PREFACE

Video surveillance is an active area of research because of its various applications in human robot interaction, entertainment, education, training, video conferencing, and human behavior analysis. Recognition of activities provide important cues for human behavior analysis techniques. In this thesis, the problems of moving object segmentation, background modeling and shadow suppression under highly dynamic background (such as bright sun, fog, heavy rain) are addressed and finally the human activities in multi-view camera are recognized. Even though this is a well explored problem in the field of computer vision, many challenges still remain when one is presented with realistic data. These challenges include highly dynamic background, gradual and sudden illumination changes, camera jitter, shadows, reflections that can provoke false detections, waves on the water surface, boat wakes, and weather issues.

First, this thesis is focus on the problem of moving object segmentation. Segmentation of moving object is a process of isolating the foreground object from background of a video sequence. Due to dynamic environmental conditions such as illumination variations, changing background, abrupt motion of object, and presence of shadow, moving object segmentation is a difficult and complicated task. The objective of proposed work is two-fold. In the first fold, a comprehensive literature review and comparative study of various classical as well as state-of-the art methods for moving object segmentation under varying illumination conditions is presented. Further, an efficient approach for moving object segmentation in complex wavelet domain under varying illumination conditions is proposed and its comparative study with other methods under consideration are presented. The qualitative and quantitative comparative study of the various methods as well as the proposed method is tested on six different datasets.

The merits, demerits, and efficacy of each methods under consideration have been examined. The extensive experimental comparative analysis on six different challenging benchmark data sets demonstrate that proposed method is performing better to other state-of-the-art moving object segmentation methods and is well capable of dealing with various limitations of existing methods.

Second, this thesis is focus on the problem of background modeling and shadow suppression of moving objects in a scene that contains small movements of non-static objects such as tree branches and bushes blowing in the wind, waving trees, shadow regions, maritime object, boat wakes, and weather issues (such as bright sun, fog, heavy rain). To deal with these issues, a framework for dynamic background modelling and shadow suppression under rapidly changing illumination conditions for moving object segmentation in complex wavelet domain is proposed. It consists of eight steps i.e.: wavelet de-composition of frame using complex wavelet transform; use of change detection on detail coefficients (LH, HL, HH); use of improved Gaussian mixture based dynamic background modeling on approximate co-efficient (LL sub-band);cast shadow suppression; use of soft thresholding for noise removal; strong edge detection; inverse wavelet transformation for reconstruction; and finally using closing morphology operator to be applied on given video frames. A comparative analysis of the proposed method is also presented, both qualitatively and quantitatively, with other standard methods available in the literature for six datasets in terms of various performance measures. Experimental results demonstrate the good efficacy of the proposed method. The proposed segmentation method works well in presence of noise as well as in case of non-stationary video sequences. In case of highly dynamic background such as moving object in water surface, boat wakes, and weather issues (such as bright sun, fog, heavy rain), moving object in a rainfall, and maritime object detection during

night time the above proposed dynamic background modelling and shadow suppression framework does not work properly.

To deal with above mentioned issue, a fast and robust moving object segmentation method on a water surface for maritime surveillance using Dynamic Background Modelling and Shadow Suppression (DBMSS) in the complex wavelet domain is developed. For dynamic background modeling, frame difference, background registration, background difference, and background difference mask in the complex wavelet domain are used. For shadow detection and removal, the high frequency sub-band in the complex wavelet domain is exploited. A comparative analysis of the proposed method is presented both qualitatively and quantitatively, with other standard methods available in the literature for publicly available datasets of videos in different maritime scenarios, with varying light and weather conditions. Experimental results indicate that the proposed method is performing better in comparison to other standard methods for all the test cases.

