DESIGN AND FABRICATION OF INTELLIGENT COMBAT ROBOT

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ABSTRTACT:

The objective of this study is to develop a combat robot that can operate in intense combat situations, with the aim of minimizing human casualties. The robot is designed to be voice controlled, hand gesture controlled, and IoT-based, allowing it to be operated remotely using a mobile device or laptop. It has a range of functions including scouting, search and rescue, supply delivery, and firing. The robot is equipped with a wireless camera for remote monitoring of the enemy, and it is armed with firearms that can be controlled by the operator. Additionally, the robot can be armed and disarmed remotely, and it is capable of moving swiftly in challenging terrains. It can be used to supply soldiers with necessary equipment and communicate with them in the battlefield. The robot is powered by solar energy through solar panels and a rechargeable DC power supply battery. It utilizes an ESP32 camera IC with a built-in Wi-Fi module for operation. The combat robot is intended for use in war fields to reduce casualties and handle situations where there is a shortage of manpower.

Keywords: Embedded Systems, Solar Energy , DC Motors, , Laser light, Headlight, IoT (Internet of Things).

I .INTRODUCTION

This paper aims to develop a combat robot, named "Viper," that can be wirelessly controlled using various methods such as voice commands, hand gestures, and an IoT-based control system. The robot incorporates the use of an ESP32 module with an integrated camera for live video streaming and surveillance. It utilizes DC motors, a motor driver, and other necessary components for its operation. The camera, mounted on the robot, provides live video feed to the user, which can be accessed through a web browser when connected to the internet.

The objectives of the paper includes:

1. Surveillance of war fields or inaccessible areas: The combat robot, Viper, aims to provide a means for surveillance in war fields or areas that are difficult to access by humans. With its integrated camera and live video streaming capability, it can capture real-time information and relay it back to the operator, allowing for remote surveillance and situational awareness.
2. Cost-effective design of a combat robot: Another objective of your project is to develop a combat robot that is cost-effective. By utilizing components such as the ESP32 module

and DC motors, you aim to design a robot that is affordable while still maintaining the necessary functionality for combat and surveillance purposes.

3. Development of an IoT-based warfield spy robot: The project aims to incorporate IoT (Internet of Things) technology into the combat robot, enabling remote control and monitoring capabilities. By integrating the robot with an IoT-based control system, users can control the robot wirelessly using voice commands, hand gestures, or other control methods. Additionally, the live video feed from the robot's camera can be accessed through a web browser, providing real-time surveillance and monitoring from anywhere with an internet connection

II. Literature Survey

Carpin, S., et al.[1] experimented the dedicated to examining the role of robotics in homeland security and defense, emphasizing the importance and impact of military robots in modern military operations. Adams, J. A., et al[2] explores the significance of robotics and artificial intelligence in improving land force operations. The article delves into the potential advantages, challenges, and future prospects associated with military robots, shedding light on their potential contributions to the field of defense. Birk et al [3] presented The paper offers insights into the development of autonomous mobile robots and their applications in extreme environments, using the mission as a case study. It highlights the challenges faced and the advancements made in the field of robotics for space exploration, particularly in the context of collecting and returning samples from Mars. Bartsch, A., et al.[4] published in Sensors, delves into the applications of unmanned aerial systems (UAS) in traffic monitoring. Although its main focus is on traffic-related aspects, the article provides valuable insights into UAS technology, which holds great relevance to military reconnaissance and surveillance robots. The article sheds light on the capabilities and potential of UAS, offering valuable knowledge that can be extrapolated to enhance the effectiveness of military robotic systems in various operational scenarios. Makris, D., & Krinidis, S. [5] published in IEEE Access, focuses on the design of an autonomous ground vehicle specifically intended for military logistics support. The paper offers valuable insights into the development process and challenges associated with military robotic systems. By examining the design considerations and functionality of the autonomous ground vehicle, the research contributes to the broader understanding of how robotics can enhance military logistics operations, highlighting the potential benefits and addressing the unique obstacles in this context. Christensen, H. I., & Goldberg, K. [6] published in the International Journal of Robotics Research, offers a comprehensive overview of robot perception techniques.

