

IOT ENABLED SURVEILLANCE ROBOT

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Abstract :

The ongoing revolution of Internet of Things (IoT), together with the growing diffusion of robots in many activities of everyday life, makes IoT-aided robotics applications a tangible reality of our upcoming future. Accordingly, new advanced services, based on the interplay between robots and things", are being conceived in assisting humans. Nevertheless, the path to a mature development of IoT-aided robotics applications requires several pivotal issues to be solved, design methodologies to be consolidated, and strong architectural choices to be made. Robots are playing a vital role in today's industrial automation and monitoring system. As technology developed these robots have increased their applications and functionality. Working robots will cooperate to the people makes the work more effortless and uncomplicated. Our project is used for monitoring and surveillance purpose in any industries or institutions etc. In this project 4 different controls has been using for controlling the robots, i.e., forward, backward, left, right. These movements are given by the user using Blynk Android App. The smart phone at the transmitter side sends control signals to the receiver side through IoT (Internet of Things). The controller (NodeMCU) at the receiver area receives these signals and gives direction to the robot through IoT i.e. through cloud. The Cloud infrastructure and its extensive set of Internet-accessible resources has potential to provide significant benefits to robots and automation systems. We consider robots and automation systems that rely on data or code from a network to support their operation, i.e., where not all sensing, computation, and memory is integrated into a standalone system.

I. INTRODUCTION

The ongoing revolution of Internet of Things (IoT), together with the growing diffusion of robots in many activities of everyday life, makes IoT-aided robotics applications a tangible reality of our upcoming future. Accordingly, new advanced services, based on the interplay between robots and things", are being conceived in assisting humans. Nevertheless, the path to a mature development of IoT-aided robotics applications requires several pivotal issues to be solved, design methodologies to be consolidated, and strong architectural choices to be made. Robots are playing a vital role in today's industrial automation and monitoring system. As technology developed these robots have increased their applications and functionality. Working robots will cooperate to the people makes the work more effortless and uncomplicated. Our project is used for monitoring and surveillance purpose in any industries or institutions etc. In this project 4 different controls has been using for controlling the robots, i.e., forward, backward, left, right. These movements are given by the user using Blynk Android App. The smart phone at the transmitter side sends control signals to the receiver side through IoT (Internet of Things). The controller (NodeMCU) at the receiver area receives these signals and gives direction to the robot through IoT i.e. through cloud. The Cloud infrastructure and its extensive set of Internet-accessible resources has potential to provide significant benefits to robots and automation systems. We consider robots and automation systems that rely on data or code from a network to support their operation, i.e., where not all sensing, computation, and memory is integrated into a standalone system.

Existing System

Now a days due to advancement in technology various newly designed smart homes make use of IoT enabled robot for various applications. Mostly they are used for home security purpose. Thus one can keep an eye on the people coming inside home just by the robot car just by introducing a camera into it.

Various other application are also done by this robot car like doing various works on the command ex- switching on the lights when the robot is given command by the IoT enabled device.

Proposed System

The robo car can be easily moved from one place to another just by a single device. Robo car can be used for security purpose with the installation of a camera. We can make the car do various task like moving an object from one place to another without applying any physical force.

II. SYSTEM SPECIFICATIONS

2.1 Scopes and Purpose of System Specification

The system specification shows the description of the function and the performance of system and the user. The scope of our project “Internet of Things” is immense. The future implications of the project are very great considering the amount of time and resources it saves. The project we have undertaken can be used as a reference or as a base for realizing a scheme to be implemented in other projects of greater level such as smart homes, various robot controlled industries etc.

2.2 RESEARCH METHODOLOGY

The control of robot movement which is developed in this study is the control of motion direction of the robot. They are forward, backward, right and left motion. When any change occurs, Joystick will be sent to robot via Wi-Fi, then, the robot will move according to the changes of the value. There must first be established the connection between the smartphones and the robot via Wi-Fi.

Blynk application running on a network, working of the Wi-Fi controlled Robot is very easy, we just need to Drag or Slide the Joystick in the direction, where we want to move the Robot. Like if we want to move the Robot in Forward direction then we need to drag the Joystick ‘circle’ in forward direction. Likewise, we can move the Robot in Left, Right and Backward direction by dragging the joystick in respective direction. Now as soon as we release the Joystick, it will come back to center and Robot stops.

Blynk App sends values from two Axis Joystick to NodeMCU, through Wi-Fi medium. NodeMCU receive the values, compare them with predefined values and move the Robot accordingly in that direction.

Android smartphones are undoubtedly the most popular gadgets in these days. You will find various apps on the Internet that exploit inbuilt hardware in these mobile phones, such as Bluetooth and Wi-Fi, to control other devices. Presented here is a phone controlled robot that can be controlled via an app on your mobile. The control commands are sent via WiFi.

