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A Comparative Approach for Human Motion Detection & Tracking System

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Abstract- Today, security of human being is the most active research area. In this paper, we review the two different techniques of video surveillance system based on motion segmentation and tracking. The first system is based on dual frame differencing method followed by the morphological operations & Kalman filtering. The second technique is the use of visual background subtraction combined with illumination insensitive template matching algorithm. This paper explores the different methods of visual tracking & their experimentation results to enhance the study in the field of image processing.

Index Terms-Motion Detection, Video Surveillance, Frame subtraction,

1. INTRODUCTION

Ensuring the security at the public places is in general the most challenging task. In recent years [1, 2] there are numerous approaches proposed in this area. Today's security system acts like video storage anything that comes under the surveillance area is recorded in the computer system. Their basic concern is on the video compression and the frame retrieval. Such kind of surveillance system serves two important functions: First, assisting the human operator by providing the footage of the incident taken place for identifying the danger and second capturing the evidence for investigation purpose. Although these are the initial steps in surveillance system yet they could not be applied to detect crime in the real time and take necessary action against it.

In this paper we begin with the survey of related techniques for video surveillance system. Then present the methods of motion segmentation and tracking. After that the result of the system are presented. Finally the paper ends with the conclusion.

2. RELATED WORK

There is an enormous literature in the field of motion detection & object tracking. Here we discuss the relevant object tracking system.

Fan Yang *et al.* [3, 2014], proposed a super pixel tracking system in which the structural information is captured to make a tracker distinguish the target from the background. The method is also capable of dealing with occlusion and drift problems. An online object tracking method described by Wang *et al.* [4, 2013], with sparse prototypes, using principal component analysis (PCA) to train the appearance models. The tracking task is accomplished by online trained sparse prototypes. This algorithm is effective on motion blur & occlusion handling.

Olivier Barnich *et al.* [5, 2011], presented an innovative technique of adapting the pixel to the background based on its resemblance to the stored pixel. If the value of pixel matches with the stored pixel at the same location or in neighborhood location the pixel is considered to be the part of background otherwise foreground. Peng Cui *et al.* [6, 2012], proposed an action representation system using unsupervised categorization. In this video decomposition is done where videos are considered to be spatially distributed pixel and after replacing these pixels with their prototype multi action is recognized using duality between pixel clustering and action clustering.

Tudor BARBU [8, 2012], proposed a human tracking system using static camera. In this system temporal differencing method along with morphological processing is used. This is then processed by human properties such as size, skin segments which is then matched by using correlation process. Tal Ben-Zvi et al. [9, 2012], presented a study of the signals approaching the target and classify the object intention as the suspicious based on tracking of the signals. Jianguo Lu et al. [10, 2010], presented the appearance model using the human body structure. This structure is then processed by Markov Chain Monte Carlo (MCMC) method to estimate the solution of target data problem. The method best suited the complex environment, occlusion & irregular target motion.

3. SYSTEM METHODOLOGY

3.1 Dual Frame Differencing Method

Human Motion detection & tracking algorithms have to deal with various challenges as described earlier. To overcome these problems the system, consists of three frame differences and morphological blob analysis to avoid false motion detection.

The proposed system works in three stages. At first stage gray scale frames are extracted from video & frame difference between frame Fn-2 and Fn-1 and second frame difference between the frame Fn-1 and current frame Fn are taken. It is different than other algorithms where only the difference between the current and previous frame is considered. In second phase, morphological operation is performed on the resultant frame difference to suppress the remaining errors. Then the background regions are extracted, holes are filled and small regions are removed. It gives, two background masks, after morphological operations which are then compared with the threshold calculated followed by the AND operation applied to eliminate the false motion detection. Finally, the Kalman filter [11] is used to remove the noise and other changes in pixel due to illumination or any other reason. Extracted foreground is then tracked by the rectangle around it. The system is depicted as figure 1 below.

