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Development of an Android Based Voice Controlled Autonomous Robotic Vehicle †

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Abstract: This research presents the development of an android based voice controlled autonomous robotic vehicle. The article was developed in a way that the robotic vehicle was controlled using voice commands. An android application combined with an android microcontroller was used to achieve this task. The connection between the android app and the autonomous vehicle was facilitated using Bluetooth technology. The vehicle was controlled with either the aid of the buttons on the app or by spoken commands by the user. The movement of the vehicle was achieved by the four DC motors connected with the microcontroller at the receiver side. The commands from the app was converted into digital signals using the Bluetooth RF transmitter for a specific range (about 100 meters) to the autonomous vehicle. At the receiver end, the data gets decoded by the receiver and is being fed to the microcontroller which moves the DC motors of the vehicle for navigation. The voice controlled autonomous robotic vehicle performed navigational tasks by listening to the command of the user. This was achieved by converting the voice commands into text string on the android app, which will be readable by the Arduino microcontroller for controlling the navigation of the robot. The vehicle was tested under different conditions, and was observed to perform better using this technique and also the results was satisfactorily when compared with other previous research done in this area.

Keywords: voice control; autonomous robot; android; Arduino; Bluetooth; microcontroller

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1. Introduction

Robotics is fast growing and becoming one of the most researchable areas in engineering, even though robotics emanated from advancement of technology. This is contrary to human's perception, as they are usually amazed by the concept of artificial intelligence [1,2]. The reason of using robots is that it provides cheap labor, and its high accuracy of output. It has different applications which possess a problem of finding a technique to accurately and efficiently control the robots [3], can be applied in medicine, industries, transportation, military and surveillance [4,5]. The framework of the autonomous voice-controlled vehicle consists of the chassis, the Bluetooth module, DC motors, Arduino Uno microcontroller and other important component. The control of the vehicle is realized using the Bluetooth communication module [3]. This is connected to the DC

motors and the microcontroller. The vehicle is operated by giving wireless commands from the app using the functions that was initially programmed for it. The vehicle moves in four directions; right, left, forwards or backwards. For the case of the right direction, the four motors will move in the clockwise direction, while for the left direction, the motors will move in the anticlockwise direction. For the forward movement, the motors will move in the forward direction, while for the backwards movement, it will move in the reverse directions. Also, in order to stop the autonomous vehicles movement, the motion of the motors is stopped, and the vehicle stops moving [6]. However, the autonomous vehicle receives command through the android app using Bluetooth medium to control the movement of the motors.

There are some research works done in the field of voice controlled autonomous robotic vehicle. Ref. [7] developed and designed a voice controlled talking robot using mobile phone based on Arduino Uno microcontroller. The robot's movement was based on the voice commands that were given to it, and in turn responds to the command that was given. A memory card was provided in the design for the robot to save prerecorded audio files that was used for developing the talking system of the robot. Also, ref. [8] developed a robotic vehicle which was controlled by voice commands through a smart phone using Arduino Uno microcontroller and a Bluetooth sensor. The VoiceBot application and the Google voice were used as voice commands. A low cost autonomous robotic vehicle was presented by [9] which was controlled by voice command. However, the user of the robotic vehicle may be located at a particular location, but as long as the user in connected to the internet, the vehicle follows the voice instructions. The concept was successful using Arduino IDE, Adafruit, NodeMCU ESP866 and Google Assistant and If-This-Then-That (IFTTT). A voice controlled robotic car was also produced by [10], the robotic car working principle was based Arduino Uno microcontroller, Bluetooth and motor drivers. The hardware component of the car was developed, while the software component was simulated, and later the two were interfaced in order to achieve effective coordination and control of the vehicle. In [11], a voice-controlled robot (VCR) which was mainly designed using Arduino IDE. The user provides voice commands to the vehicle using Google thing speech through ESP32 microcontroller which forwards the commands to the Arduino on the robotic vehicle. The VCR was able to move either forward, backward, left or right directions respectively. The robotic vehicle was designed using some predefined voice command by [12]. The commands could be either forward, backward, left or right. A camera with an LCD screen was mounted on the vehicle to view distances of obstacles between the vehicles. Also, a GPS was attached to the vehicle to locate the position of the vehicle at any time. Finally, ref. [13] designed a robotic vehicle which uses voice commands using an android application for navigation of the vehicle. The commands speech spoken were translated to text using speech to text in the android app before it is sent to the vehicle. The android app controls the vehicle using Bluetooth medium, which was embedded in the Arduino Uni microcontroller on the vehicle.

The rest of the paper is structured as follows; section one discusses the introduction while section two presents the materials used towards the successful achievement of the article. Section three gives the results and discussion, and finally the conclusion is given in section four.

2. Materials

This subsection outlines the materials used for the design of the android based voice controlled robotic vehicle.

2.1. Arduino Uno Microcontroller

This is a programmable circuit board that is used in building electronic projects. It is an open-source platform which consist of a software or an integrated development environment (IDE) that runs on a computer system. The codes are written in IDE language

and uploaded to the physical circuit board. The board contains microcontroller which is programmed for controlling and sensing of objects in the physical world. Figure 1 shows the Arduino Uno microcontroller.

