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Audio-Video Scrutinizing bot with Night Vision

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Abstract - In this paper, a remote-controlled bot is designed and implemented to control the bot in any direction using a mobile application with the help of a wifi module. This bot uses the nodeMCU microcontroller board, L298N Motor Driver, and two electric DC motors to move the bot and handle all basic functionalities. Another additional feature of this bot is that it can capture images and live streaming video with the help of a camera module interfaced to the bot. At the same time, it is controlled using an application. The purpose of this project is one of the challenging issues faced in the mining industry, i.e., the safety of the mining workers. The Mining areas in remote areas are usually located where one May confront high altitudes, snow and ice climates, deep rainforests, or even widespread deserts. The mining region is of increased risk for people who work there. This project proposes developing and implementing a remote-control bot using a mobile device with a camera to make their lives safer. Using this bot, the mining worker will not have to go into the mining area in person. Instead, the worker can send the bot inside the mining area where the bot can capture various images, and the user will display those images on the mobile device. This project aims to expand the limited range of a bot using wifi technology to control the bot for more considerable distances.

Key Words: **Arduino, wifi module, Camera module, Blynk application**

1.INTRODUCTION

The evolution of wireless communication plays a vital role in today's times. A bot is a machine designed with speed and precision to perform one or more jobs repeatedly. There are many kinds of remote-controlled bots as many tasks for them to do. A remotely controlled bot is an artificial agent or a mechanical device, usually an electromechanical device driven by electronic circuitry or a computer program. Robots can be either autonomous or semi-autonomous. In performing repetitive and dangerous work that people prefer not to perform or are unable to function as a result of different limitations such as size limits or limits because of situations in which there are extreme environments, like in the outer surfaces, the sea bottom, or high risks, have been replaced by human robots.

There can be various applications to the bot by using different modules in the project. For instance, a user can use a GPS module for location. The user can use a camera module for live streaming of video or capture real-time images or temperature modules for receiving sensor data.

Designing wifi controlled wireless bot which a user can control remotely with the help of a mobile application is the primary goal of this project. The main issue comes with the average range of the bot because the bot is unable to travel a long distance. With the wifi Module, we can achieve an improved range and better wireless connectivity and have resolved the issue of limited range. The other important aspect behind this project development is utilizing a mobile application Instead of traditional hardware controls, which effectively reduce costs and make use and control easier. The mobile app has been developed with the needed software and functions as a controller, which controls the car's movement in any direction the user would like the bot to move. The bot is connected to the smartphone via a wifi module. An additional feature of capturing real-time images and visualizing the photos in the mobile application is also considered in this project. NodeMcu is used as a microcontroller of the proposed model. ESP8266 facilitates the ease of the Arduino coding to interface it with the hardware. There will be two separate units within the control system: the mobile phone and the bot. There will thus be two working environments. The mobile

application will operate the bot in any direction the user wants to go. In contrast, the bot will work outdoors as the user directs through the mobile application to run the hardware correctly.

In addition, the project is developed to connect two technologies i.e., wifi and IoT.

1.1 RELATED WORKS

The project aims at simplifying tasks and people's safety. The proposed equipment is made of a WIFI module and NodeMCU microcontroller. There are several pieces of research made similar to the proposed model for a variety of purposes. The best way is that it should be user-friendly and portable.

The few related works that are published have been mentioned ahead. One of the research papers [1][2][3] has been successful in implementing the remotely controlled bot with the help of Bluetooth technology. But the disadvantage is that we can handle only a shorter range of distances using Bluetooth. Therefore, we have considered using more secure technology, i.e., wifi technology, to control the bot over more considerable distances. Other papers [4][5] proposes a model of implementing a remote-controlled bot with the help of wifi technology. However, the disadvantage is that this proposed model does not contain any specific application. The bot's application would depend on the sensor, which has been interfaced into the bot. Therefore, in our proposed model, we have taken a camera module that is interfaced to the bot to capture real-time images and video streaming. Other papers [6], which include the camera module, have a disadvantage of capturing the real-time streaming in a darker environment. In contrast, our prescribed model has an additional advantage of night vision which lets it capture in the dark too. Another paper [7] proposes to implement an IoT-based motion-controlled car with the help of wifi technology. But the disadvantage to this project is there are limitation range issues. The bot's wireless range is too small, which would thereby disconnect in no time. Hence, our proposed model has a higher range and can be controlled from more considerable distances.

As mentioned above, there are multiple disadvantages, and our project proposes to control the bot with the help of a mobile application. The camera interfaced to the bot will be capturing real-time live streaming video. Hence, the bot could be used for various applications. Another advantage is that the bot can catch the live streaming even when it is in a dark room or the night due to night vision capability.

