Journal of Electrical and Electronics Engineering
Vol. 1, No. 2, December 2016, Pages 56-61

A Remote Controlled Car Using Wireless Technology

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ABSTRACT

Automation or automatic control is the use of various control system for operating any equipment or device such as a remote controlled (toy) car, switching on telephone networks, and other useful applications with minimal or reduced human interventions. This paper proposes a design and implementation of a remote controlled car by wi-fi technology via computer or mobile devices. In completing this research work, wireless software and hardware technologies have been used, such as wireless module of ESP8266 for transceiver (transmitter and receiver), Arduino Uno as microcontroller, an H-bridge L293D IC for motor controller, and two electric DC motors are used to move the automobile. Two objectives of this project are to expand the limitation range of a normal radio frequency car using wi-fi technology and also to create a ubiquitous technology for automobile that operates in daily life with a control system. The test result shows that the controlled car can move in any direction. However, the performance depends on the device signal strength where the maximum testing range is only about 20 meters' distance from the user's location.

Keywords: automation, wi-fi technology, remote controlled car, Arduino, signal strength.

ABSTRAK

Otomatisasi atau kontrol otomatis adalah penggunaan berbagai sistem kontrol untuk mengoperasikan peralatan atau divais seperti mobil mainan yang dikontrol dengan remote, saklar jaringan-jaringan telepon, dan aplikasi bermanfaat lainnya yang sedikit atau bahkan tanpa intervensi manusia sama sekali. Artikel ini memberikan deskripsi tentang sebuah disain dan implementasi dari mobil mainan yang dikontrol dengan remote melalui medium teknologi nirkabel dengan menggunakan komputer atau 'divais bergerak' seperti telepon genggam. Dalam menyelesaikan penelitian ini, baik teknologi nirkabel perangkat lunak mapun perangkat keras telah digunakan, seperti halnya modul ESP8266 yang berfungsi sebagai pemancar dan penerima, Arduino Uno sebagai mikrokontroller, dan sebuah IC dengan tipe H-bridge L293D yang berfungsi untuk kontroller motor, dan dua motor DC elektrik yang digunakan untuk menggerakkan mobil remote kontrol tersebut. Dua tujuan utama dari penelitian ini adalah untuk memperbesar jangkauan batasan normal mobil frekuensi radio dengan menggunakan teknologi nirkabel dan juga untuk menciptakan teknologi kontrol yang memasyarakat dan dapat beroperasi dengan baik dalam kehidupan sehari-hari. Hasil dari tes percobaan menunjukkan bahwa mobil mainan yang dikontrol dapat bergerak ke segala arah. Namun, kinerjanya tergantung kepada kekuatan sinyal divais di mana jangkauan tes maksimum hanyalah 20 m jauhnya dari lokasi pengguna.

Kata kunci: otomatisasi, teknologi nirkabel, mobil kontrol remote, Arduino, kekuatan sinyal.

I. INTRODUCTION

In 1898 in an exhibition at Madison Square Garden Nikola Tesla demonstrated a small boat which could apparently obey commands from the audience but was in fact controlled by Tesla interpreting the verbal requests and sending appropriate frequencies to tuned circuits in the boat [TKS06]. Then in 1966 the first commercial radio controlled cars, produced by the Italian company El-Gi (Electtronica Giocattoli) from Reggio Emilia. The first model was Ferrari 250LM and was released in UK [RCC15]. The principles of radio controlled car was very simple, the components needed are a transmitter, and a receiver, and a power supply. The transmitter has joysticks for controlling, steering and wheeling. The receiver uses amplitude modulation for the radio signal and pulse width modulation to control the motors. And the power supply supplies the power needed for the car to operate. Figure 1 shows the illustration of the basic wireless controlled car diagram.