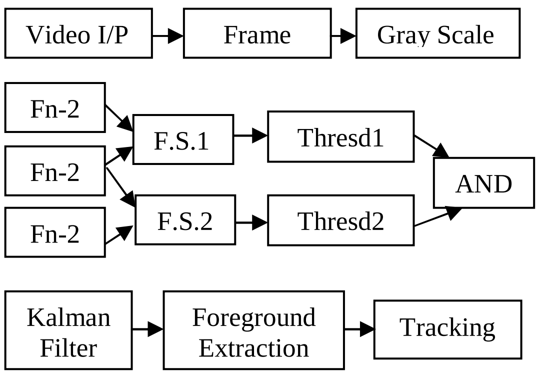


Figure 1: Dual Frame difference System Stages

3.2 Visual background & Template Matching Method

A method for accurate detection & tracking of human motion in an image sequence by combining visual background extraction technique [12] for motion detection and illumination intensity minimization based on template matching technique for object tracking is proposed.

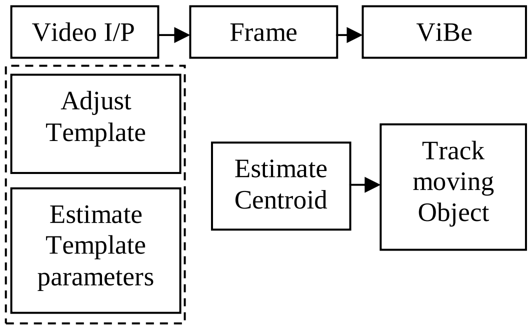


Figure 2: Visual Background & Template Matching System Stages.

The system will take care of illumination changes in real images caused due to automatic exposure alterations of the camera, adjustment of light cause irradiance, appearance of shadows or movement of the tracked objects. The objective of research is to provide a robust and improved method to find the moving objects in the video frame as well as to track them. The proposed method is effective in reducing the number of false alarms that may be triggered by a number of reasons.

Figure 2 shows the different stages involved in the system. First, image frames are taken out from video, and then, image motion is predicted using visual background extraction model to which morphological operation is applied to fill the gaps and nullify the small blobs present due to error. Extracted foreground is then tracked by rectangle for which centroid calculation is done. Simultaneously, illumination insensitivity hyperplane method [13] for template matching is also applied to perfectly track the object.

3.3 Motion Database

Any algorithm must be carefully validated on appropriate data sets to show its potential for real-world applications. The data sets should be chosen to be representative for the applications under consideration. Experimentation work for the algorithms described is carried out on different databases. First, different publically available motion database namely "Weizmann database", "KTH database", "CMU Graphics Lab Motion Capture Database", "CRCV database" and different motion videos. Second, "Self database" developed by the author; this database contains 86 sequences having five classes of actions in indoor (namely Jump, Run, Walk, Side, Handwaving) & four classes of actions at outdoor (namely Jogging, Walking, Handwaving, Jumping) respectively performed by 19 different subjects

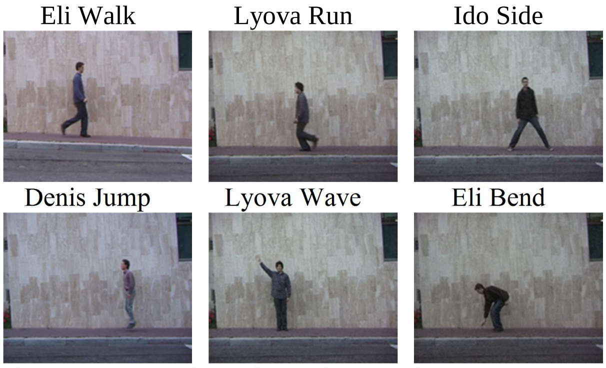


Figure 4: Images from the Weizmann data set.

