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"JEEVAN RAKSHA" for MILITARY GROUND ROBOT USING IOT and ML

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Abstract: This robotic system combines advanced technologies to enhance military security and immediate medical access. It employs AI-driven face recognition for personnel identification, ensuring secure access in critical zones, and laser targeting to detect and track threats. Landmine detection technology allows safe navigation through hazardous terrains, while ultrasonic sensors enable autonomous obstacle avoidance. In emergencies, the robot detects soldier distress, sends an SOS alert, and autonomously provides access to first aid supplies. These integrated capabilities improve battlefield safety, reduce response times, and increase operational efficiency, making the system a versatile and reliable tool for modern military operations.

Keywords: Deep Learning, Face Recognition, Military Robotics and SOS alert.

I. INTRODUCTION

This project focuses on developing a sensor-based automated laser targeting system for border security, utilizing Ultrasonic sensors and microcontrollers to detect and target living objects or movements within a secured range. Traditionally, border security relied on manual surveillance with watchtowers and iron spike wires, placing immense responsibility on soldiers. This system reduces human error by sharing surveillance duties while improving accuracy and efficiency. Integrated face recognition technology further enhances security by identifying and distinguishing specific individuals from stored datasets in real time. Robots equipped with cameras and sensors can autonomously detect intruders, navigate terrain, and perform tasks like laser target gun[[1]], metal detection. These AI-powered systems are designed to reduce human losses during military operations and improve situational awareness in high-risk areas. Although military robots raise ethical concerns, their capability to replace humans in repetitive, dangerous tasks ensures improved safety and operational efficiency. By combining automation, robotics, and ML, this model provides a robust, reliable, and scalable solution for modern border security challenges.

II. METHODS AND MATERIALS

1. **Hardware Setup:** Begin by assembling the hardware components. Attach a Raspberry Pi[[2]] board to the robot chassis, connect a high-quality camera module for surveillance, and Detects Soldier's injury, sends SOS message and opens the door for first aid kit ensuring immediate access to medical supplies.
2. **Power Supply:** Choose a robust power supply system for the Raspberry Pi robot. Consider using rechargeable batteries that provide sufficient power to support continuous operation in the field. Implement power management mechanisms to optimize energy consumption.
3. **Camera Integration:** Configure the camera module to capture high-resolution images. Set up the necessary libraries and software to enable real-time streaming[[6]] of the surveillance footage to a central processing unit on the Raspberry Pi.
4. **Sensor Data Acquisition:** Implement code to read Ultrasonic and IR sensors. Ensure accurate readings and consider calibrating the sensors for optimal performance. Establish a data logging mechanism to store historical health data for each soldier and border security[[3]].
5. **ML Model Integration:** Develop or employ a pre-trained machine learning model capable for detecting soldier injuries, sends SOS message and automatically opens the door for quick access to medical supplies. Integrate this model into the Raspberry Pi system, ensuring it can process the real-time data from the sensors.
6. **Communication Setup:** Implement a communication system to send data to a central server or cloud platform. Utilize protocols such as MQTT or HTTP for secure and efficient data transmission.

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Set up a reliable network connection to ensure continuous communication, even in challenging environments and surveillance of border security[**Error! Reference source not found.**].

7. **Emergency Alert System:** Design an emergency alert system that can be triggered based on predefined health thresholds or manual activation. Include GPS modules to retrieve the robot's location and embed this information in the alert message. Utilize messaging services or satellite communication for reliable transmission of alerts.

