OVERHEAD VISION SYSTEM FOR MOBILE ROBOT ORIENTATION DETECTION

FADZILAH BINTI HASHIM

UNIVERSITI MALAYSIA PERLIS
2010

UNIVERSITI MALAYSIA PERLIS

DECLARATION OF THESIS

Author's full name : FADZILAH BINTI HASSIM

Date of birth : 31ST DECEMBER 1969

Title : OVERHEAD VISION SYSTEM FOR MOBILE ROBOT VISION DETECTION

Academic Session : 2008/2009

I hereby declare that the thesis becomes the property of Universiti Malaysia Perlis (UniMAP) and to be placed at the library of UniMAP. This thesis is classified as :

☐ CONFIDENTIAL (Contains confidential information under the Official Secret Act 1972)*

☐ RESTRICTED (Contains restricted information as specified by the organization where research was done)*

☑ OPEN ACCESS I agree that my thesis is to be made immediately available as hard copy or on-line open access (full text)

I, the author, give permission to the UniMAP to reproduce this thesis in whole or in part for the purpose of research or academic exchange only (except during a period of ____ years, if so requested above).

Certified by

SIGNATURE

691224-08-6274

(NEW IC NO. ~~PASSPORT NO.~~)

Date: 28TH MAY 2009

SIGNATURE OF SUPERVISOR

DR. HJ. BADLISHAH AHMAD

NAME OF SUPERVISOR

Date: 28/5/09.

NOTES : * If the thesis is CONFIDENTIAL or RESTRICTED, please attach with the letter from the organization with period and reasons for confidentially or restriction.

OVERHEAD VISION SYSTEM FOR MOBILE ROBOT ORIENTATION DETECTION

by

FADZILAH BINTI HASHIM
(0730210149)

A thesis submitted
in fulfilment of the requirement for the degree of
Master of Science (Computer Engineering)

School of Computer & Communication Engineering
UNIVERSITI MALAYSIA PERLIS
2010

APPROVAL AND DECLARATION SHEET

This thesis titled Overhead Vision System for Mobile Robot Orientation Detection was prepared and submitted by Fadzilah binti Hashim (Matrix Number: 0730210149) and has been found satisfactory in terms of scope, quality and presentation as partial fulfillment of the requirement for the award of degree of Master of Science in Computer Engineering in University Malaysia Perlis (UniMAP).

Checked and Approved by

_____

(ASSOC. PROF. DR. R. BADLISHAH AHMAD)
Project Supervisor

School of Computer & Communication Engineering
University Malaysia Perlis

January 2010

DEDICATION

Dedicated to my parents and beloved family especially my husband, Zainol and my children, Farid, Hidayah and Sakinah

Acknowledgement

I would first like to dedicate my thanks to the Ministry of Higher Education for their financial support to persue my master program in UniMAP.

I would like to express my sincere gratitude to my supervisor, Assoc. Prof. Dr R.Badlishah Ahmad, for providing the initial idea and for this research works. His encouragement, patient guidance and support in all aspects have made me to complete this research works successfully. I would like to express my thank to Assoc. Prof. Dr Paulraj M.P., my co-supervisor, for his assistant developing codes using MATLAB. His guidance and assistance especially in providing the understanding of the mathematical basis in image processing and neural network is so valuable. His assistance, encouragement and support has been exemplary and tireless for nearly two years.

Finally, thanks are also due to my colleagues in the Embedded Computing Research Cluster (ECRC) and Acoustic Cluster for their helpful suggestions and advices. Particular thanks to Madam Hema Chengalvarayan Radhakrishnamurthy, Mr. Sofian Yusoff and Mr Muhd Hanif Abdul Hamid.

