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Research Article

An Efficient Multiple Human and Moving Object Detection Scheme Using Threshold Technique and Modified PSO (IPSO) Algorithm

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Abstract: The Detection and Tracking of human objects is one among the significant tasks encountered in Computer Vision. Yet, numerous problems associated with it are developing even at present. Various monitoring systems involved in the automatic detection of human objects in motion is found to have difficulty in spotting the difference in brightness, while the brightness of the moving human objects and the background is indistinguishable. Target tracking mainly concern with the evaluation of object's speed and position over time using one or multiple sensors. This study introduces the human object detection and tracking system, in which multiple objects are being detected without flaw. For a given video clip, the system does segmentation and tracking of similar video clips. The segmentation is done using the threshold method. After the segmentation process, we have introduced an optimization technique in order to refine the segmented results. The optimization used in our proposed work is a modified form of Particle Swarm Optimization (IPSO). Once the optimization of the segmented result is done the detection of human and moving object are performed The implementation is done in the working platform of MATLAB and the results shows that our proposed method delivers better detection of multiple objects than other existing methods.

Keywords: Block matching, improved particle swarm optimization, object detection, object detection, shot segmentation, thresholding

INTRODUCTION

Ever since computer vision researchers embarked on developing algorithms for complete scene understanding, understanding human activities has been an important goal. More importantly, human activity recognition has found a niche in security and video surveillance and most of the related algorithms depend on recovering human shapes and structures in the images. Further, accurate human segmentation can help in developing better systems for white balancing (Vineet *et al*., 2011). Video surveillance can be an effective tool for today's businesses, large and small, in security surveillance, production monitoring and deterring predatory and purloining behaviors. Since the introduction of analog video surveillance systems back in the 1970s, tremendous strides have been made in sensing, storage, networking and communication technologies. The consequence is that, instead of employing video surveillance mainly as an "after-effect" forensic tool, it is now feasible to deploy digital, network-based surveillance systems to provide interactive, real-time monitoring and surveillance (Niu *et al*., 2004).

Traditional video surveillance takes a huge amount of storage space. Recording everything captured by a surveillance camera consumes excessively the disadvantages limit the effectiveness of traditional video surveillance. To solve these problems recording only video that contains important information, i.e., video that contains motion in the scene. This can be done with a web camera and a motion detection algorithm that detects motion. When the lighting condition changes, it is difficult to distinguish real motion from lighting changes (Sreedevi *et al*., 2012). A huge and growing number of videos are available online today. Human actions are one of the most important parts in movies, TV shows and personal videos. Analysis of human actions in videos is considered a very important component in computer vision systems because of such applications as content-based video retrieval (Seo and Milanfar, 2009).

In detection alone schemes, various detection algorithms have been proposed based on background

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subtraction, frame differencing and optical flow. Methods based on background subtraction are common in video-based surveillance systems when cameras are fixed. In these systems, accurate and robust background modeling is a prerequisite step; however, due to significant intensity variations in images, it is difficult to parameterize the scene analytically (Wang *et al*., 2006). The detection of the presence of humans is of importance for example in save robot navigation and automatic video surveillance. In this study we focus on video surveillance applications with stationary cameras where human detection is generally used as an assistive technology for the system operator. A computer-based surveillance system must be able to reliably detect a possible intruder and alert the system operator (Ramoser *et al*., 2003). The focus of a great deal of research has been the detection and tracking of simple models of humans by exploiting knowledge of skin color or static backgrounds. Progress has also been made on the problem of accurate 3d tracking of high-dimensional articulated body models given a known initial starting pose. A significant open issue that limits the applicability of these 3d models is the problem of automatic initialization. Simpler, lower-dimensional, models are needed that can be automatically initialized and provide information about the 3d body parameters (Fablet and Black, 2002).