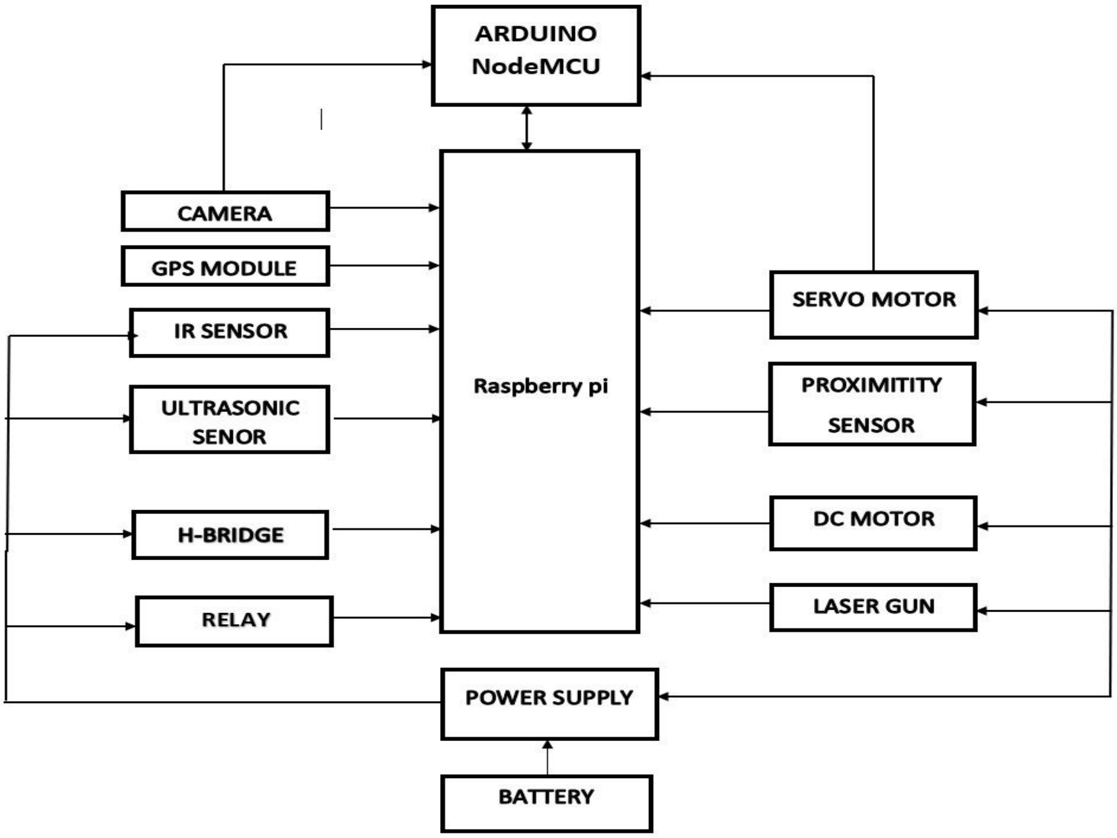

Fig 1: Schematic View of Military Robot

This is a block diagram illustrating the components and their interconnections.

Key Components:

1. **Main Controller**:
- **Raspberry Pi** acts as the central processing unit managing inputs, outputs, and communication.
- **Arduino/NodeMCU** interfaces with additional sensors and modules for specific functions.

2. **Sensors and Modules**:
- **Camera**: Captures video or images for face recognition and surveillance[[4]].
- **IR Sensor**: Detects intruders or obstacles based on infrared signals.
- **Ultrasonic Sensor**: Measures distance to obstacles for autonomous movement.
- **Proximity Sensor**: Detects nearby objects or obstacles.

3. **Actuators**:
- **DC Motor**: Drives the robot's wheels for movement.
- **Servo Motor**: Controls mechanisms like the first-aid box opening or other robotic arms.
- **Laser Gun**: Engages threats based on intruder detection.

4. **Additional Modules**:
- **Relay**: Controls high-power devices like motors or the laser gun.
- **H-Bridge**: Motor driver module for controlling the DC motor's direction and speed.

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5. **Power System**:
- **Battery**: Powers the entire system.
- **Power Supply**: Regulates voltage to ensure proper power delivery to all components.

6. **First-Aid Box**: Automated opening mechanism using a servo motor when detecting soldier injuries.

Connections:
- Sensors and actuators are interfaced with the **Raspberry Pi**, which processes the data.
- The **Arduino/NodeMCU** assists in managing servo motor.
- Power is supplied to all components through a regulated **power supply unit**.

Materials:
1. **Hardware:**
- Raspberry Pi 4
- Ultrasonic Sensor
- Laser Gun
- Servomotor
- Relay
- Camera
- DC Motors
- L293D Motor Drive
- Proximity Sensor
- Power Supply Module
- GPS Module
- Arduino NodeMCU(ESP8266)

2. **Software:**
- Arduino IDE
- Raspbian OS
- Open CV
- Python

III. IMPLEMENTATION

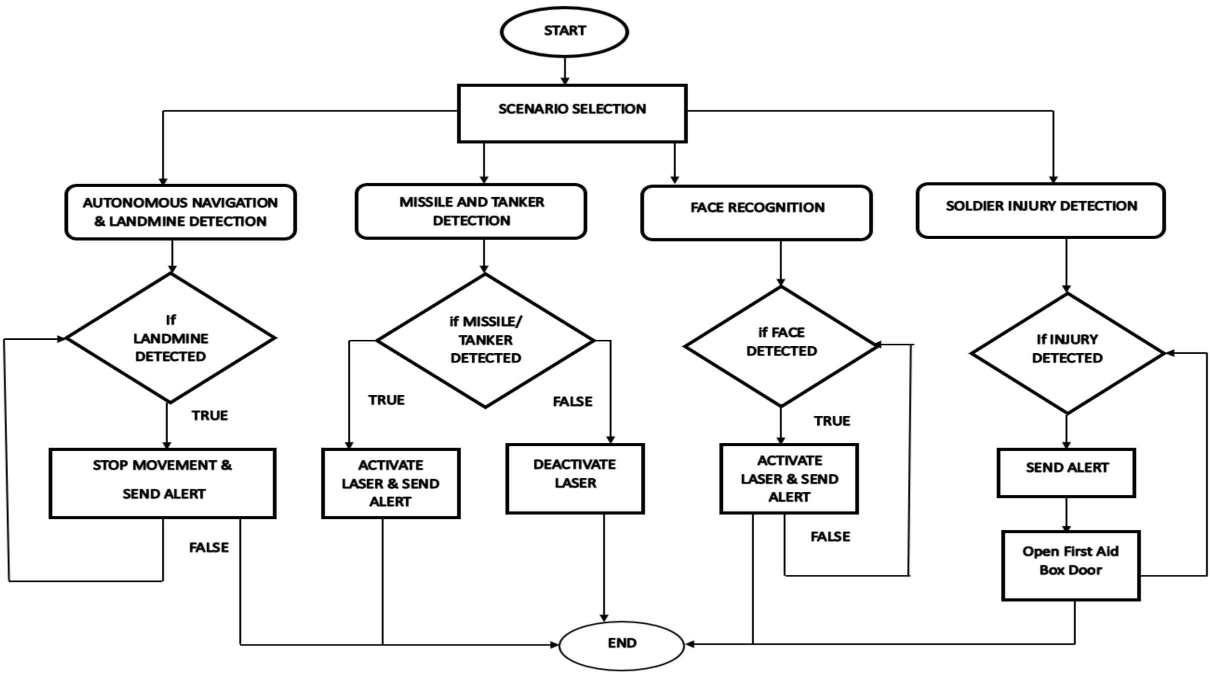

Fig 2: Flow of Military Robot

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1. Face Detection

CNN (Convolutional Neural Network) and YOLO (You Only Look Once) are two key algorithms used for image recognition, intruder detection, and real-time object tracking. These algorithms help the robot process and interpret visual data, enabling it to identify and react to specific objects or threats in its environment.

