UNIVERSITI TEKNIKAL MALAYSIA MELAKA

SELF-DRIVING TOY CAR

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree in Electrical Engineering Technology (Industrial Automation and Robotics) with Honours

by

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This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor in Electrical Engineering Technology (Industrial Automation and Robotics) with Honours. The member of the supervisory committee is as follow:

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ABSTRAK

Projek ini adalah pelaksanaan kereta autonomi atau kereta memandu sendiri bagi sebuah kereta mainan. Kereta mainan ini akan bergerak ke destinasi yang tertentu berdasarkan input destinasi koordinat daripada pengguna. Kereta mainan dipandu dengan menggunakan modul GPS, kompas elektronik dan mikropengawal. Kereta mainan pada dasarnya boleh bergerak secara autonomi dengan hanya menggunakan modul GPS dan mikropengawal. Walau bagaimanapun, arah pergerakan kereta mainan tidak diketahui dan ini menjadikan Elektronik Kompas sangat berguna untuk menentukan arah pergerakan semasa kereta mainan. Walaupun, Kompas elektronik akan menghadapi masalah baru kerana gangguan dari pergerakan kereta dan litar elektronik, sebuah casis kereta mainan akan direka untuk mengurangkan ralat kecondongan dan gangguan magnet Kompas Elektronik. Di dalam masa yang sama, modul GPS mempunyai masalah untuk memberikan kedudukan data yang tidak tepat apabila dalam persekitaran yang dinamik dan perjalanan jarak jauh. Kedua-dua masalah ini tidak dapat dielakkan kerana fungsi utama kereta mainan adalah sebagai sebuah mobil dan jarak perjalanan tidak terhad kepada jarak pendek sahaja. Oleh demekian, pembahagian titik laluan perjalanan kereta mainan akan ditingkatkan supaya masalah perjalanan jarak jauh dan persekitaran yang dinamik dapat diselesaikan. Ketiga-tiga masalah utama projek ini akan berkurangan dan pencarian kedudukan akan menjadi lebih tepat.

ABSTRACT

This project is about implementation of autonomous car or self-driving car for a toy car. The toy car move to the particular destination based on input of the destination coordinate from the user. The toy car is guided by using GPS module, Electronic compass and Microcontroller. The toy car basically can move autonomously by only using GPS module and Microcontroller. However, the direction of toy car movement is unknown and this makes Electronic Compass come in handy to determine the current heading of the toy car. Even though, the Electronic Compass will face new problem because of interference from the car movement and the electronic circuit, a chassis of toy car is designed to reduce the tilt error and magnetic disturbances of Electronic Compass. Meanwhile, the GPS module give inaccurate of position data when in dynamic environment and long distance travel. Both of these problems are inevitable since toy car main function is as a mobile and distance of travel is not limited to short distance only. The distribution of waypoints course for toy car is increased to solve the long distance travel issue and dynamic environment problem. These three main problems of the project are reduced and the positioning of coordination is more accurate and precise.

DEDICATION

Specially dedicated to my family

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Assalamualaikum wbt,

First of all, thanks to Allah Almighty for mercy and grace I can finish this project until to the end. Thanks to my supervisor En.Mohd Hanif Che Hasan never bored entertain and provide guidance. He is an efficient mentor and teaching in a transparent.

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This project was completed not by my efforts alone, but all those who were involved directly or indirectly and also to people who are always giving words of encouragement and moral guidance. Although at the beginning, the flow of project not well organized and difficult as overall, and their support become the key to drive success.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLE

LIST OF SYMBOLS AND ABREVIATIONS

SDTC	-	Self-Driving Toy Car
MCU	-	Microcontroller Unit
GPS	-	Global Positioning System
MIPS	-	Millions of Instruction per Second
PDA	-	Personal Digital Assistant
UART	-	Universal Asynchronous Receiver Transmitter
NMEA	-	National Marine Electronic Assosiation
1^2C	-	2-wires Interface
SPI	-	Serial Peripheral Interface
PWM	-	Pulse Width Modulation
PID	-	Proportional Integrater Derivative
ABS	-	Absolute Sensor

CHAPTER 1

INTRODUCTION

The self-driving car also known as an autonomous car, driverless car, drive-free car or a robot car, is a vehicle system that capable to handling vehicle by itself either fully autonomous or partially autonomous. By the definition in Oxford dictionary, the word autonomous means able to do things and make decisions without help from anyone else.

1.1   Background

As the technology keep grows, the society always looking for the best ways to facilitate daily routine. Transportation becomes important nowadays for people to travel to their desire places. The car technology exist recently is has focus on safety and satisfaction such auto-braking system, adaptive cruise control, GPS, parallel parking and other. These features need to be improved to fulfil the driver desire. As the research shows more than 90% car accident comes from the driver itself and other percentage from vehicle(mechanism) failure and environment(road conditions). There is a lot beneficial for the user in term of facilities such as facing road traffic, answer phone without need to focus on the road, blind people can drive and other advantages.

