International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 01 | January - 2024 SJIF Rating: 8.176 ISSN: 2582-3930

IoT Enabled Unmanned Ground Vehicle with Robotic ARM - UGVRA

Shubhangi Saxena[1], Maaz Bin Zafer[2], MA Muqtadir[3], S. Zubair Ahmed Faraz[4]

[1]Department Of ECE, Assistant Professor, Muffakham Jah College Of Engineering & Technology
[2,3,4] Department Of ECE, Student, Muffakham Jah College Of Engineering & Technology

---

Abstract - An Unmanned Ground Vehicle (UGV) is a battery operated remote controlled robot on wheels which is created with the preliminary function of moving around in an area and capturing visual information to carry out specific task at hazardous locations where human access is difficult. It can negotiate steep and gentle slopes, can travel through narrow corridors, and tow objects to reach risky regions. Using its robotic arm, it can elevate objects, move the objects to other positions of sites and move unnecessary objects out of its way. With IoT enabled feature it can be remotely controlled over the range. The integration of the Internet of Things (IoT) into the field of robotics has led to the emergence of a new class of technologically advanced machines capable of executing a wide range of functions, including remote control, live video streaming and autonomous navigation. The proposed Unmanned ground vehicle, for instance, is outfitted with a robotic arm and an ESP-32 cam module i.e. microcontroller that enables it to transmit live video footage and receive instructions from a user in real-time to perform a specific task with the help of a robotic arm. The purpose of the robot is to traverse a designated area, capturing and transmitting live video information that can be viewed by authorized personnel on a remote screen, thus facilitating the various actions as per the necessary requirements. The vehicle has extensive applications in sectors such as defence, healthcare, apartment security, and more.

Key Words: Surveillance, monitoring, inspecting, Robot, IoT, IIoT, live video streaming, robotic arm.

1. INTRODUCTION

An Unmanned Ground Vehicle (abbreviated as UGV) is a vehicle that is operated while in touch with the ground and without the occupancy of a human on board. UGVs can be used for many applications where the presence of a handler is inconvenient, dangerous, or impossible. Generally, the vehicle will have an assemblage of sensors to monitor the environment, and will either independently make decisions by itself or pass the information to the handler present at a diverse location who will control the vehicle through the process of teleoperation.

The UGV is the ground based vehicle counterpart to unmanned aerial vehicles (UAV) and unmanned underwater vehicles (UUV). Unmanned robotics are being actively developed and deployed for both civic and military to perform a variety of critical and threatening activities.

Based on its requirement, unmanned ground vehicles will include major integrant such as platforms, sensors, control systems, guidance interfaces, communication links, and systems integration features. The platform is based on all topographies vehicle design and includes a power source. Wheels or legs are the prevailing forms of locomotion. The platform may consists an articulated body incorporated with other equipment. Renewable power sources such as batteries playing an important role in both propulsion for smaller UGVs and in supporting electronic systems for larger UGVs. Unmanned ground vehicles are generally considered Remote-Operated (manually operated) or Autonomous. A remote-operated UGV is a vehicle that is controlled by the handler via an interface. All actions are performed by the operator based on direct visual observation using a digital video camera. Depending on the type of control system, the interface between the machine and the human operator can include a control board, computer programs, or voice commands. Communication between UGV and the control station can be done via a wireless communication source. It may also communicate with other machines or robots involved in the operation. System architecture develops the reciprocity between hardware and software and determines UGV's success and autonomy.

The internet of things (IoT) is a system of reticulated devices that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without a need of human-to-human or human-to-computer interaction. Sometimes, these devices communicate with other related devices and act on the information they get from each other. The devices do most of the work without the intervention of humans, although people can interact with the devices -- for instance, to set them up, give them instructions or access the data. The protocols of networking, communication and connectivity depend largely on the specific IoT application deployed. There are many types of IoT applications based on their usage.

2. OVERVIEW OF EXISTING PROJECT

2.1 In ref.1 (Vishnu Vardhan battu et al 2021) paper, the author has used different controllers such as for controlling the vehicle Arduino UNO board is used, for robotic arm Node MCU is used and for live streaming ESP-32 Cam module has been used, this leads to costlier, more power consumption, less performance and no synchronization. The user interface is also different for live streaming and controlling, it is less convenient for usage.

2.2 In ref.2 (Teoh Jiehan et al 2022) paper, the author has used different controllers for controlling the robotic arm and for live streaming. The user interface is also separate for monitoring and controlling. This is not suitable in all the conditions.