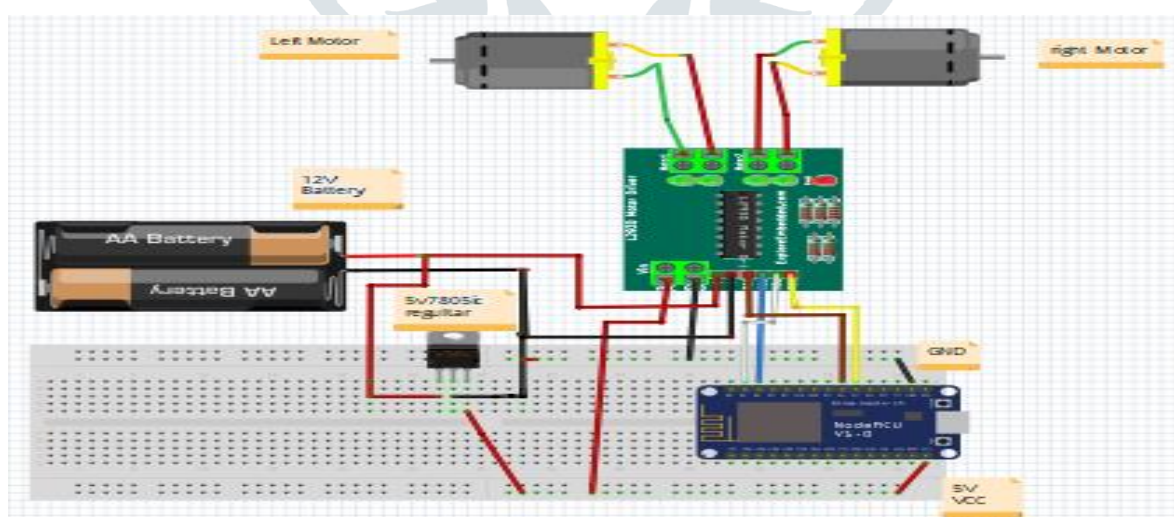


Figure 2.1: Circuit Diagram of surveillance Robot using IoT

2.3 Intended Users and Uses

Robot car controlled by Wi-Fi will make our work much more easier as we can make the robot do any work we need by just a single movement on our mobile phone on computer. In near future we can see such designs getting too common and being used extensively for household purposes

III. DESIGN AND ARCHITECTURE OF COMPONENTS

3.1 Blynk Cloud Structure

Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, visualize it and do many other cool things.

There are three major components in the platform:

- **Blynk App** - allows to you create amazing interfaces for your projects using various widgets we provide.
- **Blynk Server** - responsible for all the communications between the smartphone and hardware. You can use our Blynk Cloud or run your private Blynk server locally. Its open-source could easily handle thousands of devices and can even be launched on a Raspberry Pi.
- **Blynk Libraries** - for all the popular hardware platforms - enable communication with the server and process all the incoming and outgoing commands.

Now imagine: every time you press a Button in the Blynk app, the message travels to the Blynk Cloud, where it magically finds its way to your hardware. It works the same in the opposite direction and everything happens in a blink of an eye.

There is Blynk Android App that is to be installed in smart phone and installing, user has to register with valid email id. Once user registration is completed, user has to create a project, one authentication key will be send to uesr on his/her registered email ID.

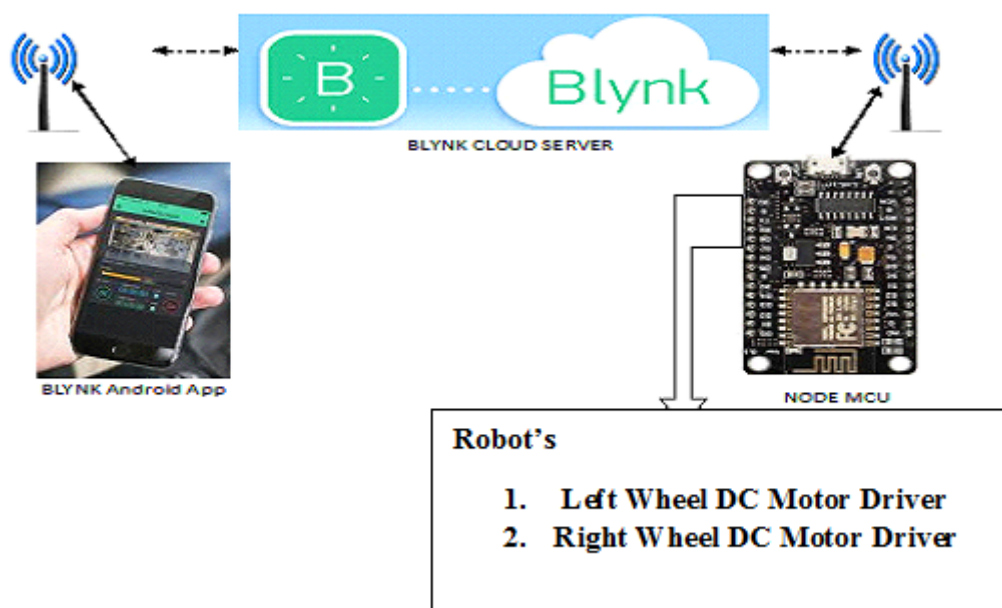


Figure 3.1: Cloud Structure for Blynk

The sent authentication key is to be used in program with local wifi user name and password to make connectivity between Blynk App and wifi enabled card.

3.2 Creation of Switch Buttons

Whenever, the first time new project is created then its canvas is empty. To add control buttons or switches, User has to tap on canvas anywhere to open widgets. All available widgets will appear on the canvas.

Now tap on the Joy Stick to open the settings of button and select Merger Mode, in this mode only one Virtual pin is required for x and y axis. Assign any name to Joy Stick like WiFi Robot as per your requirement and then select the Virtual pin V1 for the Joy Stick control action. It can work for all four mode of operation.

Now tap on the Button widget, assigned a name to it and assign virtual pin V2 to it for enabling and disabling the robot. At last, move the slider from push to switch for getting switching action means switch once pressed then particular appliance will get ON and second time pressing action on same button, same appliance will get OFF.

3.3 Required Components:

- NODEMCU (Discussed in chapter 3)
- L293D
- 12V DC Motors -2
- Batteries
- 7805 Regulator
- Robot chassis plus wheel
- Castor wheel
- Android Mobile phone
- Blynk App(Discussed in chapter 4)

3.3.1 DC Motor

Almost every mechanical movement that we see today is accomplished by an electric motor. An electric motor takes electrical energy and produces mechanical energy. Electric motors come in various ratings and sizes. Some applications of large electric motors include elevators, rolling mills and electric trains. Some applications of small electric motors are robots, automobiles and power tools. Electric motors are categorized into two types: DC (Direct Current) motors and AC (Alternating Current) motors. The function of both AC and DC motors is same i.e. to convert electrical energy to mechanical energy.