- CNN (Convolutional Neural Network): A Convolutional Neural Network (CNN) is a class of deep learning algorithms commonly used for image classification and feature extraction. CNNs are particularly effective at analyzing visual data, such as images or video, by detecting patterns or features at different levels of abstraction. In the case of the Jeevan Raksha robot, a CNN would be trained to recognize various objects, faces, or anomalies in the robot's camera feed. The network applies filters to the image, progressively identifying key features such as edges, shapes, and textures, then combining them to recognize more complex patterns or objects. CNNs are typically used for tasks like facial recognition, intruder detection, or identifying specific objects or people in the robot's field of view.

- YOLO (You Only Look Once): YOLO (You Only Look Once) is a real-time object detection algorithm that is widely used for locating and classifying multiple objects in images and video streams. Unlike traditional object detection algorithms, which may require multiple passes over an image to identify and label objects, YOLO performs detection in a single forward pass through the network, making it extremely fast and suitable for real-time applications. YOLO divides an image into a grid and predicts bounding boxes and class probabilities for each grid cell. This makes YOLO particularly suitable for applications where fast and accurate detection of multiple objects is necessary, such as threat detection or monitoring large areas in military scenarios. In the project, both CNN and YOLO would be used together to enhance the robot's ability to autonomously detect and engage threats. For instance, YOLO could quickly identify objects in the robot's visual feed[[7]], such as intruders, obstacles, or suspicious movements. The CNN could then analyze the identified objects further, allowing the robot to verify and classify the threat, such as recognizing human faces or specific military equipment. Combined, these algorithms allow the robot to perform real-time surveillance, improve its decision-making, and take actions like engaging with a laser gun or sending alerts to human operators.

2. Obstacle Detection

Fig 3: Ultrasonic sensor for Obstacle Detection

IR sensor module is used for obstacle detection. It is connected to Raspberry pi and it detects the obstacles in the straight-line path. If the obstacle is detected it sends the signal to the Raspberry pi and the direction of the rover will be changed according to which it is programmed. An infrared sensor is an electronic device, that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measure only infrared radiation, rather than emitting it that is called as a passive IR sensor. Infrared Obstacle Sensor Module has built-in IR transmitter and IR receiver that sends out IR energy and looks for reflected IR energy to detect presence of any obstacle in front of the sensor module. The sensor has very good and stable response even in ambient light or in complete darkness.

3. Image Processing

Web camera is used for capturing the images, of about 2 per second instead of sending a greater number of images as it increases the network traffic. The image processing is done in raspberry pi using C or python instead of MATLAB. Only the images are taken and processed instead of video as the images are enough. We can view the images in the remote host which is sent through internet. Multiple object detection and trailing in outside setting may be a difficult task owing to the issues raised by less lighting conditions, variation in human poses, shape, size, clothing, etc. In case if the image is dark, the exposure will be increased with the image processing techniques[[8]] and similarly vice versa. During motion, the surveillance system detects other moving objects and identify them as humans, animals, vehicles. For this purpose, Image can be split into several sections and comparison of the segments is performed.

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4. Frame Capturing

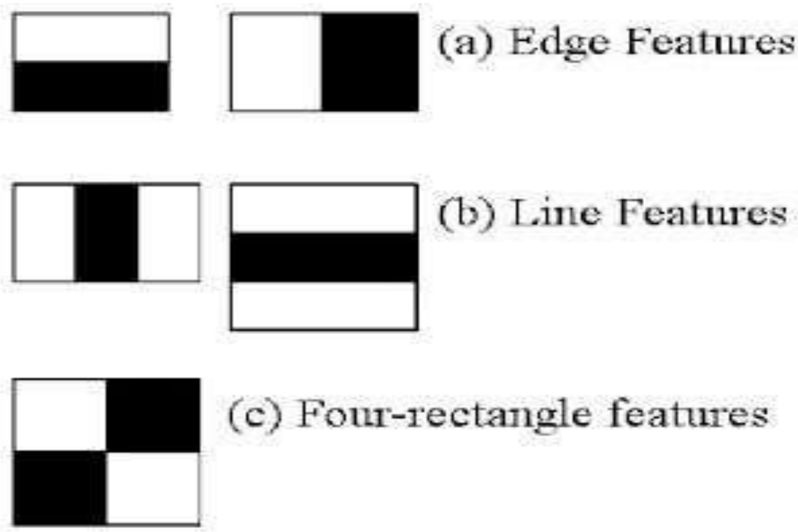

Fig 4: Pixels

The first step of the proposed EBCM application is the initialization. After taking a short video of the participant's face using the front camera of the Samsung mobile. A process Frame method will be used to create the frames from the captured video. Afterwards the colored frames will be converted to gray scale frames by extracting only the luminance component as shown in figure.