2.3 In ref.3 (MayankDharaskar et al 2018) paper, the author has used raspberry pi for live streaming and controlling the bot. Using raspberry pi is not easy at all time because of more complexity in connecting & controlling and availability of raspberry pi is very low in the market.

2.4 In ref.4 (T. A. Salh et al 2013) paper, the bot is suitable only for outdoor region. The task done here is moving around the area and observing the environment through camera. This performs better in open and brighter areas because of its massive structure.

2.5 In ref.5 (Vijay Pratap Solanki et al 2019) paper, the bot is capable of only indoor surveillance. No other task is done except roaming around the closed walls and monitoring the surroundings. This is not suitable for other regions due to its tiny and weak structure.

Table -1: Comparison of Parameters

Parameters	Proposed project	Existing project
Material	Aluminum	Acrylic plastic
DOF(Degrees of Freedom)	4	6/3
Controller	ESP 32 cam module	Arduino Uno/ Raspberry Pi/NodeMCU ESP 8266
Programming language	C/C++	Python 2.7, JavaScript, NodeJS
Actuator	MG995 servo motor	SG90 servo motor
Controlling	Web page	Blynk + web page
Rotation angle	0-180 degree	0-90 degree
Display	Camera	Camera+Blynk
Problem	Less Time delay	Time delay

3. PROPOSED SYSTEM

By surveying various journals and papers, we have tried to eliminate the various issues by using a single microcontroller and single user interface for performing various tasks which includes movable camera with perfect live streaming, controlling robotic arm and controlling the chassis. The wireless camera is fixed on a robot and the video information is transmitted by which the user can control the robot and monitor the surroundings through mobile with the help of the internet.

4. HARDWARE USED

This bot requires lot of hardware components for functioning. The main components used in this project are as follows:

1. ESP-32 Cam module:

Fig -1: ESP-32 Cam Module

ESP-32 Cam module is a small sized, low-power consumption camera module, it is a full-featured microcontroller. It is accompanied with an OV2640 camera. It can be widely used in IoT applications such as wireless video monitoring, etc.

2. CP2102 module (USB to TTL):

Fig -2: CP2102 Module

CP2102 module which is a single-chip USB to UART bridge IC. It is a cost-effective way to convert TTL signals using a USB interface.

3. L298N Motor module

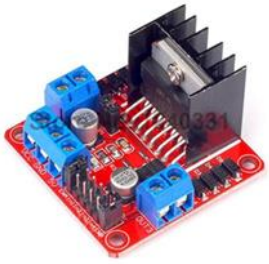

Fig -3: L298N Motor Module

It is a high power, compatible motor driver module used for driving various motors such as BO motors or DC motors. This module is capable of controlling upto 4 DC motors, or 2 DC motors with directional and speed control.

4. MG995 Servo motor

Fig -4: MG995 Servo Motor

MG995 Metal Gear Servo Motor is a rapid standard servo which can rotate approximately 180 degrees (60 in each direction). It is used in aeroplanes, helicopters, remote controlled cars and many remote operated models. This motor provides 10kg/cm at 4.8V and 12kgcm at 6V. It is a Digital Servo Motor. It processes PWM signals faster and better for receiving the data and performing operation.

5. DC to DC buck converter :

Fig -5: DC to DC Buck Converter

A buck converter is a DC-to-DC power converter which steps down the voltage from its input to its output. It is also known as a step-down converter.

Our Microcontroller is programmed and connected as per the circuit diagram. The power is supplied from the battery to the L298N motor module and DC to DC Buck converter. The role of the Buck converter is to steps down the voltage required by the microcontroller. If the power is supplied more than the required voltage, then it leads to damage to the microcontroller. A switch is connected to control the power supply. The output voltage from the Buck converter is connected to the +ve & -ve pins of the ESP-32 cam module. The 4 input pins of the L298N motor module are connected to the four GPIO pins of the Cam module with the help of jumper wires. The output pins of the motor module are connected to the DC motor 2 on each side. The servo motors are powered with the required voltage from the motor module with the help of connecting wires. Four GPIO pins are connected from the cam module to the Control of four servo motors. The chassis, Motors and wheels are assembled and a few parts have been fixed with the help of tape. An antenna has been fixed near the cam module and connected to it with the help of a connector, for better connectivity to the Internet we used an antenna.