Figure 1. Arduino Uno [14].

2.2. Direct Current (DC) Motor

This is a rotary electrical machine which converts direct current electrical energy into mechanical energy. Most DC motors rely on the forces produced by magnetic field. They possess some internal mechanisms which is either electronics or mechanical to periodically change the direction of the current flow of the motor. DC motors can be controlled over a wide range either using variable voltage supply or by changing the field winding current strength. The DC motor is shown in Figure 2.

Figure 2. DC Motor [14].

2.3. Four-Wheel Robot Chassis

This is a vehicle framework used for the control of the autonomous robot. The DIY 4-wheel drive robot chassis is the mechanical platform that is used for this robot. The kits include all the hardware and mechanical components which is required to mounts the motors, wheels, bolts and nuts. Figure 3 shows the four-wheel robot chassis.

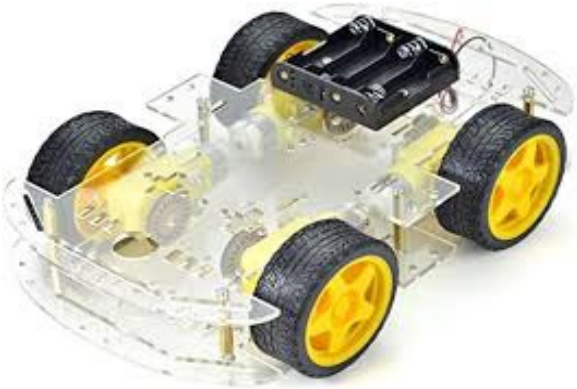

Figure 3. Four Wheel Robot Chassis [15].

2.4. Battery

This is a collection of one or more cells whose chemical reactions create a flow of electrons in a circuit. Batteries are made up of three basic components; the anode, the cathode and an electrolyte [16]. Figure 4 shows a typical battery.

Figure 4. Battery [17].

3. Results and Discussion

This subsection discusses the results that was obtained when the voice controlled autonomous vehicle was coupled and tested. Firstly, the hardware interface was designed which is shown in Figure 5 as the complete setup.

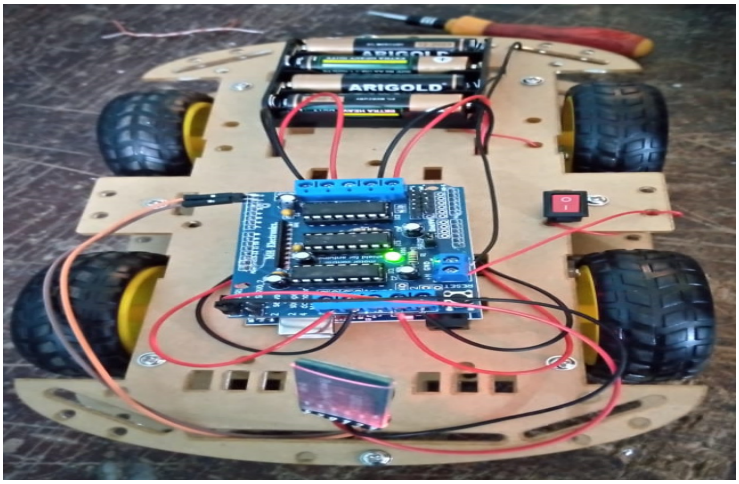

Figure 5. Complete Setup.

The software component was simulated and embedded into the setup using sequence shown in Figure 6.

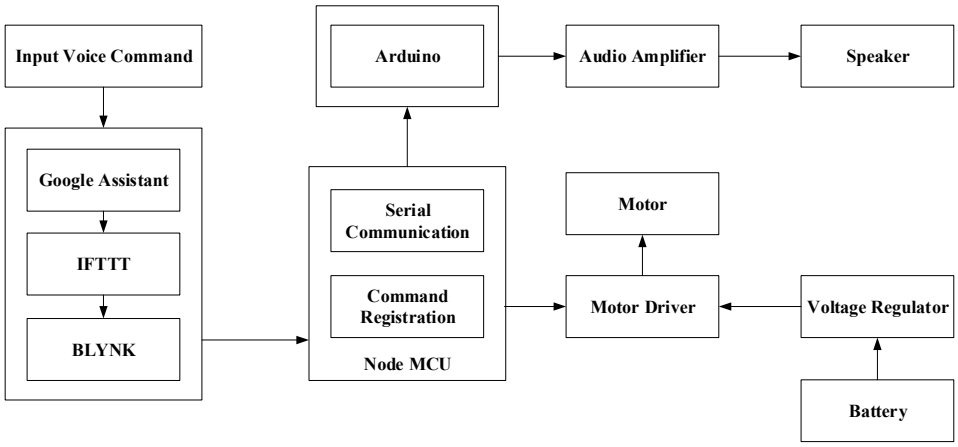

Figure 6. Robot Voice Control Sequence.

