AU Pre-Collision System

by

Rajay

Hiroshisittichok Takashima

A report submitted in partial fulfillment of the requirements for
the degree of Bachelor of Engineering in
Computer Engineering and Mechatronics Engineering

Project Advisor:

Mr. Ehsan Ali

Examination Committee:

Dr. Jerapong Rojanarowan, Dr. Wisuwat Plodpradista,
Assoc. Prof. Dr. Jiradech Kongthon, Assoc. Prof. Dr. Vorapoj Patanavijit,
Dr. Amulya Bhattarai, Mr. Ehsan Ali

Assumption University
Vincent Mary School of Engineering
Thailand
October 2022

Approved by Project Advisor:

Name: Mr. Ehsan Ali

Signature:

Date: 28/Sept./2022

Plagiarism verified by:

Name: Mr. Ehsan Ali

Signature:

Date: 29/Sept/22

-24%-

ABSTRACT

This report provides a status update on our project which is “Pre-Collision System Model for car” and it is divided into four chapters that show how we are progressing through the project plan. This report will also provide you an idea of how we will conduct our project realization from literature review and preliminary research up to a detailed plan for our project 2 conduct.

ACKNOWLEDGE

First and foremost, we would like to express our gratitude to Ajarn Ehsan Ali, who guided us through the process and gave us our initial thoughts, his support, encouragement and help in identifying the correct project for us, which is the “AU Pre-Collision System”.

Contents

1 Introduction

1.1 Project Overview

This project is to combine with the Artificial Intelligence technology, this system model will operate to avoid collision by recognizing the object and continuously travel to its designated destination. Moreover, it will automatically detect the distance between either the object or car forward. There is a DIY robot kit called Mbot. Mbot is a DIY robot kit that aims to develop programming skills. Mbot has 3 basic modes in it, Obstacle Avoidance Mode, Line-follow Mode and Manual Control Mode. In this project, we try to imitate the Obstacle Avoidance Mode. Obstacle Avoidance Mode. is basically the mode that detects the object in front of it and tries to change the direction to avoid the collision. Also, we will add some features that are related to public road safety.

1.2 Objective

Project Objectives of our project are

- If there is no obstacle, the car will go without any steering/direction changes.
- To detect the barrier in front of the car, the ultrasonic sensor will be employed.
- The Raspberry Pi4 program should be executed and the effective design stage would be improved.
- The ultrasonic sensor must determine the obstacle's distance and display it on the LCD.
- The system should control car speed according to the obstacle and other cars.
- The system should change lanes to pass the car which is in front.

2 Literature Review

2.1 Background and Study Theory

2.1.1 Indoor Localization System

In this technology age, people have access to their devices (such as mobile phones, iPads, Macs, laptops, and other electronic devices) anytime, anywhere. In outdoor positioning systems or positioning systems, people use the Global Positioning System ”GPS”. Its precise and real-time location. GPS technology could not capture the exact location of the object or place because it is inside a building or the same building. In this case, engineers and scientists have introduced new wireless communication technologies used in many wireless devices such as Wi-Fi, Bluetooth, radio frequency identification (RFID), and ultra-wideband (UWB). Among all technologies, ultra-wideband (UWB) technology is one of the best known new technologies that can be used for indoor localization and positioning systems.

2.1.2 Ultra-wideband (UWB)

UWB is a wireless indoor positioning technology that consumes less energy than Bluetooth and has a long range of about 150 m.UWB is a technology for transmitting information over wide bandwidths (less than 500 MHz). This enables the transmission of large amounts of signal energy without interfering with traditional narrowband and carrier transmissions in the same bandwidth, enabling wireless connectivity to high data rate Personal Area Networks (PANs) and data rate enables long range applications with low , radar and imaging systems that transparently coexist with existing communication systems.

UWB has less interference and is more reliable than Bluetooth Low Energy (BLE) and other technologies. Also, the use of UWB-based systems is the ability of the system to perform two-way UWB ranging, i.e. the ability of the system to calculate the time-of-flight (ToF) between devices for the exchange of ranging packets.

2.1.3 UWB Ranging And Time of flight(ToF)

UWB transmitters work by broadcasting billions of pluses on broadband frequencies. A dedicated receiver receives the signal, listens for the familiar train of pulses sent by the transmitter, and converts the pulses into data. Pulses are sent approximately every 2 nanoseconds, giving UWB real-time precision. UWB is very low power and high bandwidth (500MHz) makes it ideal for relaying large amounts of data from the host device to other devices up to 30 feet away. Time of Flight (ToF) measures range between devices (anchors). ToF is used to calculate the round trip time of challenge/response packets.

