GPS IMPLEMENTATION ON MOBILE ROBOT

Chua Wee Kok

Bachelor of Mechatronics Engineering
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"I hereby declared that I have read through this report entitle "GPS Implementation on Mobile Robot" and found that it has comply the partial fulfillment for awarding the Bachelor of Mechatronic Engineering."

Signature : .....

Supervisor's Name : Mr. Muhammad Herman Bin Jamaluddin

Date : 12 / 5 / 2010

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CHUA WEE KOK

A report submitted in partial fulfillment of requirements for Bachelor of Mechatronic Engineering.

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2010

I declare that this report entitle "*GPS Implementation on Mobile Robot*" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : Chua Wee Kok

Date : 11/5/2010

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ABSTRACT

This project is about the implementation of GPS on a mobile robot in outdoor environment. The GPS consist of a 32 channel receiver and a GPS evaluation board, interfaced with a microcontroller 16F877A via signal converter. This project is categorized to three main parts which include electric circuit, mechanical design and microcontroller programming.

The main objective of this project is enabling the automatic mobile robot to establish its own location on earth and use GPS information to navigate and move to a defined point. For further implementation, the mobile robot with better controllability might be able to construct.

The concept of this project is to use GPS to gather information such as bearing, distance and location and compare with a defined point. The program can determine whether the mobile robot should move forward, turn or even move backward by differentiating the distance and direction. The program used to process the data is C language. C compiler will execute the HEX file which needed to be downloaded into the PIC chip. The mechanical part will use differential drive to perform movement of the mobile robot.

ABSTRAK

Projek sarjana muda ini adalah tentang pelaksanaan GPS pada robot bergerak di persekitaran luar bersama dengan sensor jarak. GPS terdiri daripada penerima 32 saluran dan papan evaluasi GPS. Ia dihubungkan dengan mikrokontroler dengan melalui pengubah isyarat. Projek ini dikategorikan kepada tiga bahagian utama, termasuk rangkaian elektrik, pembinaan stuktur mekanik dan pengaturcaraan mikrokontroler.

Objektif utama projek ini adalah membolehkan robot bergerak menetapkan lokasi sendiri di bumi dan menggunakan maklumat dari GPS untuk bergerak ke tempat yang ditetapkan pengguna. Untuk pelaksanaan lebih lanjut perhubungan dengan pusat kawalan mungkin boleh diperolehi.

Konsep dari projek ini adalah dengan menggunakan GPS untuk mengumpul maklumat seperti bearing, jarak dan lokasi dan membandingkan dengan titik yang ditetapkan pengguna. Program dapat menentukan apakah suatu perintah pergerakan samada untuk bergerak maju, berubah atau mundur dengan membezakan jarak dan arah. Program yang digunakan untuk memproses data adalah dengan menggunakan bahasa C. C compiler akan mengeksekusi file HEX yang diperlukan untuk dimuat turunkan ke dalam PIC cip. Bahagian mekanikal akan menggunakan drive diferensial untuk melakukan gerakan mobile robot.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

FIGURE	TITLE	PAGE
5.4	Assembled mobile robot front view	40
5.5	Assembled mobile robot top view	40
5.6	Trimble GPS monitor window	41
5.7	Position map window	42
5.8	LCD display for localization	42
5.9 (a)	Location on earth map view	43
5.9 (a)	Location on earth satellite view	43
5.10	Mobile robot navigation process	44

LIST OF ABBREVIATIONS

ANSI	-	American national standards institute
ASCII	-	American standard code for information interchange
C	-	Programming language
CAD	-	Computer-aided design
CAN	-	Control area network
CEP	-	Complex event processing
CMOS	-	Complementary metal-oxide semiconductor
DC	-	Direct current
DGPS	-	Differential global positioning system
DOP	-	Doppler
EGNOS	-	European geostationary navigation overlay service
FYP	-	Final year project
GGA	-	Global positioning fix data
GLL	-	Geographic position – latitude / longitude
GNSS	-	Global navigation satellite system
GPRS	-	General package radio service
GPS	-	Global positioning system
GSA	-	GNSS DOP and active satellites
GSM	-	Global system for mobile communications
GSV	-	GNSS satellites in view
ICSP	-	In-circuit serial programming
IDE	-	Integrated development environment
LCD	-	Liquid Crystal display
LED	-	Light-emitting diode
MSAS	-	Metropolitan statistical areas
NMEA	-	National marine electronics association
PC	-	Personal computer
PDA	-	Personal digital assistant