From the definition, phrase of make decision without help from anyone else can describe a particular robot or machine that doing a certain task by itself after been command or instructed. The Self-Driving Toy Car (SDTC) has the same characteristic defined by the autonomous on how it works, by receives an input from the user, the SDTC understand the instruction through machine language which is C++ Programs, it moves toward the stated coordination (Latitude and Longitude). The SDTC is aided

1

by Digital Compass to tell the current coordination and Global Positioning System (GPS) to know the destination place. The three elements, the input from user, the Digital Compass and GPS is feed to a microcontroller, Atmega2560, so that microcontroller can produce the output to control the movement of the SDTC.

The movement of SDTC driven by two dc motors to control the forward and reverse movement and one servo motor to control the left and right movement. The circle of microcontroller receive the input from Digital Compass and GPS, and give output to the servo motors is keep repeating until the destination place is reach.

1.2   Problem Statement

The application of GPS is growing fast currently due to the technology development nowadays. The civilian also use it as facility for the electronic navigation of automobile such as PDA. However, the usage of GPS not only limited to military and science purposes, the utility of GPS is also available in most of the smart phone which makes GPS as wide used system. Even though that is the fact, the conventional GPS actually has poor reliability of data in dynamic environment. The Self-Driving Toy Car (SDTC) not excluded from this problem because SDTC needs to apply GPS in the system so that it can work as it should. In order to overcome the problem, the distribution of waypoints course for toy car is increased to solve the long distance travel issue and dynamic environment problem. The Electronic Compass is introduced to determine the current heading of the toy car. At the same time, Electronic Compass also must eliminate its own problem because the Electronic Compass has tilt error and magnetic disturbances due to movement and electronic of SDTC had. These problems of Electronic Compass could be reduce by modelling the SDTC chassis.

1.3   Objective

i.   To develop self-driver car by using MCU and other electronic components.

ii.   To discover various communication protocol used for programming.

iii.   To study the data extracted from GPS receiver.

iv.   To analyses GPS technology in aspect of accuracy and precision with the aid of electronic compass for navigation.

1.4   Scope

The work scope was covered the utility of GPS in aspects tracking of moving object such Self-Driving Toy Car (SDTC) and how the GPS receiver module was communicate with satellites to receive signal for position and time. The work scope was specified into several parts. Firstly, the SDTC was developed by using Arduino Uno board, a GPS Receiver module, Electronic Compass and other common electronic components so it has guidance system. Secondly, the communication protocol was included are 1^2C and UART by using C++ language. Thirdly, the data received by the GPS receiver module from the satellite is in NMEA string format and it was decrypted to get usable information. Lastly, the Electronic Compass was used as the feedback element to the GPS Receiver to get right heading of SDTC.

1.5   Thesis Outline

The Self-Driving Toy Car report consisted of 6 chapters for the final thesis. Each of the chapter was elaborated the literature review, theory, hardware and software that depend on the need of particular chapter.

Chapter 1 briefly describe about the introduction, problem statement, objective and scope of the thesis.

Chapter 2 is focusing on the literature review of method approach of hardware and software used in the previous research.

Chapter 3 explained the throughout process of method used to collect and analyse the data which the main focus on software and hardware.

Chapter 4 elaborated the development of the project by explained the important part that used in the hardware and software.

Chapter 5 was described about the result obtained in figure form which included the circuit simulation diagram and actual hardware.

Chapter 6 discussed about the obtained result based on simulation and hardware which conclude the finding.

CHAPTER 2
LITERATURE REVIEW

This chapter had been discussed the literature review of the earlier research. The discussion was about the problem arising in previous study and the method approach use to overcome or reduce the problem. The focus of the literature review was on the guidance system for Self-Driving Toy Car (SDTC) to work autonomously. However, the consequences of the selected method have its own strength and weakness.

2.1 Hardware

The hardware section consists of several components to create a guidance system and toy car to drive it. Some previous methods improve the guidance system with monitoring system. The comparison and contrast was focus on the controller unit, GPS module, Electronic Compass, user interface system and sensor unit.

2.1.1 Controller Unit

The microcontrollers used in the project include the 68HC11 and 80C188EB. By reduce the number of components used, its increase reliability reduce power consumption. The computation was barely handled by the on-board computer. The program was written and stored in EPROM's. Either floppy or hard drive was available and the on-board computer does not provide any programming environment making debugging was a long process (Chen, N., 1997).

To design indoor air ship autopilot, a microcontroller Samsung's ARMS3C2440 is used. It can use multiple analogue signals, high-precision collect and process the signal of the ultrasonic sensor and the speed of the motor system. The available of UART is three so that can communicate with the wireless communication equipment and HMR3300 electronic compass, accepting information of motor speed system by Analogue to Digital conversion, has the PWM signal forms of control signal output capacity to control the steering gear, has high frequency with 200MHz at maximum and precise real time (Li, Y. and Liu, C., 2011)

The AT89C52 microcontroller provide low-power consumption, robust of a CMOS 8-bit microcomputer with the utility of 8K bytes of flash programmable. The on-chip Flash allows the program memory to be reprogrammed many times in system or by a conventional non-volatile memory programmer. The Atmel AT89C52 provides a highly-flexible and cheap product to many embedded control applications (Xi, B. and Fu, C., 2010).

