DEVELOPMENT OF SELF-PARKING CAR

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"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)"

Signature	:	…….
Supervisor's Name	:	…….
Date	:	…….

"I hereby declared that this report is a result of my own work except for the excerpts that have been cited clearly in the reference."

Signature : …….

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ABSTRACT

Autonomous parallel self-parking prototype for four-wheel car is presented. This idea is to design and build an autonomous car that can detect a parking space and then park itself into the space effectively. The prototype is controlled with the PIC microcontroller, and is equipped with ultrasonic sensors, servo motor for steering and dc motor for speed control. The ultrasonic sensor is used to measure distance and detect obstacles along its path. An autonomous car will park itself in the parallel parking space. The system works in three phases. First, the empty space car parking is detected by the ultrasonic sensors mounted on the car. Then, second phase is the car reverses to the edge of the parking space avoiding potential collisions. Finally in maneuvering phase, the car moves to the parking position in the parking space. The strategy integrated into automated parking system, showing capable of safety parking in narrow situations.

ABSTRAK

Prototaip kereta empat roda bebas sendiri yang meletak kereta secara sendirian dipersembahkan dalam projek ini. Idea ini adalah untuk mereka bentuk dan membina sebuah kereta automatik yang boleh mengesan ruang kosong di kawasan meletak tempat letak kereta seterusnya meletak kereta di ruang kosong tersebut dengan berkesan. Prototaip ini dikawal oleh mikropengawal PIC, dan dilengkapi dengan pengesan-pengesan ultrasonik, motor servo untuk mengawal arah stereng kereta dan motor arus terus untuk mengawal kelajuan kereta. Penderia ultrasonik digunakan untuk mengukur jarak dan mengesan halangan-halangan sepanjang jalannya. Sebuah kereta yang boleh meletakkan di tempat letak kereta selari. Sistem ini boleh dibahagikan kepada tiga fasa. Pertama, ruang kosong kereta dikesan oleh pengesan-pengesan ultrasonik yang terdapat pada kereta itu. Kemudian, fasa kedua ialah kereta berundur masuk ke dalam tempat letak kereta dan dapat mengelak dari melanggar halangan. Akhirnya, prototaip itu dapat meletak ke dalam tempat letak kereta dengan selamat. Strategi ini diintegerasikan ke dalam sistem letak kereta secara automatik bagi menunjukkan kemampuan untuk meletak kereta di ruang yang sempit secara selamat.

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LIST OF ABBREVIATIONS

PIC	-	Programmable Interface Controller
DC	-	Direct Current
I/O	-	Input Output
RAM	-	Random Access Memory
ROM	-	Read Only Memory
EPROM	-	Erasable Programmable Read-Only Memory,
EEPROM	-	Electrically Erasable Programmable Read-Only Memory
TTL	-	Transistor-Transistor Logic
AC	-	Alternate Current
GND	-	Ground
MCU	-	Microcontroller Unit
DSU	-	Data Service Unit
RS-232	-	Recommended Standard 232
RC	-	Radio Control
ANSI	-	American National Standard Institute
IDE	-	Integrated Development Environment
MOSFET	-	Metal-Oxide-Semiconductor Field-Effect Transistor
PCB	-	Printed Circuit Board
PWM	-	Pulse Width Modulation
ADC	-	Analogue to Digital Converter
LED	-	Light Emitting Diode

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CHAPTER 1

INTRODUCTION

1.1 Introduction to Project

In this technology advanced era, where future engineers intend to replace human workers with smart devices and system in our daily routine to speed up work and improve process flow and production. In recent years, more and more intelligent technologies are being applied to automobiles. One of them is the automatic parallel self-parking technology. There are two reasons for this. First, mobile robots with both mobility and manipulability have a better potential in replacing human beings in reality. Second, the recent advances in computer and sensor technologies have make it feasible to develop new and useful mobile robots. This project is to make the driving task safer and more comfortable, considerable resources are being directed to develop systems for communication, information handling and automatic controls. There has also been an increasing interest in automatic parallel parking. Parallel parking in narrow spaces is often considered as tedious and annoying task by many drivers. This situation has become harder when visibility behind the vehicle has decreased because of aerodynamic design. Thus, there is a demand for systems that perform the parking maneuver automatically.

The purpose of this project was to design an automated parallel self-parking car which was capable of finding the empty parking space and then being able to reverse and park itself into the parking space. This project system consists of both hardware and software modules. A PIC16F877A microcontroller acts as the brain of the project which making decisions and controls the motors automatically based on

the program in the chip. The mobile vehicle also include with sensors for obstacle avoidance to avoid collisions.