Ever since this tiny, less than credit-card-sized computer, Raspberry Pi zero w, it's appeared in the market, it has caught the imagination of every electronics and computer hobbyist around the world. The powerful Linux operating system combined with 40 input- output (I/O) pins can do many amazing things out-of-the-box. This article explains how to interface a USB camera and Wi-Fi with Raspberry Pi. It also to capture the image.

- Install webcam.
- Basic image capturing usage.
- Set specify a resolution.
- Set full a resolution with no banner.
- Bash script.
- Python with Bash script.
- Time lapse using CRON.

5. Laser Module

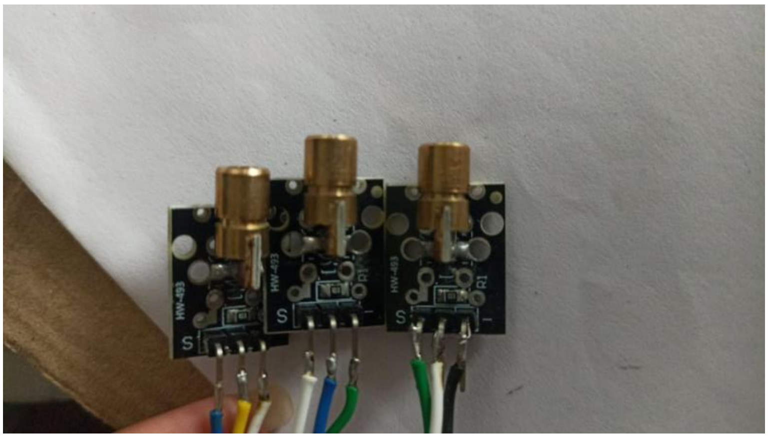

Fig 5: Lasers

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Depending on the input received from camera if face recognition fails then immediately Pi Initiates Motor and initializes the laser to shoot the unauthorized entered person. In the circuit diagram the gun firing control mechanism is replaced with LED. When the LED will not glow, means no object sensed by the sensor, so the gun will not fire means the LED is off. When the port will be high on the object detection by the sensor, the transistor LED on means the object completely destroyed by targeting gun. a device that generates an intense beam of coherent monochromatic light (or other electromagnetic radiation) by stimulated emission of photons from excited atoms or molecules. Lasers are used in drilling and cutting, alignment and guidance, and in surgery; the optical properties are exploited in holography, reading barcodes, and in recording and playing compact discs.

6. Getting Location

GPS module is connected to the Raspberry pi in order to find the current location of the bot. The GPS statement is being sent as a set of packets of data, so that it can be decoded to find International Journal of Pure and Applied Mathematics Special Issue 70 required data (i.e.) direction, timing, location and lot more. Each electric panel contains switches that redirect electricity. An electrical switchboard is a single large panel or can be a combination of electrical panels on which switches and other power control equipment are mounted. The main purpose of the board is to control the flow of power. It divides the main current supplied to it into several smaller chunks and distributes it to the devices. In precise, switchboards supply power to transformers, panels, and other equipment and from there power further gets distributed. The GPS statement we receive should be sent by at least three or more satellite such that it becomes valid.

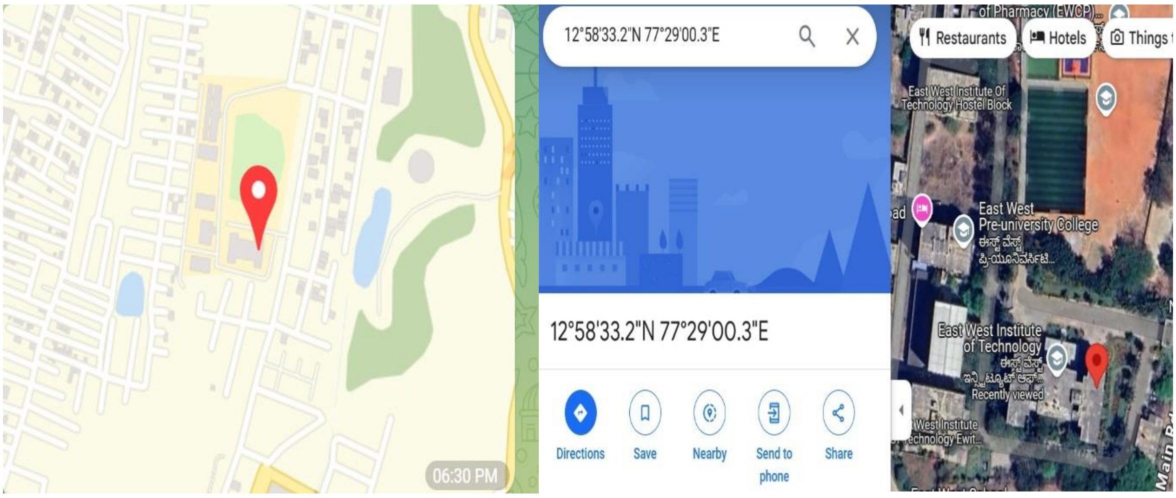

Fig 6: Location

7. Rover Movement

Fig 7: Rover Movement Chain Wheel

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Raspberry pi is used for two modes of action. The Remote-Control mode, where the rover is controlled manually from remote International Journal of Pure and Applied Mathematics Special Issue 69 device through the web server connecting it with an internet connection[[9]]. This is done when the signal is passed from the Raspberry Pi and being the master controls the movement of the rover. The movement of the robot is controlled with keys for all four directions besides with start and stop function in the web server. During autonomous mode the rover is programmed through the Raspberry Pi while the ultrasonic sensor detects in case of any obstacle and changes its direction accordingly.