$$ToF = \frac{T_loop - T_reply}{2} \tag{1}$$

2.1.4 ESP32 Ultra-wideband (Esp32 UWB)

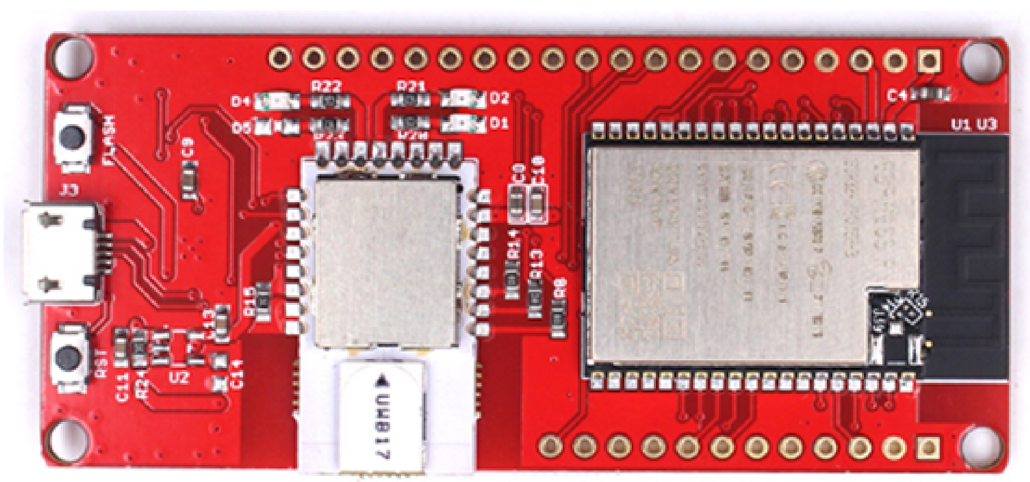

Fig. 1: Esp32 UWB with DWM1000 Chip.

The Esp32 UWB is a custom board from Makerfabs specifically designed for real-time indoor position tracking. Esp32 UWB contains ESP32 and DWM1000 chips. The DWM1000 chip is a single-chip wireless transceiver based on ultra-wideband technology. The DWM1000 chip enables the development of low-cost real-time location systems that can identify indoor and outdoor areas within 10 cm. The DWM1000 chip acts as a continuous scanning radar that accurately locks and communicates with anchors and calculates its own position. The DWM1000 chip has a range of 200 meters outdoors and 40 meters indoors, making it more reliable in real-world applications.

2.1.5 DWM1001-Dev

Fig. 2: DMW1001-Dev Board.

The DWM1001-DEV Module Development Board is designed to evaluate the performance of the Decawave DWM1001 module. With this board, you can assemble and evaluate RTLS systems including anchors, tags and gateways without designing any hardware or writing a single line of code. You can also combine the DWM1001-DEV with a Raspberry Pi to create a gateway device. Although not a turnkey professional RTLS solution, this development board is a good starting point for exploring the possibilities of UWB and APIs for customizing your application.

2.1.6 L298N Motor Driver

The L298N is a dual H-Bridge motor driver that allows for simultaneous speed and direction control of two DC motors. The module can power DC motors with voltages ranging from 5 to 35V and peak current of up to 2A. The L298N Driver

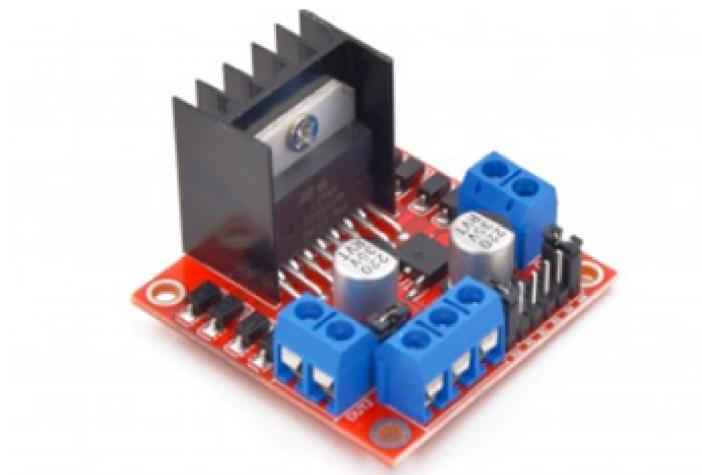

Fig. 3: An L298N Motor Driver.

Controller adjusts the motor's speed and the direction of rotation. The L298N Dual H-Bridge Motor Driver integrated circuit is the basis for the dual bidirectional motor driver. The circuit will allow you to control two motors in both directions with ease and independence. It is highly suited for robotic applications and can be connected to a micro-controller with only a few control lines per motor.

It can also be connected to simple manual switches, TTL logic gates, relays, and other electronic devices. This board has power LED indications, a +5V regulator on board, and protective diodes. Pulse width modulation (PWM) is a technique for adjusting the average value of the voltage going to an electrical device by rapidly turning ON and OFF the power. The duty cycle, or the amount of time the signal is ON vs the amount of time the signal is OFF is a signal period of time, determines the average voltage. If the pulse width is wide, the duty cycle percentage is high and the motor is spinning fast, as seen in Fig.2. If the pulse width is small, the duty cycle percentage is low, and the motor is spinning speed is slow[10].

