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In-Campus Semi-Autonomous Delivery Rover

Mrs. Lakshmi Durga[1], Aman Kumar D[2], Bhavani Singh[3], H M Sachin[4], Kruthvik K S[5]

[1]*Professor, Department of CSE, ATMECE, Mysuru*

[2,3,4,5]*Student, Department of CSE, ATMECE, Mysuru*

Abstract - The pace of technological change has always been brisk. To meet humans' needs and expectations, technologies are continuously evolving and advancing. IoT technology is revolutionizing how the world and society work and has increasingly widespread use. Using IoT we have built an in-campus semi-autonomous delivery rover. This rover can be used for any delivery purpose it may be food or medicines, or for military purposes. It can also be used in extreme conditions like pandemics for the delivery of food, medicines, and clothes as it may be dangerous for humans to go. To demonstrate its use, we are using it for food delivery inside the college campus. The rover is built using an ESP8266, Motor drivers, and gear motors which are connected to Blynk IOT Cloud. Using these we can control our rovers remotely as there will be cameras attached to rovers using which we can see and control them. Currently, existing rovers use Raspberry Pi which is costly, and they have a limited range. But we have instead used Esp8266 which is a lot cheaper and more efficient than Raspberry Pi and using IoT we have made it accessible from any part of the world.

***KeyWord*:** IoT, semi-autonomous, delivery rover, ESP8266, Motor driver, Gear motors, Blynk IoT Cloud, Raspberry Pi, Costly.

INTRODUCTION

Today the world is known as the internet age. The Internet has changed the lives of people and it has brought drastic changes in society. It is one of the most useful tools as we can connect to anyone in this world and access anything. It has ended the limitation of distance. The revolution of the “Internet of Things” (IoT) has enabled users to access information at any time on any device. IoT allows embedding sensors, software, and other technologies into the physical object to connect and exchange data with other devices over the internet**.**

Several rovers exist which are semi or fully autonomous, they make use of radio frequency transmission and artificial intelligence to communicate with controllers. These kinds of rovers are especially used by NASA for space exploration, and they are too costly. Some Rovers deliver food and medicines, but they use Raspberry Pi which is too costly thus making it unaffordable.

The proposed system solves all the problems by building a rover at a low cost. The rover is built using ESP8266 which is a low-cost Wi-Fi microcontroller providing a versatile and cost-effective approach. It is cheaper than Raspberry Pi and it is as efficient as Raspberry Pi. The ESP8266 microcontroller is connected to motor drivers and they both are connected to BLYNK IoT Cloud by which we can control the rover via Wi-Fi using a smartphone. The user uses the smartphone as a remote to control the rover from anywhere. Our system provides a low-cost and efficient solution with the use of Wi-Fi technology, internet, and smartphone application.

1. LITERATURE SURVEY

Shrikant V. Sonekar et al. [1]: This paper proposes an innovative approach for floor cleaning using a smart robot. Which is designed to full fill the task of garbage collection from certain places. Which uses third generation of Raspberry Pi which is basically a brain which act as a supervision for providing the commands to others components which runs on Raspbian OS. For the rover movement they have used L298N's motor driver controller with GPIO pins and DC motors & sensors to sense the garbage. The Raspberry Pi camera used for continuous video live stream of the garbage.

Arnab Kumar Saha et al. [2]: This paper describes an underwater remotely controlled vehicle or rover which is remotely controlled fromthe top of the host ship above the water surface. It can be used for getting a live video of underwater life and also underwater activities to learn about underwater life. It makes the job for divers, rescuers and easier with the available pictures. This paper is based on focused on ROV underwater rover instead of AOV controlled which is an Autonomous Rover that works automatically without any remote control. The major components include Raspberry Pi controlled ROV underwater rover is PVC pipes, a cassette sized programmed Raspberry pi model 3B.

Satyendra K et al. [3]: This paper describes how availability of internet everywhere have made the advancement in the field of IOT based application and became state-of-art technology among the any of the researcher. Smart energy efficient home automation

system is proposed that can access and control the home equipment's Remotely from every corner of the world which can be done easily. In this proposed system, The Internet connectivity module is attached to the main supply unit of the home system it may be anything which can be accessed through the Internet. For wireless connectivity, the static IP address is used.