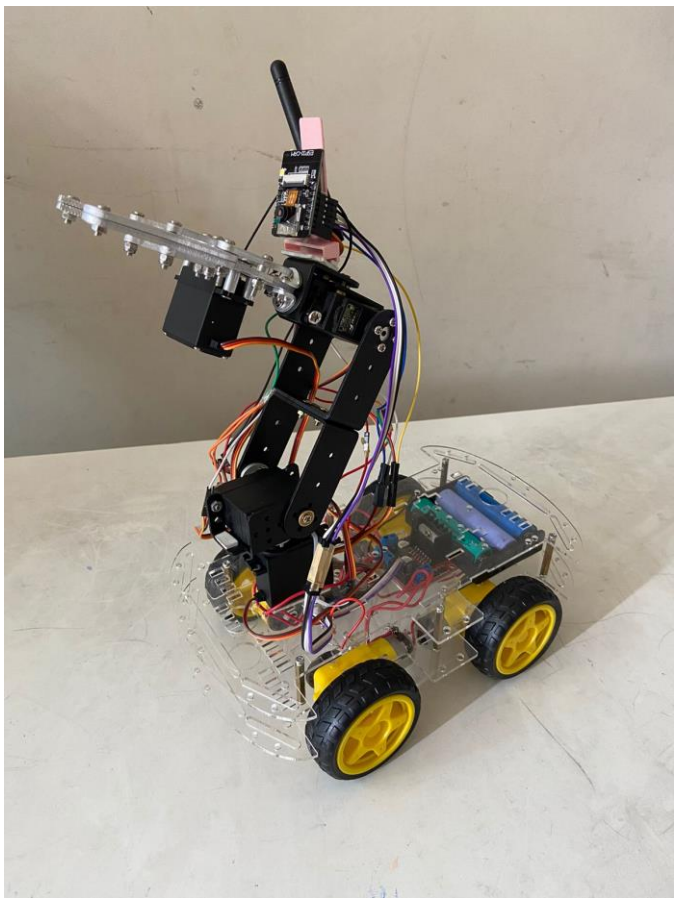

Fig -6: Assembled

5. SOFTWARE USED

Arduino IDE:

We used Arduino Software (IDE) for programming the microcontroller ESP-32. It is an open ended electronic platform enabling users to create interactive electronic objects. The Arduino programming language is based on a very simple hardware programming language called processing, which is similar to the C language. The sketch is developed and verified in the Arduino IDE, for execution it is to be uploaded on the selected board.

In this, we have included the web interface part as well so that the user can view and interact. Tools required for making a web page are HTML, CSS, and JavaScript. This development of a graphical user interface is known as Front-End Development.

VS Code:

We have used this tool to make a user interface. VS Code is a source code editor that can be used with a variety of programming languages, including Java, JS, Node, etc for coding, and debugging.

Fig -7: User Interface

User interface: This is the webpage that we have created for the user. Once the bot is connected, the live streaming of the video starts. With the help of the buttons, the user can control the bot, (Forward, Backward, Left, Right). There is a flashlight in the cam module, with the help of this flash slider you can control the intensity of light in dark regions as per the requirement. The speed of the bot can be controlled with the help of a slider. For controlling the camera and robotic arm, there are a few buttons at the bottom side of the page for controlling the four servo motors (180° degrees in each direction) which are fixed with a servo clamp on the chassis. We have used buttons for precise actions.