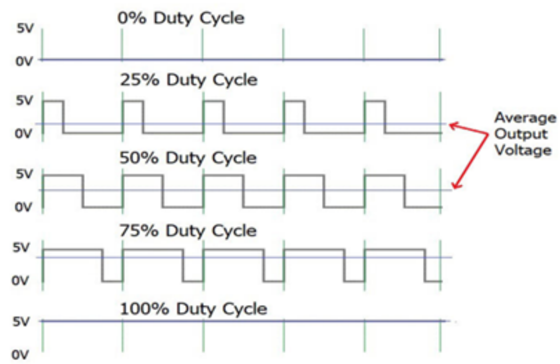

Fig. 4: The Diagram of Duty Cycle.

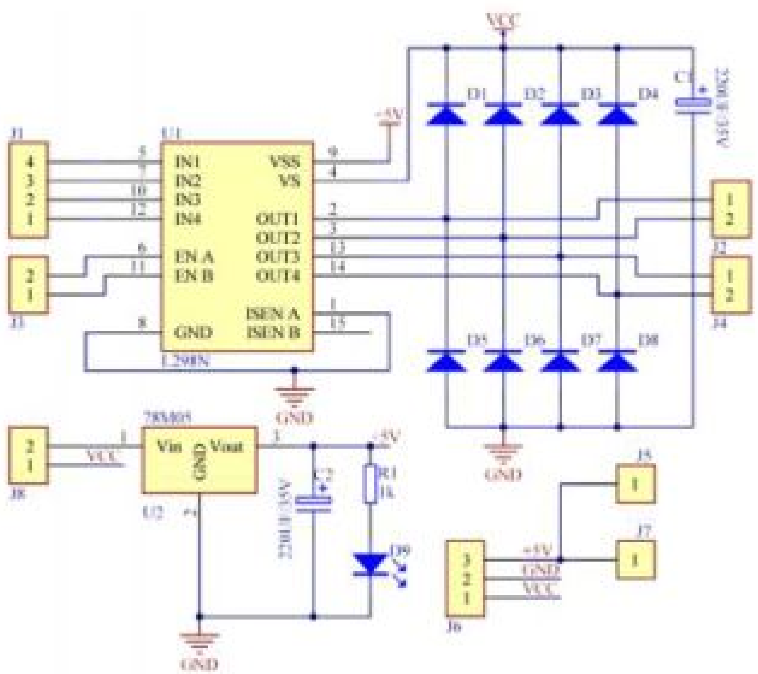

Fig. 5: Schematic Diagram of L298N motor Driver.

2.1.7 The following figure shows Board Dimension associated Pins Function of L298N motor Driver.

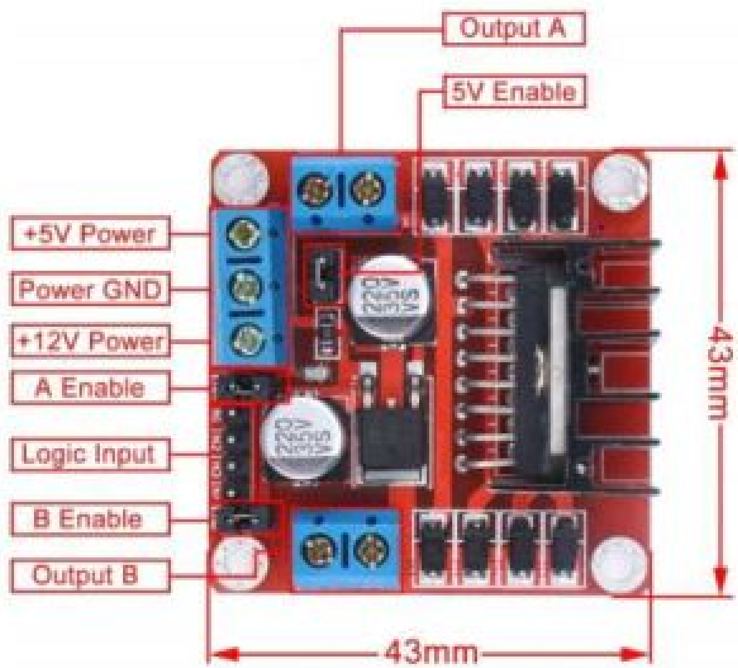

Fig. 6: Board Dimension and Pins Function of L298N motor Driver.

2.1.8 Raspberry Pi

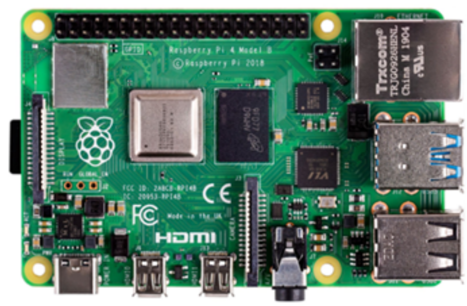

Fig. 7: A Raspberry Pi 4 Micro-Computer.

Raspberry Pi is a mini-computer that was made by Raspberry Pi Foundation. Raspberry pi is aimed to develop programming skills in the academic situation. It uses an ARM processor which is made by Arm Ltd. Because of this, Raspberry pi is also called as the revival of the BBC Micro computer which was made by Acorn Computers Ltd. which is the predecessor of Arm Ltd. The Raspberry Pi Foundation [12] shows that Raspberry pi 4 Model B is the latest and the most popular Raspberry Pi model nowadays. The Raspberry Pi 4 Model B boasts a Broad-com BCM 2711 processor; a 64-bit quad-core ARM v8 processor running at 1.5GHz covered by a built-in metal heat-sink. It also can connect with wireless RAN, Ethernet, and also Power over Ethernet.

