Design Metal Detecting Arduino Remote Control Robot Vehicle Controlled via Bluetooth

R. Jeyagopi[1*], C.K. Chan[1], M.I.N Ma'arof[1]
[1]Faculty of Engineering and Quantity Surveying, INTI International University, Persiaran Perdana BBN, Putra Nilai, Negeri Sembilan, Malaysia.

*__Email__: jeyag.raman@newinti.edu.my

***Received**:15 October 2021; **Accepted**:5 January 2022; **Published**:7 January 2022*

Abstract: In today's world, robotics is fast-growing and already interacting in many aspects of our daily lives. Robotic is part of the communication of advancement of technology, engineers have decided to work in this field to design or build robots that will make human life more advanced. There are several types of mobile robotics in today's technology world. There are tracks robots, humanoid robots, water-based robots, wheels robots and etc. Thus, a metal detecting remote control robot vehicle is designed using four wheels in this research. The system is implemented using the Arduino platform, android application, and metal detector winding. This robot vehicle has been developed with the interaction of an Android-based device. Arduino Uno is used as the brain of the robot. It also includes the part of the software that utilizes a portable application. In this paper, a metal detecting robot is designed to allow the robot vehicle to detect the metal and the robot vehicle control via Bluetooth remote control. The proposed design is compared with the automated robot in terms of accuracy of detection, turning, and costing. The results show that the proposed design robot vehicle is able to provide an accurate and fast in detecting the metal movement, easier in turning, and cheaper.

Keywords: Android Uno; Metal detector module; Bluetooth module; Ultrasonic sensor

1. Introduction

Remote-controlled application has been widely used in our daily life such as machine arms and robotic cars for convenience as we are able to operate the device from a certain distance away. In situations where human beings have inconvenience to work such as difficulty in handling radioactive substances, explosives, putting out fires in compact areas, or traversing through tight areas, it is more effective if we are able to remotely control a smaller robotic vehicle or arms to perform such tasks so that human health and safety is not compromised. A remotely controlled robotic vehicle is operated by sending a certain pulse or signal to the respective device through a receiver chip such as a Bluetooth module (Selvam, 2014). Android-based application has been growing tremendously with various apps including the Arduino Bluetooth controller which is useful in controlling a robot (Hannan et al., 2018).

The use of sensors, Bluetooth module sensor, metal detecting sensor, and ultrasonic sensor for developing a metal and obstacle detection system had started as early as the 1980s (Chinnasamy, 2015). Sensors are instruments that transform types of electricity into electrical

energy (Sonali et al., 2021). The sensors are bridges that connect the environment with different electronic devices (Yilin & Dong, 2017). The environment can be any physical environment such as smartphones, robots, tablets, intelligent clocks, military fields equipment, airports, factories, hospitals, shopping malls, and electronic devices (Ramakrishna et al., 2017). These systems have a wide variety of apps for industrial process control, protection, image, and identification.

Metal detectors have been used for diagnostic purposes. They have been used to locate countless foreign objects, including bullets, metal fragments in the eye, swallowed coins and other foreign objects and medical equipment. Rapid detection of metal objects may be helpful for diagnosis or treatment. The uses of metal detectors include detecting land mines, detecting weapons (knives and guns especially in airport security), archaeology, treasure hunting, and geophysical prospecting. Besides that, metal detectors are also used to detect foreign bodies (metal fragments) in food, and used in construction industries to detect steel reinforcing bars in concrete, pipes, and wires buried in walls and floors. Remote control robots are the common robot used in metal detecting that can sense metals and send information to smartphones or tablets by using Arduino Uno (Yeole et al., 2015). Metal detection is a primary requirement of this remote control robot. The robot detects the metal from its path through mounted sensors on the robot (Alauddin et al., 2016).

In this paper, metal detecting robot remote controlled is designed to allow the robot vehicle to detect the metal and the robot vehicle control via Bluetooth remote control using a metal detector, Bluetooth module and Arduino Uno and compared with an automated robot. The robot to drive the vehicle is powered by a lithium-ion battery. The Arduino board connects the battery circuit, the drive train motor circuit, and other accessories.