Selecting the right features plays a critical role in tracking. In general, the most desirable property of a visual feature is its uniqueness so that the objects can be easily distinguished in the feature space (Jepson *et al*., 2003). Feature selection is closely related to the object representation. Mostly all the tracking algorithms use a combination of these features: Color, Edges, optical Flow and Texture. Mostly features are chosen manually by the user depending on the application domain. However, the problem of automatic feature selection has received significant attention in the pattern recognition community.

In this study, we have introduced an efficient method of human object detection utilizing various means of techniques that involves segmentation and optimization algorithms. The proposed object detection process mainly concentrate on the moving object either it can be a human object or an ordinary object. The major objective is to detect and track the moving object from any video instance with the aid of segmentation and optimization algorithms. We have utilized Improved PSO fro optimizing the segmented output.

REVIEW OF RECENT RESEARCHES

Numerous researches have been done in the field of human object detection from the video sequence. In this section we have listed some of the recent techniques that are used in the human detection from the video sequence.

Extracting high level features was an important field in video indexing and retrieving. Identifying the presence of human in video was one of these high level features, which facilitate the understanding of other aspects concerning people or the interactions between people. Khan and Saeed (2009) have proposed a method for identifying the presence of human in videos. The proposed algorithm detects the human face based on the colour and motion information extracted from frames over wide range of variations in lightning conditions, skin colour races, backgrounds and faces' sizes and orientations. The proposed work proves to be crucial in lots of applications whose concern was mainly human activities and can be a basic step in such activities.

In the last decade, due to the increase in terrorist activities and general social problems, providing security to citizens has become the top most priorities for almost all the nations and for the same, a very close watch was required to be kept in the areas that needs security. Keeping human watch 24×7 was not possible as we all know that humans could easily be distracted and a small distraction in very sensitive and highly secure area could lead to big loses. To overcome this human flaw in the area of monitoring, the concept of making monitoring automatic came into existence. Since, video surveillance has came in the market, researches have been taking place in order to make to more easy, accurate, fast and intelligent. Patel and Wankhade (2011) have studied the phases of the video surveillance system. They proposed a method of handling occlusion using velocity and direction information.

Zhang *et al*. (2008) have presented a robust, real-time human detection and tracking system that achieves very good results in a wide range of commercial applications, including counting people and measuring occupancy. The key to the system was a human model based camera calibration process. The system uses a simplified human model that allows the user to very quickly and easily configure the system. This simple initialization procedure was essential for commercial viability.

Detection and tracking of humans in video streams is important for many applications. Wu and Nevatia (2007) have presented an approach to automatically detect and track multiple, possibly partially occluded humans in a walking or standing pose from a single camera, which may be stationary or moving. A human body was represented as an assembly of body parts. Part detectors are learned by boosting a number of weak classifiers which are based on edgelet features. Responses of part detectors are combined to form a joint likelihood model that includes an analysis of possible occlusions. The combined detection responses and the part detection responses provide the observations used for tracking. Trajectory initialization and termination are both automatic and rely on the confidences computed from the detection responses. An object was tracked by data association and mean shift methods.

Detecting human beings accurately in a visual surveillance system was crucial for diverse application areas including abnormal event detection, human gait characterization, congestion analysis, person identification, gender classification and fall detection for elderly people. The first step of the detection process was to detect an object which was in motion. Object detection could be performed using background subtraction, optical flow and spatio-temporal filtering techniques. Once detected, a moving object could be classified as a human being using shape-based, texture-based or motion-based features. A comprehensive review with comparisons on available techniques for detecting human beings in surveillance videos was presented by Paul *et al*. (2013). The characteristics of few benchmark datasets as well as the future research directions on human detection have also been discussed.

Bhattacharya *et al*. (2011) discussed the challenges of automating surveillance and reconnaissance tasks for infra-red visual data obtained from aerial platforms. These problems have gained significant importance over the years, especially with the advent of lightweight and reliable imaging devices. Detection and tracking of objects of interest has traditionally been an area of interest in the computer vision literature. These tasks were rendered especially challenging in aerial sequences of infra-red modality. That gives an overview of these problems and the associated limitations of some of the conventional techniques typically employed for these applications. They began with a study of various image registration techniques that were required to eliminate motion induced by the motion of the aerial sensor. Next, they presented a technique for detecting moving objects from the ego-motion compensated input sequence. Finally, they described a methodology for tracking already detected objects using their motion history.