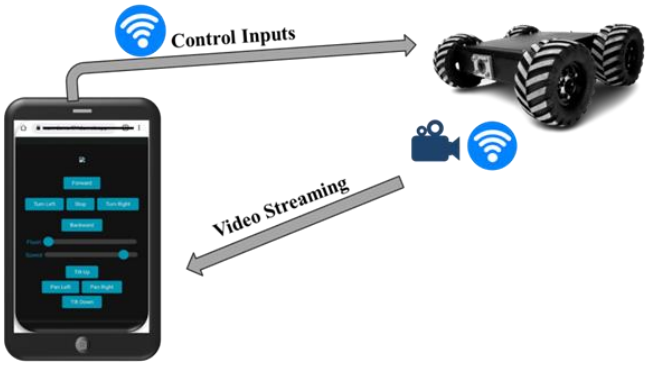

Fig -8: Connectivity

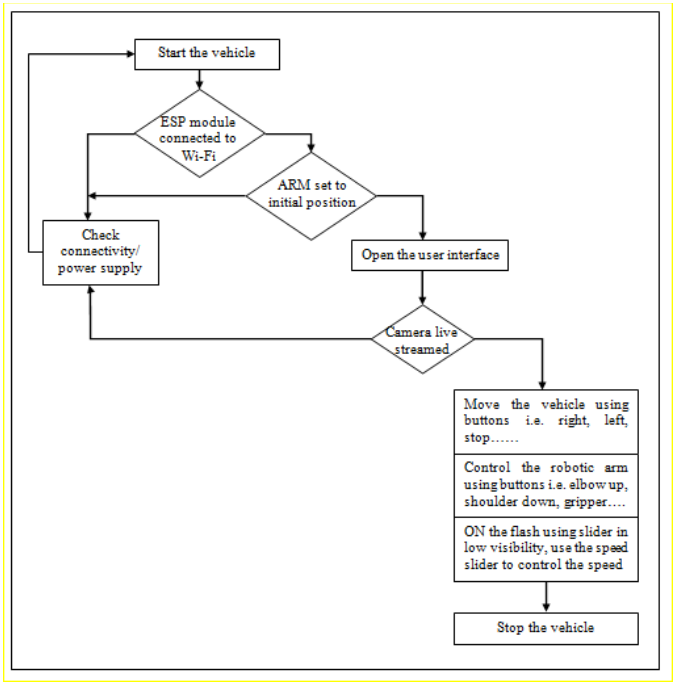

Fig -9: Flow Chart

6. BLOCK DIAGRAM

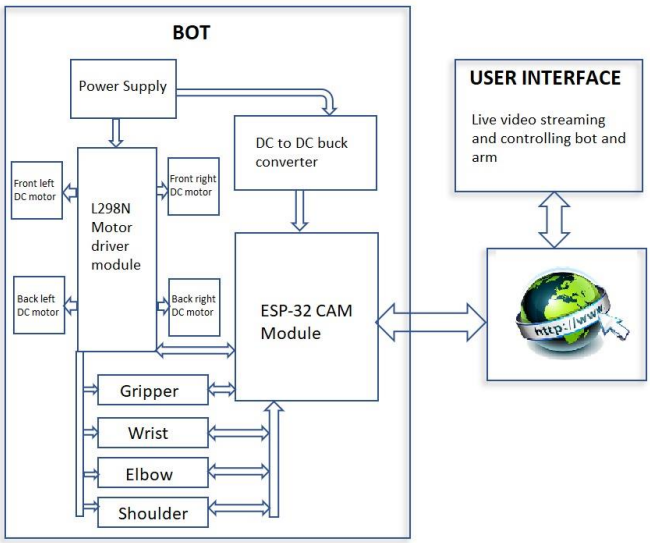

Fig -10: Block Diagram

7. APPLICATIONS

The following are the main applications of the bot:

- Can be used for industrial monitoring and inspection.
- Can be used for environmental monitoring.
- Can be used for security and surveillance.
- Can be used for search and rescue operations.
- Can be used for the inspection of infrastructure.

8. CONCLUSION

This is a lightweight, small size, compatible movable system which can be operated remotely, the usage of this vehicle is in critical situations where human reach is not possible/suitable. It is economical, affable and tranquil to deploy.

The four Degree of Freedom (4 DOF) has enabled the robotic arm to perform various actions commanded by the operator.

The vehicle was able to move in desired locations/regions as per the needs with the help of a live video stream which makes the operator execute the stipulated task using wireless connectivity.

REFERENCES

1. Vishnu Vardhan battu, Randy joy magno ventayen, A. firos, ruchi yadav, “Unmanned six-wheeled Bogie with robotic arm for surveillance and fixing objects”, Turkish journal of computer and Mathematics edition (2021).

2. Teoh Jiehan, Tee chee yen, hamna zadhy, aminatta Mohamed diallo, “Integrating IR4.0 technology in engineering education: Robotic ARM Remote Lab”, Journal of Engineering Education Transformations (2022).

3. MayankDharaskar , Vatan Gupta , Priyanka Kale , ReetaChopade, AayushJaiswal , Prof. SharadkumarGhadale, “IOT Based Surveillance Robotic Car Using Raspberry Pi”, 2018 International Research Journal of Engineering and Technology (IRJET).

4. T. A. Salh and M. Z. Nayef, “Intelligent surveillance robot”, 2013International Conference on Electrical Communication.

5. Vijay Pratap Solanki, Sunita Deshmukh, “Wi-Fi Based Home Surveillance Bot”, IEEE Xplore 2019.

6. Asha ; Ayyar; Aiswarya; Mohankumar, “Security Surveillance Bot for Remote Observation”, IEEE Xplore 2020.

7. Chandrasekaran; Lakshmi Srinivas; Chakravarthy, “Wireless Controlled Surveillance Mobile Robot through a Customized Web-User Interface”, Indian Journal of Science & Technology 2016.

8. S. Meghana, T. V. Nikhil, R. Murali, S. Sanjana, R. Vidhya and K. J. Mohammed, “Design and implementation of surveillance robot for outdoor security”, 2017 2nd IEEE International Conference on Recent Trends in Electronics, Information and Communication Technology (RTEICT), Bangalore.