From Figure 6, it showed how the movement of the autonomous robot was achieved using voice control. However, the command was giving to the robot using Bluetooth medium with the aid of an android application developed for the robot movement. Figure 7 shows the android app of the robot.

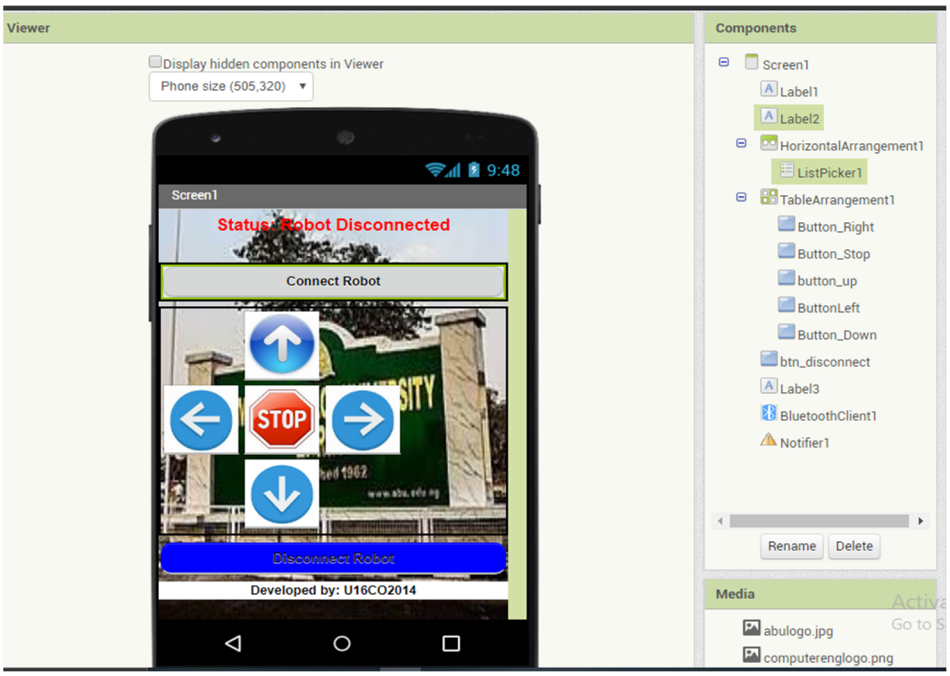

Figure 7. Android Application for the Autonomous Robot.

From Figure 7, it is shown that the movement of the robot could be forward, backward, right or left. The robot has the capability of either going towards the forward direction, backward direction, left direction or right direction. These all depends on the user's discretion.

Also, the vehicle was subjected to voice command test, Bluetooth range test, maximum weight lift test and maximum lift angle test. It was observed that for the voice command test, the vehicle responded to all the commands accordingly. Also, for the Bluetooth test, it was observed that the maximum range obtained was 8.5–12 m depending on the location. For the maximum weight lift test, different weights were attached to the motor arm and lifted automatically, the maximum mass of object lifted was 50 g. For the maximum lift angle test, it was observed that the maximum lift angle the robotic vehicle could

raise is 1.9 cm, this is due to the jack road length constraint. The summary of the test carried out on the vehicle is shown in Table 1.

Table 1. Summary of the Command Actions Obtained from the Vehicle.

	Vehicle		Appendage	
Command	**Right Motor**	**Left Motor**	**Arm Motor**	**Gripper Motor**
	Action	**Action**	**Action**	**Action**
"Backward"	Rotate Anticlockwise	Rotate Anticlockwise	Off	Off
"Forward"	Rotate Clockwise	Rotate Clockwise	Off	Off
"Right"	Off	Rotate Clockwise	Off	Off
"Left"	Rotate Anticlockwise	Off	Off	Off
"Down"	Off	Off	Rotate Anticlockwise	Off
"Up"	Off	Off	Rotate Clockwise	Off
"Close"	Off	Off	Off	Rotate Anticlockwise
"Open"	Off	Off	Off	Rotate Clockwise
"Stop"	Off	Off	Off	Off

From Table 1, it showed that the autonomous robotic vehicle performed satisfactorily when controlled with the android app, and also when executing the commands that was set for it to execute experimenatlly.

4. Conclusions

The autonomous android based voice controlled robotic vehicle has been developed in this article. Autonomous robots have become an integral aspect of human life, as it makes things easy with the advents of this devices. The robotic vehicle was controlled using android app, through Bluetooth medium. Arduino Uno microcontroller was used in achieving this mission. The interface on the android app uses button or spoken word commands. Theses buttons could either be forward, backward, left or right buttons respectively. The movements of the vehicle were achieved using four DC motors based on the command given by the user. These commands on the android were converted into digital signals using Bluetooth RF transmitter, and at the receiver end, the data gets decoded and being fed to the Arduino microcontroller to move the DC motors for navigation of the vehicle. Testing was done on the vehicle, based on Bluetooth range test, maximum weight lift and maximum weight angle test respectively. It showed that the robotic vehicle performed satisfactorily. This could be made and applied in the real-world application. Further research will consider how to incorporate artificial intelligence to the robotic vehicle.

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