Shrikant V. Sonekar et al. [4]: The paper specifies a Smart Surveillance cum Waste Cleaning Rover build raspberry pi presents the design and development of a smart surveillance and waste cleaning rover that can be controlled through IoT technology. The system is composed of a rover equipped with cameras and sensors to detect and identify objects in its surroundings, as well as a garbage cleaning. The mechanism which can collect the waste. The rover is controlled by a Raspberry Pi board, which receives commands from a mobile application, and it can be controlled remotely through Wi-Fi or Bluetooth connectivity. The system also includes a cloud-based platform to store the data collected by the rover.

Dhiraj Sunehra et al. [5]: The paper presents an approach to the designing of a robotic vehicle that functions as a personal assistant using a Raspberry Pi as the central processing unit and Zero UI technology to enable seamless interaction with users. Zero UI uses sensory for as gestures, voice and movement to control the devices. A voice-controlled robot vehicle performs three functions, movement of the robot is controlled using voice commands. and can articulate the text from a captured image using optical character recognition and present the equivalent audio to the user by using a built-in speaker.

2. COMPONENTS USED

Table- 1: Component Table

S. No	NAME OF THE PART	USE
1.	ESP8266	The ESP8266 is a Wi-Fi-enabled microcontroller, that has a built-in CPU, RAM, and a Wi-Fi module for connectivity.
2.	Motor Driver L298N	The motor driver is the major component for controlling the motors in the rover. The motor driver used is the L298N motor driver which is a popular dual H-bridge motor driver which can control the speed and direction of motors connected to it
3.	Gear Motors (12v)	The gear motor is basically a combination of both an electric motor and a gearbox. This gearbox is used to manipulate the speed of the motor for the torque.
4.	Solenoid Lock	A solenoid lock is basically an electromagnetic lock that works on the principle of a current-carrying coil producing a magnetic field around it, using the magnetic field the plunger is moved into a locking position.
5.	Refrigeration Unit Box	Our rover also contains a refrigeration box which is built using sun-board Inside which we have placed a thermocol box that acts as an insulated container that is used to keep items cool.
6.	Lithium Polymer Batteries	The rover is powered by a lithium-ion battery. It is a rechargeable battery that consists of one or more cells, each with a nominal voltage of 3.7 volts.
7.	Robotic Wheels	To move our rover freely we are using robotic wheels. These wheels are specially designed for the use of robots. The rotational motions is provided by the gear motors in order to move the wheels.
8.	Sun board Chassis	The sun board which is also known as foam board can be used for a variety of applications. This sun board is made by sandwiching two layers of paper or plastic.
9.	Rotating Camera	The camera is fixed at front of the rover so the controller can view the path and control the rover. The camera can be rotated 360 degrees so that we can get a full view of the path..

1) ESP8266 Microcontroller:

The ESP8266 is a Wi-Fi enabled microcontroller which is manufactured by Espressif Systems. This microcontroller has built in CPU, RAM, and a Wi-Fi module for connectivity. It is a low cost and low power board, that's why it is a popular choice for many IOT applications, and because it has a built-in Wi-fi connectivity, which makes it easy to connect to the internet and communicate which is a major requirement for remote access and control.

Fig-1: ESP8266 Microcontroller

2) Motor Driver L298N:

Motor driver is the major component for controlling the motors in the rover. The motor driver used is L298N motor driver which is a popular dual H-bridge motor driver which can control the speed and direction of motors connected to it. The four GPIO pins of microcontroller is connected to the four input pins of Motor driver through this connectivity we can drive the motors forward, backward, left, right or stop it. The motor driver also has a head sink that helps to dissipate heat and prevent the driver from overheating.

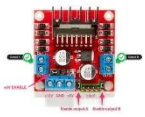


Fig -2: Motor Driver L298N

3) Gear Motors:

The gear motor is basically a combination of both electrical motor and a gear box. This gear box is used to manipulate the speed of the motor for the torque. The contents of gearbox are a set of gears that are arranged in a specific configuration. For our project

we require four gear motors having a speed of 60 rpm. Because of their small size and low power consumption which makes it ideal choice for using it in our project.