The C8051F021 microcontroller is a fully integrated mixed-signal system-on-chip, it can control the connection between digital data and external input/output pins. The microcontroller has asynchronous, with full duplex UART0 and UART1, by determining the 1PPS to achieve the synchronization collection of electronic compass information and GPS information .It also has an internal clock, so only need to access timing control component in to form a stable self-excited oscillator (Jiang et al, 2010).

To control the set point of PID controllers of the brake and throttle, the naive set point controller PID-based reactive controller is used. Unfortunately, the controller do not offer a firm guarantee that the car could arrive at either the correct time or correct velocity. Even though, the naive set point controller offers good performance in practice when provided with a feasible arrival time, in particular when seeded with the output like the optimization procedure (Au et al, 2012).

In the design, the PWM signals were generated by the MCS-51 that based on the MPC82G516A microcontroller. In that case, it enhanced version 8051 MCU has 6-channel embedded PWM outputs. The PWM function of MCU supports 8-bit resolution and programmable frequency, for an example 500Hz in the project (Run et al, 2010).

2.1.2　GPS Module

The GPS receiver are most important in the navigation system. The GARMIN 15-H was used in the project, have the function to updates the satellite signal to be sent to the GPS. The information of the GPS signal was extracted and transmitted again to the MCU by using the serial communication for every one second. Distance and direction between driverless car and destination are obtained through the calculation based on the GPS data (Run et al, 2010).

The current latitude and longitude was determined through GPS, after receive the destination latitude and longitude from user. The angle and distance between two coordinate was determine based on the four possibilities in which navigation can start after that. Two possibilities are for Y axis which is 90 and 270 degrees that decided to move either forward or backward (Riaz et al, 2009).

The Fastrax iTrax03 has 2m of positioning accuracy, portable and cheap GPS that has self-contained PNS (Chen et al, 2010).

The iTrax02 are small and low-power consumption was chose as GPS receiver. It use NMEA0183 format data and binary I-Talk format data as character string standard. The GPS receiver also has two roads of UART interface (Jiang et al, 2010).

2.1.3　Electronic Compass

The information of posture for the indoor unmanned air ship gathers from HMR3300 digital compass. It offering heading, pitch and roll that the three directions of state data. An electronic compass provide the airship posture information in indoor environment. Inertial navigation or GPS navigation was used in conventional aircraft. The latter is limited to outdoor use, while digital compass does not exists the problems. The scheme was proven feasible after a long flight test, that the airship flying has stable performance (Li, Y. and Liu, C., 2011).

With the heading of accuracy $\pm$ 1.0 °, roll and pitch accuracy $\pm$ 0.3 °, resolution $\pm$ 0.1 °, HMR3300 digital compass was selected to get the information of attitude such as

yaw and pitch, it also update frequency 8Hz, and have serial communication port. The HMR3300 are portable, low power and cheap (Jiang et al, 2010).

Honeywell 2-axis electronic compass, HMC6352 has a heading accuracy of about 2.5°. HMC6352 was used to measures the intensity of Earth's magnetic field and give the absolute angle value with respect to true magnetic north (Au et al, 2012).

The Hitachi HM55B Compass Module was used to detect the Earth's magnetic field and thereby output the angle from the true North. So that the correct decision for turning left or right can be made by knowing the direction in front of the car. Figure 2.1 below shows the concept of operation of the electronic compass, in which the x-axis of the electronic compass indicates the long axis of the car body (Run et al, 2010).
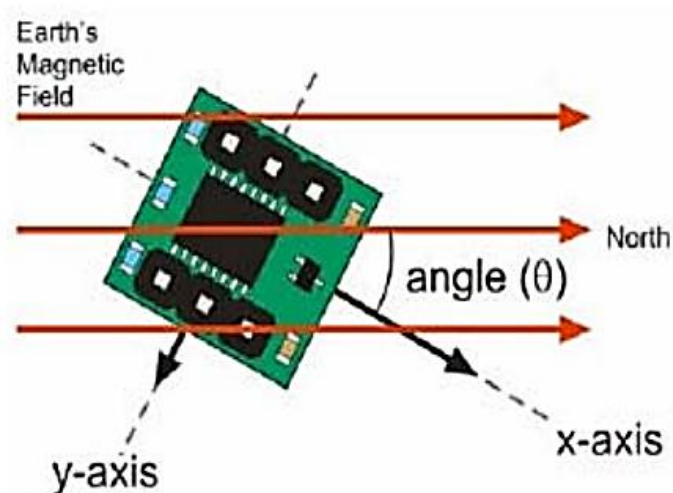

Figure 2.1: The concept of operation of HM55B (Run et al, 2010)

2.1.4   User interface system

The system use the VB programming language to design software system, so navigation data from the SCM can be read and display visually in graphic ways. The user interface includes the serial port selection, begin detection and stop detection, current latitude and longitude (Jiang et al, 2010).