2. Methodology

MethodolFigure 1 shows the system structure of the developed metal detecting robot. In this study, HC-06 Bluetooth Module, Non-Contact Metal Detector Module, servo motor, motor driver, and Android device are used to interact with each other. An Android Uno application is used to control the robot vehicle via Bluetooth. The L298N Motor Driver module is an integrated monolithic circuit in a 15 lead Multi watt and PowerSO20 packages (Arduino, 2015). The L298N motor driver can simultaneously control 2 different DC motors. An LC metal detector non-contact metal induction detection module is used as a metal detector. Arduino Uno is an open-source microcontroller board that has 14 digital input pins, 6 analog inputs, a 16MHz quartz crystal, a USB connection, a power jack, an ICSP header, and a reset button (Arduino, 2015; Chinnasamy, 2015). The DC motor is one of the rotating electrical devices that transforms direct electrical current into mechanical energy to rotate the wheel. The Arduino board is connected to DC Motor through a motor driver board (pin10, pin11, pin12, pin13) which provides power to the metal detector. The metal detecting robot is used to find metal elements on its path and send the information to a smart device via Bluetooth.

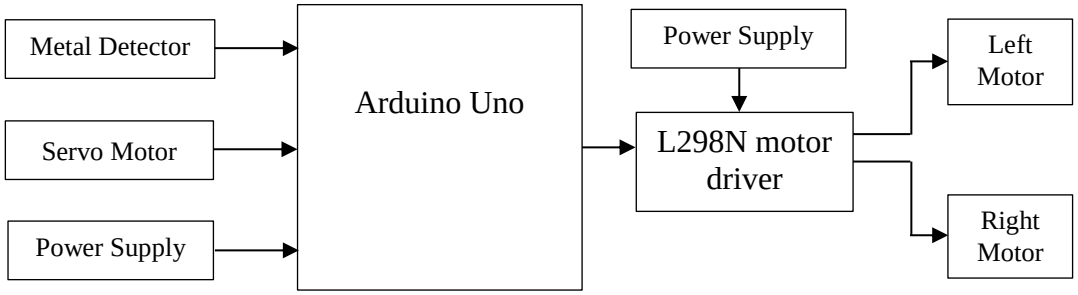

Figure 1. Structure of metal detecting robot

3. Proposed Design

3.1. Circuit Diagram

The metal detector robot consists of a Battery unit, a Non-Contact Metal Detector Module or copper winding, Arduino Uno, and DC Motors as shown in Figure 2 (a) and 2 (b). The Arduino Uno is a microcontroller board based on the ATmega328. The HC-06 Bluetooth module which has the primary function is used for data exchanging between fixed and mobile devices over a short-range distance using UHF radio waves in the ISM bands, from 2.402 GHz to 2.480 GHz, and building personal area networks (PANs). The model motor driver shield used in this project is the L298N module, it is a high voltage, high current dual full-bridge motor driver module and is capable to control one stepper motor or two DC motors simultaneously. An electromagnetic coil is created by forming a wire into the shape of a helix, spiral, or coil and an LC metal detector non-contact metal induction detection module is used as a metal detector. Two different power supplies were used in the system, a 6V volt battery which supplies power to the microcontroller module, and a 9V source that was used to power the motor drive. Four-wheel used for metal detector robot, two DC motors were mounted to both the rear wheels and two DC motors to both the front wheels and positioned side by side to ensure smooth and steady performance.