Although not military-specific, the article covers fundamental aspects such as sensing, object recognition, and scene understanding, which are crucial for the development and operation of military robots. By exploring the advancements and challenges in robot perception, this article provides valuable insights into the foundational capabilities required for military robots to effectively navigate, interact, and make informed decisions in complex environments.

III. Problem Statement

In India there are many threats and serious situations at the borders from our neighboring countries. in places like Kashmir, Galwan, Ladakh etc. Also terrorism threats have increased when compared to previous situations and such tensed conditions is experienced in places like Mumbai, Hyderabad and other highly populated metropolitan cities. It is threat for human life to investigate these places filled with havoc conditions. In war fields mainly there is lot of risk of the humans lives at the borders where the tension is and as always been high. There is a threat to humans in combat. Scouting enemies is not easy. Mapping the reconnaissance is quite hard. Surveillance of the war field is problematic due to larger area. To the solve these problems a military based robot wirelessly controlled from a safe distance can be used. An UGV (Unmanned ground vehicle) well designed and fabricated can solve the above stated problems. But the size of the robot should be compact so that the robot is not spotted by the enemy. Recently military used Daksh military robot, developed by DRDO-Defence Research and Development Organisation, in battle fields in place of a soldiers reducing the casualty rates thereby reducing the loss of human life. The main necessity for the soldier keeping the place under control in their surveillance is solved by using the IOT based control robot with live video feed sent as data to the controller giving information about the surroundings. There might be few locations where reaching or going in is quiet risky for the person, instead a robot with wireless control can be sent. Also getting view is difficult but must necessary are obtained by the spy robot. The only drawback is limited by the frequency range under site. War field robots gains its advantage because of the different modes available to the user which makes the robot highly appropriate to be used at different places for security purpose. The robot can be used for detecting any weapons placed, bombs placed and neutralize them, detect snipers and also act as a moving surveillance camera to enhance the security of the place. The robot can also be used to check the presence of any terrorist after the attack has been made which may also bring threat to human lives. The Viper robot developed in this project will be designed and fabricated accordingly being able to serve the military in a very optimal and efficient way. This paper addresses the need for minimizing human casualties in combat situations, especially in areas of high tension and terrorism threats. The robot serves as a solution to investigate and surveil dangerous locations where human presence is risky. It can provide reconnaissance and mapping capabilities in war fields, helping to reduce the risk to soldiers' lives. The use of an IoT-based control system allows for remote operation and live video feedback, enabling the robot to be deployed in areas with limited human accessibility. However, the limited frequency range of the robot's communication system poses a constraint.

IV Methodology

The combat robot, Viper, is based on embedded systems and incorporates various technologies for its operation. It is designed to be compact to avoid detection by the enemy. The robot can be wirelessly controlled using voice commands, hand gestures, or an IoT-based control system. The ESP32 module with an integrated camera provides live video streaming and surveillance capabilities. The robot is powered by solar energy through solar panels and a rechargeable battery. DC motors and a motor driver enable its locomotion. The robot is equipped with firearms that can be controlled by the operator, enhancing its offensive capabilities. Laser lights and headlights improve visibility in different conditions.

The Viper combat robot offers an effective solution for minimizing human casualties in army combats and addressing challenges in war fields. Its embedded systems, IoT technology, and mechanical components provide surveillance, reconnaissance, and communication capabilities. The compact size and wireless control allow for deployment in risky environments. Solar energy powers the robot, and the ESP32 module with an integrated camera enables real-time video streaming. The firearms and other features enhance its combat effectiveness. Overall, the Viper combat robot contributes to the safety and security of soldiers by reducing the need for human involvement in dangerous operations and minimizing casualties. I n this Paper (Project), the main focus is on developing a robot called Viper that can enhance security measures and serve the military in an optimal and efficient way. The capabilities of the Viper robot include detecting and neutralizing weapons and bombs, detecting snipers, acting as a moving surveillance camera, and checking for the presence of terrorists after an attack.

