AUTONOMOUS VEHICLES

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Abstract. *The concept of an autonomous car [1] represents a vehicle which can perceive its environment and can move on a particular route with or without the help of the driver. For a car to be considered autonomous it needs to have a variety of technologies such as radar, LiDAR, GPS, network infrastructure and sensors such as proximity, ultrasonic and ultrasound sensors. The main goal of an autonomous car is to ensure the safety of all the traffic participants including pedestrians.*

Keywords: *autonomous car, radar, Arduino Mega 2560, microcontroller board.*

Introduction

The first autonomous cars appeared in 1984 through the project named Navlab [2] formed by the collaboration of University „Carnegie Mellon" and ALV [3]. In 1985, ALV succeeded in autonomously maintaining a speed of 31 km/h. A big breakthrough was in 1995 when Navlab drove 4585 km between Pittsburgh and San Diego with a percentage of 98% autonomously driving at an average speed of 102.3 km/h. Another breakthrough was in 2017 when Audi declared that the A8 model which used the "Audi AI" [3] system could maintain a speed of 60 km/h without having the driver to perform any safety manoeuvre. In 2018 Waymo declared that their test vehicles autonomously drove 1.6 million km.

Vehicle Automation [4] can be divided into 6 levels:

Table 1

Levels of Vehicle Automation

The human monitors the driving environment			**The automated system monitors the driving environment**		
Level 0	**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**
Manual Control. All driving tasks are performed by the driver.	The vehicle features a single automated system for driver assistance (e.g., cruise control)	The vehicle can control both steering and accelerating/ decelerating but the driver can take control at any time.	Environmental detection capabilities. The vehicle can perform most of the driving task, but driver control is still required.	Vehicles can operate in self-driving mode and can intervene if a danger is detected or if a system failure appears. The driver can still take control at any time	The vehicle performs all driving tasks under all conditions and there is attention or interaction needed from the driver.

In this article we will be using levels 4 and 5 to explain our approach to an autonomous vehicle.

Hardware Design and Implementation

The car uses an Arduino Mega 2560 microcontroller board as a logical unit which carries out different tasks received through the Android app using a Bluetooth connection. The microcontroller sends commands to the DC motor for forward/backwards movement through the H bridge while for steering it sends commands to the servo motor. The units responsible for environmental detection are the HC-SR04 ultrasound sensors which will determine the distance to various objects. Using the data received by the ultrasound sensors we will be implementing various algorithms by which the car will be able to perform automatic framing manoeuvres, emergency stop, determining a viable a parking place and automated parking.

The Fig. 1 exemplifies the implementation of the hardware components while Fig. 2 exemplifies the wiring diagram.