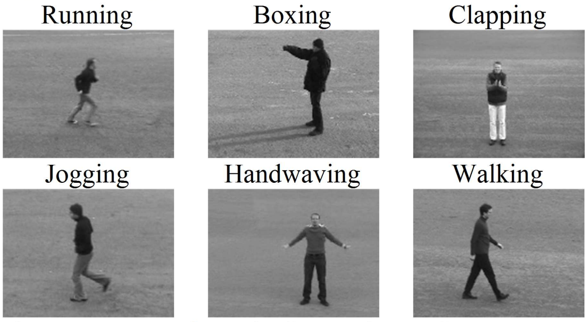


Figure 5: Images from the "KTH data set".

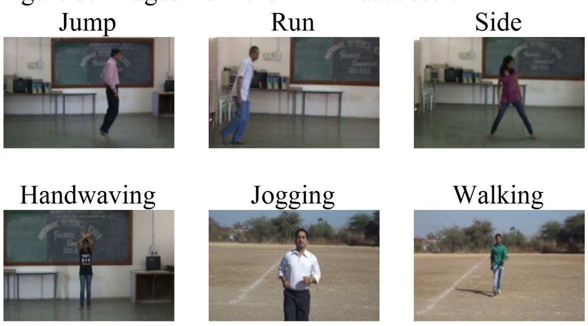
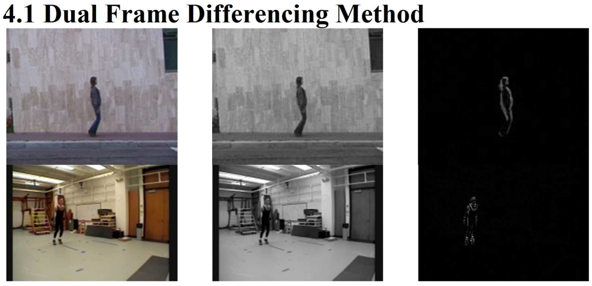


Figure 6: Images from the "Self data set".

4. RESULTS & DISCUSSION

The algorithms are implemented in MATLAB 7.10.0 (R2010a) on Windows 7.0 platform. The PC is equipped with Pentium corei3, 2.13 GHz processor and 4 GB RAM Memory. The experimental result of the dual frame background subtraction algorithm is shown in figure 7.

4.1 Dual Frame Differencing Method



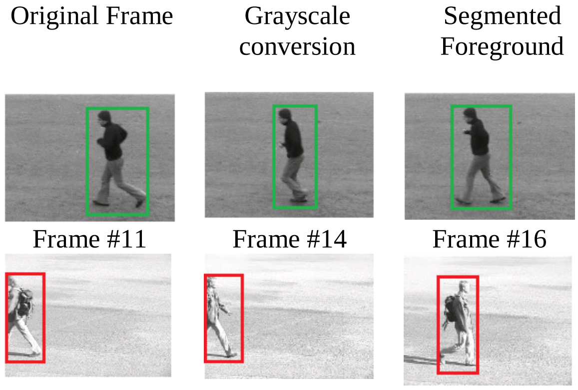


Figure 7: Experimental result of the background subtraction model on Database videos.

The computational difficulty for computing each difference is only τ ($|I_{t-} B_t|$) for the local context region of M x N pixels, thereby resulting in a fast method (100 FPS in MATLAB on an i3 machine). More importantly, the algorithm achieves robust results as shown in figures above. The summary of processing time and average speed of processing the video is given in the table 1 below.

Table 1: B.G. Subtraction model performance.