Currently, remote controlled cars use radio-frequency (RF) technology. In 2014, a group of students from Rutgers University that called the Spybot [EB14]. This project uses Bluetooth module, Arduino Motor Shield, 2 dc motors and 1 servo motor. It also uses two android phones, one for receiving the signal from Bluetooth module, and the other

Received: 10 April 2017 Revised: 30 May 2017 Accepted: 13 June 2017

one is for streaming back live video. The total cost to create the project is 160.01$ excluding the android phones. Figure 2 shows us about the Spybot Project Final Design.

I Spy Tank [IST15] was commercially released by I Spy Tank company in Sweden, in the year of 2014. The price of the I Spy Tank is 119 US $ (about 1.5 million rupiahs). The I Spy Tank can be controlled by Iphone, Ipad, or Ipod. The I Spy Tank can send video and sound from up to 100 ft. unobstructed. I Spy Tank uses 6 AA batteries for power supply. The device will be shown in Fig. 3 below.

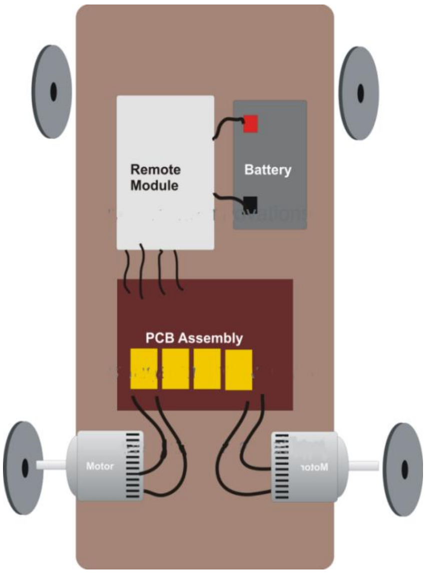


Figure 1. Illustration of basic wireless controlled car.

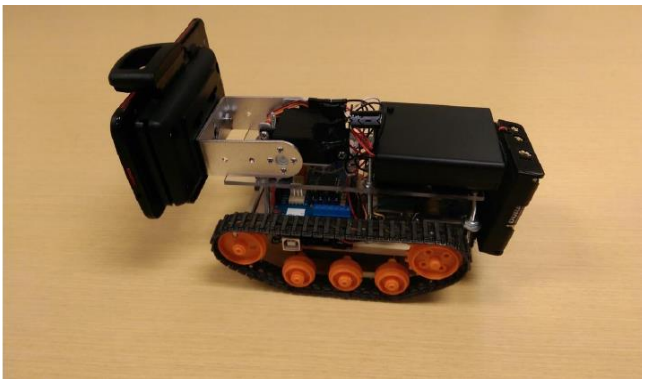


Figure 2. Spybot Project [EB14].

Figure 3. The I Spy Tank [IST15].

The rest of this paper is followed: chapter II will describe the design and implementation of this remote controlled car from hardware and software specifications and how the system works, while chapter III presents the experimental results and discussion, then the last chapter is for conclusions and recommendations.

II. DESIGN AND IMPLEMENTATION

Nowadays, wireless controlled car is commonly found as toy-grade radio controlled car with the focus on reducing production costs and also for hobby grade radio controlled which can be customized. The 2.4 GHz frequency radio has been used in the hobby-grade R/C Cars. Wi-Fi technology [JGP08] has been implemented in wireless controlled car with high data rate (54Mbit/s +), but also high power consumption. It is used when you need to connect directly to the internet, such as an internet-of-things (IoTs) device, and have an external power source. Generally, the system is divided into three parts [DJ10]: the car-end, PC-receiver-end, and PC-control-end.

In this part, we are going to discuss the required materials used for this project, those are for hardware and software specifications.

A. *Hardware Specifications*

There are some hardware materials needed to fulfill this project, like Arduino Uno as microcontroller, Wi-Fi Module as transmitter and receiver, Motor driver IC, DC motors and Power supply, chassis, and some other related equipments.

A.1. Arduino Uno

Arduino Uno is an Arduino Development Board using the microcontroller IC ATmega 328. Arduino Uno can be programmed using the Arduino software. Figure 4 shows the Arduino Uno SMD project board.

