Bluetooth-controllable/autonomous car that can avoid obstacles in autonomous mode

Coticeru Dragos-Ionut

1. Objectives of the Proposed Project

I aimed to build my own car from scratch that I could control via Bluetooth. Furthermore, I wanted the project to be financially accessible, which is why I chose to use inexpensive components that would successfully implement the desired functionalities.

2. Description of the Chosen Field and Similar Solutions

The field chosen for this project is Smart Housing and Entertainment. There are similar solutions on the market, such as Roomba vacuum cleaners, which use sensors and algorithms to navigate rooms and avoid obstacles. However, Roomba vacuums can become quite expensive.

Additionally, there are remote-controlled cars used for entertainment (especially for children's entertainment). The project implements similar functions, with our car being controllable via a phone using Bluetooth.

Some other scenarios where such a phone-controlled car would be useful include:

- Exploring dangerous areas (high radiation zones like Chernobyl) or tight spaces where a person cannot enter (sewers, pipes)
- Surveillance of an area (it can patrol a perimeter without the guard having to physically go there)
- Anti-terrorism (the car can approach dangerous objects that might be bombs to study them up close)
- Deliveries and transport
- Remote data collection (for example, in agriculture, it can go into the field to measure various parameters).

3. Description of the Proposed Solution

The project involves building a controllable/autonomous car using an Arduino board and motors for movement.

The first mode of the car is controllable. By using the ‘BT Car’ phone app, the car can be controlled via Bluetooth in all 8 directions (Forward, Backward, Left, Right, Forward-Right, Forward-Left, Backward-Right, and Backward-Left).

The second mode of the car is autonomous. The car is equipped with a distance sensor that allows it to detect obstacles in its path. The algorithm implemented in the Arduino code allows the car to stop in front of obstacles, turn right to avoid them, and then resume moving forward.

4. Description of the Implemented Solution with Presentation of the Functionalities

The project consists of a car with four 3-6V DC motors connected to an Arduino Uno via a motor shield, with all parts mounted on an acrylic platform. We can connect to the car to control it through an external HC-05 Bluetooth module (since the Arduino Uno does not have an integrated Bluetooth chip), using the "BT Car" application, which I sourced from the internet as I couldn’t find an open-source one. For the autonomous mode, the car uses an ultrasonic sensor to detect distance, allowing it to avoid obstacles. The entire assembly is powered by two 3.7V 2500mAh batteries.

In manual mode, the car receives different commands through the Bluetooth module for moving forward, backward, left, right, etc. To move forward and backward, the motors rotate the wheels in the direction of travel, and for on-the-spot turns, the motors on one side rotate in the opposite direction to those on the other side, allowing the car to turn on the spot. For a wider turn, we can only operate the pair of motors on one side, causing the car to execute a turn on a larger radius.

Initially, when powered on, the car enters autonomous mode for 60 seconds to demonstrate these capabilities. After 60 seconds, the manual mode is activated, allowing us to control it via the phone.

Component list:

- Acrylic platform
- Bluetooth module HC-05
- L293D Shield (motor driver)
- Arduino Uno
- Distance Sensor
- 4x DC Motors 3-6V
- 4x Wheels
- Breadboard
- Wiring harness
- 4x 3.7V 2500mAh Samsung 18650 batteries (2 spare)
- Battery holder
- Nuts, screws, brackets

Testing the Solution

To ensure that the project functions as intended, I conducted tests after each stage of its construction. The tests I performed are as follows:

Testing each component individually:

I tested if the motors work individually as well as simultaneously when receiving current.
I tested the Arduino board to verify if it functions properly.
Motors were tested with different types of batteries to determine which performs best.
I tested the Bluetooth module and distance sensor.

Testing the connections between components:

I tested soldered wires with a multimeter to verify if each connection is made correctly.
I tested the connection cable between the Arduino board and the laptop.
I tested if the Arduino board correctly sends the signal to the shield and motors by implementing code that only commands forward movement.

Testing the correct operation of the vehicle:

I tested if the vehicle responds correctly to commands given through Bluetooth.

Testing obstacle avoidance:

I tested if the vehicle correctly avoids obstacles, stopping when the distance sensor signals an obstacle and then rotating to the right before continuing forward.

Challenges Encountered:

The cable used to connect the Arduino board to the laptop was not functional, so I replaced it.
I encountered errors when uploading the code to the Arduino board because the motor shield was connected to the board and didn't allow the upload of new code. Therefore, every time I uploaded new code to the board, I first disconnected the Motor Shield.
The code was modified many times until I found a version that successfully fulfilled the desired functionalities.
The power wire of the distance sensor burned out.

Bibliography:

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Shield L293D (Motor Driver):
https://www.instructables.com/Arduino-L293D-Motor-Driver-Shield-Tutorial/
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https://projecthub.arduino.cc/Isaac100/getting-started-with-the-hc-sr04-ultrasonic-sensor-7cabe1
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