2. PROPOSED MODEL

The proposed model has several components that have to be interfaced together based on the connections shown in the circuit diagram. It can be able to control it using a mobile application efficiently without errors. Several hardware components are used, as shown in the circuit diagram. Apart from the hardware components, we have a software IDE namely Arduino, to code the instructions, data related to the connections made and put it into the microcontroller. This section describes the importance of each module and component used to implement the proposed system. The circuit diagram for the proposed model is given below.

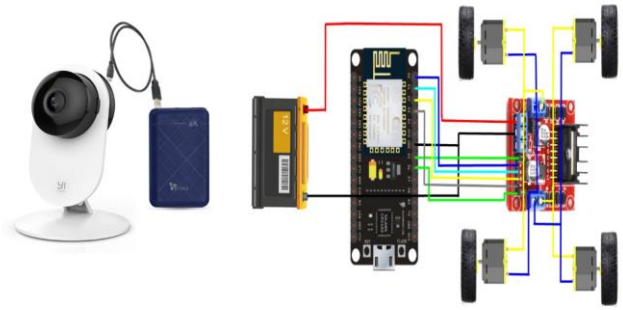

Fig -1: Circuit Diagram

2.1 HARDWARE DESCRIPTION

The hardware components used for the development of the proposed model are listed below. NodeMcu works as one of the most crucial hardware components, i.e., it is the microcontroller used in the project. All the hardware components are soldered, and are connections are made keeping in mind the circuit diagram. This interfaced bot is further coded with the help of Arduino, which is a software IDE used for coding. The hardware interfacing is carried out by connecting the components, and coding is done to ensure that the interfaced hardware bot has its unique functionalities.

COMPONENTS USED

1)NodeMCU: NodeMCU is a microcontroller. It is preferable for IoT start-up students. It is applicable for devices using Wi-Fi as well as tethering hotspot. Here, we are doing this prototype using Arduino IDE. In such a prototype, the NodeMCU connects with the router, which possesses an IP

address that our pc or mobile can employ. So, that we can host or control the prototype using such an application installed. The wifi module serves as a connection for smartphones and wifi. The code which is written in the Arduino will be burnt into the microcontroller, i.e., NodeMCU. We will use the ESP8266 module for the proposed system, either used as a receiver or a transmitter. The transmitter usually acts as a smartphone, and a wifi module will serve as the receiver.

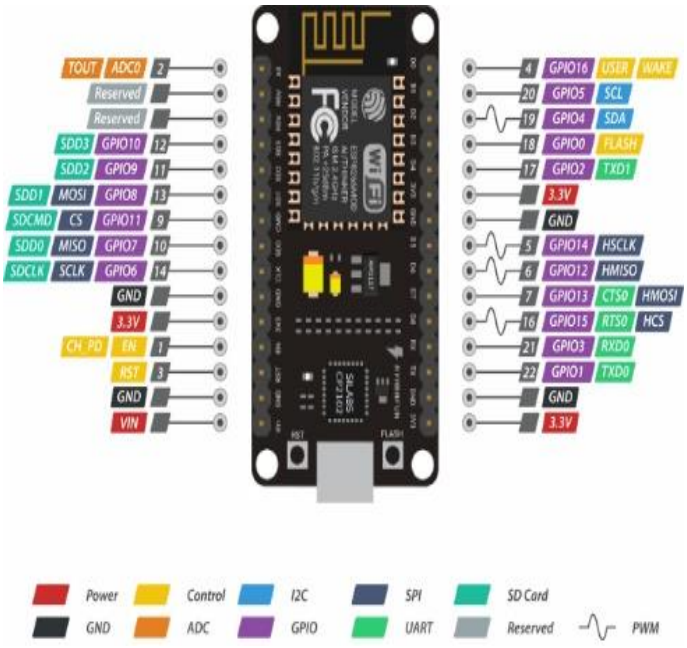

Fig -2: NodeMCu

2)Breadboard and Wires: A breadboard is used to quickly build and test circuits before any circuit design is completed. It has several pinholes where one can insert various circuit components like ICs and resistors. It is considered a base for the prototyping of electronic circuits. We do not need to solder the wires if not required. Instead, we can mount them on the breadboard and can reuse them when needed.

Wires are either electrical wire or a group of them put together inside a cable with the help of a connector or pin at each end which is generally used to interface the components on the breadboard without soldering. These wires are used to interface two or more hardware components together.