SISTEM VISI ATAS BAGI MENGESAN ORIENTASI ROBOT BERGERAK

ABSTRAK

Hubungan kerjasama dan koordinasi di antara robot adalah sangat penting di dalam kebanyakan aplikasi industri. Pengkomputeran menggunakan pemprosesan imej untuk mendapatkan posisi dan orientasi bagi pergerakan robot adalah satu keperluan bagi operasi robotik. Untuk menjayakan aplikasi yang menggunakan robot, keperluan menentukan kedudukan dan orientasi robot yang tepat adalah perlu. Terdapat pelbagai jenis teknik-teknik yang telah dikaji oleh penyelidik-penyelidik di seluruh dunia. Di antara teknik-teknik tersebut ialah momen-momen geometri, kompleks dan analisa komponen asas. Di dalam penyelidikan ini, satu prosedur untuk menentukan orientasi bagi robot bergerak dibentangkan dan dianalisis. Kamera-kamera digunakan untuk mengambil imej-imej robot bergerak dari pelbagai orientasi. Imej-imej ini dipreproses dan ciri-ciri penting diambil untuk diaplikasikan di dalam kaedah yang dicadangkan di dalam penyelidikan ini. Di dalam penyelidikan ini juga, beberapa kaedah untuk mendapatkan ciri-ciri dari imej-imej yang telah dipreproses dibangunkan, dibentangkan dan dikaji. Ciri-ciri yang telah didapati ini kemudiannya digunakan sebagai masukan-masukan bagi rangkaian neural yang mudah. Orientasi yang diukur secara manual bagi setiap imej digunakan sebagai vektor tumpuan. Satu rangkaian neural mudah dibangunkan untuk mendapatkan orientasi pergerakan robot. Keputusan-keputusan simulasi menunjukkan bahawa algoritma-algoritma yang dicadangkan dapat mengenalpasti atau mendapatkan orientasi yang tepat bagi robot yang sedang bergerak.

OVERHEAD VISION SYSTEM FOR MOBILE ROBOT ORIENTATION DETECTION

Abstract

Robot cooperation and coordination is absolutely necessary in many industrial applications. The computation of a mobile robot position and orientation is a common task in the area of computing vision and image processing. For a successful application, it is important that the position and orientation of the mobile robot are properly determined. Computing the orientation is not a straightforward technique. Number of methods has already been studied by many researchers. These methods include the concepts of geometric moments, complex moments, and principal component analysis. In this work, a simple procedure for determining the orientation of the mobile robot using overhead vision system is presented and analysed. Cameras are used to capture the images of mobile robot at various orientations. The images are preprocessed and important features are extracted to be used in the proposed methods. In this research, simple methods to extract the features from the preprocessed images are developed. The extracted features are then used as the inputs to a simple feed forward neural network. The orientation of each image is measured manually and used as a target vector. A simple neural network model is developed to estimate the orientation of the mobile robot. Simulation results show that the proposed algorithms can be used to estimate the orientation of the mobile robot accurately.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS, ABBREVIATIONS & NOMENCLATURE

2D	-	Two Dimensional
3D	-	Three Dimensional
ANN	-	Artificial Neural Network
x	-	Input training vector, $x = (x_1, x_2, \ldots, x_i, \ldots, x_n)$
t	-	Output target vector, $t = (t_1, t_2, \ldots, t_f, \ldots, t_m)$
δ_k	-	Portion of error correction weight adjustment for w_{jk} that is due to an error at the output unit Y_k, which is backpropagated to the hidden units that feed it into the unit Y_k
δ_j	-	Portion of error correction weight adjustment for v_{ij} that is due to the backpropagation of error to the hidden unit Z_j
α	-	Learning rate
Xi	-	*i*th input unit
v_{oj}	-	Bias on the *j*th hidden unit
Z_j	-	*j*th hidden unit
w_{ok}	-	Bias on the *k*th output unit
Y_k	-	*k*th output unit

CHAPTER 1

INTRODUCTION

1.1 Introduction

Autonomous mobile robots which are designed to move freely in the world have the same problems as humans when navigating while performing their tasks. The world is a complex environment and if robots only move around without 'looking' at where their action takes them, they might get lost because of the imperfections in their moving mechanisms and the environment. The research here therefore, focuses on a localization strategy that employs visual sensor and neural network for the robot to 'see' its surroundings and then estimate its own position and orientation.

1.2 Challenges in Mobile Robot Navigation

In order for a mobile robot to perform its assigned tasks, it often requires a representation of its environment, a knowledge of how to navigate in its environment, and a method for determining its position in the environment. These problems have been characterized by the three fundamental questions of mobile robotics, which are "Where am I?", "Where am I going?" and "How can I get there?' (Leonard, J.J.and Durrant-Whyte, H.F., 1992).

The first question is one of localization. The robot has to know where it is in a given environment based on what it sees and what it was previously told. The second and