PIC	-	A family of microcontroller
PND	-	Personal navigation devices
PVT	-	Position-velocity-time
PWM	-	Pulse width modulation
RMC	-	Recommended minimum navigation information
RTCM	-	Radio technical commission for maritime services
RX	-	Receive
SBAS	-	Satellite based augmentation system
TTL	-	Transistor-transistor logic
TX	-	Transmission
USB	-	Universal serial bus
UTeM	-	Universiti Teknikal Malaysia Melaka
VTG	-	Course over ground and ground speed
WAAS	-	Wide area augmentation system
ZDA	-	Time & date

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

This chapter describes the project overview, problem statement, project objectives, and project scope. Problem statement explains about engineering issues for this project. The project objective is the description of the expected result and goal of this project. Project scope explains about the limitations and boundaries on this project.

1.1 Project Overview

This project is about GPS Implementation on Mobile Robot. This project is developed by interfacing GPS system with microcontroller for localization and navigation of a mobile robot. The system consists of two continuous phases, which are localization phase and navigation phase. For localization phase, the GPS system will receive the localization data from satellite signal to determine the global coordinate of the robot. Then it will send the coordinate data to microcontroller through signal converter to input current location data. Current location data will the display through LCD. For navigation phase, microcontroller will process the localization data for current coordinate and compare with destination coordinate. Then, a navigation algorithm will be navigating the mobile robot to its destination.

1.2 Problem Statement

Nowadays, the GPS system is so advanced that the size has been reduced to miniature size and the precision of the GPS system has also been increased. These improvements of GPS make it easy to implement into other devices such as autonomous

and control, where hazardous areas can be mapped efficiently and safely using remote controlled vehicle.

By completing this project, a mobile robot with self-navigation GPS will be produced. By setting the goal point, the mobile robot can navigate itself to the destination. The platform can be used in many ways depending on the additional hardware added. Such applications include information gathering, transportation of small materials, environment surveying, and military uses.

1.3 Project Objective

The goal of this project is to develop a GPS implemented mobile robot that can perform localization and navigation to a predefined coordinate. To achieve the goal, this project aims to meet several objectives as below:

- To design and establish basic structure of mobile robot,
- To design interface for microcontroller with GPS system,
- To implement of localization and navigation using information from GPS system,
- To analyze the effectiveness of GPS system on mobile robot.

1.4 Project Scope

This project is aim to design and develop a GPS implemented mobile robot which can perform localization and self navigation in outdoor and open space environment. This GPS implemented mobile robot is designed to perform short range navigation in flat surface and obstacle free area. There is no other sensor except GPS system that is installed in this mobile robot.

This project consists of the construction of mechanical structure of mobile robot, design of electronic circuit, software programming, and analysis of the effectiveness of the GPS on mobile robot. Mechanical structure of mobile robot is built by using extruded aluminium so that it can be assembled with the entire component of mobile robot such as motors, wheels, batteries, circuit board and GPS system. This mobile robot consists of two electronic circuits, which are power circuit for voltage regulation and control circuit

software for localization and navigation have to be designed using C language for mobile robot so that it can perform its task. Finally, test running of mobile robot have to be done at an open area at the UTeM tennis court to evaluate the effectiveness of GPS system on mobile robot.

CHAPTER 2

LITERATURE REVIEW

The literature is founded based on its content which is related to the GPS implementation on the mobile robot project. Source of the idea of this design, concepts, specifications, and other information that are related to this project will be explained. There are two related paper and one similar project that are included in this review.

2.1 First Review: Autonomous Robot Using Environmental Sensing and Navigational Algorithms [4]

This paper was developed by Chris Forster from The University of Reading on 2005. This paper outlines a few of the design and implementation methods of an autonomous mobile robot which is required to move between a series of GPS points avoiding obstacles in its path. The robot features a variety of different hardware and software. The hardware consists of sonar, GPS, motors, PC and a CAN, and the software is a custom built package designed to incorporate them all together. The details of the paper outline the reasons for the robot being built. It goes into detail with regards to the hardware implementation of the GPS, the methods used to determine the location of the robot, how the robot moves between waypoints while building up a map of the local space and also the reaction of the robot if dynamic obstacles, such as if cars interrupt its path.