PROPOSED METHODOLOGY

Tracking of object from video: The moving human object detection and tracking in any security and surveillance environment has been an active area of research in computer vision. The moving human detection from a video sequence is a tedious job as there will be variation in background in each frame as well as the camera resolution. In this study we have developed an efficient system for the human object detection from the video input. Motion of the human object from any video sequences can be identified based on the movement of the object in each frame of the video sequence. The proposed method can deliver high detection efficiency while considering the techniques utilized.

Proposed human object detection steps: The proposed work introduces the human object detection and tracking system, in which multiple human objects are being detected without flaw. For a given video clip, the system does segmentation and tracking of similar video clips. The segmentation is done using the threshold based technique. Here two components are considered namely the static (background) and the

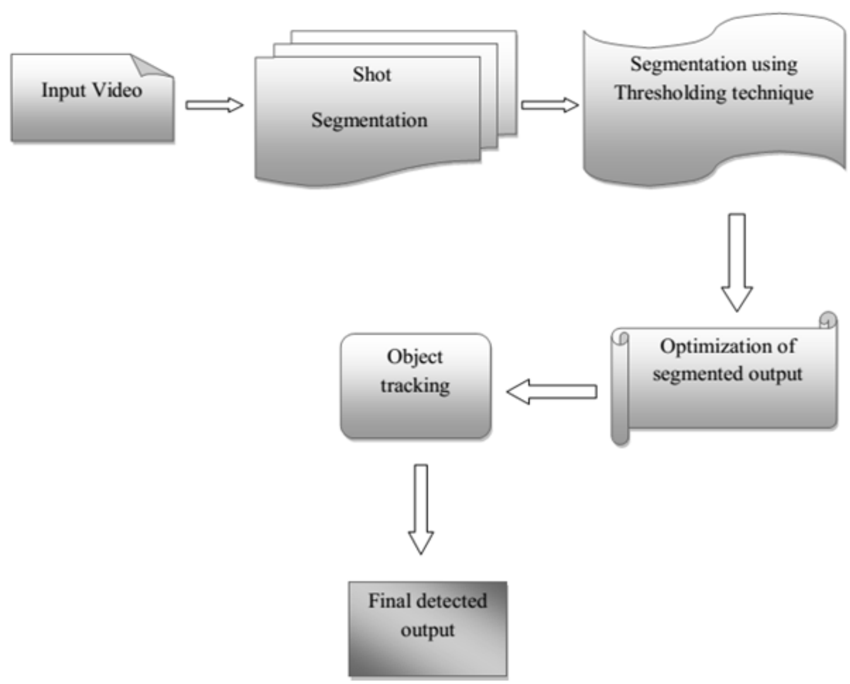


Fig. 1: Proposed work flow

moving population (moving objects). The inter frame difference calculation will enable the human objects to be identified based on the motion of human in the frames. The segmented outputs are then optimized in order to refine the segmentation process and finally the human object and the moving objects are detected and their performances are validated. The flow diagram for our proposed method is depicted in Fig. 1.

Preprocessing: The preprocessing is the initial step in our proposed method. Normally preprocessing is done to make the video input suit our proposed method for further processing. The input video of the gait sequence is collected and these video are preprocessed to make it suitable for further steps like feature extraction and classification. The major step in the preprocessing is to remove the other objects from the video input. Normally the video input contains various objects along with the target object. These objects are to be removed for further processing in order to obtain the corresponding results in an efficient manner. In our proposed method we have employed the background subtraction in order to separate the target object from the background objects. Background subtraction proved to have better processing rate and hence we have employed the process of background subtraction in our proposed method for separating the required object. The various operations carried out in the background subtraction process is explained in below section.