A direct current, or DC, motor is the most common type of motor. DC motors normally have just two leads, one positive and one negative. If you connect these two leads directly to a battery, the motor will rotate. If you switch the leads, the motor will rotate in the opposite direction. To control the direction of the spin of DC motor, without changing the way that the leads are connected, you can use a circuit called an H-Bridge.

An H bridge is an electronic circuit that can drive the motor in both directions. H-bridges are used in many different applications, one of the most common being to control motors in robots [10]. It is called an H-bridge because it uses four transistors connected in such a way that the schematic diagram looks like an "H." You can use discrete transistors to make this circuit, but for this tutorial, we will be using the L298 H-Bridge IC. The L298 can control the speed and direction of DC motors and stepper motors and can control two motors simultaneously. Its current rating is 2A for each motor. At these currents, however, you will need to use heat sinks.

8. Capturing Image

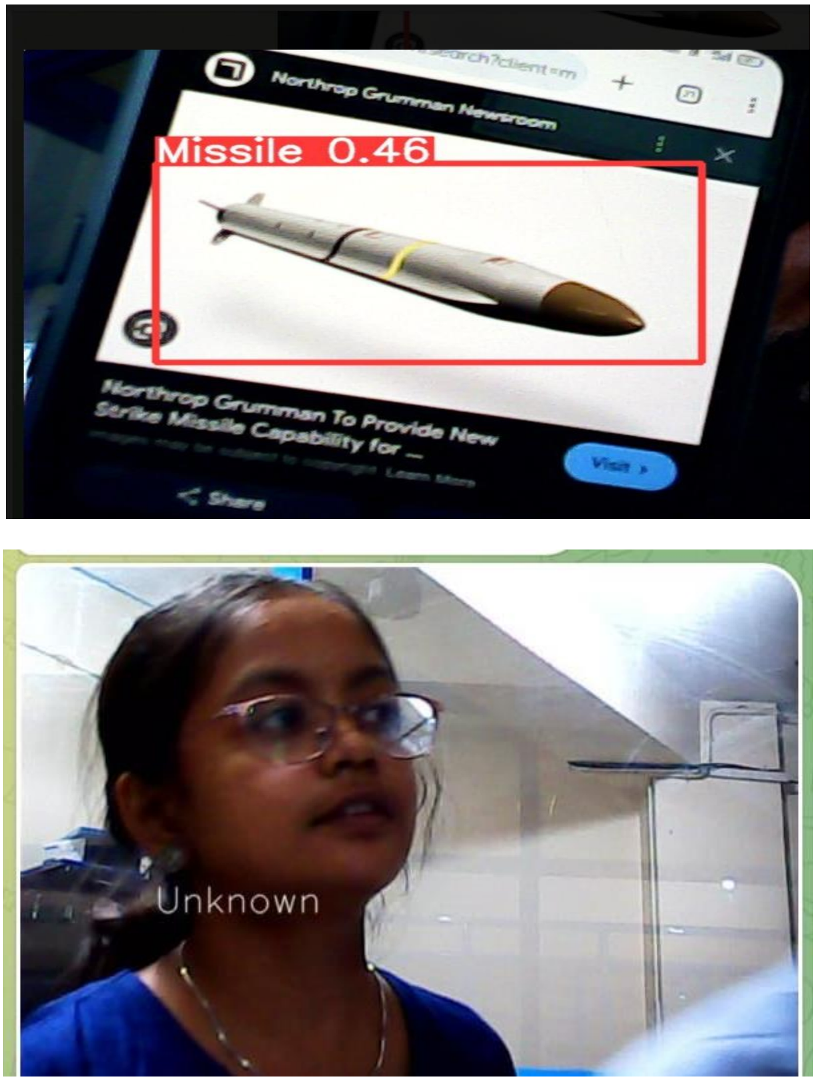

Fig 8: Image Capturing

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A webcam is a video camera which feeds its images in real time to a computer or computer network, often via USB, Ethernet or Wi-Fi. Their most popular use is the establishment of video links, permitting computers to act as videophones or video conference stations.

This common use as a video camera for the World Wide Web gave the webcam its name. Other popular uses include security surveillance and computer vision. The Webcams are known for their low manufacturing cost and flexibility, making them the lowest cost form of video telephony. They have also become a source of security and privacy issues, as some built-in webcams can be remotely activated via spyware.

To take pictures in 0.025s with picamera you'll need a frame-rate greater than or equal to 80fps. The reason for requiring 80 rather 40fps (given that 1/0.025=40) is that currently there's some issue which causes every other frame to get skipped in the multi- image encoder so the effective capture rate winds up as half the camera's framerate.

The Pi's camera module is capable of 80fps in later firmware’s (see camera modes in the picamera docs), but only at a VGA resolution (requests for higher resolutions with framerates >30fps will result in upscaling from VGA to the requested resolution, so this is a limitation you'd face even at 40fps). The other problem you'll likely encounter is SD card speed limitations. In other words, you'll probably need to capture to something faster like a network port or in-memory streams (assuming all the images you need to capture will fit in RAM).

