Multiple Degree of Freedom Stereo Camera Platform for Active Vision

Designing the Core Architecture of the Processor

Jayathu G. Samarawickrama

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)

Department of Electronic & Telecommunication Engineering
University of Moratuwa, Sri Lanka

May 2007

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.

UOM Verified Signature

J.G.Samarawickrama
Candidate

Date: 26/06/2017

UOM Verified Signature

Dr. A.A.Pasqual
Supervisor

Department of Electronic & Telecommunication
Engineering University of Moratuwa
Sri Lanka

Acknowledgement

I would like to take this opportunity to convey my deepest and sincere thanks to those who gave me a tremendous assistance and corporation in completing the research project and the thesis successfully.

First of all I would like to thank my project supervisor Dr. A.A Pasqual for providing continuous guidance, advice, constructive suggestions and invaluable support throughout the project. He allowed me to carry out the work freely without setting any restrictions but helped me and directed me in organising and carrying out the work. I would like to express my gratitude and appreciation towards him for spending his valuable time in assisting me to make this project a success.

I extend my gratitude to Dr. A.A. Pasqual for providing me the scholarship and research grants.

I would also like to thank the chairman of the examining committee Dr. T Nanayakkara for his kind advice and invaluable suggestions given.

My gratitude goes to Dr. D.A.I Munindradasa , Dr. U.K.D.L Udawatta and Dr. S.R Munasinha for their guidance given throughout the project.

A few tasks of this research was done jointly with my colleague M. G. B. Sumanasena. I would like thank him for his contribution to the mechanical design and the instruction set architecture.

I would also like to thank Mr Thissa Senevirathna and Mr Tilak Mayurawansha in the Ceylon German Technical Training Institute for their support in machining the mechanical components. My gratitude also goes to the students of the machine work shop in the above institute for their support in machining the mechanical components.

I thank all the academic and non academic staff members for their assistance and the support.

Finally I would like to thank my parents, friends and colleagues for their encouragement, support and the corporation.

Jayathu G.Samarawickrama
University of Moratuwa
May 2007

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.

Contents

List of Figures

List of Tables