Shot segmentation: A wide range of digital videos have been developed due to the quick progress in computing and network infrastructures. Commonly, a hierarchical structure is used to describe the videos and shots from the fundamental units for building up high level semantic scenes. Hence, shot boundary detection is an essential preprocessing step used for the efficient browsing and additional content investigation. A shot is comprised of consecutive frames that are taken through a single camera action. Typically, no considerable content modifications are inspected between successive frames in the shot (Li *et al*., 2009).

The shot segmentation is performed with the help of block matching technique which is defined as follows:

- Split the frame into blocks of block size 16.
- First perform block matching for two blocks which are adjacent to each other.
- Then in block matching find the distance of blocks.
- Take mean value of distance.
- Repeat these steps for each frame in the video.
- Check whether the mean value is greater than 1.
- The mean value greater than 1 is stored in a variable and these variable lengths are measured.
- Thus the video are shot segmented into various frames with block matching technique.

Segmentation of human and moving object using threshold based technique: Images are virtually split into small blocks either in foreground or background component. Based on intensity variation these classifications as foreground or background is done. At first, the camera captured business card images are virtually split into small blocks. A block is part of either background or a foreground component. This classification is done on the basis of intensity variance within the block. The intensity variance is defined as the difference between the maximum I_{max} and the minimum I_{min} gray scale intensity within the block. It is observed that the intensity variance of a text block is considerably more than that of a background block. This has been the key idea behind the present approach. So, if the intensity variance of a block is less than an adaptive threshold (T), it is considered as part of the background. Otherwise, it is considered as part of a foreground component.

The threshold T has two sections, i.e., a fixed one (T_f) and a variable one (T_v) as shown in Eq. (1). T_f is a stable subject to tuning. The formulation of T_v is specified in Eq. (2). It may be noted that I_{min} must be greater than a heuristically selected threshold T_{min}. Otherwise, the block is regarded as part of a center object. This exposes the actuality that even if the intensity variance of a block is less than T_0, it is not categorized as background until the minimum intensity inside the block exceeds T_{min}. This diminishes the opportunity of miss-classifying foreground blocks as background ones:

$$T_0 = T_f + T_v \tag{1}$$

$$T_v = \left[(I_{\min} - T_{\min}) - \min(T_f, I_{\min} - T_{\min}) \right] * 2 \tag{2}$$

where,

I_{min} = The minimum intensity in a block
T_{min} = The minimum threshold value attained
T_f = The threshold value we consign

It is clear from Eq. (2) that the computation of T is such that the more is the standard intensity inside the grid, the larger is the threshold. In other words, if the intensity band of the block falls towards the higher sort of the overall intensity band, then T turns into larger. Such formulation assists to competently eradicate the background from the target objects. The target objects in our proposed method are the human object as well as the moving objects in the video frames. The threshold based segmentation provides a better segmented outcome where both the human as well as the moving object are being segmented in order to detect those images in the video. The segmentation process results in various detection of objects and inorder to refine the process to a moderate stage we utilize the optimization process which optimizes the segmented results inorder