One of the key features of the Viper robot is the ability to control it, its gun, and headlight from a web browser while simultaneously viewing the live video feed. This enables operators to have remote control over the robot's actions and access real-time information from its perspective. Ease of control is another important aspect of the project. The Viper robot should have intuitive controls that are easy to learn and use, ensuring that operators can quickly and effectively maneuver the robot, operate its gun, and control its headlight without any complexity or difficulty. The project also incorporates IoT (Internet of Things) based control. This means that the Viper robot will be connected to a network, allowing it to be controlled and monitored remotely through the internet. IoT technology enables seamless communication and integration between the robot and other devices, facilitating efficient and convenient control mechanisms. By focusing on these aspects, the project aims to develop a highly capable and user-friendly robot that can enhance security measures, protect lives, and assist military operations effectively.

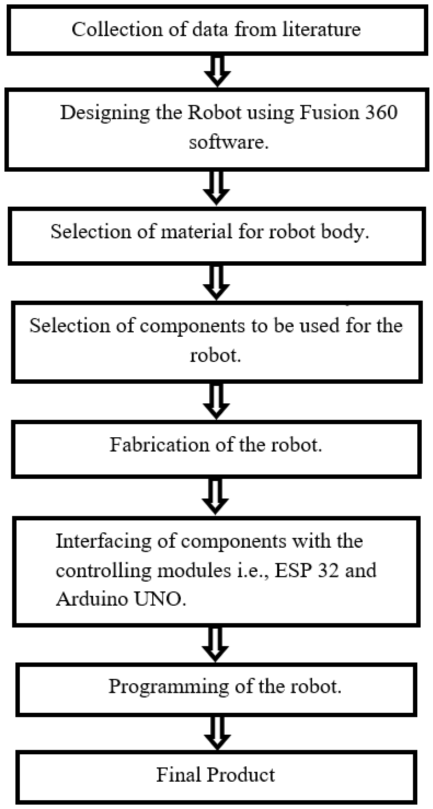
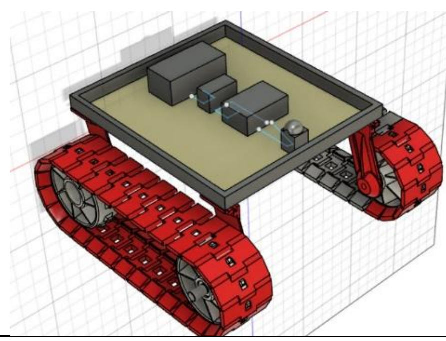


Figure 1: Methodology in developing the Viper robot.

V 3D Design of the robot



First step before implementing any idea is designing of the model, checking for appropriate parameters of geometry and dimensions and also decide about the locations to place the components. We designed 3d model of the robot using Fusion 360 software.

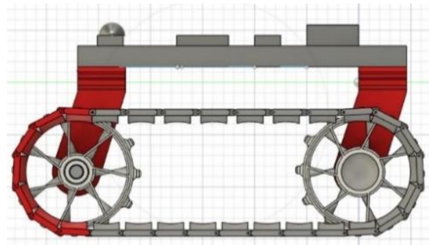


Figure 3: 3D model of the combat robot

a) Components of the Robot

- ESP32 Module with Camera.
- DC Motors.
- Stepper motor.
- L293D driver.
- Rechargeable battery.
- Head light.
- Chain track belt.

b) ESP 32:

Figure 4: ESP 32 Module and Camera

The ESP32 module is indeed a versatile and popular choice for integrating with various components of a robot. Its features, such as easy operation and coding, low cost, and Wi-Fi connectivity, make it suitable for a wide range of applications. By using the ESP32 module, you can interface and control different microcontrollers, sensors, motor drivers, and other peripherals. With the built-in camera support, the ESP32 module can capture images or record video for surveillance or other visual tasks. Its integration with the internet through Wi-Fi allows for remote control, data transfer, and communication with other devices or servers. This capability opens up possibilities for remote monitoring, data logging, or even controlling the robot from a different location.Overall, the ESP32 module serves as a central hub for the robot's operation, allowing for seamless integration and control of various components while providing connectivity options and ease of programming.