2.1.9 Proximity sensors

According to Smooth [1], a proximity sensor gives the ability to detect objects or measure the distance between the object and the machine accurately. Proximity sensors are varied into many kinds by their size and the range when they measure. There are several kinds of proximity sensors: ultrasonic sensors, photoelectric sensors, laser rangefinder sensors, and inductive sensors. All of them have the range of the measure as a few inches up to tens of feet.

2.1.10 Ultrasonic Sensor

Ultrasonic sensors use ultrasonic pulse to detect objects, just like the mechanism of echolocation. The transmitter emits the ultrasonic sound wave first. Then, it reflects the object and comes back. Thus the ultrasonic sensor knows the existence and the distance of the object. Ultrasonic has the advantage in its high refresh rate. A high refresh rate means high accuracy. Also thanks to using ultrasonic waves, the measurement will not be affected by the object's color or transparency. On the other hand, the ultrasonic sensor should have a transmitter and receiver in one or separate units. Because it uses the sound wave, the accuracy will change when the temperature changes or the object is a soft object [1].

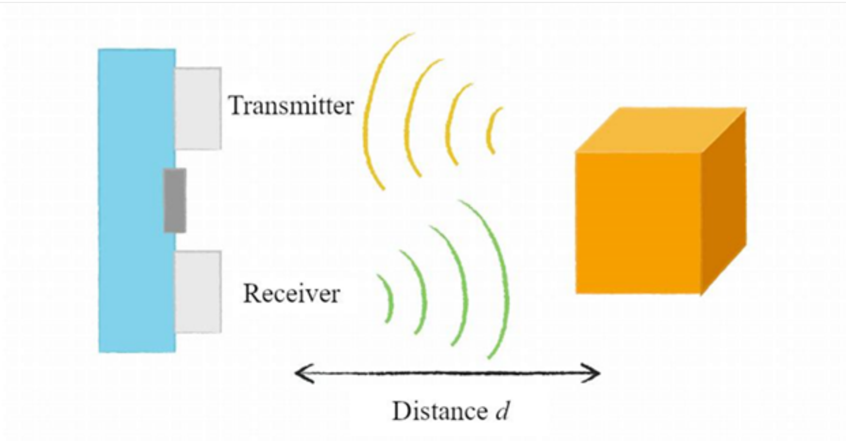

Fig. 8: Diagram of the function of an Ultrasonic Proximity sensor shown by smooth.

2.1.11 Photoelectric Proximity Sensor

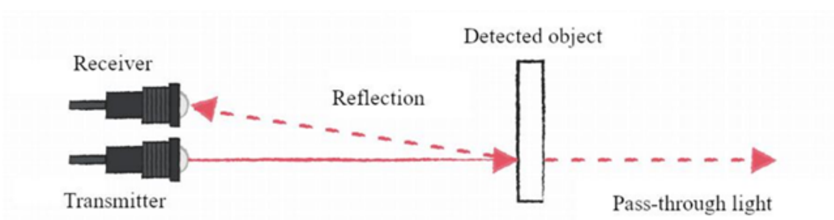

Fig. 9: Function of a Diffuse-reflective Photoelectric Proximity Sensor.

Photoelectric sensors have three major types: through-beam photoelectric sensors, retro-reflective photoelectric sensors, and diffuse-reflective photoelectric sensors.Diffuse-reflective photoelectric sensors arrange the receiver beside the transmitter same as the ultrasonic sensors. Ultrasonic sensors have the advantage in their long lifespans and the range of the objects that can detect. But they are not able to measure the distances[1]

2.1.12 Liquid Crystal Display(LCD)

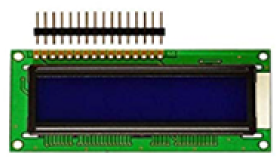

Fig. 10: Liquid Crystal Display.

One of ways to display data acquired by sensors is to use a liquid crystal display. In comparison to the technologies they replaced like light emitting diodes(LED) were a huge improvement. Cathode ray tubes are significantly thicker than LCD panels. LCD screens require a lot less power than LED and gas display displays because they block light instead of emitting it.

2.1.13 DC Gear Motor

Fig. 11: A DC Gear Motor and its Wheel.

