Vision based localization of remotely operable agricultural vehicles

Jayaweera Mudiyanselage Lasitha Chandana Piyathilaka

09/8068

Degree of Master of Philosophy

Department of Electronic and Telecommunication Engineering

University of Moratuwa

2011 June

Declaration

"I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text".

Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my thesis/dissertation, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

.....

Signature

Date:

The above candidate has carried out research for the Masters/MPhil/PhD thesis/ dissertation under my supervision.

.....

Signature of the supervisor

Date:

Abstract

This thesis addresses the problem of outdoor autonomous robot localization for agricultural operations. A 12hp power tiller, commonly known as the walking two wheel tractor is used as the test platform after after introducing electrical actuators for its remote and autonomous operation. The mathematical model of the power tiller has been developed and simulated in MatLab SImulink. A vision based outdoor localization system is developed using off-the-shelf electronic components, and its accuracy has been verified in small agricultural fields. Visual odometry using a downward faced camera is tested with better resolution for relative localization, and popular visual odometry algorithms were tested for speed and accuracy in agricultural fields. A stereo vision based range measurement system has also been developed and field tested as an absolute localization system that can bound the incremental error caused by the visual odometry system. The extended Kalman filter with measurement gaiting has been implemented using both visual odometry and stereo range measurement data. Experimental results verified that the proposed system as an effective low cost technique for outdoor localization of field robots in small agricultural fields.

To my parents Mr and Mrs Piyathilaka.

Acknowledgements

First and foremost, I wish to express my sincere gratitude to my research supervisor, Dr. S.R. Munasighe Senior Lecturer at Department of Electronic and Telecommunication Engineering, University of Moratuwa for the valuable advice and guidance throughout my research.

I would also like to thank Dr. A. A. Pasqual for the support shown as the PG coordinator and memebers of the progress evaluation committee for giving invaluable cosntructive ideas.Also I would like to thank Dr. E. C. Kulasekere, head of Department of Electronic and Telecommunication Engineering and all academic and none academic staff of the Department of Electronic and Telecommunication Engineering for facilitating and supporting this research work.

This research wouldn't be possible if not the support given by Dayan Rajapakshe and Bhanu Watawana during the implementation and testing stages.

I also gratefully acknowledge the financial assistance provided by the National Science Foundation of Sri Lanka under the grant No:RG-2007-E-05.

On a more personal note, I am extremely indebted to my beloved parents and my dearest wife Uthsuka Ekanayake for being a constant source of inspiration, strength and encouragement throughout this endeavor .

Contents

List of Figures

List of Tables