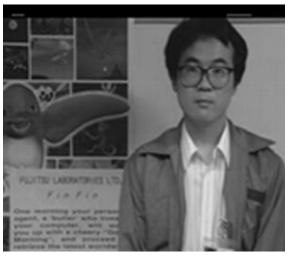

Fig. 5(c)

Fig. 5(g)

Fig. 5(d)

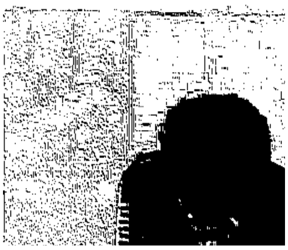

Fig. 5(h)

Fig. 5(e)

Fig. 5(i)

Fig. 5. Bowing video. (a) Reference frame (3rd frame). (b) – (e) Original target frames (frames 50th, 100th, 130th and 170th). (f) – (i) Output generated by proposed method.

proposed technique are shown in Fig. 4(f) – 4(i).

For Bowing video sequence, we have taken 3rd frame as the reference frame which is shown in Fig. 5(a). The original target frames (50th, 100th, 130th and 170th) are shown in Fig. 5(b) – 5(e). And their corresponding outputs using our proposed technique are shown in Fig. 5(f) – 5(i). From the figures Fig. 4(f) – 4(i) for the Hall-monitor video and Fig. 5(f) – 5(i) for the Bowing video sequence, it is very much clear that our proposed method works very well. Initially we have taken 20 chromosomes in the mating pool. Then selection and crossover operations are operated one by one in a single iteration. This process is continued until the average fitness value is stabled.

## IV. CONCLUSIONS

In this paper moving object detection in a video sequence is achieved through temporal segmentation. Here clustering is done with the initial cluster centroids. After that we optimized it using Genetic Algorithm. Here we have considered the video sequences which have captured by fixed camera. Also we have taken into consideration those videos which have the reference frame without any object. The output results of the proposed method are significantly good.

## ACKNOWLEDGEMENT

The authors express their sincere gratitude to the faculty members of the Department of Engineering & Technological Studies, University of Kalyani, West Bengal, India, where the work has been carried out with the financial support of PURSE scheme, DST.

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