The basic difference between these two is the power supply which is an AC source for AC motors and a DC source like a battery for DC motors. Both AC and DC electric motors consist of a stator which is a stationary part and a rotor which is a rotating part or armature of the motor. The principle of working of an electric motor is based on the interaction of magnetic field produced by the stator and the electric current flowing in the rotor in order to produce rotational speed and torque.

There are different kinds of DC motors and they all work on the same principle. A DC motor is an electromechanical actuator used for producing continuous movement with controllable speed of rotation. DC motors are ideal for use in applications where speed control and servo type control or positioning is required.

A simple DC motor is shown below.



Figure 1.2: BO DC Motor

Working Principle of DC Motor

An electromechanical energy conversion device will take electrical energy at the input and produces a mechanical energy at the output side. There are three electrical machines that are extensively used for this task: a DC motor, an induction or asynchronous motor and a synchronous motor. Induction motor and synchronous motors are AC motors. In all the motors, the electrical energy is converted into mechanical when the magnetic flux linking a coil is changed. An electric motor takes electrical energy as input and converts into mechanical energy.

When the electrical energy is applied to a conductor which is placed perpendicular to the direction of the magnetic field, the result of the interaction between the electric current flowing through the conductor and the magnetic field is a force. This force pushes the conductor in the direction perpendicular to both current and the magnetic field, hence, the force is mechanical in nature. The value of the force can be calculated if the density of the magnetic field B , length of the conductor L and the current flowing in the conductor I , is known.

The force exerted on the conductor is given by

$$F = B \times I \times L \text{ Newtons} \quad \dots(3.1)$$

The direction of the motion of the conductor can be determined with the help of Fleming's Left Hand Rule. Fleming's Left Hand Rule is applicable to all electric motors. The figure representing Fleming's Left Hand Rule is shown in figure 4.

When a conductor which is carrying current is placed in a magnetic field, a force acts on the conductor that is perpendicular to both the directions of magnetic field and the current.

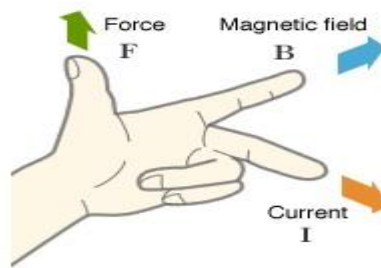


Figure 3.3: Fleming's Left Hand Rule

According to Fleming's Left Hand Rule, the left hand thumb represents the direction of the force, the index finger represents the direction of the magnetic field and the middle finger represents the direction of the current.

A DC motor consists of two sets of coils called armature winding and field winding. Field winding is used to produce the magnetic field. A set of permanent magnets can also be used for this purpose. If field windings are used, it is an electromagnet. The field winding is the fixed part of the motor or a stator. The armature winding is rotor part of the motor. The rotor is placed inside of stator. The rotor or the armature is connected to the external circuit through a mechanical commutator.

Generally, Ferro magnetic materials are used to make both stator and rotor which are separated by air gap. The coil windings inside the stator are made of series or parallel connections of number of coils. The Copper windings are generally employed for both armature and field windings.

The principle of operation of a DC motor is explained below. Consider a coil placed in a magnetic field with a flux density of B Tesla. When the coil is supplied with direct current by connecting it to a DC supply, a current I flows through the length of the coil.

The electric current in the coil interacts with the magnetic field and the result is exertion of a force on the coil according to the Lorentz force equation. The force is proportional to the strength of the magnetic field and the current in the conductor.