In addition to moving through the scene, the humans that are present may be performing individual activities that should be detected and recognized by the system. A number of different approaches exist for activity recognition in both aerial and ground level videos. Most of the methods of activity recognition are view dependent and deal with recognition from one fixed view. As a solution to this limitation, an efficient view invariant framework for the recognition of human activities is presented. The proposed framework is composed of three consecutive modules: (i) detecting and locating people by background subtraction, (ii) view invariant spatio-temporal template creation for different activities, and (iii) finally template matching is performed for view invariant activity recognition. The foreground objects present in a scene are extracted using change detection and background modeling. The view invariant templates are constructed using

the motion history images and object shape information for different human activities in a video sequence. For matching the spatio-temporal templates for various activities; the moment invariants and mahalanobis distance are used. The proposed approach is tested successfully over different standard video datasets. From the experimental results and analysis over the chosen datasets, it is observed that the proposed framework is robust, flexible and efficient with respect to multi-views activity recognition, scale and phase variations. This method provides good recognition result for single human activities for multiple views but it fails in case of multiple human activities. To resolve this problem, a feature based multiple human activity in different views is proposed that uses both contour-based pose features from silhouettes and uniform rotation local binary patterns for view invariant activity representation. The proposed framework is composed of three consecutive modules. These are (i) background subtraction (ii) feature extraction and (iii) classification. The background subtraction has been performed using change detection method. The contour-based pose features from silhouettes find the different key poses for human activities such as bending, standing, sitting etc. After that uniform rotation invariant LBP descriptor has been computed. Its rotation invariant nature provides view invariant recognition of multi-view human activities and uniform patterns facilitate good discriminating capabilities. Multiclass SVM classifier has been applied for recognition of different activities. The proposed approach is tested successfully on different multi-view datasets. From the experimental results and analysis over the chosen datasets, it is observed that the proposed framework is robust, flexible and efficient with respect to multi-view human activity recognition for multiple people. The overall thesis is organized into seven chapters as follows

Chapter 1 presents a brief introduction of the problems addressed in this thesis followed by the objectives of the thesis. Finally the chapter concludes with a brief account on contributions of this thesis in the field of image/video processing.

Chapter 2 discusses the theoretical background for video surveillance system. In this chapter, we have also given an overview of complex wavelet transform. Further, in this chapter a literature survey of prominent approaches for moving object segmentation and activity recognition are given.

Chapter 3 presents a review and experimental study of various recent moving object segmentation methods available in literature and these methods have been classified into four categories i.e. moving object segmentation methods based on (i) motion information (ii) motion and spatial information (iii) learning, and (iv) change detection. The objective of this chapter is two-fold. In the first fold, this chapter presents a comprehensive literature review and comparative study of various classical as well as state-of-the art methods for moving object segmentation under varying illumination conditions. Further, in this chapter, an efficient approach for moving object segmentation in complex wavelet domain under varying illumination conditions is proposed and its comparative study with other methods under consideration is presented. The qualitative and quantitative comparative study of the various methods under four categories as well as the proposed method is presented for six different datasets.

Chapter 4 presents two new methods for dynamic background modeling and shadow suppression in the complex wavelet domain. First method handles the small movements of non-static objects such as tree branches and bushes blowing in the wind, waving trees, shadow regions that are projected by foreground objects and are detected as moving objects. Second method deals with highly dynamic background such as a moving object in a water surface, boat wakes, and weather issues (such as bright sun, fog, heavy rain),

moving object in a rainfall, and maritime object detection in the night. Robustness of the proposed methods in comparison to other state-of-the-art methods has been tested for different types of videos. Finally, the quantitative performance values for different cases have been computed for the proposed methods and other state-of-the-art methods and then compared in terms of different performance evaluation metrics.

Chapter 5 addressed the problem of multi-view human activity recognition. In this chapter, a multi-view human activity recognition system based on spatio-temporal template is proposed. Performance of this method has been analyzed in terms of confusion matrix and recognition accuracy.

Chapter 6 presents a method for multi-view activity recognition for multiple human. In this chapter a multi-view human activity recognition method is proposed by using multiple features i.e. (i) Contour based distance signal feature (ii) Uniform rotation local binary patterns. Further, the activities are recognized by using multiclass support vector machine (SVM). Performance of the proposed method has been analyzed in terms of confusion matrix and recognition accuracy.

Chapter 7 concludes the thesis and summarizes main findings of the work done. This chapter also proposes some possible future perspectives of the thesis.