**ABSTRACT**

A long standing challenge in the areas of computer vision, image processing and autonomous drive systems is to achieve high accuracy with real time performance. It is very critical for applications deployed on autonomous vehicles to deliver results in real time, for not only meeting functional requirements, but also safety requirements. Any lapse in the performance of application can have catastrophic results. Hence, there is immense need to perform reliably at real time. Military and defense application areas also have critical needs for high performance applications. One of the most prominent situations in these contexts, is to process video data received at ground station from Unmanned Aerial Vehicle (UAV). The ground station will have scope of hosting high performance hardware that can be used to exploit the received data for making immediate intelligent decisions. The availability of instantaneous results enable the authority at the ground station to take an immediate action on any intrusions in the area under surveillance. These demands to process the data in real time requires efficient implementation of algorithms on to the target hardware.

This thesis focuses on high performance implementations of key computer vision and image processing algorithms. These algorithms are chosen such that both the areas of autonomous vehicles and UAV based applications are covered. Adaptive contrast enhancement and Motion de-blur are the chosen applications that are implemented on a High performance hardware server used in ground stations that exploit UAV data. The high performance hardware here consists of multiple processing elements like Single Board Computer (SBC), GPU, DSP & FPGA. This work exploits SBC and GPU for implementing these applications using concepts of data parallelism and memory optimizations.

In the autonomous drive area, there are more challenges to make the applications run on an Embedded hardware with limited resources both in terms of computation and memory. In this work, applications are developed that exploit pipelining, parallel processing and task based parallelism techniques. Autonomous SOCs used for testing these applications are Renesas based Rcar-H3 SiP and nVidia’s Tegra X1 SoC. Fog rectification, temporal denoising and stereo disparity applications are implemented to exploit these embedded hardware. To further understand and exploit the usage of GPU, Stereo disparity application is implemented using parallel GPU streams.

This thesis focuses on the design and implementation of these image processing and computer vision applications. The high performance computing concepts are explained in detail for each algorithm. Performance analysis is done for each of the algorithms and achieved speedups are reported. The speedups range from 2X to 8X depending on the kind of application and employed performance techniques.

**CONCLUSION**

In this work, different kinds of high performance parallel implementations are discussed. Adaptive contrast enhancement and Motion de-blur applications are implemented using GPGPU and corresponding design, implementation and performance details are discussed. The techniques of extracting data parallelism from a sequential flow is explained in these applications. Speedups in the range of 2X to 4X are reported here.

Fog rectification and temporal denoising algorithms are implemented on Renesas Multi-core CPU SoC platform. The complete utilization of multiple CPU cores is explained in these applications. Also, the concepts of pipelining and task based parallelism are explained in great detail. Performance analysis is done are results are reported. Speedups in the range of 4X to 6X are reported here. For stereo disparity, block matching algorithm is discussed using CUDA intrinsics, shared memory and texture memory. A scalable design using parallel streams is also discussed here.

The high performance implementation ideas discussed in this work can be further extended to the advanced technological areas like deep learning, visual computing etc. Some more areas like finance, marketing, statistical analytics also benefit from the high performance computing.