A.2. ESP8266 Wi-Fi Module

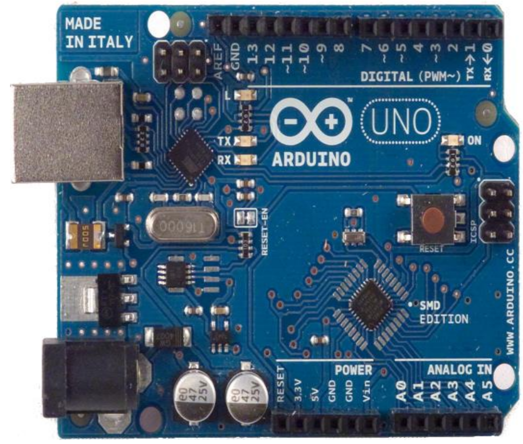


Figure 4. Arduino Uno Smd [AUS15].

ESP8266 stands for Espressif Connectivity Platform, 8266 is the series. It serves as Wi-Fi adaptor, and can be added to any microcontroller-based design. In this project it serves both as transmitter and receiver. It will send the signal from the computers or mobile devices to the Arduino Uno. Figure 5 shows the ESP8266 module.

A.3. L293D Motor Driver IC

The 4017 is an IC (integrated circuit) that is designed to allow DC motor to drive on both directions. It has 16 pins just as any other 16-pin IC. L293D can control two DC motors simultaneously in any directions. It has voltage supply range from 4.5V to 36V. Figure 6 describes about the L293D pin configurations.

There are 4 input pins for L293D, pin number 2, pin number 7, pin number 10 and pin number 15. Pin number 2 and 7 connects to output pin on Arduino for controlling left motor, pin number 10 and 15 connects to output pin on Arduino for controlling right motor. Pin number 3 and 6 connects to right motor, and pin number 11 and 14 connects to left motor. The driving “algorithm” of this project will be shown in Fig. 7.

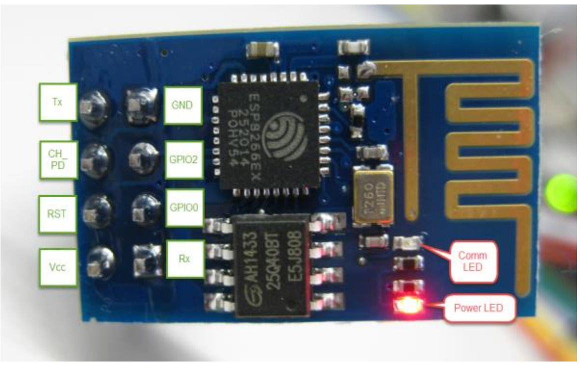


Figure 5. ESP8266 module.

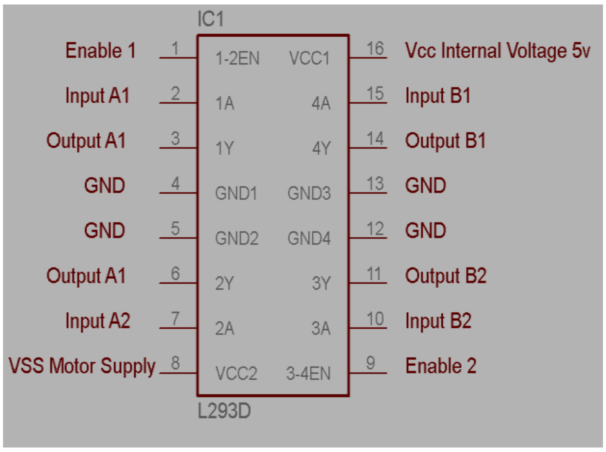


Figure 6. L293D pin configurations.

Left Motor	Right Motor	Direction
Front	Front	Front
Front	Back	Right
Back	Front	Left
Back	Back	Back

Figure 7. Driving “algorithm.”