1.2 Project Objective

There were several technical objectives that the project was expected to perform. The aim of this project was to design an automated self-parking car with the following capabilities:

i. The ability to find the empty space along the path.
ii. The ability to detect the obstacle and avoid collision.
iii. The ability to reverse and park itself into the parking space effectively.

1.3 Project Scope

There were several project scopes was expected to cover in this project to design an automated self-parking car. There are:

i. Design and build the self-parking car prototype using servo motor, DC motor and ultrasonic sensors.
ii. The prototype equipped with servo motor, DC motor and ultrasonic sensors can interface with computer using serial port communication.

1.4 Problem Statement

Parallel parking is an ordeal for many drivers, but with parking space limited in big cities, squeezing the car in the narrow space need skillful maneuver. Parallel parking in narrow space often considered as a tedious and annoying task by many drivers. Many drivers have difficulties or make errors while parallel parking or pulling out of a parking place. Thus, this report is to build a self parking car prototype that able to park itself at parallel parking space.

CHAPTER 2

LITERATURE REVIEW

2.1 Automatic Parallel Parking

Title: Automatic Parallel Parking [1]

Prepared by:
Y. K. Lo, A. B. Rad, C. W. Wong and M. L. Ho
Department of Electrical Engineering
The Hong Kong Polytechnic University
Hung Hom, Kowloon,
Hong Kong

This is the main reference for this project. In this report an automated parallel parking strategy for a vehicle-like robot is presented. This study addresses general casts of parallel parking within a rectangular space. The procedure consists of three phases. In scanning phase, infrared sensors in the robot are used to scan the parking environment in order to search a suitable parking position. Then maneuvering path is generated for different parking space in the next phase, starting phase. The robot moves backward to the edge of the parking space and starts its parking strategy. In maneuver tracking phase, the robot follows the maneuvering path to the parking position. It depends on the width of the rectangular space which had been scanned in the previous phase. This strategy has been implemented in a vehicle-like robot and is developed for an assistant to help human drivers in the future. The research on this topic can be classified into two groups which is stabilization of the vehicle to a point by means of feedback state and planning a feasible path to reach a point and

following the path. In the former category, Yasunobu and Murai [2] have proposed a controller based on human experience to develop a hierarchical fuzzy control and predictive fuzzy control for vehicle parking. The vehicle is controlled moving point by point. That algorithm generates the maneuvering path point by point from the human knowledge base in the predictive fuzzy controller. Researchers not only concerning the classical four wheels vehicle, trailer vehicle are also considered. Jenkin and Yuhas [3] have reported a simplified neural network controller by decomposition. The neural controller is decomposed by subtasks. The neural controller is trained based on the kinematics data, however the decomposed neural network require less training time thus it has simplified the training process. Kinjo, Wang and Yamamoto [4] have used Genetic Algorithm (GA) to optimize neural controller for controlling trailer truck. Initially the neural controller is produced randomly and GA changes the weighting of the controller to a suitable value. The algorithms discussed above are based on the kinematics data to formulate intelligent controllers.

For the path planning category, Paromtchik and Laugier [5] presented an approach to parallel parking for a nonholonomic vehicle. In that approach, a parking space is scanned before the vehicle moves backward into its parking bay. The vehicle follows a sinusoidal path in backward motion, while the forward motion is along a straight line without sideways displacement. In this approach, the possible collision during reverse between the vehicle and the longitudinal boundary of the parking space is not discussed. Murray and Sastry [6] worked on steering a nonholonomic system between arbitrary points by means of sinusoids.

Automatic parallel parking involves many problems, such as recognition of driving circumstances, maneuvering path planning, communication and vehicle control. This paper focuses on the maneuvering path planning. The system works in three phases. In scanning phases: the parking circumstance is scanned by infrared sensors after the parking command is activated. It then goes to next phase, starting phase, after a suitable parking space has been detected. The maneuvering path is also produced according to the scanned information. The robots moves backward to the edge of the parking position and begins its parking strategy. In order to avoid potential collision, the robot starts at the suitable position which depends on different

dimension of parking space. In the final phase, maneuver tracking phase, the robot follows the path to a desired parking position. The parameters of the maneuvering path have been produced off-line.

How did this paper contribute to the project?

This project briefly gave some ideas on the strategy of the automated self-parking car. In this project divided into three phases which is scanning phase, starting phase and maneuvering phase. In this project, the vehicle-like robot used infrared sensor to find the empty parking space and used fuzzy control methodology. Even though it used different methodology, but the idea of parking maneuver can be as a reference in this project as well.