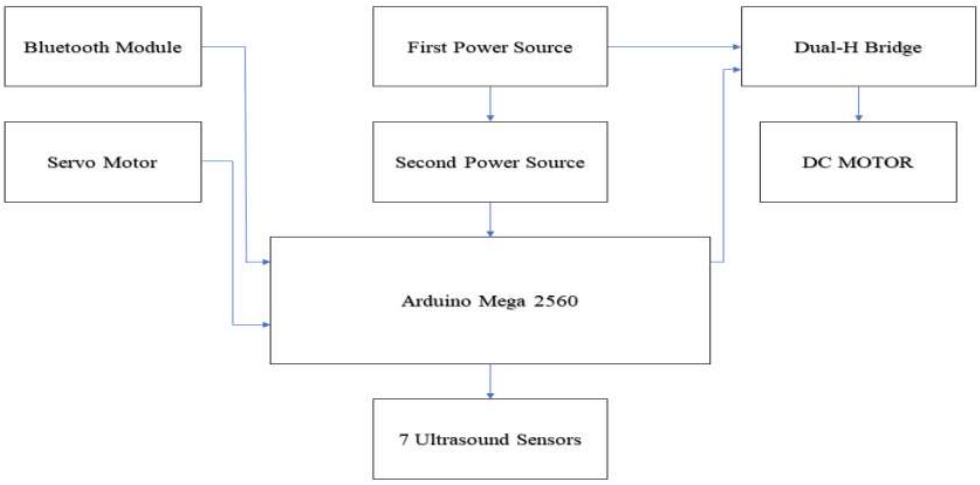

Figure 1. Hardware Implementation block scheme

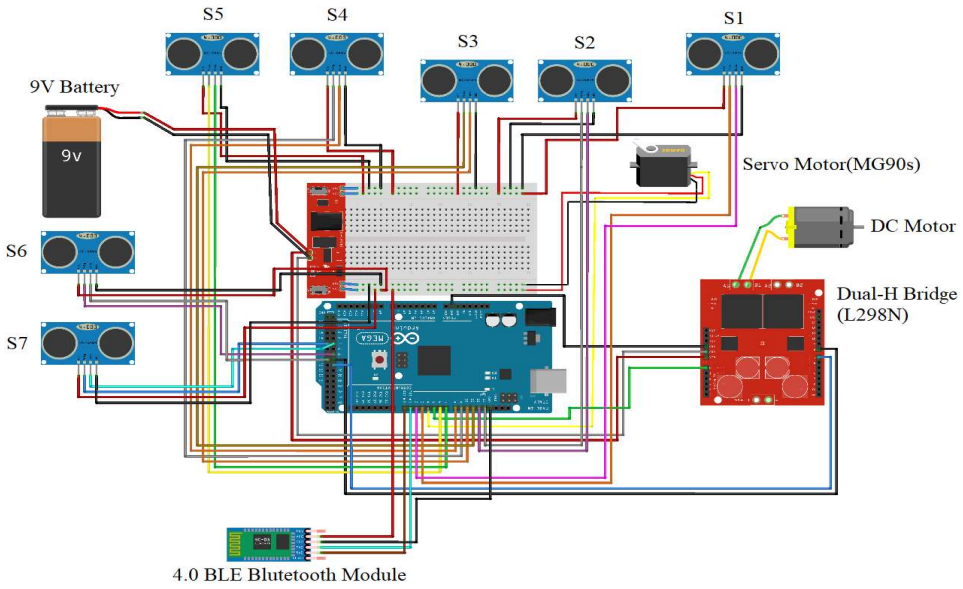

Figure 2. Wiring Diagram

The main reason we chose the Arduino Mega 2560 as the microcontroller board was for its multitude of digital pins used for connecting all 7 HC-SR04 ultrasound sensors. Although this microcontroller board also has its drawbacks, one of them being that this board cannot generate a high enough electrical current intensity on its output pins which made it necessary for us to use a Dual-H Bridge to achieve a high enough electrical current intensity to power the DC Motor. For the Dual-H Bridge we chose the L298N module.

For the servo motor we chose the MG90S module due to its small dimensions and its capability to rotate 180°. In order for the car to be able to turn left and right the servo motor was mounted on the neutral position at an angle of 90°.

The final product can be observed in Fig. 3.

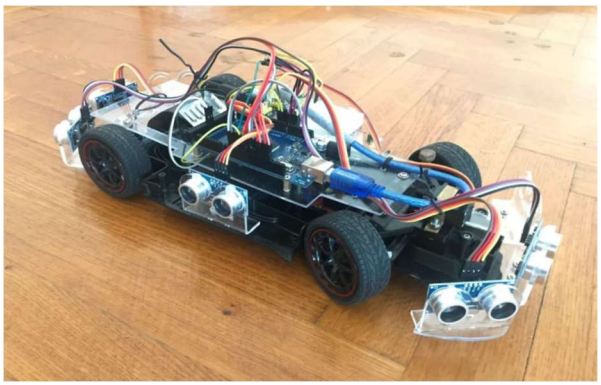

Figure 3. Practical implementation of the car

Software Design and Implementation

The main used technologies are:

- Arduino IDE, which is used to write and compile the Arduino program.
- MIT AppInventor which is used for the Android app interface.

By declaring a detection threshold for each ultrasonic sensor, we implemented a series of algorithms which the car uses to detect possible obstacles and perform tasks such as maintaining travel direction by using a lateral wall as a point of reference, detecting if there is an available parking place or performing manoeuvres such ass parallel parking.

Using MIT AppInventor we developed an android application with which we can control the car. The application has 3 menus:

- Autonomous mode
- Search for parking spot
- Parallel Parking

Conclusions

Implementing this project proved to be a very difficult task even at the theoretical stage, there are many variables needed to be considered for even a simple scenario such as parallel parking, but with all the technical difficulties we managed to implement a simple solution for an autonomous car. However, implementing this kind of project in a real word environment and making the transition to Level 4 Vehicle automation will prove a difficult task but not an impossible one, there are a plethora of car companies that are working on implementing auto vehicles capable of Level 4 Vehicle automation, but their biggest obstacle are the legislations and laws regarding the safety of all traffic participants. Nevertheless, I think this topic is relevant for the future of car manufacturing and useful for the future of the automotive industry.

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