A DC motor's basic premise is to convert electrical energy into mechanical energy. A DC motor operates on the basis that a current carrying conductor receives a mechanical force when it is put in a magnetic field. The Fleming Left-hand Rule determines the mechanical forces's direction, and its magnitude is determined by:

$$F = B\ .I\ .L \tag{2}$$

When an electric current flows through a coil in a magnetic field,the magnetic force produces a torque that turns the DC motor, according to Fleming's left hand rule. This force is perpendicular to the wire and also the magnetic field. When the torque output of a controlled motor increases, a gear motor is a combination of a gearbox that reduces the speed of the motor. When determining the type of motor for the project, gear motors are appropriate when the output power is estimated.

$$P_{out} = Torque\ *\ W \tag{3}$$

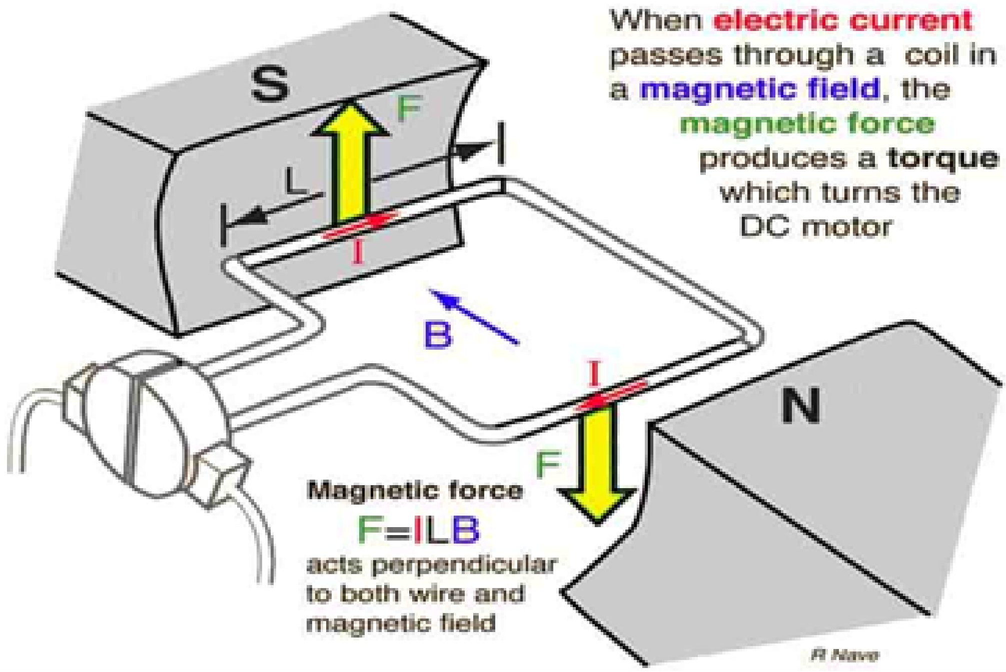

Fig. 12: Diagram of the function of a DC Motor.

2.1.14 Triangulation-based positioning Algorithm

The algorithm always uses properties of the arriving signal such as arrival time, phase, and strength. Differences in time and phase are useful for tag placement. First, the distance from the receiving antenna to the target is determined from the travel time of the signal reaching the receiving antenna, and then the target coordinates are found using the principle of triangulation. Using he TOA with RFID tracking system has some drawbacks.Since the indoor positioning scene is usually narrow, the distance from the tag to the reader is short, and the propagation speed of electromagnetic waves in the air requires a high short-range distance. Time accuracy, on the other hand, requires that the transmitter and receiver are precisely synchronized. Adding an accurate time stamp is difficult due to the relatively slow communication speeds of wireless devices.

2.1.15 The Evaluation Indicators of Indoor Positioning Algorithms

Evaluating the performance of indoor positioning algorithms has been considered from various perspectives. Commonly used performance metrics for indoor target positioning algorithms are positioning accuracy, positioning accuracy, environmental adaptability, real-time performance, poser consumption, and implementation complexity and cost.

2.1.16 Positioning Accuracy

It is the most important and most used metric when evaluating positioning algorithms. In target positioning systems, position accuracy generally refers to the deviation of the target's actual position from its estimated position.

2.2 Environmental Adaptability

Positioning ability refers both to the number of targets an algorithm can find simultaneously and to the scenarios in which the algorithm is applied.

2.2.1 Real-Time Performance

This typically includes location algorithm calculation time and system installation and configuration time. This is an important criterion for evaluating positioning algorithms. For indoor sports targets, real-time and fast detection of the target position is of great value for the practical application of the system.

2.2.2 Power Consumption

This is the factor that has the greatest impact on algorithm design and implementation. Different algorithms have different levels of complexity and require different numbers of positioning devices to participate in positioning. Moreover, the energy for placing tags is very limited. Therefore, under the requirement of satisfying positioning accuracy, algorithms with low communication overhead, computational complexity, and memory overhead should be selected.

2.2.3 Implementation Complexity and Cost

Implementation complexity is an important criterion for evaluating the merits of positioning algorithms. Algorithms with high location accuracy but complex implementation are often not used. The implementation cost is mainly the total cost of infrastructure, additional hardware, and other equipment required for a given algorithm, and it is possible to implement a low-cost location algorithm under the guarantee of location accuracy and limited resources. You have to choose.

2.3 Hardware Component

Table 1: The Quantity of The Components Needed in The Project.