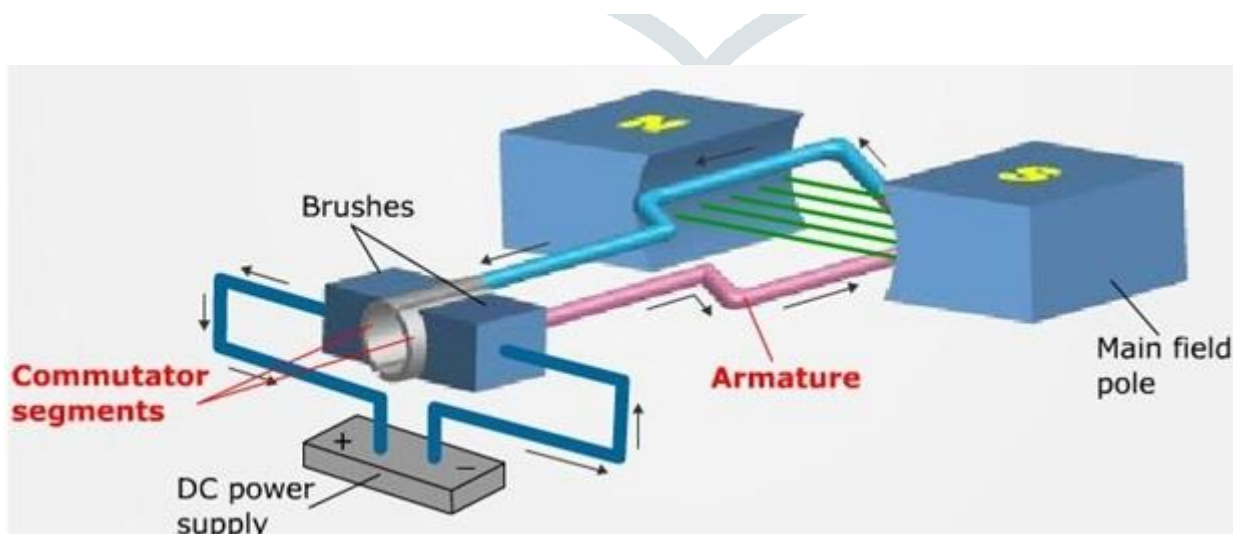


Figure 3.4: Principle of operation of DC Motor

The same principle is used in DC motor and it consists of several coils that are wound on the armature and all the coils experience the same force. The result of this force is the rotation of the armature. The rotation of the conductor in the magnetic field will result in torque. The magnetic flux linking with the conductor is different at different positions of the coil in the magnetic field and these causes to induce an emf in the coil according to the Faradays laws of electromagnetic induction. This emf is referred to as back emf. The direction of this emf is opposite to the supply voltage which is responsible for current to flow in the conductor. Hence the total amount of current flowing in the armature is proportional to the difference between the supply voltage and the back emf.

A DC motor electrical equivalent circuit is divided into two circuits: field circuit and armature circuit. Field circuit is responsible for the magnetic field and is supplied with a separate DC voltage V_f . The resistance and inductance of the field winding are represented by R_f and L_f . As a result of the voltage, a current I_f is produced in the winding and it establishes the necessary magnetic field.

In the armature, a voltage V_T is applied across the terminals of the motor and a current I_a flows in the armature circuit. The resistance of the armature winding is R_a and the total voltage induced in the armature is E_b .

Applying Kirchhoff's Voltage Law in both the circuits,

$$V_f = I_f * R_f \quad \dots(3.2)$$

$$V_T = I_a * R_a + E_b \quad \dots(3.3)$$

The torque developed in the motor is

$$T = K * I_a * \Phi \quad \dots(3.4)$$

Where k is constant depending on coil geometry and Φ is magnetic flux.

The electrical power of the motor is $E_b * I_a$.

The developed power which is the power converted to mechanical form is given below:

$$P = T * \omega_n \quad \dots(3.5)$$

where ω is the angular speed.

This is the total power that is delivered to the induced armature voltage and

$$E_b * I_a = T * \omega_n \quad \dots(3.6)$$

3.3.2 L293D Motor Driver Module

As the name suggests, L293D is a quadruple H-bridge, high current motor driver IC. It can be used to drive two motors at a time in both the directions with an output current of 600mA for each motor. L293D IC is designed to drive relays, DC motors, stepper motors and other inductive loads with high current and high voltage requirements.

The L293D IC receives signals from the microprocessor and transmits the relative signal to the motors. It has two voltage pins, one of which is used to draw current for the working of the L293D and the other is used to apply voltage to the motors.

The L293D switches its output signal according to the input received from the microprocessor. For Example: If the microprocessor sends a 1(digital high) to the Input Pin of L293D, then the L293D transmits a 1(digital high) to the motor from its Output Pin. An important thing to note is that the L293D simply transmits the signal it receives. It does not change the signal in any case.

The L293D is a 16 pin IC, with eight pins, on each side, dedicated to the controlling of a motor. There are 2 INPUT pins, 2 OUTPUT pins and 1 ENABLE pin for each motor. L293D consist of two H-bridge. H-bridge is the simplest circuit for controlling a low current rated motor.

The Theory for working of a H-bridge is given below.

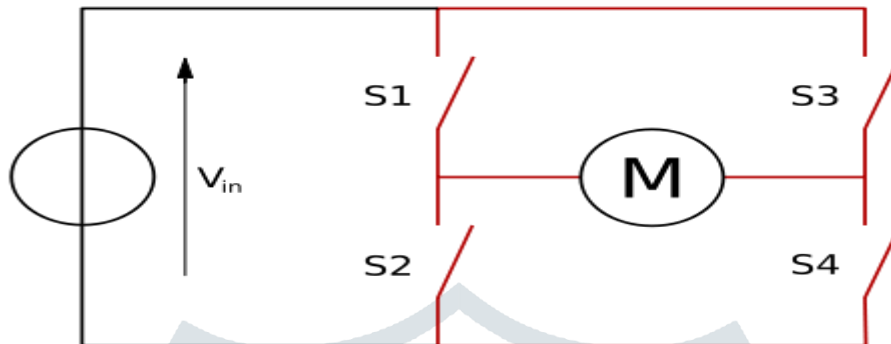


Figure 3.5: H-Bridge

In the given diagram, the arrow on the left points to the higher potential side of the input voltage of the circuit. Now if the switches S1 & S4 are kept in a closed position while the switches S2 & S3 are kept in an open position meaning that the circuit gets shorted across the switches S1 & S4. This creates a path for the current to flow, starting from the V input to switch S1 to the motor, then to switch S4 and then the exiting from the circuit. This flow of the current would make the motor turn in one direction.

The direction of motion of the motor can be clockwise or anti-clockwise, this is because the rotation of the motor depends upon the connection of the terminals of the motor with the switches. For simplicity, let's assume that in this condition the motor rotates in a clockwise direction.

Now, when S3 and S2 are closed then and S1 and S4 are kept open then the current flows from the other direction and the motor will now definitely rotate in counter-clockwise direction.

When S1 and S3 are closed and S2 and S4 are open then the 'STALL' condition will occur (The motor will break).