2.2 Automatic Parallel Parking Assistance System

Title2: Automatic Parallel Parking Assistance System. [7]

Prepared by:
Tom Airaksinen, Hedvig Aminoff, Erik Byström, Gustav Eimar, Iracema Mata, David Schmidt
Cognitive Science Program, University of Linköping, June 2004

This is one of the main references for this project. In this report, such a system is under development of Mechanical Engineering (IKP) at the University of Linköping in cooperation with Volvo. The driver activates the system when it is on a street where it wants to park. Ultrasonic sensors place on the car scanning the surroundings until it find a space that is large enough to park in. The system then notifies the driver. If it accepts the space, the in-car computer takes control over the electronic steering servo and the driver only has to adjust the speed and monitor the surroundings while the car automatically steers into the space and stops.

How did this paper contribute to the project?

In this project it used ultrasonic sensor as a scanning tool to scan the surrounding for a parking space. Besides that, it used computer to take control of the electronic steering servo. In this advanced high technology era, the computer aided can be used to control the steering of the car, but to apply in this project, it really cost a lot of money, Therefore, through this project it gave an idea that can use servo motor as a front wheel which is for turning the angular position of the car.

CHAPTER 3

PROJECT THEORY AND BACKGROUND

3.1 Introduction

It has various type of microcontroller in the market, such as PIC, 68HC11, Basic Stamp and 8051/8052. In this section will discuss each type of microcontroller and its characteristic. So, PIC was selected in this project due to its outstanding characteristic compare to other microcontroller. Beside that, the comparison of the type and the performance of the motor such as dc motor, servo motor and stepper motor. Furthermore, type of the sensor will also be discussed in this section.

3.2 Microcontroller Selection

A microcontroller is a computer on a chip that is programmed to perform almost any control, sequencing motoring and display function. Because of its relatively low cost, it is a natural choice for design. It performs many of the functions traditionally done by simple logic circuitry, sequential control circuits, timers or a small microcomputer.

3.2.1 PIC

Microcontrollers from Microchip are easily programmable cheap microcontrollers. The PIC is the name for the Microchip Microcontroller Unit (MCU)

family, consisting of a microprocessor, I/O ports, timer(s) and other internal, integrated hardware. The main advantages are a low external part count, a wide range of chip sizes (from 8-pin up), great availability of compilers and source code and easy programming [8].

The PIC family of chips has a wide variety of options to choose from. Variations include the amount of memory, the number of internal registers, the number of I/O lines and the speed of the crystal. Thus PIC16F877A were considered for research in this project. The PIC simply requires a crystal oscillator and voltage regulator to operate. No extra circuitry is needed. Beside that, The PIC requires a special programmer that links to a PC. The chip must be placed in the programmer every time a new program is loaded. This is more troublesome than the 68HC11. The range of languages supported by the PIC is larger than that of the 68HC11. The PIC can be programmed in assembler, C code or PICBASIC. Compilers for these languages are readily available for downloading from the internet. The PIC range offers less complicated external circuitry and more programming languages than the 68HC11. The PIC micro-controllers are also cheaper than 68HC11. Thus the PIC range was preferred. The most common use of PIC is 16F84 and PIC16F877A, so when comparing the two PIC options it was noted that the 16F84 was not as powerful as the newer 16F877A chip. The PIC16F877A has larger memory and more I/O lines which can fulfill all the projects requirements with a reasonable price. Thus, PIC16F877A was selected as micro-controller to be used in this project.

3.2.2 68HC11

68HC11 (made by Motorola) is a powerful 8-bit data, 16-bit address microcontroller from Motorola with an instruction set that is similar to the older 68xx (6801, 6805, and 6809) parts [9].

The 68HC11 range is fairly limited with only eight possible options. The main difference between chips is the amount of EEPROM or RAM offered. The 68HC11A1 requires a crystal and voltage regulator that is standard for all chips. However, it also requires a special reset circuitry that makes the external circuitry

more complex than necessary. The HC11 range only needs a PC for programming, as the compiled hex code can be downloaded straight to the micro-controller through a serial cable. The freeware program PCBUG11 allows for programming in assembler code. However, assembler programming is time consuming and not a preferred language. C compilers for the 68HC11 do exist, but are not freeware and are difficult to obtain.

3.2.3 Basic Stamp

The Basic Stamp (made by Parallax) is a small computer that is programmed with Parallax Basic (PBASIC) programs. The Stamp contains a microcontroller, memory, a clock, and a voltage regulator in a package that resembles an integrated circuit [9]. A PC is needed to program it and a 9V battery or other power supply. Basic stamp has fully programmable I/O pins that can be used to directly interface to LEDs, TTL devices, speakers, servos, and many more things.

3.2.4 8051/8052

The 8051 is an 8 bit microcontroller originally developed by Intel in 1980. A typical 8051 contains CPU with Boolean processor, 5 or 6 interrupts, 2 or 3 16-bit timer/counters, programmable full-duplex serial port, 32 I/O lines, RAM and ROM/EPROM in some models. One strong point of the 8051 is the way it handles interrupts [9].