IV. RESULTS AND CONCLUSION

MODEL OTLOOK

Fig. 9: Final Model Outlook

1. **Face Recognition (Known and Unknown Identification):**

- Detection: The robot achieved in detecting and distinguishing between known personnel (authorized soldiers) and intruders (unknown individuals) using a pre-trained face recognition model.
- Response: On detecting an unknown face, the robot activated its alert system, notifying the command centre in real-time.

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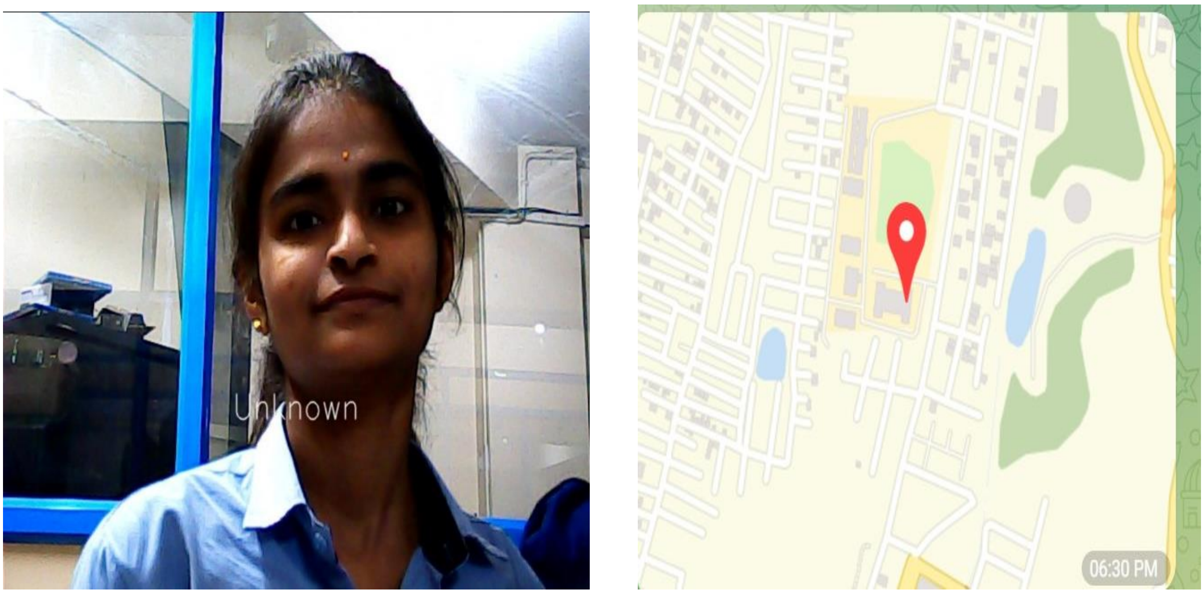

Fig. 10: Unknown Person Detection

2. **Missile and Tanker Detection with Laser Response:**

- Detection: Successfully identified missile launchers and tankers using object detection models.
- Response: Upon detecting threats, the robot automatically engaged them using a mounted laser gun, neutralizing potential hazards. The precision targeting system ensured minimal error in threat engagement.

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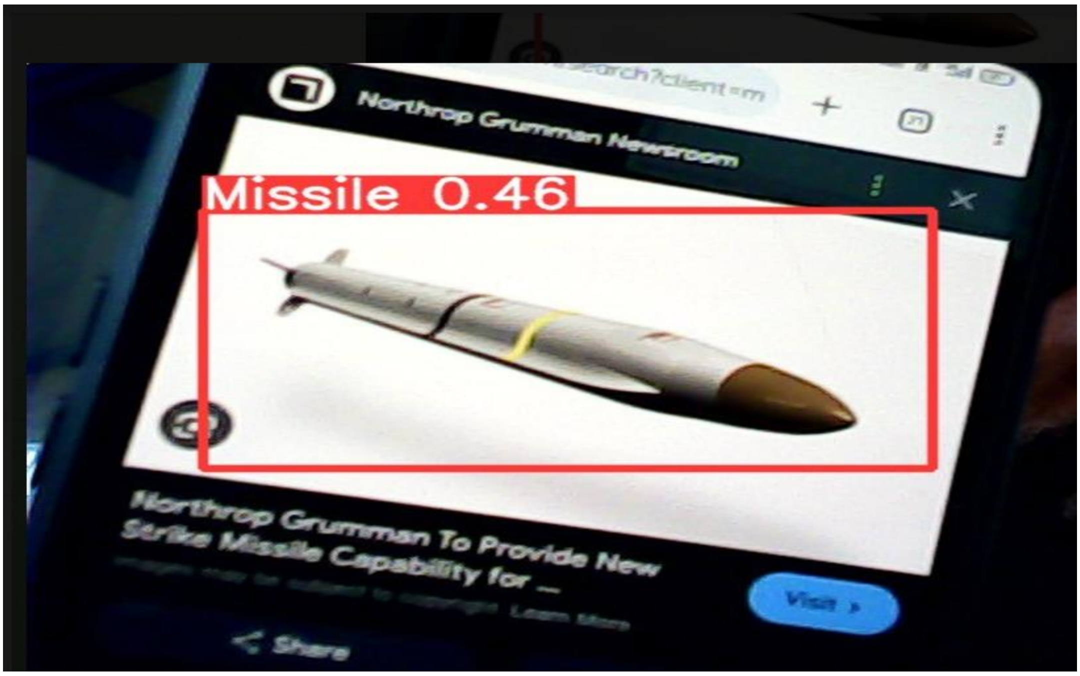

Fig. 11: Tanker and Missile Detection

3. **Landmine Detection with SOS Alert:**

- Detection: Equipped with specialized sensors, the robot effectively detected landmines.
- Response: When a landmine was detected, the robot halted, marked the location, and sent an SOS alert to the operator. This information was accompanied by the location co-ordinates to aid in further neutralization.