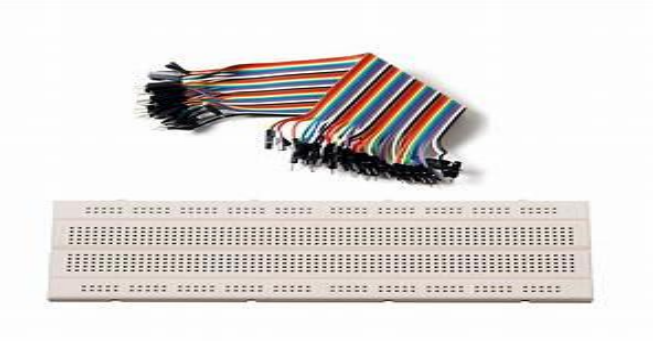

Fig -3: Breadboard and Wires

3)L298n Motor Driver: Typically, L298N Motor Driver is used to monitor speed and control the direction of motors. It is used to enable our motors connected to the bot, to drive smoothly and efficiently. Out of the four motors, the first two motors, A and B, are connected. The positive and the negative terminals are connected to OUTPUT A of the motor driver such that the motors can run smoothly. In the same way, the other two motors C and D, are connected. The positive and the negative terminals of these two motors will be connected to OUTPUT B of the motor driver such that the expected output can be achieved. A 12 volts battery has been used for the motors and system components interfaced to the bot. This battery will be connected further to a 12 volts power supply on the L298n motor driver. All pins A, B, and logical inputs are connected to the nodeMCU ESP8266, which allows us to drive the motors efficiently with the data or information sent from the wifi module.

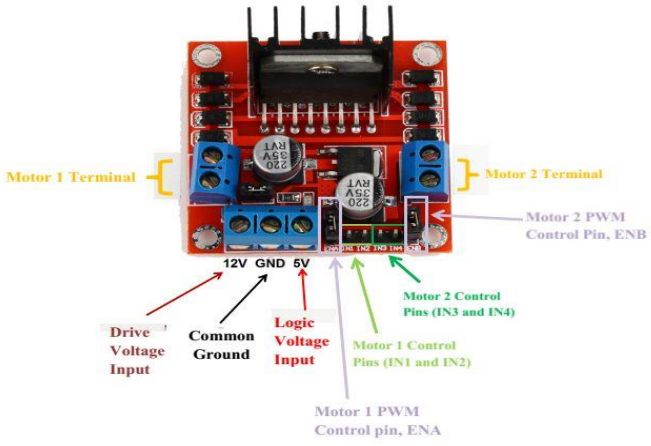

Fig -4: L298n Motor Driver

4) Chassis and Wheels: A chassis can protect some internal parts and consists of an inner vehicle frame. It is a framework of an artificial object that structurally supports the object in its construction and function. The chassis

consists of a DC gear motor and provides a motor power supply of around 3-6v. DC gear motor is present because it is used to hold the force produced by the motor. The chassis and its internal vehicle frame support the components of the vehicle's body and the additional loads of the parts it is supposed to carry. The chassis has multiple pins and holes so that you can fit your components properly on it.

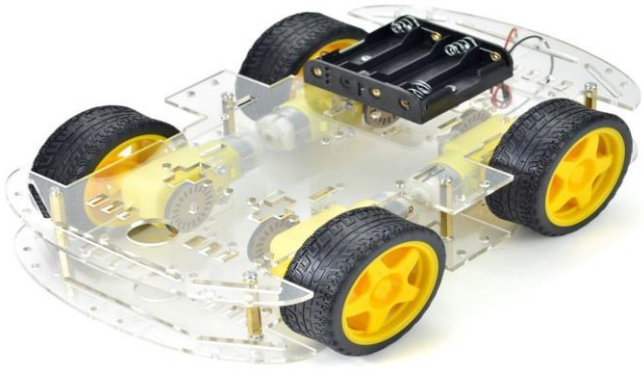

Fig -5: Chassis and Wheels

5) Camera module: The camera module is a hardware device that is used to capture real-time streaming videos and audio. In the proposed project, we have interfaced the camera module onto the bot. It captures the audio and video, which the controller can view, i.e., in the mobile application used to control the bot. The camera records in 720p HD and has a convex lens of the camera, capturing clear images and using a 2-way audio, i.e., a built-in microphone and speaker. This camera ensures to clear and high quality of the content projected through it. It is a weather-resistant device and can be used in any environmental condition. It can be rotated 360 degrees from more considerable distances, i.e., high-quality panoramic view, and can be controlled using a mobile application. The camera has a feature of inbuilt night vision that can function in dim environments using a 940mm infrared sensor without letting the monitored knowing. Thus, the camera module is responsible for seamlessly recording video and sending crystal clear videos projected through the mobile application such that the user who is using the bot can view from their mobile application.