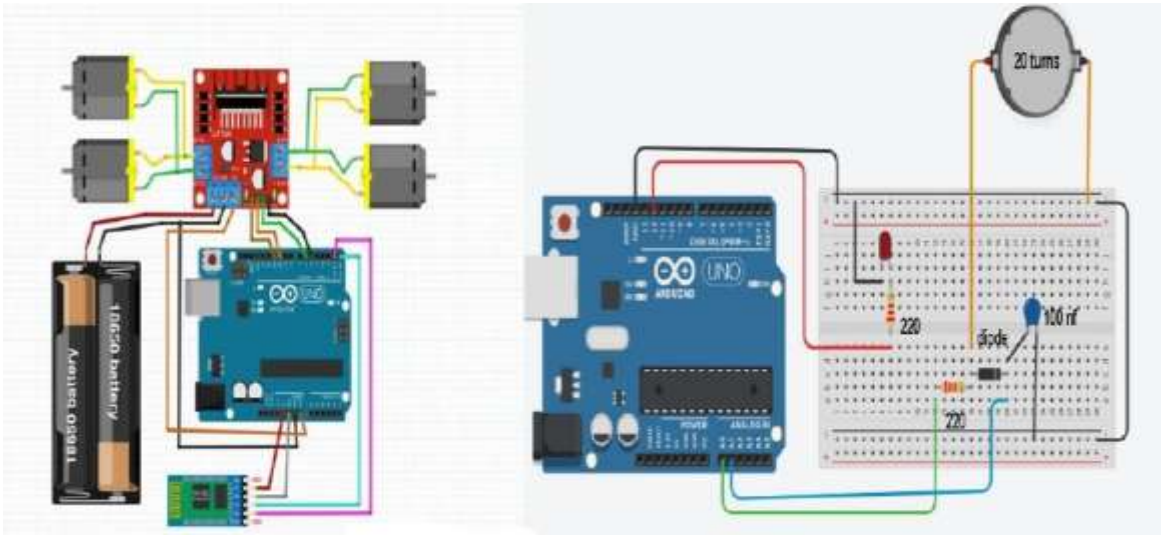

Figure 2 (a). Metal detector module **Figure 2 (b).** Metal detector using coil

3.2. Chassis and prototype design

Figure 3 shows the metal detector robot chassis plate frame which is designed using an impart-board that can fit the Arduino Uno R3, L298N, battery holder, and metal detector. The thickest robot chassis is 5mm used, covering the components and wiring at the middle. To accommodate various components used as well as to support the whole robot. The chassis plates measured 170mm × 200mm in maximum width and length are designed. The robotic frame of four wheels is mounted with two rear wheels and two front wheels, as shown in Figure 4 (a). The wheels are made up of plastics, which are attached directly to the servo motor. A caster wheel was used due to its lightweight in other to avoid overload of the robot. Figure 4 (b) shows the automated robot frame-mounted with two rear wheels and two front wheels respectively. The metal detector is placed in front of the robot to detect a metal object and respond via a built-in buzzer. For an automated robot ultrasonic sensor is placed just on top of the robot high enough to follow the pavement of the lawn to avoid hitting the lawn. The bodywork of the robot was designed to accommodate all the essential components of the system.