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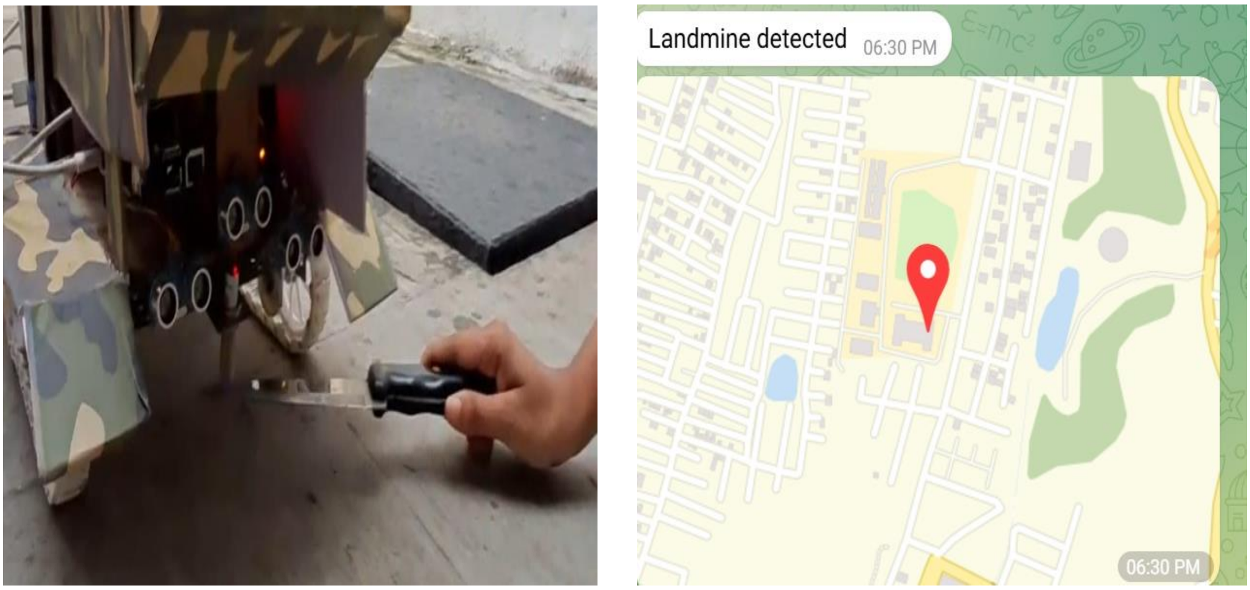

Fig. 12: Landmine Detection

4. **Soldier Injury Detection with SOS and First Aid Kit Access:**

- Detection: Detects the soldier injuries through camera.
- Response: On detecting an injury, the robot: Sent an SOS alert with the soldier's location to the command centre.

Opened its first aid kit compartment, ensuring immediate access to medical supplies.