No.	Device	Quantities
1.	Gear a DC motor	2
2.	Raspberry pi	1
3.	Toy Car Chassis	2
4.	Rechargeable battery 12V	2
5.	Mini breadboard	2
6.	Jumper wire	-
7.	Ultrasonic sensor	8
8.	L298N motor driver	2
9.	Wheel	2
10.	LCD	2
11.	DMW1001-Dev	4
12.	Power Bank	3

2.4 Project Architecture

2.4.1 Usage of Raspberry Pi

We will use raspberry Pi to do all processing activities including controlling the motor. And, we will program to control all activities for our project.

2.4.2 Usage of L298N Motor Driver

We will use an L298N motor driver to control speed using pwm works. We cannot connect our motors to the controller board directly because it could break it.

Table 2: L298N Motor Driver Controller Logic.

Motor 1	**Motor 2**	**A**	**B**	**Action**
Low	Low	0	0	Stop
High	Low	12V	0	Clockwise
Low	High	0	12v	Anti-Clockwise
High	High	12V	12V	Break

2.4.3 Usage of Ultrasonic sensor

To detect objects in front of the car, we will utilize an ultrasonic sensor. Ultrasonic sensor uses an ultrasonic sound wave to measure the distances and detect the object.

2.4.4 Usage of LCD

We will use LCD to display the distance between that car and the obstacle and other cars.

2.5 Project Diagram

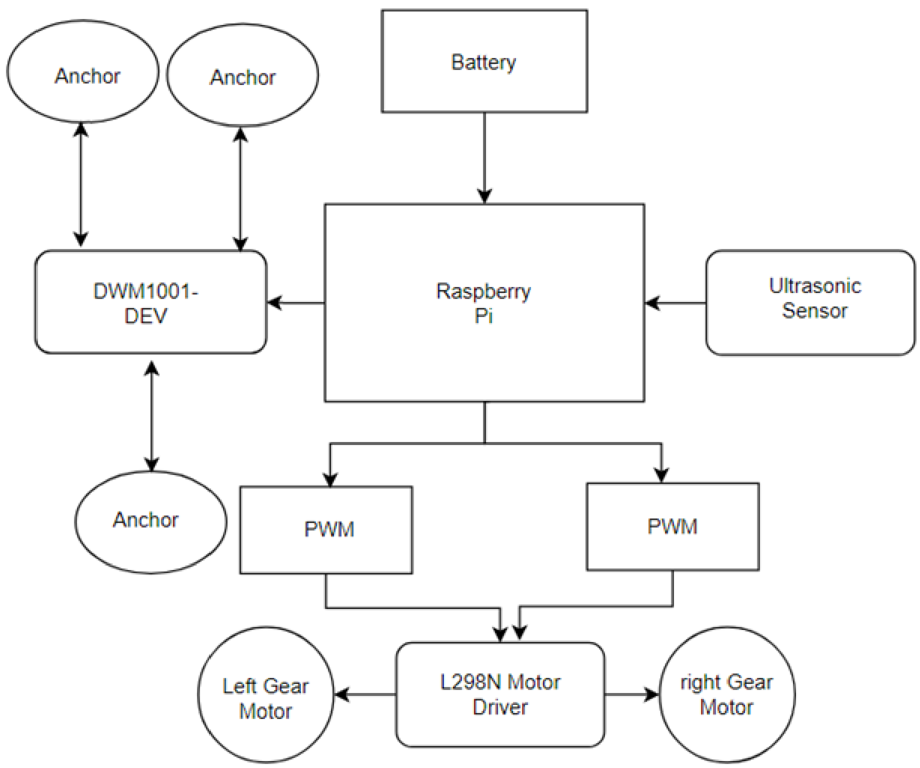

Fig. 13: High level Schematic Diagram.

When we turn on the Raspberry Pi, it will begin to run the Python code and begin the application. To remove the barrier in front of the car, it will accept input data from the ultrasonic sensors. The L298N motor driver will be used to regulate the speed of the motors on the Raspberry Pi.

