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Multiple Degree of Freedom Stereo Camera Platform for Active Vision

Designing the Core Architecture of the Processor

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A dissertation submitted to the
Department of Electronic and Telecommunication Engineering
University of Moratuwa
in partial fulfilment of the requirements for the
Degree of Master of Science
(Major component of research)

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May 2007

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DECLARATION

The work submitted in this dissertation is the result of my own investigation, except where otherwise stated.

It has not already been accepted for any degree, and is also not being concurrently submitted for any other degree.

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Abstract

Vision is our most powerful sense. It provides us remarkable amount of information about our surrounding and enables us to interact intelligently with the environment, all without direct physical contact. Vision is also our most complicated sense. The knowledge we have accumulated about how biological vision systems operate is still fragmentary. Nature has proven to be capable of creating versatile and flexible vision systems, which are much more efficient than all artificial vision systems already designed. Therefore, the comprehension of some of the biological principles of vision has brought important ideas and concepts for the development of computational vision.

One of the main goals of the research is to develop a high-performance stereo active vision head, that can be used for studying human vision. The head consists of two eye modules and a neck module on which the two eyes are mounted. The camera platform has a total number of seven degrees of freedom, three in its neck and two in its each eye. Stepper motors with custom built gear wheels are used to drive all the degrees of freedom and the motors are used in a closed loop control system with sequential optical encoders for providing position feedback.

This research also focuses on implementing an FPGA (Field Programmable Gate Array) based microprocessor that interprets the instructions given by the user, calculates all the necessary parameters for driving the motors as required and controls the motors accordingly. This stand alone processor includes several floating-point units operating in parallel with the other motor control units. A total no of five floating point operations can be done in parallel that consists of 4 addition(or subtraction) and one multiplication(or division)operations. In addition, a CORDIC processor also runs in parallel to calculate trigonometric functions and root squares. With altogether the processor gives grater improvement to the performance in terms of speed exploiting parallelism.

The results show that the FPGA based microprocessor for controlling the multi degree of freedom stereo vision head is very efficient for active vision.

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