Video surveillance is a rapidly evolving area that is providing vital tools to a variety of organizations for their safety and security needs. Initially, it was dominated by conventional CCTV (Closed-Circuit Television) based surveillance systems which were used for display and recording of the live video streams of a scene. The current generation of video surveillance systems is moving towards automation of these systems which allows automatic extraction and analysis of information from live incoming video streams and enables automatic detection and tracking of targets without human interventions while multiplexing many high resolution video streams in real-time. The resulting increasing demand on parameters such as frame rate, resolution, storage capacity, functionality, and number of video streams to be processed results in implementation issues related to high data rates, real-time processing, and memory bandwidths which are impossible to handle in pure software based solutions. Therefore, accelerating computationally intensive and time consuming repetitive key operations in dedicated hardware architectures is crucial to sustain real-time performance in the advanced next generation automated video surveillance systems.

To achieve this goal, this thesis presents the design and development of innovative VLSI architectures for three hardware accelerators to be used in a real-time automated video surveillance system, implemented on an FPGA platform. The first architecture is capable of performing real-time motion detection in a live video stream with low complexity and low memory requirement. It supports PAL (720x576) size color video processing and also allows video history generation for a live video stream. Second architecture is an area efficient architecture for finding focused regions in a video scene. This architecture supports focused region extraction, based on edge width information, in a live video stream. Furthermore, this architecture has been combined with motion detection architecture to filter the frames of interest based on motion detection only in focused regions in a scene. Finally, the third architecture performs real-time object tracking based on modified particle filtering, histogram computation, and sum of absolute differences computation and supports purposive camera movement (pan-tilt) to follow the target object. The results of these implementations have also been compared with the competing methods and trade-offs have been discussed. Finally, a combination of motion detection and focused region extraction architectures, as well as object tracking architecture, has been successfully integrated into a prototype automated video surveillance system whose details are also presented in the thesis. This system has been
implemented on an FPGA based development board using a PTZ (Pan-Tilt-Zoom) camera for video acquisition and covering a wide field of view. The prototype successfully and robustly detects the motion in a live video stream, generates the history of a live video stream, filters the frames of interest based on motion detection only in focused regions in a scene, automatically detects the moving target and tracks the detected target in subsequent video frames while also generating commands for purposive camera movement to follow the tracked object and keep it in the field of view of the camera as long as possible.