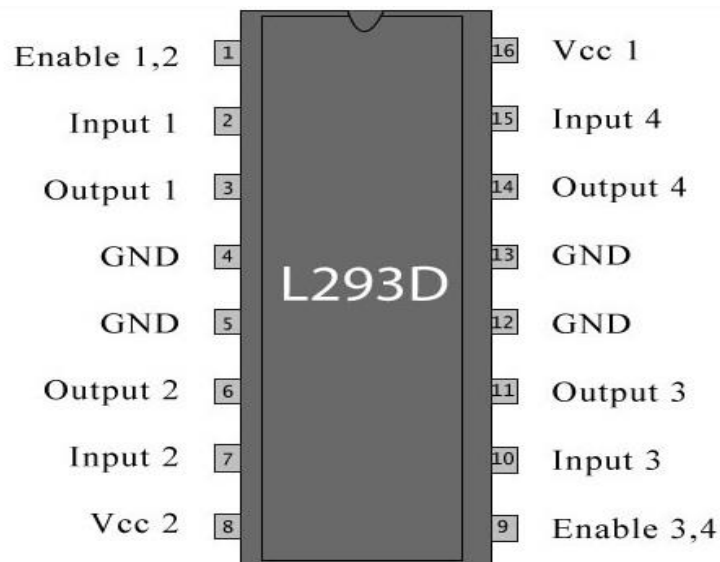


Figure 3.6: LM293D Pin details

Working Mechanism

Now depending upon the values of the Input and Enable the motors will rotate in either clockwise or anticlockwise direction with full speed (when Enable is HIGH) or with less speed (when Enable is provided with PWM). Let us assume for Left Motor when Enable is HIGH and Input 1 and Input 2 are HIGH and LOW respectively then the motor will move in clockwise direction.

3.3.3 7805 IC Voltage Regulator

A regulated power supply is very much essential for several electronic devices due to the semiconductor material employed in them have a fixed rate of current as well as voltage. The device may get damaged if there is any deviation from the fixed rate.

The AC power supply gets converted into constant DC by this circuit. By the help of a voltage regulator DC, unregulated output will be fixed to a constant voltage. The circuit is made up of linear voltage regulator 7805 along with capacitors and resistors with bridge rectifier made up from diodes. From giving an unchanging voltage supply to building confident that output reaches uninterrupted to the appliance, the diodes along with capacitors handle elevated efficient signal conveyal.

Regulated power supply is a device that mechanized on DC voltages and also it can uphold its output accurately at a fixed voltage all the time although if there is a significant alteration in the DC input voltage.

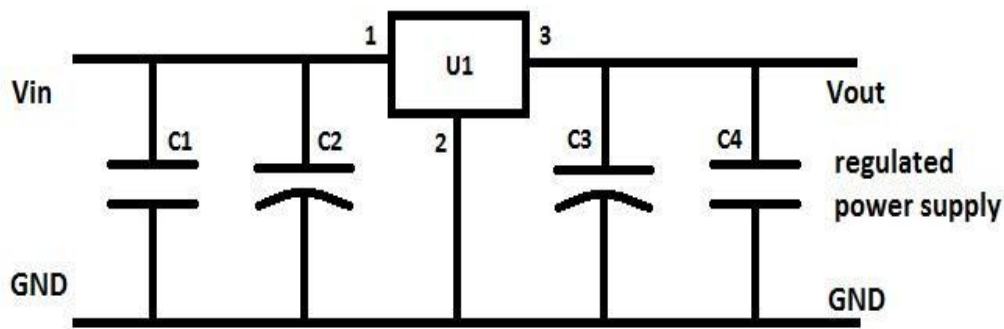


Figure 3.7: Regulated Power Supply Circuit

ICs regulator is mainly used in the circuit to maintain the exact voltage which is followed by the power supply. A regulator is mainly employed with the capacitor connected in parallel to the input terminal and the output terminal of the IC regulator. For the checking of gigantic alterations in the input as well as in the output filter, capacitors are used. While the bypass capacitors are used to check the small period spikes on the input and output level. Bypass capacitors are mainly of small values that are used to bypass the small period pulses straightly into the Earth.

3.4 NODEMCU and Its Configuration with Arduino IDE

Development boards, such as Arduino and Raspberry Pi, are common choices when prototyping new IoT devices. Those development boards are essentially mini-computers that can connect to and be programmed by a standard PC or Mac. After it has been programmed, the development boards can then connect to and control sensors in the field. Because the "I" in IoT stands for internet, the development boards need a way to connect to the internet. In the field, the best way to connect to the internet is by using wireless networks. However, Arduino and Raspberry Pi do not have built-in support for wireless networks. Developers will have to add a Wi-Fi or cellular module to the board and write code to access the wireless module.

In this article, I will introduce an open source IoT development board called NodeMCU. One of its most unique features is that it has built-in support for Wi-Fi connectivity, and hence makes IoT application development much easier.

3.5 NodeMCU

The NodeMCU (Node Microcontroller Unit) is an open source software and hardware development environment that is built around a very inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains all crucial elements of the modern computer: CPU, RAM, networking (Wi-Fi), and even a modern operating system and SDK. When purchased at bulk, the ESP8266 chip costs only \$2 USD a piece. That makes it an excellent choice for IoT projects of all kinds.

However, as a chip, the ESP8266 is also hard to access and use. You have to solder wires, with the appropriate analog voltage, to its PINs for the simplest tasks such as powering it on or sending a keystroke to the "computer" on the chip. And, you have to program it in low-level machine instructions that can be interpreted by the chip hardware. While this level of integration is not a problem when the ESP8266 is used as an embedded controller chip in mass-produced electronics, it is a huge burden for hobbyists, hackers, or students who want to experiment with it in their own IoT projects.

Borrowing a page from the successful playbooks of Arduino or a Raspberry Pi, the NodeMCU project aims to simplify ESP8266 development. It has two key components.