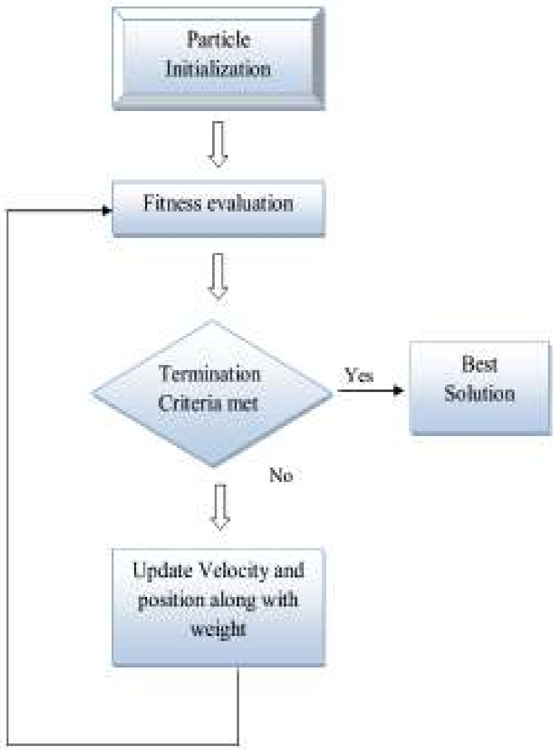


Fig. 2: General flow diagram for particle swarm optimization

to develop an efficient object detection system. The optimization we introduce is a modified for of Particle Swarm Optimization (IPSO) where the weight factor comes into consideration. Addition of the weight factor can help in an improved optimization result when compared to the normal PSO optimization process.

Optimization of the segmented output using improved PSO (IPSO): PSO owes its origin to the recreation of community conduct of birds in a herd. In this technique, every particle hurries in the pursuit space with a velocity adapted by its own flying memory and its companion's flying practice. Every particle has its unbiased function value which is determined by a fitness function. PSO is an evolutionary computing method similar to that of the Genetic Algorithm in which a specific system is initialized by a population of arbitrary solutions. In PSO, in addition to every latent key, randomized velocity is also allocated to fabricate a particle. Every particle goes along its coordinates in the dilemma space with reference to the superlative key. Moreover, the fitness value is also taken into account for the supplementary procedure. This fitness value is designed as *pbest.* The position of these solutions is deemed as *gbest.* In our ambitious method, we have taken an innovative procedure by means of a tailored edition of PSO. Here, we have allocated the weight factor calculation after the robustness choice with an eye on enhancement of e the probability of choosing the most excellent particle.

It is evident that the PSO has come out with flying colors in yielding a superior solution and the phases through which the process proceeds are very well illustrated in the following section. The usual stages of execution as regards the Improved Particle Swarm Optimization are exhibited in the Fig. 2.

Steps in improved particle swarm optimization: The diverse stages through which the execution of IPSO flows are shown below:

- At first, initialize a population of particles (solutions) with position and velocity selected arbitrarily for n-variable in the dilemma space.
- For every one of these particles, estimate the optimization robustness traits in n-variables.
- Thereafter analyze this fitness value with the particles pbest value. If the current fitness value is superior to the *pbest* then select it as the *pbest* for the supplementary dispensation.
- These fitness values are contrasted with the whole best prior values and if the current value is superior then revise the *gbest* for the current particles array index and treat it as the new *gbest*.
- Modify the velocity and the position of the particle and then replicate the steps till the standard of superior fitness is achieved. The velocity and the position of the particle are amended by using the following equations:

$$v_j(n+1) = v_j(n)(W_f) + a_1 d_1 (g_j(n) - h_j(n)) + a_2 d_2 (g_j^{'}(n) - h_j(n)) \quad (3)$$

$$h_j(n+1) = h_j(n) + v_j(n+1)(W_f) \quad (4)$$

- The weight factor is included in the velocity and position calculation inorder to improve the PSO results. The weight factor is calculated based on the iteration values which is given by:

$$W_f = (0.75 - 0.4) * ((10 - \mathrm{I})/\mathrm{I}) + 0.4 \quad (5)$$

- The procedure is executed again and again till the key with superior fitness value is attained.

In the above equations, a_1 and a_2 symbolize the acceleration constants essential for blending every particle with the *pbest* and *gbest.* Revise the best position of the particle as per the ensuing equation:

$$g_j(n+1) = \begin{cases} g_j(n), & k(h_j(n+1)) \geq k(g_j(n)) \\ h_j(n+1), & k(h_j(n+1)) < k(g_j(n)) \end{cases} \quad (6)$$

The particle velocity at every dimension is restricted to the interval [$\pm V_{max}$] and are then calculated and contrasted with the V_{max}. The V_{max} is a vital constraint. The V_{max} has the function of ascertaining the resolution with which the region between current position and the target position are hunted. The V_{max} values provide a basis to assess whether the particles turn out a superior key or not. With the use of the equations given above, we can assess the fitness of the solution and choose the optimal solution according to these fitness values.