- The smallest 802.11b/g/n Wi-Fi BT SoC module.
- Low power 32-bit CPU, can also serve the application processor.
- Up to 160MHz clock speed, summary computing power up to 600 DMIPS.

- Built-in 520 KB SRAM, external 4MPSRAM.
- Supports UART/SPI/I2C/PWM/ADC/DAC.
- Support OV2640 and OV7670 cameras, built-in flash lamp.
- Support image Wi-Fi upload.
- Supports TF card.
- Supports multiple sleep modes.
- Embedded Lwip and Free RTOS.
- Supports STA/AP/STA+AP operation mode.
- Support Smart Config/AirKiss technology.
- Support for serial port local and remote firmware upgrades (FOTA).

Specifications :

- Wireless Module: ESP32-S WiFi 802.11 b/g/n + Bluetooth 4.2 LE module with PCB antenna, u.FL connector, 32Mbit SPI flash, 4MBit PSRAM.
- External Storage: micro SD card slotup to 4GB.
- Camera
- FPC connector.
- Support for OV2640 (sold with a board) or OV7670 cameras.
- Image Format: JPEG(OV2640 support only), BMP, grayscale.
- LED flashlight.
- Expansion: 16x through-holes with UART, SPI, I2C, PWM.
- Misc: Reset button.
- Power Supply: 5V via pin header.
- Power Consumption.
- Flash LED off: 180mA @ 5V.

d)DC Motor:

Figure 5: DC Motor

A DC motor uses electrical energy to produce mechanical energy, very typically through the interaction of magnetic fields and current-carrying conductors. The reverse process, producing electrical energy from mechanical energy, is accomplished by an alternator, generator or dynamo. Many types of electric motors can be run as generators, and vice versa. The input of a DC motor is current/voltage and its output is torque (speed). We are using DC motot with 10kg-cm torque and 10 rpm for the robot able to move the robot in required direction.

Working of DC motor:

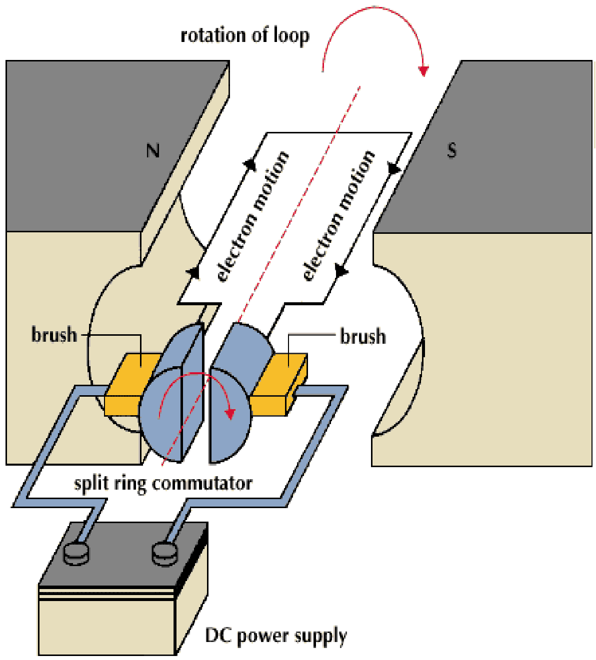


Figure 6: Working of a DC Motor

E) STEPPER MOTOR

A **stepper motor**, also known as **step motor** or **stepping motor**, is a brushless DC electric motor that divides a full rotation into a number of equal steps. The motor's position can be commanded to move and hold at one of these steps without any position sensor for feedback (an open-loop controller), as long as the motor is correctly sized to the application in respect to torque and speed. The ESP 32 camera is fixed on the stepper to provide the rotation of the camera. Nema 17 is used.