- An open source ESP8266 firmware that is built on top of the chip manufacturer's proprietary SDK. The firmware provides a simple programming environment based on eLua (embedded Lua), which is a very simple and fast scripting language with an established developer community. For new comers, the Lua scripting language is easy to learn.
- A DEVKIT board that incorporates the ESP8266 chip on a standard circuit board. The board has a built-in USB port that is already wired up with the chip, a hardware reset button, Wi-Fi antenna, LED lights, and standard-sized GPIO (General Purpose Input Output) pins that can plug into a bread board. Figure 1 shows the DEVKIT board, and Figure 2 shows the schema of its pins.

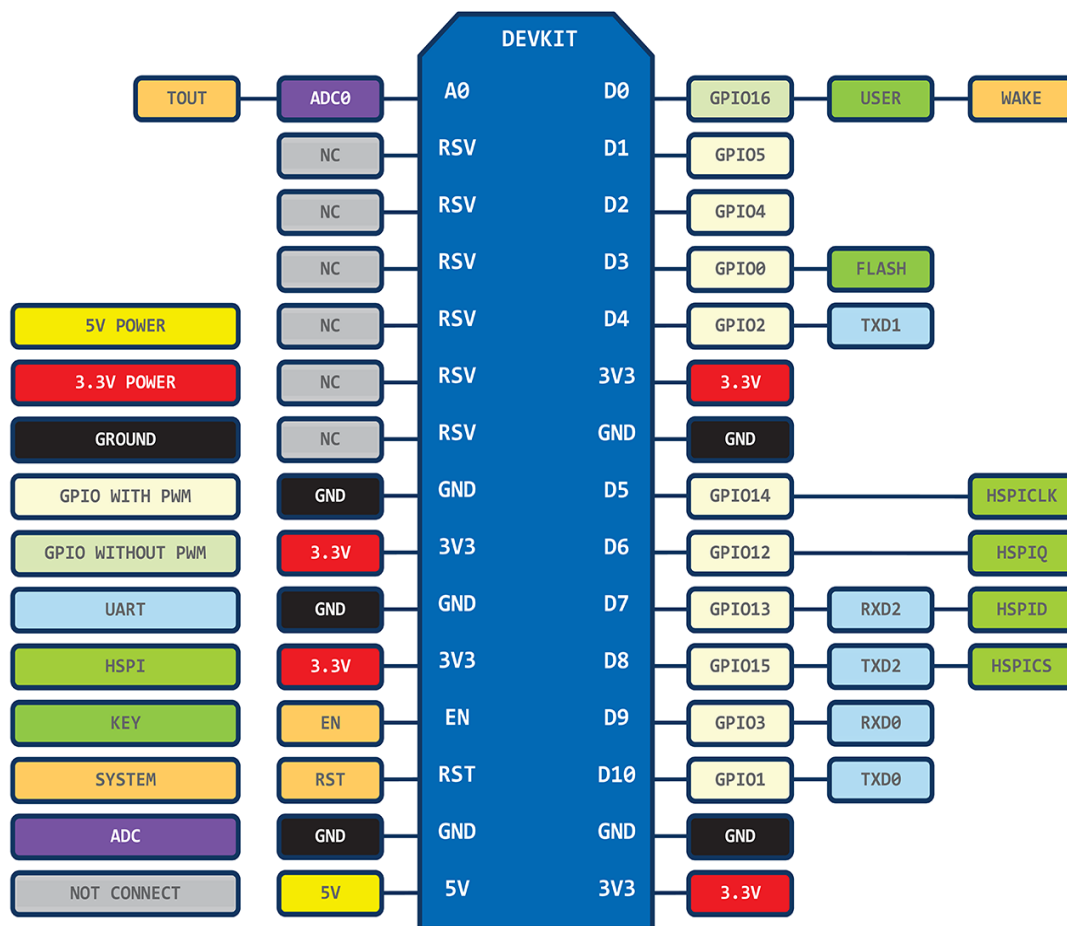


Figure 3.8: NodeMCU PINs Details

The NodeMCU DEVKIT board that comes preloaded with the firmware can be purchased for \$8 USD a piece, which makes it a very economical device for prototyping and even for production use.

But, what about Arduino, you ask? The Arduino project creates an open source hardware design and software SDK for a versatile IoT controller. Similar to NodeMCU, the Arduino hardware is a microcontroller board with a ready USB connector, LED lights, and standard data pins. It also defines standard interfaces to interact with sensors or other boards. But unlike NodeMCU, the Arduino board can have different types of CPU chips (typically an ARM or Intel x86 chip) with memory chips, and a variety of programming environments. In fact, there is an Arduino reference design for the ESP8266 chip as well. However, the flexibility of Arduino also means significant variations across different vendors. For example, most Arduino boards do not have Wi-Fi capabilities and some even have a serial data port instead of a USB port. I feel that NodeMCU provides a more consistent and accessible experience for IoT developers.

3.6 NodeMCU Specification

- Voltage:3.3V.
- Wi-Fi Direct (P2P), soft-AP.
- Current consumption: 10uA~170mA.
- Flash memory attachable: 16MB max (512K normal).
- Integrated TCP/IP protocol stack.
- Processor: Tensilica L106 32-bit.
- Processor speed: 80~160MHz.
- RAM: 32K + 80K.
- GPIOs: 17 (multiplexed with other functions).
- Analog to Digital: 1 input with 1024 step resolution.
- +19.5dBm output power in 802.11b mode
- 802.11 support: b/g/n.
- Maximum concurrent TCP connections: 5.

The most basic way to use the ESP8266 module is to use serial commands, as the chip is basically a Wi-Fi/Serial transceiver. However, this is not convenient. What we recommend is using the very cool Arduino ESP8266 project, which is a modified version of the Arduino IDE that you need to install on your computer. This makes it very convenient to use the ESP8266 chip as we will be using the well-known Arduino IDE. Following the below step to install ESP8266 library to work in Arduino IDE environment.