This makes it clear that IPSO are capable being of employed to find solutions to the optimization dilemmas such as other evolutionary algorithms. It can be extensively exploited in diverse domains such as signal processing, robotics, simulations applications and the like. Once the optimization process is completed we employ the object tracker operation which enables to detect the moving object including the human from the video frame. The objects thus detected proved to be efficient in terms of its separation from the static objects. The results we obtained shows that our proposed method is efficient in detecting the required object from any video sequence.

RESULTS AND DISCUSSION

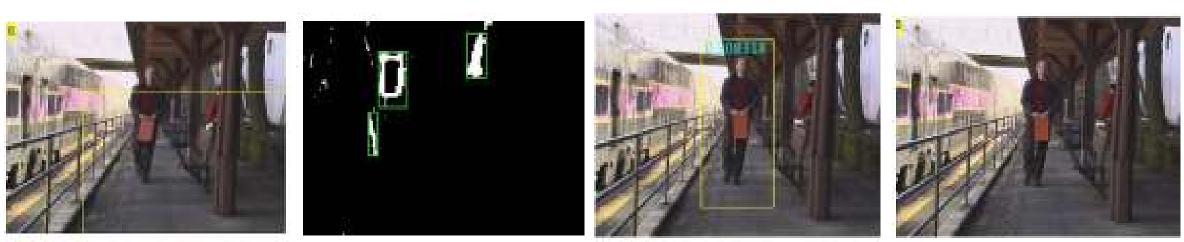
The proposed human and object detection system was implemented in the working platform of MATLAB. The detection process is tested with different frames of video and the upcoming result of the proposed work has been shown below. Initially, the video are segmented to different shots or frames and then segmentation and human and object are performed followed by the detection process. The results obtained by our proposed method for different frames of the input video is shown below.

As mentioned in the proposed part, the input video is first segmented into different frames for processing. The frame got after the segmentation is then applied for the remaining steps in our proposed method. First the input frame is subjected to threshold based sementation followed by optimization of segmented image. The Fig. 3a is the original image obtained from the shot segmentation. Figure 3b is the output after the Segmentation process, Fig. 3c shows the resultant image after the human object detection process and Fig. 3d shows the detected object in the first frame. Similarly for different frames the process is repeated and finally the object is detected. The proposed methodology proved to be more effective and accurate in object detection and tracking.

Figure 3a is the original image obtained from the shot segmentation. Figure 3b is the output after the Segmentation process, Fig. 3c shows the resultant image after the human object detection process and Fig. 3d shows the detected object in the 10th frame.

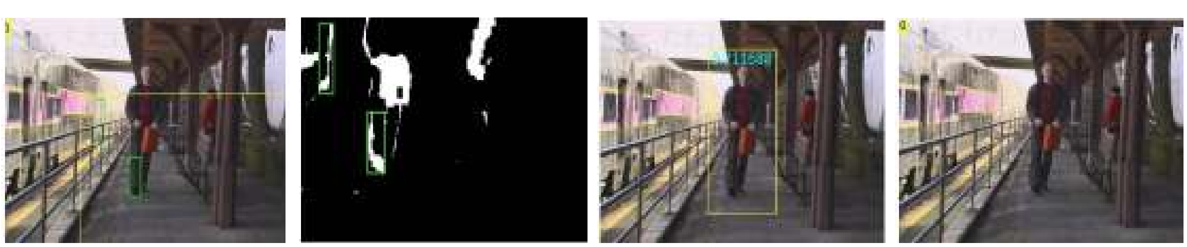
The Fig 4a is the original image obtained from the shot segmentation. Figure 4b is the output after the Segmentation process, Fig. 4c shows the resultant image after the human object detection process and Fig. 4d shows the detected object in the 20th frame.