2.6 Flowchart for the Project

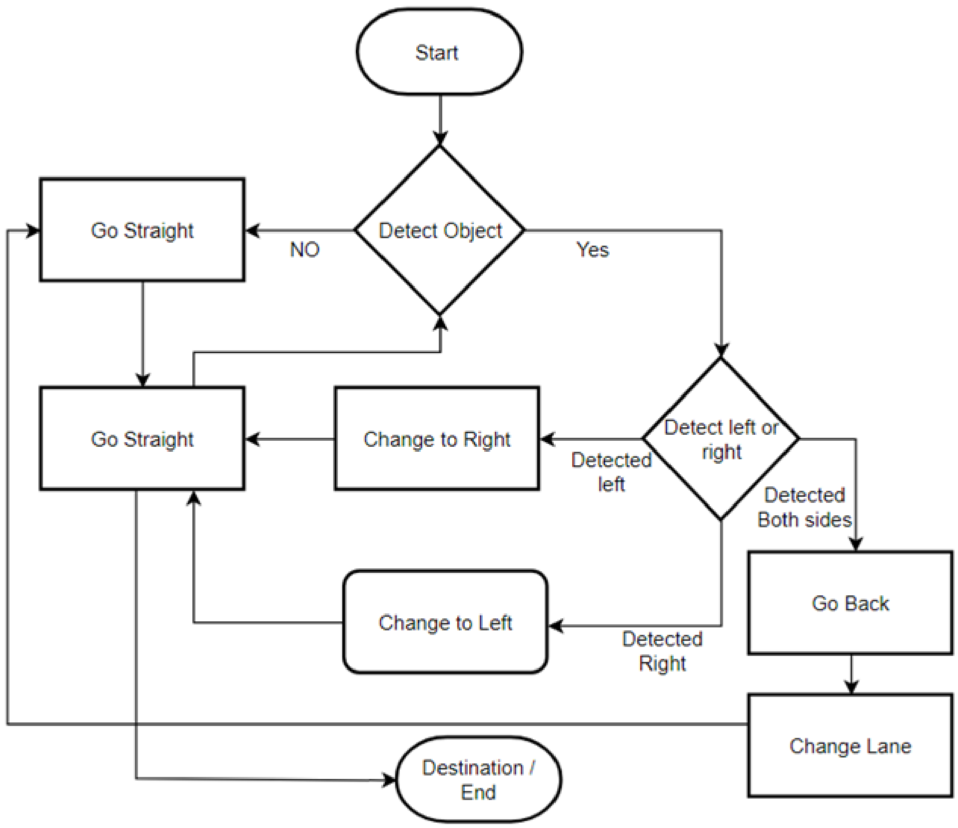

Fig. 14: Flowchart for Pre-Collision System.

After we write code for the system, the cars will go straight until the car faces an obstacle. When it is faced, it will avoid and go straight again. If the car sees a moving obstacle or car, we will decide to change lanes or not. If we decide not to change, the car will control speed and follow until it stops. Everything will work and detect within the infinite loop which will only terminate when we force it to terminate or any error occurs.

3 Methodology

3.1 Current Progress

After we got our components, We tested all our components to know if the components were working or not. We use Ultrasonic to get data of the distance between the car and the obstacle.

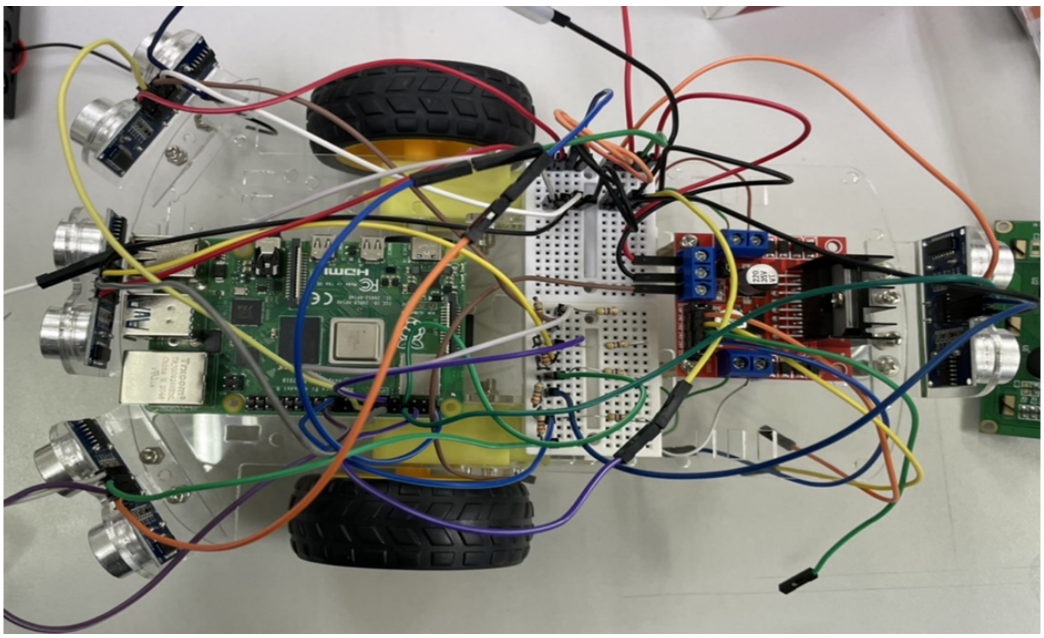

Fig. 15: Top View of Project.

3.2 Result and verification

There are majority issues we faced during the pandemic academic years. we cannot meet at the campus and cannot discuss with friends and teachers to get more ideas for projects. And we do not get our equipment on time due to the pandemic. As a first project for us due to less experience we have difficulties in researching the topic for the project.

4 Conclusion

In conclusion, this project will help to reduce using too much manpower in working fields such as industry, airport and port. This system is safe and based on sensors used to track the environment condition to continue the next step so it is less life risk. In our project, we used an ultrasonic sensor to detect the obstacle, DC gear motor is used for the movement and L298N motor driver is used to rotate the direction of the motor and control the speed of the motor.We implemented Ultra-wideband (UWB) technology for indoor localization and positioning. From this project, we had gained theory, ideas and knowledge that we could implement in the real-world application.