IV. RESULTS AND CONCLUSION

4.1 RESULTS

Surveillance Robot will be used for monitoring and surveillance purpose in any industries or institutions etc. In this process our Robot will use 4 different controls, i.e., forward, backward, left, right. These movements are given by the user using Blynk Android App.

At first we have to start or open the blynk app and go to new project section then we have to choose ESP8266 section to create the project, here it will send the Auth Token to the mail that we have given in the program. Next, we will go to the joystick section.

Hence in this way, we will setup the joystick and that joystick is been given in the figure below

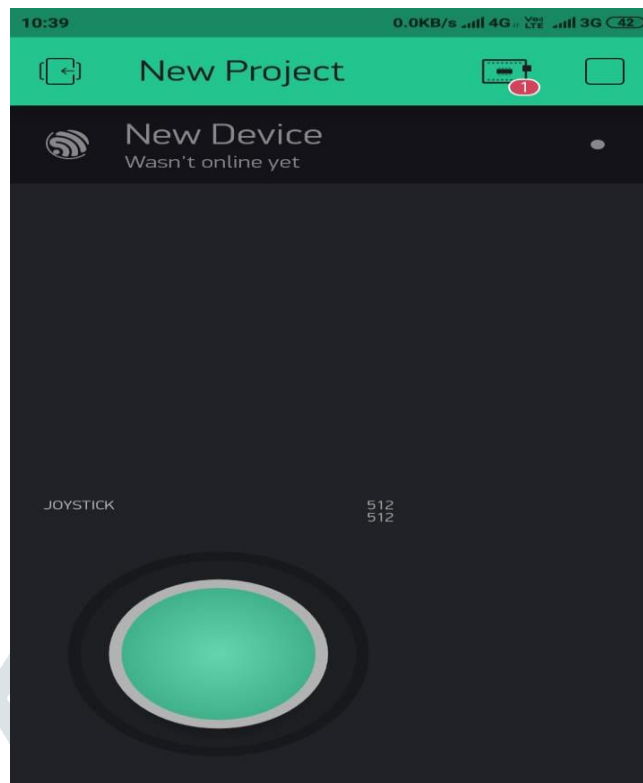


Figure 5.1: Joystick in Blynk App

By using this joystick we will control our Surveillance Robot and in this process our Robot will move in different directions. First it was moved to the forward direction and backward direction as shown in the figure below, the input values are 1,1 and 0,0 respectively.

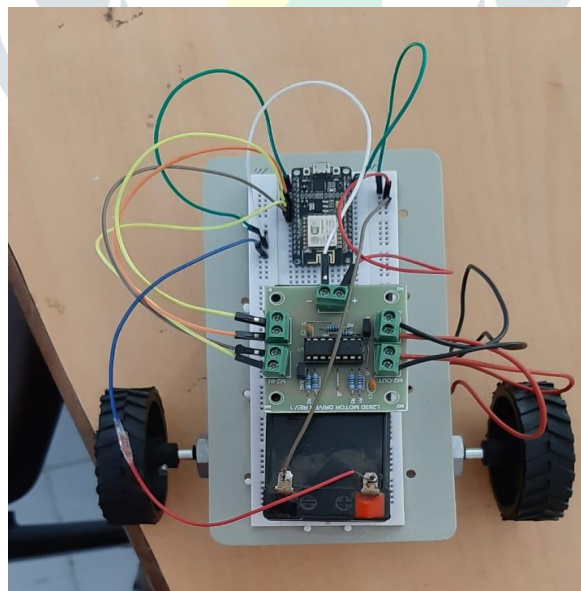


Figure 5.2: Robot moving in forward and backward direction

Similarly it was also moved to the right direction as shown below, the input values are 0,1.

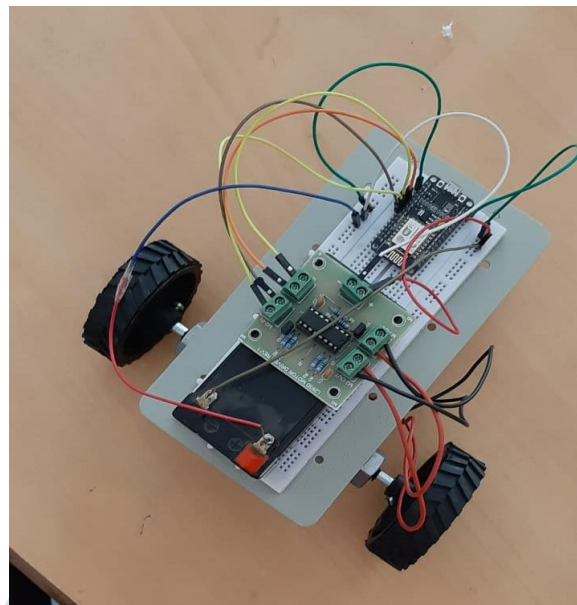


Figure 5.3: Robot moving in Right direction

Similarly it will also moves to left direction as shown below, the input values are 1,0.