Fig -3: Gear Motors

4) Solenoid Lock:

A solenoid lock is basically a electromagnetic lock which works on the principle of current-carrying coil produce a magnetic field around it, using the magnetic field the plunger is moved into a locking position. They can be operated remotely, making them ideal for use in automation and IOT device. In our project it is used to lock the refrigeration box to ensure the items inside the box are protected during transport

Fig -4: Solenoid Lock

5) Refrigeration Unit Box:

Our rover also contains a refrigeration box which is build using sun-board inside which we have placed a thermocol box which acts as a insulated container which is used to keep items cool. This box is used for transporting items, like food, medicine, or biological samples.

Fig-5: Refrigeration unit box

6) Lithium Polymer Batteries:

Our rover is powered by lithium-ion battery. It is a rechargeable battery that consists of one or more cells, each with a voltage of 3.7 volts. They are used in portable electronic devices like smartphones, tablets, and in small electronics project that requires compact and lightweight power source.

Fig- 6: Lithium Polymer Battries

7) Robotic Wheels:

To move our rover freely we are using robotic wheels. These wheels are specially designed for the use of robot. The rotational motions is provided from the gear motors in order to move the wheels.

Fig -7: Robotic Wheels

8) Sun board Chassis:

The sun-board which is also known as foam board which can be used for variety of applications. This sun board is made by sandwiching two layers of paper or plastic. It is lightweight and sturdy material and it resistant to moisture, heat, and chemicals, making it a durable and long-lasting material.

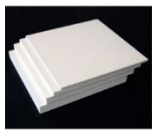


Fig -8: Sun Board

9) Rotating Camera:

The camera is fixed at front of the rover so the controller can view the path and control the rover. The camera can be rotated 360 degrees so that we can get a full view of the path.

Fig -9: Rotating Camera

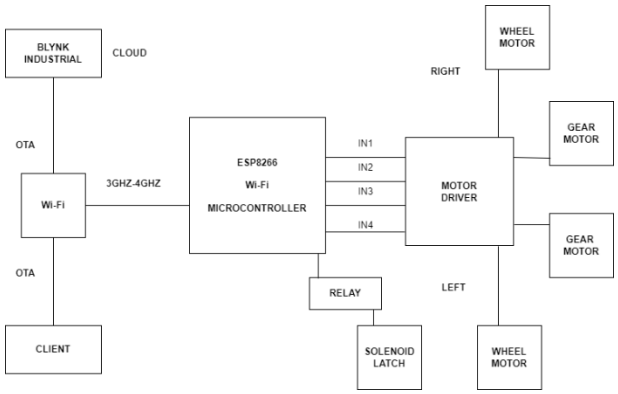
3. METHADOLOGY

3.1 Overview

In the proposed system the rover is used for the delivery of food on the college campus. The above picture depicts the architecture of the entire rover.
The rover contains 4 robotic wheels which are attached to 4 gear motors. These 4 gear motors are then connected to the motor pins of the L298N motor driver. 4 input pins IN1, IN2, IN3, IN4 are connected to ESP8266 Wi-Fi Microcontroller digital pins. Power is supplied using a 12V Lithium polymer battery to the motor driver. Then 5v are drawn from the motor driver and given to the ESP8266 board. Movement is controlled using the Blynk app on smartphones. The rover also contains a refrigerating unit which is used to carry food items inside it. To

protect the food items from being theft we have used a solenoid lock which is nothing but an electromagnetic lock that provides security to the food items. The lock can also be controlled via the Blynk app on the smartphone. The rover also contains a camera so that the controller(human) can see visuals and control the rover remotely.

3.2 Working



1. Hardware

To create the base of the rover we use sun board and cut it into a rectangular size of 55x30 cm. Then we attach 4 gear motors each of 12V 60rpm and connected them to the motor drivers. Then attach 4 robotic wheels to the gear motors Power is drawn from a 12V Lithium polymer battery which is a DC supply that runs through the motor driver. Then 5V of current is drawn from the motor driver to the ESP8266 board. 4 input pins IN1, IN2, IN3, IN4 are connected to ESP8266 Wi-Fi Microcontroller digital pins using jumper wires.
A rectangular refrigeration box is placed on the sun board which is protected using a solenoid lock.
The solenoid lock is connected to a relay which is powered by a 12V DC supply from a lithium battery. Command or code to ESP8266 is inserted using a USB data cable. These codes help the ESP8266 to communicate with the Blynk Cloud and the L298N motor driver.