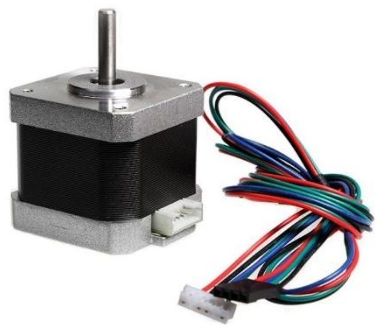


Figure 7: Stepper motor

F) Motor Driver:

The L293 and L293D are quadruple high-current half-H drivers. The L293 is designed to provide bidirectional drive currents of up to 1 A at voltages from 4.5 V to 36 V. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications. It is used to control or drive the DC motors and the stepper motor connected to the robot.

Figure 8: L293D Driver

Features of L293D:

- 600mA Output current capability per channel
- 1.2A Peak output current (non repetitive) per channel
- Enable facility
- Over temperature protection
- Logical “0”input voltage up to 1.5 v
- High noise immunity.
-

G) Battery Power Supply:

12v 1amh battery is used to give the power supply of the robot which can be recharged normally by plugging in to power supply or using solar cells.

Figure 9: Rechargable Battery

g) . LED:

LED bulb is used to provide light at night times for proper vision of the camera. A light-emitting diode (LED) is a semiconductor light source. LEDs are used as indicator lamps in many devices, and are increasingly used for lighting. Introduced as a practical electronic component in 1962, early LEDs emitted low-intensity red light, but modern versions are available across the visible, ultraviolet and infrared wavelengths, with very high brightness.

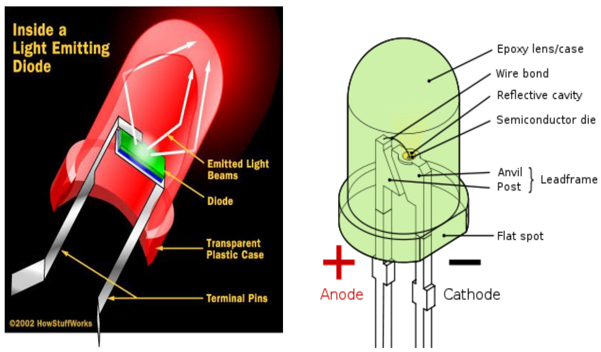


Figure 10: Inside a LED & Parts of a LED

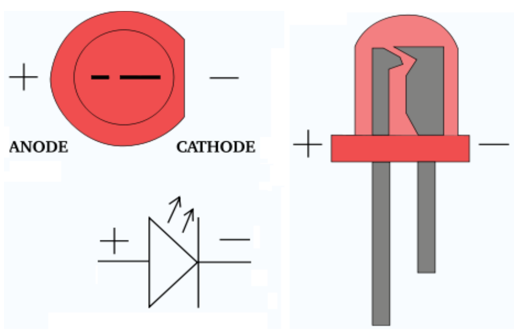


Figure 11: Electrical Symbol & Polarities of LED

h) Chain track belt

Figure 12: Chain track belt Drive   Figure 13: Chain track belt & Wheels.

It seems like you have described a chain track belt drive mechanism for a robot. This mechanism utilizes 52 chain links that are divided into two belts, each consisting of 26 links. The belts are mounted on four wheels, and the entire system is driven by two motors, one for each chain track belt.The wheels have a 6mm shaft hole, which is suitable for the 6mm shaft DC Geared Motors that serve as dead axles. This setup allows the robot to maintain maximum friction contact with the ground, enabling it to move smoothly on various surfaces, including uneven ones, without slipping.

Here is a summary of the components you mentioned:

- 52 x Chain Links with connecting rods: These are used to create the chain track belts, with each belt consisting of 26 chain links. The connecting rods are used to connect the chain links together.
- 4 x Wheels with 6mm shaft hole: These wheels are designed to accommodate the 6mm shafts of the DC Geared Motors. They provide the contact between the robot and the ground.
- 2 x Dead Axles: These are the 6mm shaft DC Geared Motors that serve as the driving motors for the chain track belt mechanism. They provide the power to move the robot.
- Weight: 200.00g: This is the weight of the entire system, including the chain links, wheels, dead axles, and any other associated components.

With this setup, the robot can effectively navigate various terrains while maintaining traction and stability through the use of the chain track belt drive mechanism.