Similarly for different frames the process is repeated and finally the object is tracked. The proposed methodology proved to be more effective and accurate in object detection and tracking (Fig. 5).



(a) (b) (c) (d)

Fig. 3: Results of human and object detection in first frame (Video); (a): Input frame; (b): Segmented output output; (c): Detected human with detection score; (d): Object detection



(a) (b) (c) (d)

Fig. 4: Results of human and object detection in 10 th frame (Video); (a): Input frame; (b): Segmented output; (c): Detected human objectwith detection score; (d): Object detection

(a) (b) (c) (d)

Fig. 5: Results of human and object detection in 20 th frame (Video 1); (a): Input frame; (b): Segmented output; (c): Detected human objectwith detection score; (d): Object detection

Table 1: Precision and recall for the proposed method

	Performance Analysis					
	Precision		Recall		F-Measure	
S. No	Proposed method	Existing method	Proposed method	Existing method	Proposed method	Existing method
1	0.9988	0.71	1	0.15	0.9993	0.2477
2	0.9995	0.65	1	0.24	0.9997	0.3506
3	0.9995	0.59	1	0.35	0.9997	0.4394
4	0.9935	0.52	1	0.46	0.9967	0.4882
5	0.9925	0.47	1	0.52	0.9962	0.4937

Table 2: Average F-measure for proposed and existing methods

	Methods	
F-measure	Proposed	Existing
Average F-measure	0.9983	0.4039

Performance analysis: The precision and recall value for the proposed method are calculated for analyzing the performance. Let the human object to be tracked be denoted by O_{HT} and the tracked output is denoted as T_{HO}, then precision and recall is expressed as:

$$precision = \frac{\{O_{HT} \cap T_{HO}\}}{\{T_{HO}\}} \tag{7}$$

$$recall = \frac{\{O_{HT} \cap T_{HO}\}}{\{O_{HT}\}} \tag{8}$$

Precision measures how much of T_{HO} covers the O_{HT} and recall measures how much of O_{HT} is covered by the T_{HO}. Using Eq. (7) and (8), the precision and recall values for the query image are calculated for the proposed method and also for the existing method. The F-measure for the proposed method is then calculated using the expression:

$$F = 2\left(\frac{precision\,.recall}{precision + recall}\right) \tag{9}$$

The values obtained from the calculation are given in Table 1. These values are used for the analysis of performance between the proposed and existing method. Here the existing method is the previous paper

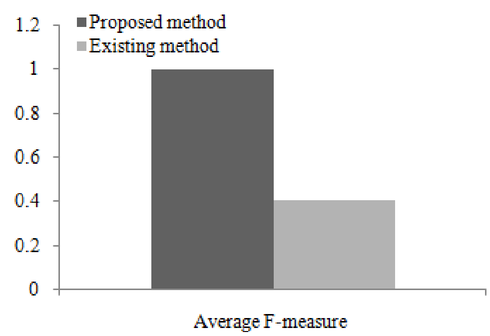


Fig. 6: Graphical representation of average F-measure for proposed and existing method

where object detection and tracking using low level features is performed. Each values relating to the methods are entered in the table for comparison and from the table it is clear that our proposed method delivers better precision and recall than the existing method. Here the existing method is the vision based object detection and tracking (Kalpesh *et al*., 2011).

The average F-measure value for the proposed and existing method is found out and the values are tabulated and given in Table 2. The corresponding graph is shown in Fig. 6.

CONCLUSION

In this study we have proposed efficient human object detection and tracking system. We developed a unique method using thresholding technique and IPSO optimization algorithm. As the results shows the proposed methodology proved to be more efficient and accurate in object detection and tracking than the previous methods. To prove the effectiveness of our proposed method we have compared the precision and recall value along with F-measure of the proposed method with existing method for the object detection and tracking process. As per the performance analysis, it is clear that our proposed method provides better F-measure value when comparing with other method. As a result it can be concluded that our proposed method is efficient in the field of moving object detection.

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