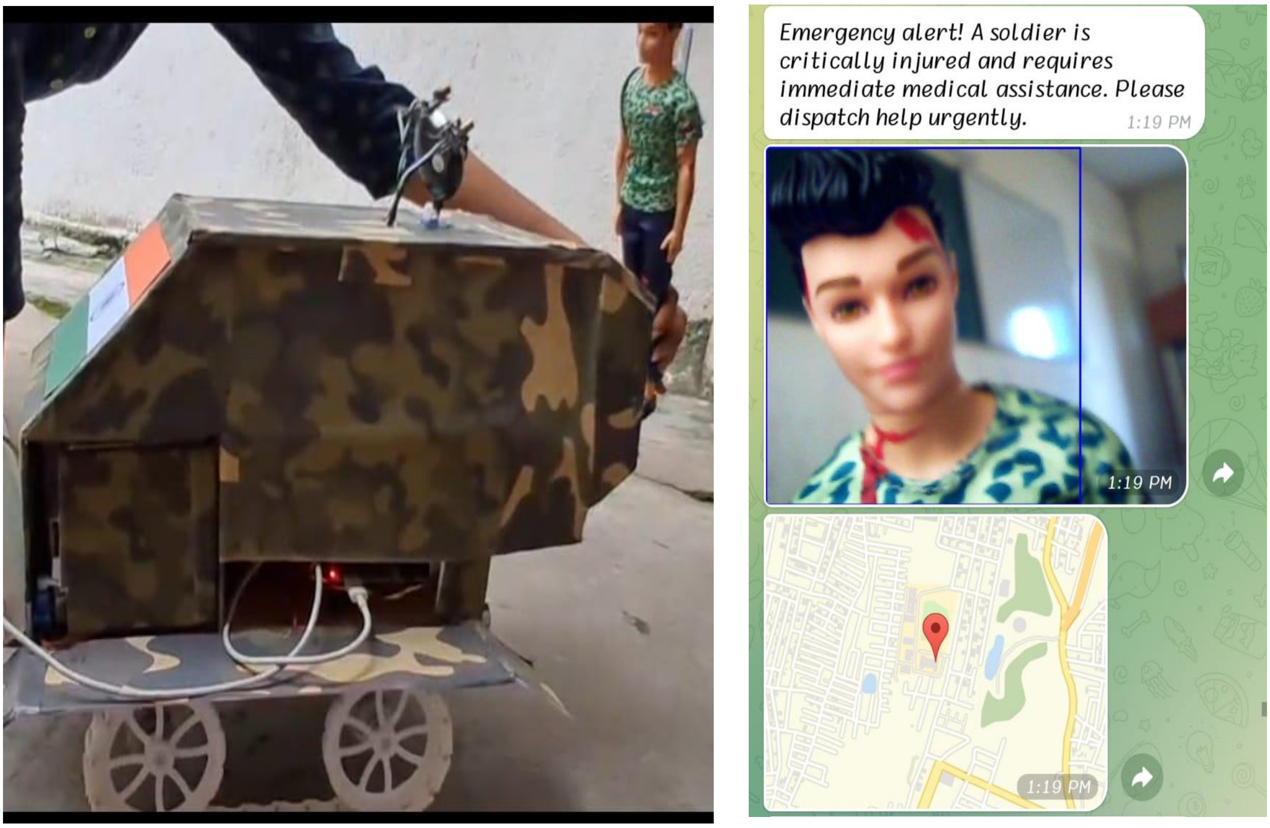

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Fig. 13: Soldier Injury Detection

V. DISCUSSION

1. **Face Recognition for Intruder Detection:** The integration of a pre-trained face recognition model enabled identification of known and unknown individuals. This ensures enhanced security in military zones, preventing unauthorized access. This capability reduces human dependency in monitoring and ensures quicker identification of threats, improving response times during critical situations.

2. **Missile and Tanker Detection with Laser Response:** Object detection models were successfully deployed to identify large threats like missiles and tankers. The robot's laser gun response was both precise and effective in neutralizing these threats autonomously. Autonomous threat engagement minimizes human exposure to hostile environments while ensuring immediate countermeasures, which is critical during combat scenarios.

3. **Landmine Detection and SOS Alert:** The robot demonstrated reliable landmine detection, significantly reducing the risk of casualties in dangerous terrains.

4. **Soldier Injury Detection and First Aid Kit Access:** The robot's injury detection system accurately identified wounded soldiers through motion analysis. The automated SOS alerts provided real-time updates to command centres. Additionally, the first aid kit access ensured immediate support until further medical assistance arrived. This feature not only saves lives but also boosts morale among troops, knowing there is immediate support in the event of injuries.

5. **Technological Implications:** The success of the Jeevan Raksha robot underscores the transformative potential of IoT and ML in military operations by enhancing autonomy, enabling data-driven decision-making, and improving cost-effectiveness. Its ability to operate independently reduces the burden on human operators, while real-time data collection provides actionable intelligence for informed decisions. Additionally, by preventing injuries and ensuring mission success, the system significantly contributes to cost savings in both human and material resources.

6. **Challenges and Future Work:** Future iterations of the Jeevan Raksha robot should focus on enhancing environmental adaptability for reliable performance in extreme conditions, upgrading its threat response to handle multiple threats with higher precision. We have employed this robot using trained ML model, in future this can be developed using spontaneous non-invasive Brain Machine Integration. With high-end processors like NVIDIA Jetson and Intel i7/i9, the robot can process faster and more accurate.

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VI. CONCLUSION

A serious problem that has arisen in this century is attacks and smuggling. Due to improper and less security near border area. It is a major challenge on our part to project to detect these smugglers, intruders, terrorists and other illegal activities breaking the security. Since the border area is so large that effective patrolling is not possible and it require a very large amount of manpower, there has to be some kind of security system which can effectively provide more security. A border security system would cease all kind of illegal movements near the border and help BSF in controlling these activities in a better and more precise way. The border area is so large that effective patrolling is not possible and it require a very large amount of manpower, so this kind of security system which can effectively provide more security. In future the system can be implemented using face recognition, so that the system will work more efficiently. The surveillance robot serves as a security monitoring device which replaces the human security at less critical areas where humans are really not necessary without compromising security. The outcome of this project deals with the recorded evidences of images when an unusual activity occurs and alerts to the remote host immediately. Henceforth, by enhancing the capabilities of these technologies and integrating them, we hope to introduce the 'Motion Detection' system and to contribute to the current security system. This system would be an alternative for expensive security systems being used in the present day. This system does not require any special modifications to the infrastructure where installation is required and can be implemented without any hassle.

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I am also grateful to the technical staff and colleagues who helped with the hardware setup, troubleshooting, and system integration. Their collaborative efforts and suggestions were crucial in overcoming several challenges faced during the development of the project.

A special thanks to my family and friends for their unwavering support and motivation, which kept me focused and driven throughout this journey.Lastly, I would like to acknowledge the resources and tools provided by the university and the online platforms, which played a significant role in enhancing my learning experience and ensuring the project’s success.

This project would not have been possible without the contributions of all these individuals, and I am truly grateful for their support.

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