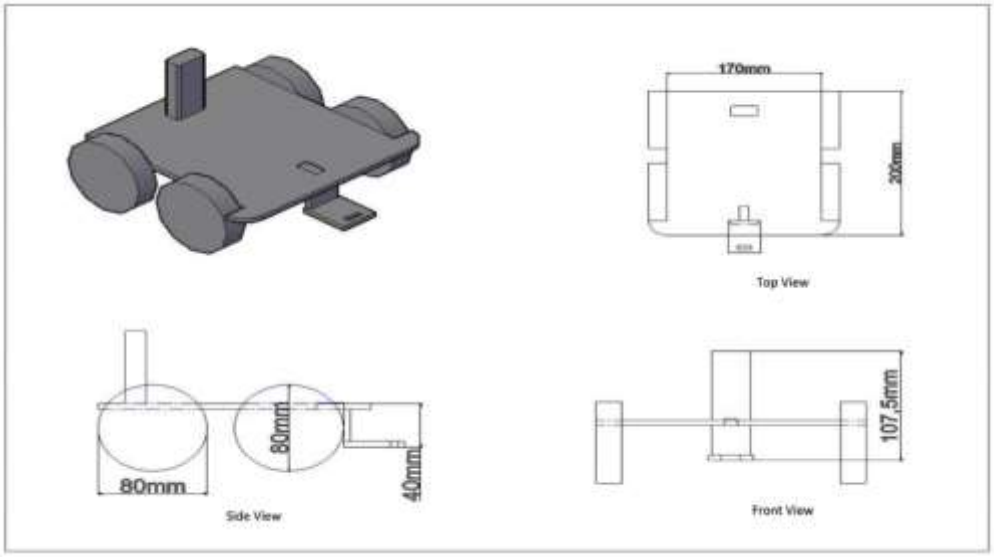

Figure 3. Structure of metal detecting robot

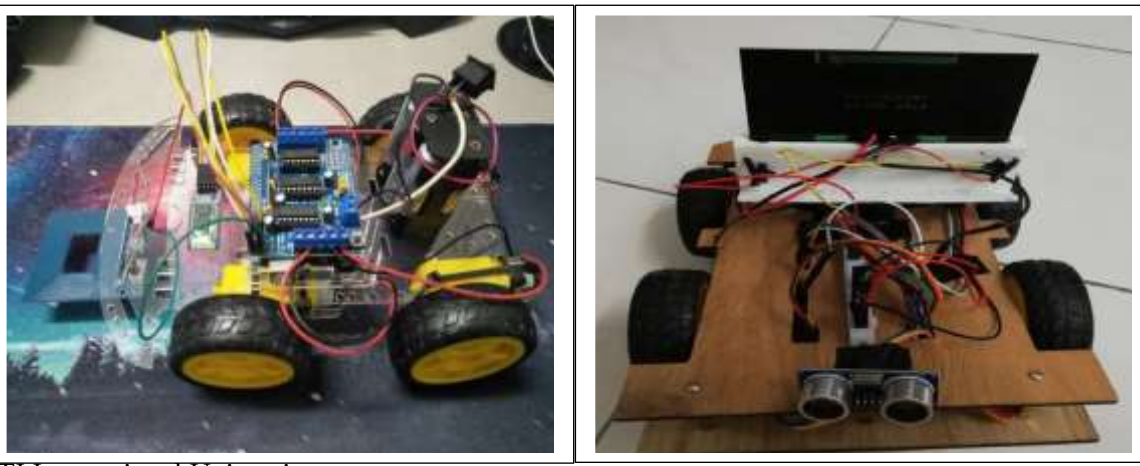

Figure 4 (a). Integration of proposed chassis with wheel and motor module.

Figure 4 (b). Integration of metal detection module.

4. Software implementation

The system was implemented in C and C++ using the Arduino software. The data is sent to the Arduino Uno from the Arduino application. Arduino Uno tracks incoming signals and informs the driver which signals are to be transmitted. Thus, the robot moves in a certain order according to the inputs navigated via remote controller. The flow chart in Figure 5 represents the methodology to drive the robot towards the forwarding direction. The buzzer will be triggered once the metal detector sensor detects a metal, the Arduino prompts the motor to move forward via remote controller. The ultrasonic sensor transmits a sound at 37 kHz and then waits to receive a corresponding echo from the sent signal.

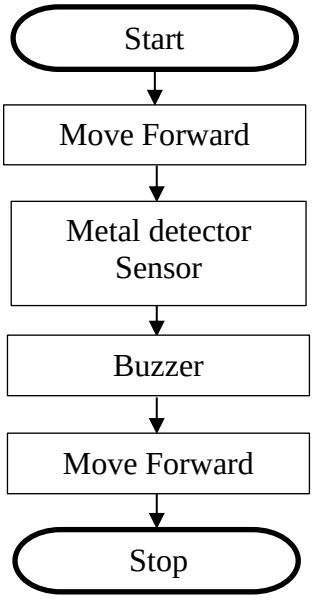

Figure 5. Proposed design flow chart

5. Result and Discussion

The input voltage of each component was measured from Arduino as shown in Table 1. The measured Arduino input voltage is 10.48V and the battery output is 11.1V. The input voltage for motor drivers is approximately 13~14V. Motors are used to drive the robot forward via Bluetooth Module. The remote control robot is easier to handle while detecting the metal via Bluetooth the movement of the robot to move forward or backward. The metal detecting robot can rotate on the ground by powering the motors on the left and right oppositely. When the robot turns right the motor will rotate in the clockwise direction. Therefore, the motor on the left rotates forward while the motor on the right rotates backward. If the robot turns to the left the motor should rotate anticlockwise.