2. 2 Second Review: An Outdoor Navigation System Using GPS and Inertial System [12]

This paper is developed by S. Panzieri, F. Pascucci, and G. Ulivi from Universita

This paper present a localization algorithm based on Kalman filtering that tries to fuse information coming from an inexpensive single GPS with inertial and, sometimes uncertain, map data. The algorithm is able to produce an estimated configuration for robot that can be successfully fed back in navigation system, leading to a motion whose precision is only related to current information quality. Some experiments show difficulties and possible solutions to this sensor fusion problem.

2. 3 Third Review: Autonomous Mobile Robot (AMRSBot) with GPS Navigation and Ultrasonic Obstacle Avoidance System [9]

This paper is developed by Mr. Mohamad Hanif Abd Hamid from Universiti Malaysia Perlis on October 2008. This paper described the use of GPS and application of sonar sensor. The focus of the project is to determine GPS Navigation for mobile robot according to waypoint that preset to the GPS module and the application of Sonar Sensor. Power management for autonomous mobile robot also discuss in this project. Autonomous Mobile Robot (AMRSBot) can navigate through desired waypoint and at the same time apply the obstacle avoidance rules.

2.4 Strength Point from Research

After reviewing a few papers of conducted research on GPS mobile robot, several strength point of the similar project has been discovered. The strength points from other similar project are:

- Mobile robot equipped with distance sensor for detect object in the path [4, 9].
- Using personal computer to control the mobile robot for faster performance [4].
- Obstacle detection and avoidance system for moving in an unknown area [4].
- Movement mechanism with compass assistant for faster navigation [4].
- Predefined waypoint for better navigation [4, 12].
- Path routing system for selecting the shorter path to reach destination.

2.5 Weakness Point from Research

By undergoing research on similar project, few weakness points of them have been found. The weakness points of the similar project are:

a) System complexity due to many sensor s in the mobile robot such as distance sensor and inertial navigation sensor [4, 9].
b) Bigger platform due to the place required to assemble a personal computer [4].
c) Higher cost due to more advanced component needed [4, 9].
d) Using large memory storage due to the usage memory for storing many location data for waypoint [4, 9].

2.6 Opportunity from Research

By studying on the few similar GPS implementation project, few opportunities of the GPS implementation project have been highlighted. The opportunities of this project are:

a) Installation of GPS system on mobile robot can increase the controllability of human controlled mobile robot alongside with other sensors.
b) Developments of GPS implementation on mobile robot encourage the development of unmanned robot.

2.7 Threat of Research

By studying the few similar GPS implementation projects, a few threat of the GPS implementation project have been identified. The misused of the GPS system can cause many issues of public safety. The threats of this project are:

a) Unmanned mobile robot with GPS navigation system can be designed to perform booming action by terrorist.
b) A surveillance mobile robot with GPS implemented can used to perform unethical action on the public, like capturing the private pictures.

CHAPTER 3

PROJECT BACKGROUND

This project can be divided into two major parts which are the hardware and the software. This division is formed for the ease of designing and developing the whole system for this project. The hardware part involves the designing and constructing of mobile robot and its interface circuit. Besides that, the hardware part also includes the GPS system and power circuit. Meanwhile, the software parts consist of the development of the program for microcontroller to communicate with GPS system, to perform localization task, and to execute navigation task for mobile robot.

3.1 Hardware

The hardware for this project can be divided into more specific components which are the mechanical parts and electrical parts. The mechanical parts consist of the skeleton structure of the mobile robot, LINIX brushless DC motor, LINIX brushless DC motor driver, wheels, roller wheels, and batteries. The electrical parts consist of microcontroller 16F877A, a GPS evaluation board, 32 channel GPS receiver, power regulation and filter circuit and LCD. The main component such as the GPS evaluation board, 32 channel GPS receiver, LINIX brushless DC motor, LINIX brushless DC motor driver, and USB ICSP PIC programmer will be explained in detail.

3.1.1 GPS Evaluation Board

This is an evaluation board that supports the connection to the 32 channel GPS receiver, FB-85A. It provides serial interface for USB over the FT232RL and a classic