CHAPTER 6

Conclusion and Future Scope

6.1 Introduction

In this thesis, Two dimensional and Monocular three dimensional Object detection and tracking algorithm have been designed and examined using the proposed algorithm for the indoor and outdoor surveillance environment. The proposed algorithm is evaluated with the standardized datasets to track single and multiple moving objects and its comparison is done with other similar approaches. The proposed algorithm consists couple of major modules: (a) Foreground detection for the two dimensional and Monocular three dimensional object (b) Object tracking using discrete kalman filtering. The improvised Gaussian Mixture Model (Chapter - 3) is used to estimate the background model of every video sequences. Parameter optimization algorithm is used to provide the optimized mixture and learning parameters for GMM. Following the parameter optimization, Adaptive thresholding is used to segment the foreground objects under various constraints and challenging conditions. Later the dataset noises, outliers and other noises are removed and improvement is observed in the performance evaluation of the proposed algorithm using the Preprocessing (Adaptive Local Noise Reduction Filter) and Post processing (Morphological closing) approaches. Results of the proposed algorithms results are shown and compared (Chapter - 5) with the similar approaches.

The detected objects have been tracked using the discrete kalman (Chapter - 4) filtering. The proposed tracking approach is able to track two dimensional and Monocular three dimensional objects in both the indoor and outdoor environments. The performance evaluation of the foreground detection and background subtraction methods can’t be evaluated with single performance so various other performance metrics are used to evaluate the proposed algorithm such as Precision- Recall Curve, Fail Rate Detector or Miss Rate analysis and Similarity Measures (chapter - 5). The results of the proposed algorithm are compared with the other similar approaches (Chapter - 5).
6.2 Conclusion

The proposed system functions efficiently well on the various aspects investigated towards the objectives of the thesis. The proposed Object detection and tracking algorithm is implemented for two dimensional & monocular three dimensional video sequences and further its results are presented and discussed. The intrinsic and extrinsic improvements in the Gaussian Mixture Models are discussed. Also their results and other performance metrics were compared with the other similar approaches.

The major findings of this investigation can be summarized as follows:

- Proposed algorithm is robust and it efficiently detects objects for both indoor and outdoor environment with complex and dynamic backgrounds.
- The proposed algorithm ably handles partial occlusions and certain amount of shadows.
- Optimized mixture parameters (Intrinsic improvement) handles non stationary and clutter background efficiently.
- Adaptive threshold (Intrinsic improvement) ably detects foreground objects.
- Preprocessing and post processing (Extrinsic improvement) helps in reducing the dataset noises, outlier and false positives wherein reduction in false positive significantly improves motion detection accuracy.
- Monocular 3D approach handles objects with similar appearance.
- The proposed algorithm is robust to any object class and also operates under many lighting conditions.
- The proposed algorithm is invariant to camera views, camera perspective and efficiently handles the crowded scenes.
- The proposed algorithm is able to handle diverse image resolution and at the same time it is able to handle multiple objects.

The proposed algorithm has certain limitations like shadow detection becomes difficult in a video frames with small texture foreground and background variations, unable to detect stationary foreground objects, difficulty in tracking fully occluded objects. Foreground detection performance decreases in extreme and sudden light changes and it is very tough to detect object edges in a very low resolution video sequences.
Besides meeting all of the thesis objectives, several contributions have been achieved by this proposed work such as:

(i) **Intrinsic Improvement – Parameter Optimization algorithm**

Intrinsic Improvements in the Gaussian Mixture Model which concern the modification made in Gaussian Model parameter initialization, parameter maintenance during execution at every new pixel or frame level and at the foreground detection (motion segmentation) level. The appropriate selection of mixture parameter is indeed an impact on the performance of the overall surveillance system, as the same algorithm is applicable for both indoor and outdoor surveillance. Literature survey shows that usually, the model parameters are predefined or initialized by some algorithms like k-means cluster algorithm, EM or MLE approach etc. In proposed algorithm model parameters can be initialized by parameter optimization algorithm for the every video sequences. This Proposed algorithm is evaluated with the standard video datasets and compared with the other similar approaches and the significant improvements are shown.

(ii) **Intrinsic Improvement – Foreground Detection (Motion Segmentation)**

Foreground detection plays a vital role in surveillance system. Background model is sensitive enough to segment every moving object. Literature survey provides different Intensity, Region, Texture, Edge or Motion based segmentation approaches. Static threshold provides poor foreground detection and may lead to increases either false positive or false negative. In proposed approach foreground detection is achieved by means of Adaptive Thresholding instead of static thresholding. The proposed approach is evaluated with the standard dataset and resultant foreground mask is compared with the ground truth and other similar approaches. The observation is that most of the false negatives generated by the traditional pixel and region based methods are removed by the intrinsic improvements.
(iii) Extrinsic Improvement – Pre processing

Extrinsic Improvements emphasizes purely on improving the performance of the model and hence it improves the results. The image and dataset noises are removed by using the preprocessing. The proposed algorithm uses Adaptive Local Noise Reduction Filter as a pre-processing method to remove dataset noises.

(iv) Extrinsic Improvements – Post processing

Post processing is again an external tool to perform the evaluation. In proposed algorithm Morphological Closing (dilation followed by erosion) is being used as a post-processing method for the sake of reducing the noise and outliers in the datasets. As a result most of the false positives generated by the traditional approaches are removed.

6.3 Future Work

The object detection and tracking algorithm proposed in this work targets wide range of object class with other dataset particulars. However there are still several areas and future work that address further improvement in making the algorithm more generic. The various future potentials are as follows:

- Intrinsic improvement in Gaussian Mixture Model - maintain the mixture parameters by means of dynamic approach.
- Different values for the learning parameters and the other approaches to calculate the learning parameters make it easy to handle the sudden illumination variations.
- The algorithm can be more robust by adding other pixel features such as texture and edges.
- For the real time surveillance application, DSP or other hardware realization is required.