Fig -6: Camera module

2.1 SOFTWARE DESCRIPTION

We used version 1.8.1 of Arduino IDE to write the software code. Arduino is an open-source tool for embedded systems that are used to program in different operating systems such as Windows, Linux, Mac, etc. It is used because it is easier to understand and making changes is also feasible. It has advantages such as large community, the free and broad classification of libraries of codes, relatively cheaper or low-cost components. Arduino is an IDE (Integrated development environment) that is used for writing code and uploading it to the circuit board or the physical board, i.e., uploading it to the real-time environment. It can also be uploaded to other vendor development boards with the help of third-party cores. Here, the circuit board refers to the microcontroller used in the project, i.e., ESP8266. Arduino consists of a varied set of libraries and sample codes, making it easier to code and removes a lot of complexity. Arduino can be written in C, C++, Python, and other high-level programming languages too. There are two sections of coding and programming in Arduino. The first section is where all the variables are defined. The second section consists of the loop section where the program is continuously running.

Arduino is used to putting instructions or code of the functions of the proposed system into the NodeMCU, the microcontroller used in the project. We used 'C language programming' for coding purposes. Then the written code is burnt into the microcontroller. Initially, the program, i.e., the code, is stored in the microcontroller's EEPROM, located in the ESP8266 NodeMCU. With the help of Arduino, we write data and instructions into the code for controlling the bot in various directions such as forward, backward, left, and right operations. Similarly, a mobile application is developed connected to the bot with the help of the wifi module interfaced inside the bot. When we click on the buttons through the mobile application, the corresponding signal of the button clicked will be sent through the microcontroller,

i.e., NodeMCU ESP8266 and the L298n motor driver who would thereby drive the bot in the direction that the user has clicked through the mobile application. When the data from the signal arrives into the microcontroller, the pin that would correspond to the specific input will be high. Further, that particular pin gives its output to the motor driver. The motor driver would switch according to the data bit, i.e., if the data bit is low, then that particular corresponding pin of the motor driver will not work. Else, if the data bit is high, then that specific corresponding pin of the motor driver is considered to be ON and working.

3. IMPLEMENTATION

3.1 WORKING METHODOLOGY

The working prototype of wifi controlled NodeMCU bot begins with connecting the motors with the wheels, a bit of soldering work which includes the motors to be connected to the sockets of the driver. Before joining the motor with the provided L298n driver, there is one most significant principle which has to be followed, i.e., we should execute the code before putting it through the Arduino UNO.

Firstly, we would be supplying the power from the battery directly to the connected motor driver and the nodeMCU. We have D0, D1, D2, and D3, which states that the power supply is directly connected to the motor drivers IN1, IN2, IN3, IN4. Here, IN1, IN2, IN3, IN4 described as states of the motor driver, i.e., to the motors of the L298n motor driver. We have two outputs states as Motor A and two outputs stated as Motor B, which are connected to all four wheels of the bot. These two output states of Motor A will be connected to the wheels, which are on the left-hand side, and the other two output states of motor B will be connected to the wheels present on the right-hand side. The jumper on the L298n motor driver must be present because we are using a power supply of fewer than 12 volts. We can remove the jumper if the power supply is more than 12 volts in any case. The L298n motor driver consists of two power supply input ports. One of the power supply input ports supplies 5 volts, and the other input port provides 12 volts. The bot must be connected to the power supply coming from the battery's positive terminal must be connected to the input port that supplies 12 volts. This section describes how the hardware parts have been interfaced and how connections are made between various components of the bot.

Secondly, we come to the coding part of the bot, which will be burnt into the microcontroller of the bot such that the bot functions based on the instructions and data that have been given through the code. The code written in the Arduino will be focusing on initializing the motor pins and their connections to the nodeMCU and L298n driver. Once we have declared connections through our code, we need a username and password to be written into the code such that the bot gets connected to the wifi and the mobile application. Later, to use the Blynk app, we generate an authentication key that will be sent to the registered email. Once we receive the authentication key, we will paste the authentication key to the code and give username password fields for the bot to get connected. The authentication key is used to connect the bot to the mobile application. Once we have declared all the essentials required for the bot to get connected to the application, we will be initializing the speed of the motors. Then, we will be giving conditions for the bot to move in directions using conditional statements based on the speed of the motors. Also, we will be using conditional statements to move the bot forwards, rightwards, backward, leftwards, and stop conditions. These conditions will be more focused on whether the pin connection is high or low. Based on the pin, the state will determine its direction. Thus, we should test the mobility of the wifi-controlled bot's forward, backward, leftwards, and rightwards conditions.