VI Fabrication of the Robot

Figure 14: Working on fabrication of the robot

Frame of the Robot

According to the design made first we made the base frame of the robot made of steel. We welded the steel bars together in shape of a rectangle using arc welding machine. For the bars to weld in proper position and angle to other, they were held together using magnets and welded.

Robot fabrication with hardware

Then wooden board is fitted over the frame which gives base to the components used for the robot. The wooden board is screw fit to the frame with self-drilling screw. The other components like rechargeable battery, ESP 32, camera, stepper motor etc. are fixed on the board. The components are fixed on the robot according to the preferable locations.

The wheel are fixed to the high speed DC motors. The chain drive is fixed over the wheels with required length and fixing of the robot. The chain belt is going to drive the robot in different directions as per required by the user. Later, the all the components are safe guarded with wooden surface surrounding them on the frame of the robot.

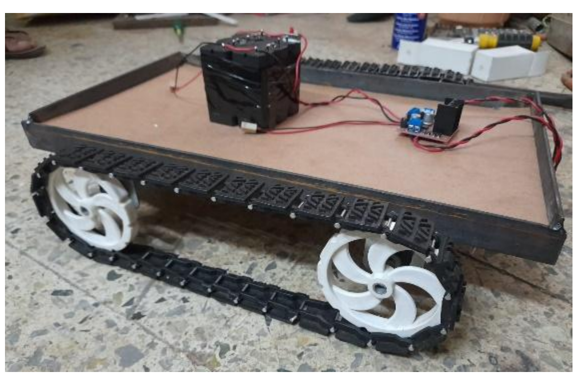


Fig 15: Partially Fabricated Robot with frame and wheel drive.

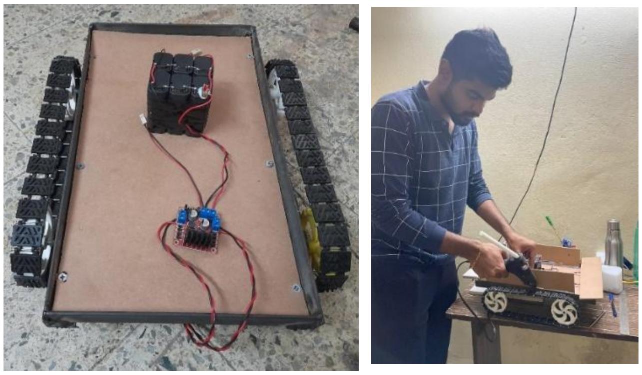
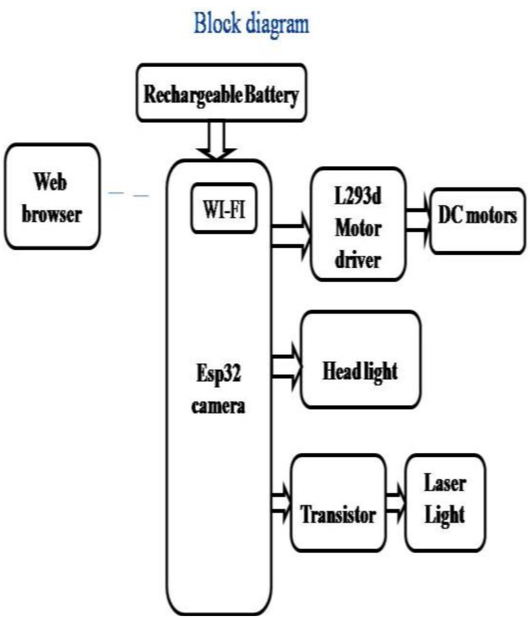


Figure 16: Fabrication and fixing of the components of the Robot.