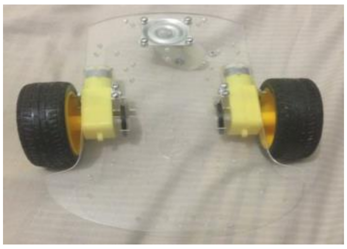
A.4. DC Motors and Chassis

DC motor has voltage supply range from 3-12 Volts. A 9 V Battery is used to power the motors, and a power bank is used to power the Arduino Uno. Figure 8 shows an example of the DC motor and chassis which are used in this project. The material for the chassis is acrylic with two wheels for steering and driving and one wheel for balancing the car.

B. Software Specifications

Two softwares are used in this project. The first software is Arduino IDE from Arduino’s website to program the Arduino board, the second is Window’s Notepad to design the HTML controller’s page.

(a)



(b)

Figure 8. (a) DC motor and (b) chassis

C. Working Mechanism

Now we are going to explain about how the project was implemented. First step is programming Arduino and ESP8266, and L293D IC. The second step will be making the controller. Here, there is no physical controller being used because this project utilizes HTML page to control the car. The logic is, first we connect to the access point made by ESP8266, and then we navigate to the HTML page that function as controller, and in the HTML page there are some navigation buttons that can be pressed. After pressing the navigation button, it will send a command into the Arduino through the ESP8266. Arduino will interact with L293D motor driver IC and will determine how the motor will act. How the system works will be illustrated by the block diagram in Figure 3.7. The final step is to put all of the components in a chassis.

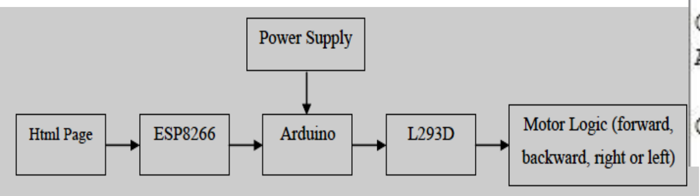


Figure 9. Block Diagram of System's Operation

III. Results and Discussion

Before showing the experimental results and start to discuss it, here we explain first the connection mechanism between Arduino and ESP8266, Computer with ESP8266, and Controller-Motor Connection.

A. Arduino - ESP8266 connection

Arduino and ESP8266 connection will be tested using Arduino software. Plug in the USB power supply into the computer. Next, open the Arduino software, using the software's serial monitor. If there is a connection between Arduino and ESP8266, the serial monitor will send a sequence of message. The blue LED in ESP8266 will also be turned on. Figure 10 shows the received messages on Arduino's serial monitor software.

When the first attempt of testing the Arduino-ESP8266, there was an error happened. The serial monitor showed nothing, this indicates that the connection is unsuccessful. This problem was solved by checking the Tx and Rx pin on the ESP8266, it found out that the pins are reversed. After reversing the pins, the problem was solved.

Figure 10. Received messages on Arduino's serial monitor software.

B. Computer – ESP8266 Connection

After testing the connection between Arduino and ESP8266, the next step is testing the connection between computer and ESP8266. This task is simply done by connecting to the access point that ESP8266 has made. The SSID is ESP_984D4D. After connecting into the access point, this step is done. Figure 11 shows that the connection status is successful.

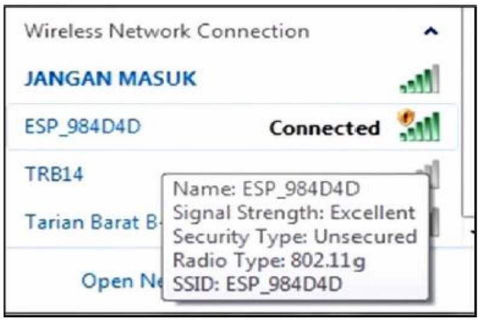


Figure 11. Connection status between computer and ESP8266.

C. Controller and Motor Connection

After testing connection from computer and ESP8266, now the project can be continued to setting up the controller and motor connection. Open the controller's HTML page, and click on the buttons shown in the HTML page. Make sure that the computer is still connected to the ESP8266 access point, and the testing phase will begin. There are four directions that needed to be tested. Forward, reverse, left, and right. The Figure 12 is the preview of the controller's HTML page interface.