2. Software

Coming to the software part, we use Arduino IDE to code. We use embedded C++ language for coding instructions about in which direction should the rover move and even to control the solenoid lock. We use two functions void setup where we use the same virtual pins which we have used in the ESP8266 board, and we write functions to each pin. Then we use the void loop function to reuse it again and again. Then the code is uploaded to the ESP8266 board via a USB data cable.

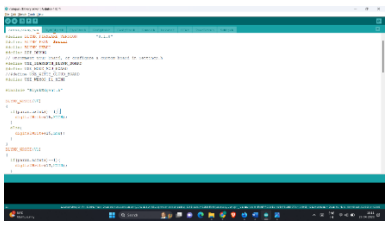


Fig -11: Arduino Software Interface

Blynk is a cloud-based Internet of Things (IoT) platform that allows users to easily create and manage their IoT projects. It is used to prototype, deploy and remotely manage connected devices at any scale. In this, we log in and create an email and then choose our device (ESP8266) and network type (Wi-Fi). Then it creates an Auth Token which must be added to the Arduino IDE code. Then in the Blynk IoT cloud, we should open the widget box and create buttons and name them and define the output pins which are the same as the pins mentioned in the code.

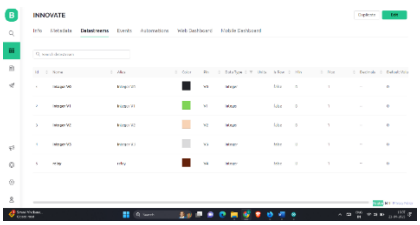


Fig- 12: Blynk IoT Cloud Interface

Blynk IoT mobile app is a companion app to the Blynk IoT platform, which allows users to control and monitor their IoT devices remotely using their mobile devices. The app provides an easy-to-use interface that allows users to view sensor data, control device settings, and receive alerts and notifications from their connected devices. We install the Blynk app on the smartphone and log in with the same email as used in the Blynk cloud and then use it as a remote to control the motors of the rover and the solenoid lock. The smartphone is connected to the ESP8266 with the help of Wi-Fi using a hotspot. Users can control the rover remotely from any distance.

Fig -13: Rover Remote in Blynk App

4. RESULT

If a user wants to move the rover an action is performed on a particular button in the smartphone, and it is then directed towards Blynk cloud. Then the cloud receives the input from the smartphone and then transfers the signal to the ESP8266. It is the brain of the rover as it contains all the code in it and based on the function associated with the virtual pin, the command gets executed and the instructions are sent to motor drivers. Then the motor driver powers the specific gear motors and instructs the motors to move in the direction specified by the user

a) b)

Fig 14: a) Refrigeration unit open b) Refrigeration unit close

In Figure 14, the prototype of an in-campus semi-autonomous delivery rover is displayed. The system consists of ESP8266, Motor driver L298N, gear motors, refrigeration unit box along with solenoid lock and a rotating camera. Figure 14 (a) depicts that the solenoid lock is open, and the refrigerating box is opened and figure 14(b) depicts that the refrigerating box is closed and is locked with solenoid lock.

Fig 15: Rover remote in Blynk app

Figure 15 shows the remote of the Rover. Remote that consist of 4 buttons. Buttons on right control motors of right side of Rover and buttons on left control motor on left side of Rover, these motors are connected to wheels which gives motion to Rover. To move Rover in forward direction Forward Left and Forward Right buttons are pressed together, and Back Right and Back Left for moving in backward direction. Rover can also be rotated 360 in its position by pressing button that are diagonal to each other, that is Forward Right and Back Left rotates Rover in clockwise direction and Forward Left and Back Right rotates rover in anti-clockwise.

CONCLUSION

In the end of our project, we can conclude that our project reduces the price very drastically for building a rover using IOT compared to the rovers which are build using raspberry pi. We can conclude that ESP8266 is a very cost-effective and affordable microcontroller that can easily be programmed to build a fully functional rover. Using this technology helps the users to achieve the features and functions of Raspberry Pi rovers without spending more money.

We can use this system for military application installing suitable sensors. By changing the unit design, we can use it in hospitals for patient monitoring. It can also be used to deliver food and medicines in extreme conditions like pandemics, or for mining purposes.

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