4.6 Hardware Description



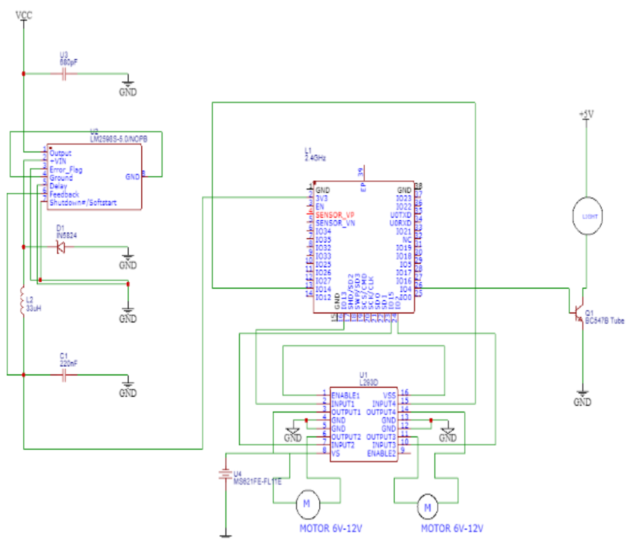


Fig 17: Block diagram of Esp32cam -IoT spy robot **Fig 18: schematic diagram of Esp32cam -IoT spy robot**

Interfacing of components with ESP 32

The above schematic diagram explains the interfacing section of each component with microprocessor and input output modules. The components are glued to the frame surface of robot, so that the components will not freely move which might disconnect and fall of the robot.

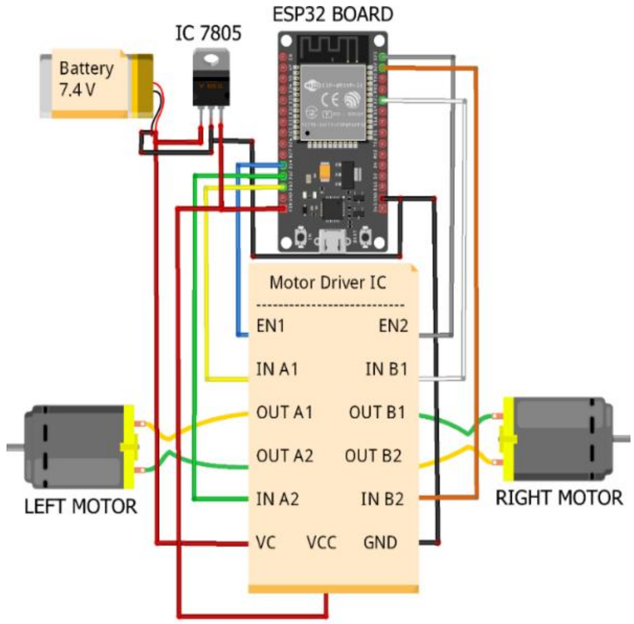


Figure 19: The components of robot: Battery, stepper motor, L298N motor driver , DC motor interfaced to the ESP 32 Module

IIX) Working:

The Paper described is an Esp32cam-based IoT spy robot with a 360-degree camera. The ESP32 module serves as the brain of the robot and executes commands received from the user. It facilitates data transmission between the robot and the controller. The robot's movement is controlled by signals sent to the L293d motor driver, which powers the DC motors connected to the robot's wheels, enabling it to move in different directions. Combat robots play a significant role in modern warfare, providing advantages such as increased situational awareness, remote operation, and the ability to carry out dangerous tasks without exposing human personnel to immediate risks. Their development continues to advance with advancements in technology, enabling improved performance, enhanced capabilities, and increased effectiveness on the battlefield.

The camera is mounted on a stepper motor, allowing for a 360-degree field of vision. The stepper motor is also controlled using the L293d motor driver module. The live data captured by the camera is transmitted to a specific IP address through the internet, enabling users to access the robot and view the video feed from a mobile device or any internet-connected device. The video stream is transmitted to the controlling device, which needs to be within the Wi-Fi range of the robot. The robot is powered by a 12V rechargeable battery.

The control interface is a webpage with clickable buttons for controlling the robot's movement and camera direction. Users can click these buttons using a cursor or touch input on mobile phones and tablets. Additionally, voice command and gesture control can be incorporated for more intuitive operation of the robot. The addition of solar cells would enable the robot to recharge itself while deployed in the field.The advantages of this project include its usefulness in rescue systems, Wi-Fi control for robot movement, and the potential to incorporate a laser gun for shooting enemies. It is also highly sensitive, cost-effective, simple, and reliable. However, a limitation is that the robot requires a Wi-Fi network and operates only within its range.