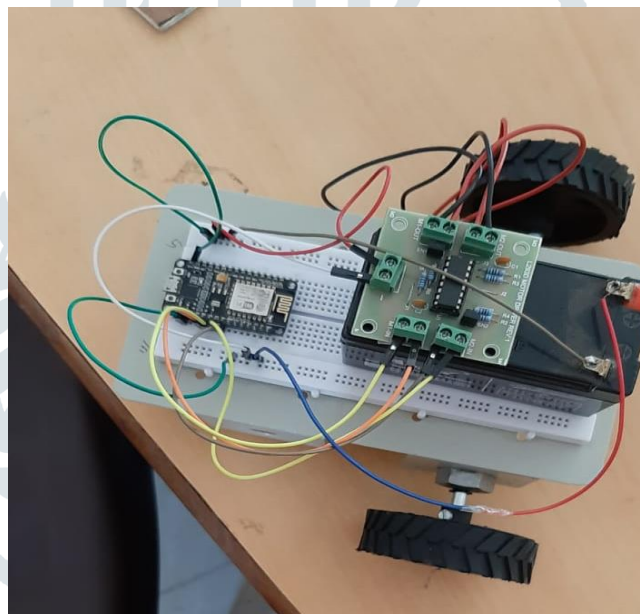


Figure 5.4 Robot moving in Left direction

After wards it will also gives the live streaming through the camera that is present on the Robot and it will give the streaming through ip webcam application and we will monitor all this process through our laptop or mobile and the Robot with camera is given below

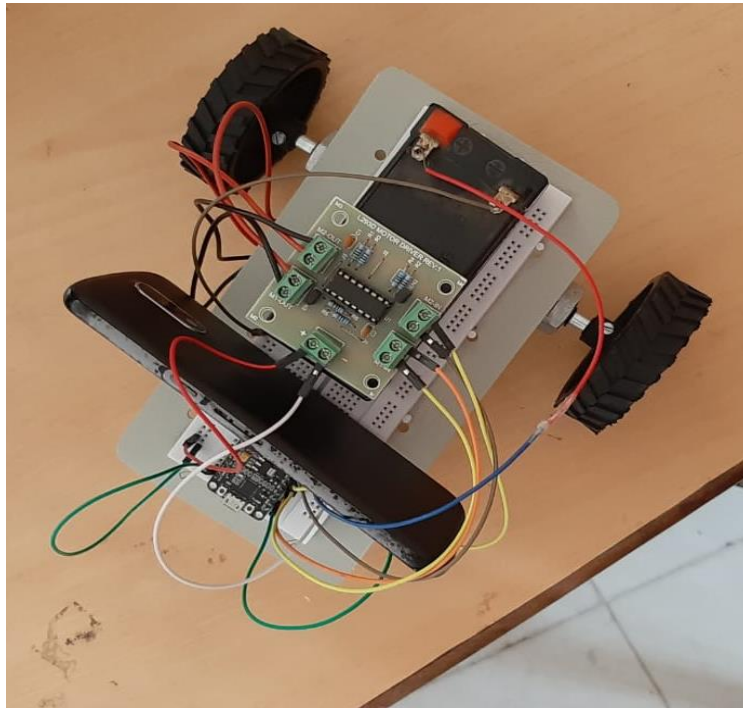


Figure 5.5: Robot with camera

As our whole future generations will depend on the Internet only. Our project will be used for the monitoring and security purpose. As it was the Robot, it will travel to every place in even typical conditions also. Automation is a technology that is developing rapidly in our world. Our project will also be used on behalf of monitoring and security persons or jobs.

4.2 CONCLUSION

The hardware components are successfully assembled and interfacing the microcontroller with robot is achieved. Controlling the motion of robot via webpage as well as from android applet is successfully obtained. Controlling the motion of robot via internet is one of the easiest means as it requires the user to access the designated webpage to guide it. This system can be used in defence applications for detecting landmines in war field and for bomb detections by mounting a metal detector sensor on it. Further, the size of device can be miniaturized based upon specific applications. We proposed a fast and simple algorithm for hand gesture recognition for controlling robot using IoT and wireless network. In our system of gesture controlled robots, we have only considered a limited number of gestures. Our algorithm can be extended in a number of ways to recognize a broader set of gestures.

REFERENCES

- [1] Y. Huang and G. Li, —Descriptive models for internet of things,|| in Intelligent Control and Information Processing (ICICIP), 2010 International Conference on, 2010, pp. 483–486.
- [2] L. Hour and N. Bergmann, —Novel industrial wireless sensor networks for machine condition monitoring and fault diagnosis,|| Instrumentation and Measurement, IEEE Transactions on, vol. 61, no. 10, pp. 2787–2798, 2012.
- [3] Z. Key, L. Yang, X. Wang-hui, and S. Heejong, —The application of a wireless sensor network design based on zigbee in petrochemical industry field,|| in Intelligent Networks and Intelligent Systems, 2008. ICINIS '08. First International Conference on, 2008, pp. 284–287.
- [4] G. Cena, A. Valenzano, and S. Vitturi, —Wireless extensions of wired industrial communications networks,|| in Industrial Informatics, 2007 5th IEEE International Conference on, vol. 1, 2007, pp. 273–278.
- [5] K. Koumpis, L. Hanna, M. Andersson, and M. Johansson, —Wireless industrial control and monitoring beyond cable replacement,|| in Proc.2nd PROFIBUS Int. Conf., Coombe Abbey, Warwickshire, UK, 2005.
- [6] S. Trikaliotis and A. Gnad, —Mapping wireless hART into profinet and profibus fieldbusses,|| in Emerging Technologies Factory Automation, 2009. ETFA 2009. IEEE Conference on, 2009, pp.

- [7] Siemens, —Profinet the industrial Ethernet standard for automation,| 8th IEEE International Workshop on Factory Communication Systems COMMUNICATION in AUTOMATION, 2007. [Online]. Available: <http://wfcs2010.loria.fr/files/Siemens.pdf>
- [8] D. Miorandi, E. Uhlemann, S. Vitturi, and A. Willig, —Guest editorial: Special section on wireless Technologies in factory and industrial automation, part i,| Industrial Informatics, IEEE Transactions on, vol. 3, no. 2, pp. 95–98, 2007.
- [9] J. Antony, B. Mahato, S. Sharma, and G. Chitranshi, —A web plc using distributed web servers for data acquisition and control: Wed based plc,| in Information Science and Applications (ICISA), 2011 International Conference on, 2011, pp. 1–4.