S.N.	Sequence	Resolution (Pixels)	Frame Number	Overall Average Time (s)	Average Speed (frame/s)
1	Daria Jump	180 x 144	67	48	1.373
2	ADA Handwaving	1280 x 720	30	12.209	2.457
3	Girl	320 x 240	20	3.688	5.422
4	RDK Run	1280 x 720	54	9.56	3.457

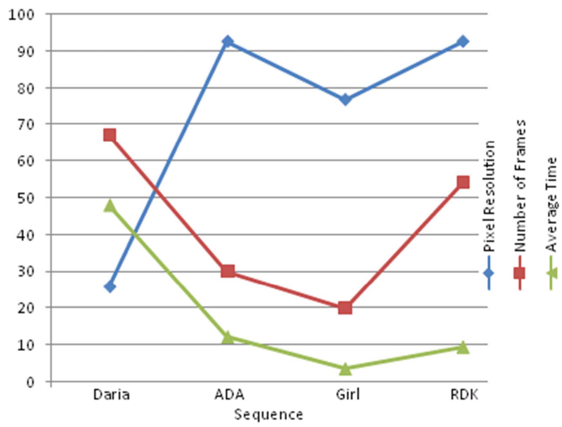


Figure 8: Graphical representation of performance.

The figure 8 shows the representation of overall average time for the frames to be processed. As seen in the graph increase in pixel resolution hardly affects the processing speed of the method. Moreover, this method takes less than 1s to compute the image difference, while the image scan takes less than 0 to 5s depending on the specific configuration.

4.2 Visual background & Template Matching Method

The Visual background & Template Matching Method results are compared with the other background subtraction processes as depicted in figure 9. In few numbers of video sequences the gradient mask is not accurately observed due to radiance variation & other problems.

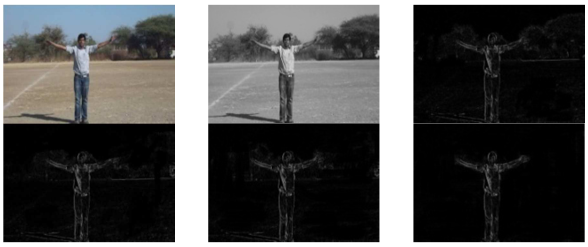


Figure 9: Image from database sequence, grayscale conversion, "Adaptive mixture models" [14], "Haritaoglu" [15]. "Romain" [16], and described technique. (Read row-wise).

Table 2: Tracking window variation for change in element σ performance.

Sr. No.	Run	Scale Parameter σ	Target Scale
1	Run 1	0.25	0.9990
2	Run 2	0.5	0.9994
3	Run 3	0.75	0.9940
4	Run 4	1	0.9866
5	Run 5	1.25	0.9725
6	Run 6	1.5	0.9687
7	Run 7	1.75	0.9523

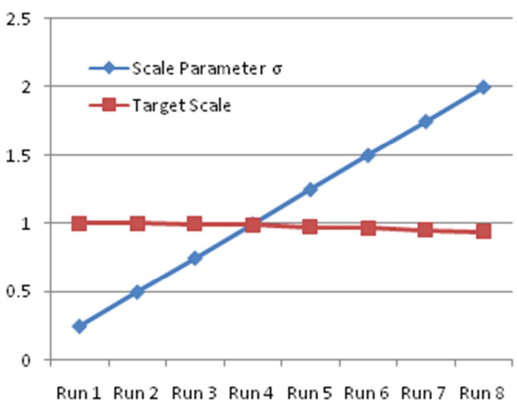


Figure 9: Graphical representation of table 2.

The target tracking efficiency is increased through the weighted context region of the last target location. Furthermore, the size of the object also changes with time depending on whether the object is approaching nearer to the camera or going away from the camera. Hence, the scale element σ should be updated accordingly. Table 2 represents the variation of tracking rectangle when the element σ is changed for various values.

5. CONCLUSION

In this paper, we have analyzed two methods of human motion segmentation & tracking. First method is the use of three frame subtraction which overcomes the disadvantage of simple frame differencing algorithm. This method achieves accurate segmentation of moving pixels. The second method is combination of visual background extraction and illumination insensitive template matching technique. Experimentation result of the model shows its effectiveness against motion changes due to camera movement, and cluttered background. Method also reduces false alarm triggering due to noise and illumination changes. Our future direction of study includes the study of surveillance system for the prediction of the speed & distance of the object in the scene. This would be useful in vehicle safety & sports activity analysis & applications.

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