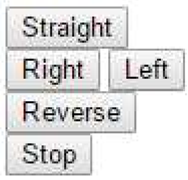


Figure 12. Controller's HTML page interface.

User may know that the connection is successful by seeing the directions of the DC motors. If Straight button is pushed, both DC motors will turn in the same way. If Right button is pushed, only the right DC motor will turn. If Left button is pushed, only the left DC motor will turn. If Reverse button is pushed, both DC motors will turn in the same way but in opposite direction from the Straight. And if Stop button is pushed, no DC motors will turn.

When attempt of testing the controller and motor connection was initiated, there was several errors occurred. The first problem was, when the buttons on the HTML page was clicked nothing happened. No motors moving at all. After checking, the error is caused by human error. The connection between computer and ESP8266 was not established, it means that the computer is not connecting to the ESP8266's access point. Author forgot to connect the computer into the access point. The second problem is the motors are moving randomly or not following the buttons that are pushed. After several trials and errors, author found out that this problem was caused by excessive commands on the controller's page. ESP8266 execute one command at a time, therefore patient is the solution here. Do not triple click or click random commands, because the commands will be queued and the controller will not work properly. It is recommended to click or send command one at a time.

D. Range – Testing Results

The range testing is conducted in two environments, with obstacles and without obstacles. Both testing are conducted indoors. The one with obstacles was conducted in a two floor house full with doors and walls, furniture, and the one without obstacles was conducted in an empty space of a badminton field. The facility being used was a laptop with no external antenna, along with the Wi-Fi Controlled Car. Table 1 below describes the range-testing results.

Table 1. Range-Testing Results

Distance	Results		Comments
	With Obstacles	Without Obstacles	
1 meter	Excellent	Excellent	The signal bar is full
5 meters	Excellent	Excellent	The signal bar is full
10 meters	Good	Excellent	The signal bar is full for without obstacles, only half power for with obstacles
15 meters	Poor (car still moves)	Good	The signal bar is only 2-3 bars with obstacles, half power for without obstacles.
20 meters	Poor (car still moves)	Poor (car still moves)	The signal bar is not detected with obstacles, only 2-3 bars without obstacles.
25 meters	Negative	Negative	Did not work, signal not detected

From Table 1 we see that the results are vary depends on the range. The performance depends on the signal strength on the device. For the one with obstacles, the problem exists in range above 10 meters where the signal is not strong enough, and as for the one without obstacles, the problem exists in range approximately 20 meters. So what makes the difference between with obstacles and without obstacles in terms of signal strength? The obstacles are clearly interfering with the signal. The walls, doors, and furniture are the problem to our project's range. If we remove the obstacles, the maximum range will be 20 meters long. Standard radio control cars operate in the 27 MHz and 49 MHz, based on the frequencies, the maximum theoretical range is about 11 meters.

IV. Conclusions and Recommendations

A. Conclusions

In this paper, the expanded range of a normal radio-frequency car using Wi-Fi has been implemented. According to Table 1, the maximum range is 20 meters, comparing to the 11 meters of the standard radio control toy car. A well designed ubiquitous technology for automobile that operates in real-time with a control system has been created. As the testing goes well, the car can move forward, backward, to the right, and to the left: in any direction.

B. Recommendations

As a matter of fact, this project still has a lot of room for improvements. Below are some possible improvements that can be added to this project:

1. The L293D motor driver IC can be improved by replacing it with motor shields. L293D can only control 2 DC motors simultaneously, on the other hand motor shields can control more DC motors and also can control servo motors. It is also more programmable and has its own libraries. Therefore the car can be better controlled. Servo motors also can be added into the project so the car has separate motors for wheeling purposes and steering purposes.
2. The chassis of the car can be improved by adding more accessories like gears, bumpers, full body kit, to improve the movements of the car.
3. The range can be improved by using external antenna on the Wi-Fi transceiver.

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