With the help of a mobile application, we can connect the IP address through which the bot is controlled. In case of any discrepancies, we should check whether the power supply is given appropriately. There might be any loose contacts with the soldering, which is done. We should not overrate the power supply more than 12v. We also interface a camera module to the bot used to stream the projected audio-video through the mobile application. The camera module will be launching the video when controlled using the application, which would be viewed in darker environment conditions, too, i.e., the bot has an added feature of night vision. The blynk application controls the bot. This application contains an IP address-based connection system. So, by using our IP address of the wifi module, we can control our bot. That's how this prototype works.

3.2 APPLICATION DEVELOPMENT

The development and building of an application have been one of the main parts of the proposed project. We had to develop an application that would act as a controller with the help of wifi. By connecting wifi to the bot, we will control our implemented wireless remote-controlled bot seamlessly and use it to perform all the basic functionalities. We have used the blynk application to build the application and inserted the required things that we would need in our

application so that we can run our wireless remote-controlled bot properly. We can add buttons or instead use a joystick to drive the bot in various directions, i.e., Forwards, Backwards, Rightwards, leftwards. The bot and application are connected via wifi such that the bot can drive seamlessly and adequately.

We have added the button labeled D8, and below that, we added a joystick in our application used to move the bot in different directions. The joystick is wholly based on conditions of the X-axis and Y-axis. These axes have to be defined such that the bot will move in a specific direction based on both these axes. Initially, both X-axis and Y-axis will be initialized to 256. Both the axes will be at the center of the joystick when the values are as they are initialized, i.e., the bot will be at the stop condition, and thus it won't move in any direction. The values of axes and their readings will be shown in the top right-hand side area as the bot is moved in different directions. For the D8, which is a button, we have given an output like a switch.

When the switch is pressed, it will internally change from 0 to 1. We can add label names and color options for different conditions. In our case, when the switch is off, the label of the button is represented in red color, and when the switch is pressed ON, a red light on the bot lightens up, and the label of the button will be represented in green color, and the button will be labeled as PROCEED. The button visual properties can be modified as the user wants it to be. We have marked the button visuals properties as rounded and solid. For joystick, we need to define X-axis and Y-axis such that the bot can move properly and efficiently. Apart from that, we can set color options and change the joystick's visual properties similarly as that of the button. We can view the axes readings on the top right corner and can also set the conditions to take those readings after every specific interval of time. The mobile application will also view the real-time streaming video and its audio which is being projected from the camera module interfaced to the bot.

4. Results

We have designed and implemented the project in two modes. The first mode of the project focuses on controlling the bot in any direction with the help of a mobile application via wifi. The basic functionalities of the bot are to drive in various directions, i.e., front, back, leftwards, and rightwards as well as an action to stop the bot. The second mode of the project deals with capturing real-time audio and video and viewing them in the mobile application with the help of the camera module interfaced with the bot. The functionality of the second mode is to view the audio and video through the mobile application, which can be considered under any environmental conditions, i.e., even in darker environments. Therefore, the second mode has an added functionality of night vision.

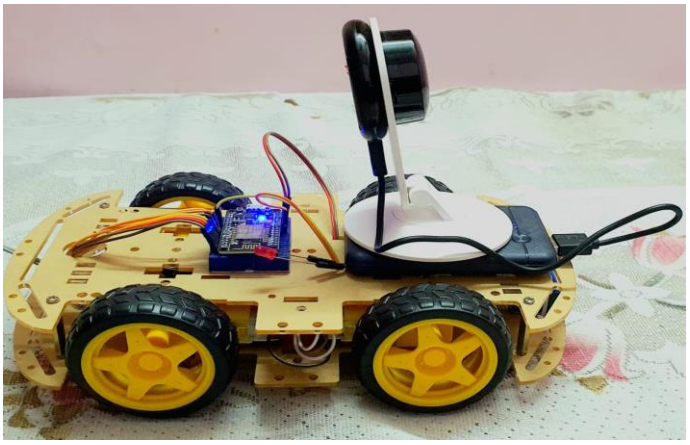

Fig -7: Proposed model

5. CONCLUSIONS

We have designed and implemented a wireless bot using IoT, controlled using a mobile application. The results of performance have shown that the connectivity of the bot with IoT is efficient. The wireless range is too extensive. The user can handle the bot from more considerable distances, which makes it more efficient in real-time. Including the feature of capturing audio-video and night vision makes it useful for various purposes, especially for the problem and safety of mining workers, which has been kept in mind for the proposed project. Adding a GPS tracker is considered one of the main future works that need to be implemented.

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