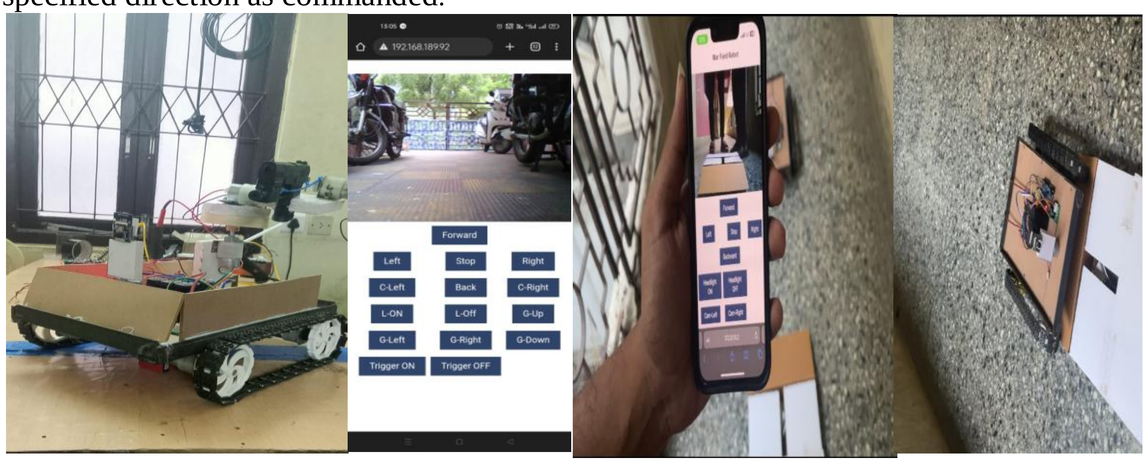
The applications of this project include military use, restricted areas, and night-time patrolling. It can effectively perform scouting operations and provide real-time video feed and control capabilities from portable devices with an internet connection.

Advantages

- It is very useful for rescue systems.
- Wi-Fi control of robot directions and movement.
- To shoot the enemies using laser gun.
- Highly sensitive.
- Low cost
- Simple and Reliable.

IX. Result and discussions

The project "**Esp32cam -IOT spy robot with 360 Camera**" was designed with live streaming ability and controlling the robot using Esp32 module and a web application for operation. The Robot was able to perform scouting operation effectively, when controlled from any portable device with internet connection such as phones, laptops etc. The robot was able to provide the live stream data about the surroundings and was able to be controlled to move in specified direction as commanded.



The prototype of Viper Robot with Viper

X) Conclusions

This paper/ Project has taken careful consideration in integrating all the hardware components and has successfully implemented advanced ICs with the help of growing technology. This ensures that the robot functions optimally and efficiently. The focus on developing a robot that can be used in situations like post-attack scenarios to check for the presence of terrorists or potential threats demonstrates the practical application and relevance of your project. By blending into the surroundings and effectively performing scouting operations, the robot can gather valuable intelligence without putting human lives at risk. This application of the combat robot highlights its potential in enhancing security measures and improving situational awareness in challenging environments. The integration of surveillance capabilities, wireless control methods, and IoT technology allows for remote operation and real-time monitoring, enabling efficient data gathering and analysis. By providing a tool for post-attack assessment and threat detection, your combat robot, Viper, can contribute to ensuring the safety of personnel involved in security operations and aid in making informed decisions based on the collected intelligence.Thus, the project has been successfully designed and tested. One of the major advancements in combat robots is the move towards autonomous operation. Future combat robots could have advanced AI and machine learning capabilities that enable them to operate independently, make decisions in real-time, and adapt to changing situations. This would reduce the need for constant human control and increase the efficiency and effectiveness of the robot's tasks. Future scope of Combat robot With advancements in technology, robotics, and artificial intelligence, combat robots have the potential to play a significant role in defence, security, and humanitarian applications, enhancing mission capabilities, reducing risks to human personnel, and improving overall operational outcomes.

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