5 References

[1] Smoot, J. Comparing Proximity Sensor Technologies. CUI Devices.(2021, February 17). https://www.cuidevices.com/blog/comparing-proximity-sensor-technologies

[2] Sensors: Automotive, Industrial Commercial Vehicles. (n.d.). Automotive, Truck, Bus Off-Road Sensors. Retrieved September 15, 2022, from https://www.te.com/usa-en/products/sensors/automotive-sensors.html

[3] Vehicle Detection Sensors. (n.d.). Banner Engineering. Retrieved September 15, 2022, from https://www.bannerengineering.com/th/en/products/capabilities/vehicle-detection.html

[4] Thomas A. Kinney . Application Engineer . Baumer Electric. (2001, September 2). Proximity Sensors Compared: Inductive, Capacitive, Photoelectric, and Ultrasonic. Machine Design.
https://www.machinedesign.com/automation-iiot/sensors/article/21831577/proximity-sensors-compared-inductive-capacitive-photoelectric-and-ultrasonic

[5] Dejan.L298N Motor Driver - Arduino Interface, How It Works, Codes, Schematics. How To Mechatronics.(2017, August 8).
https://howtomechatronics.com/tutorials/arduino/arduino-dc-motor-control-tutorial-l298n-pwm-h-bridge/

[6] How why to use L298N Module. (n.d.). Make It Mech. Retrieved September 15, 2022, from
https://makeitmech.com/how-why-to-use-l298n-module-l298n-motor-driver-connection-with-arduino/

[7] What are Gear Motors Used For?Power Electric.(2018, July 10).
https://www.powerelectric.com/motor-resources/motors101/what-are-gear-motors-used-for

[8] Swagatam. L298N DC Motor Driver Module Explained. Homemade Circuit Projects.(2017, September 23). https://www.homemade-circuits.com/l298n-dc-motor-driver-module-explained/

[9] Contributor, T. LCD (Liquid Crystal Display). WhatIs.Com; TechTarget.(2019, September 13) https://www.techtarget.com/whatis/definition/LCD-liquid-crystal-display

[10] What is PWM: Pulse Width Modulation. (n.d.). Circuitdigest.Com. Retrieved September 15, 2022, from https://circuitdigest.com/tutorial/what-is-pwm-pulse-width-modulation

[11] (N.d.). Handsontec.Com. Retrieved September 15, 2022, from http://www.handsontec.com/dataspecs/L298N

[12] Raspberry Pi Ltd. (n.d.). Raspberry Pi 4 Model B specifications –. Raspberry Pi. Retrieved September 15, 2022, from https://www.raspberrypi.com/products/raspberry-pi-4-model-b/specifications/

[13] Obeidat, H., Shuaieb, W., Obeidat, O. et al. A Review of Indoor Localization Techniques and Wireless Technologies. Wireless Pers Commun 119, 289–327 (2021). https://doi.org/10.1007/s11277-021-08209-5

[14] Makerfabs. (n.d.). ESP32 UWB(Ultra Wideband) Module. Quick PCB Assembly, IOT Solution, Open Hardware - Makerfabs. Retrieved September 15, 2022, from https://www.makerfabs.cc/product/esp32-uwb.html

[15] (N.d.). Ait.Ac.Th. Retrieved September 15, 2022, from http://ise.ait.ac.th/wp-content/uploads/sites/57/2020/12/Indoor-Loccalization-System-Using-Ultra-Wide-Band-Device.pdf

[16] New Forest.Precise Realtime Indoor Localization With Raspberry Pi And Ultra-Wideband Technology (Decawave DWM1001 Developement Boards). Medium. (2019, August 20).
https://medium.com/@newforestberlin/precise-realtime-indoor-localization-with-raspberry-pi-and-ultra-wideband-technology-decawave-191e4e2daa8c

[17] Guvenc, I., Gezici, S., Sahinoglu, Z., Kozat, U. C. (Eds.). (2011). Reliable communications for short-range wireless systems. Cambridge University Press.

[18] Vishwas, Tatachar, Kondur, Amith, Varun, Kiran. (2021). Zigbee, It's Applications and Comparison with Other Short Range Network Technologies. International Journal of Engineering Research Technology (Ahmedabad), 10(6). https://doi.org/10.17577/IJERTV10IS060412

[19] H. Obeidat, W. Shuaieb, O, Obeidat, R. Abd-Alhameed, ”A Review of Indoor Localization Techniques and Wireless Technologies,”Wireless Personal Communications no.119, pp 289–327,2021. https://doi.org/10.1007/s11277-021-08209-5

[20] infsoft, (n.d.). ”Indoor Positioning, Tracking and Indoor Navigation with Wi-Fi”, from https://www.infsoft.com/basics/positioning-technologies/wi-fi/

[21] Inpixon. (n.d.). Wi-Fi Location Tracking Positioning. Inpixon.Com. Retrieved September 15, 2022, from https://www.inpixon.com/technology/standards/wifi

[22] Hindawi. (n.d.). Determination of an Indoor Target Position: An Accurate and Adaptable Approach Based on Differential Positioning. Hindawi.Com. Retrieved September 15, 2022, from https://www.hindawi.com/journals/ijap/2019/6202095/