Thus, the motor on the left rotates backward while the motor on the right rotates forward. The measured voltage for the motor, which is either the remote robot or the automated robot

as shown in Table 1. The measured voltage for the motor is of the same value when the motor is moving in the same direction. However, the measured voltage increases when the motor turns left or right, while another side is zero. The measured voltage in remote robots is higher than the voltage drops in an automated robot. Thus, this will cause the remote-controlled metal detecting robot to be steady, have faster movement, and be easier to control.

Table 1. Arduino and Motor Voltage

Component	Voltage measured from Arduino (V)	
Input to Arduino	10.48	
Input to Motor driver	13.38	
	Remote robot Voltage (V)	Automated robot Voltage (V)
Motor Driver	6.94	6.82
Bluetooth Module	4.97	4.82
Metal Detector	4.98	4.93
	Robot moving forward	
DC Motor	Voltage (V)	Voltage (V)
DC Motor 1 (Left Front)	5.46	5.43
DC Motor 2 (Right Front)	5.51	5.46
DC Motor 3 (Left Back)	5.49	5.46
DC Motor 4 (Right Back)	5.47	5.43

6. Conclusions

There are many papers designed with Arduino Uno, Raspberry pi, and Android platforms to address metal detecting robots. Metal detecting robot was developed using Arduino platform, android implementation, and metal detecting sensor in this studies. Arduino Uno has been used as the robot's brain. It also involves the portable application portion of the software. The robot's fundamental motions are given by taking input from the Android application. A degree of accuracy and minimum probability of failure was obtained. The commissioning of such a robot can improve its effective operation and control its tasks remotely via Bluetooth. Thus, the evaluation of the remote-controlled metal detecting robot system shows that it is capable of detecting metal, ability stop the movement, and change its position easily.

Acknowledgements

We would like to thank INTI International University, Malaysia for supports in the research.

References

Alauddin, T., Islam, M.T., & Zaman, H.U. (2016, 23-25 Jan. 2016). Efficient design of a metal detector equipped remote-controlled robotic vehicle. *2016 International Conference on Microelectronics, Computing and Communications (MicroCom)*:

Arduino. (2015). Arduino software (ide). https://www.arduino.cc/en/Guide/Environment

Chinnasamy, R. (2015). A review: Comparative analysis of arduino micro controllers in robotic car. World Academy of Science, Engineering and Technology, 9, 365-374.

Hannan, M., Zain, A.S.M., Salehuddin, F., Hazura, H., Idris, S.K., Hanim, A.R., . . . Yusoff, N.M. (2018). Development of lpg leakage detector system using arduino with internet of things (iot). Journal of Telecommunication, Electronic and Computer Engineering, 10, 91-95.

Ramakrishna, G., Shashidhar, K., & G.K.D., P.V. (2017). Arduino based automatic vehicle control system. International Journal of Scientific Research in Computer Science, Engineering and Information Technology, 2(6), 214 - 218.

Selvam, M. (2014). Smart phone based robotic control for surveillance applications:

Sonali, S.P., Mrunali, M.W., Pragati, V.P., & Atul, S.B. (2021). Bluetooth controlled metal detector spying robot. International Journal of Creative Research Thoughts (IJCRT), 9(4), 4847 - 4851.

Yeole, A., Bramhankar, S., Wani, M., & Mahajan, M. (2015). Smart phone controlled robot using atmega328 microcontroller. IJIRCCE, 3297.

Yilin, L., & Dong, W. (2017, 17-19 Aug. 2017). Research of the metal detector based on finite element analysis. *2017 3rd IEEE International Conference on Control Science and Systems Engineering (ICCSSE)*: