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ON

"Intelligent Rover: An IoT Based Smart Surveillance Robotic Car for Military"

A report submitted in the partial fulfillment of the requirements for the award of the degree of

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Submitted by

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CERTIFICATE

Certified that the **Technical Seminar (18CSS84)** entitled **INTELLIGENT ROVER: AN IOT BASED SMART SURVEILLANCE ROBOTIC CAR FOR MILITARY** carried out by **Suryansh Kumar Srivasatava (1SG20IS100),** bonafide students of 8th semester, Department of Information Science & Engineering carried out at our college **Sapthagiri College of Engineering**, Bengaluru in partial fulfillment of the award of **Bachelor of Engineering** in **Information Science & Engineering** of the **Visvesvaraya Technological University,** Belagavi during the year 2023-24. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the Report deposited in the departmental library. The technical seminar report has been approved as it satisfies the academic requirements in respect of Technical Seminar prescribed for the said Degree.

Signature of the Guide Prof. Gayathri R Assistant Professor	Signature of the Co-Ordinator Prof. Chaithanya T. Assistant Professor	Signature of the HOD Dr. H. R. Ranganatha Professor & HOD

ABSTRACT

Intelligent Rover is a military based surveillance robotic car that is trained to detect human beings and weapons while moving according to the user need. Intelligent Rover is controlled via smart phone and uses raspberry pi and Arduino to achieve the mission of the rover. It captures live video using picamera and streams it, which can be viewed from a webpage. The camera can be swiveled horizontally and vertically. Intelligent Rover employs yolo V3 algorithms to detect weapons and persons individually. When it detects any objects, it notifies the user via an email. The DC motors connected to the wheels sets the rover into motion that is controlled through the webpage from smartphone or any other devices. This robotic automobile is also capable of detecting metals via sensors and notifies the same to the user via email.

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CHAPTER 1

INTRODUCTION

1.1 Overview

The internet of things (IoT) embeds software, sensor, processors and other devices and technologies that are utilized to link and share data and information from one device to the other with the help of the internet. The world of IoT does not have any extremities and extends to a wide range of applications that are advantageous for the mankind by predominantly safeguarding them and their properties.

The advent of IoT has succored humans in numerous areas spotlighting security in military field. There have been different systems and devices for the surveillance of the intruders, weapons and metals. But most of such devices are very complex in their design and are very expensive. [1] shows an IoT based smart sniper that is automated to detect enemy and extinguish them by firing manually. [2] presents a device that is efficient in capturing, extracting and processing the information existing in the war field and transferring these in the form of a caution or an alert to the troopers. [3] conveys a military based object detection algorithm using hyperspectral imagery (HSI).

In this paper, we present an intelligent surveillance robotic rover that operates on the principles of IoT. This robotic device is used for the surveillance in the military field with the potential to detect guns, people and metal, live stream these and notifying the user about the same through an email. This device assists the troopers in detecting the enemy and traps using yolo V3 algorithm and sensors, thereby saving their precious lives. The scene of detected object is saved for future reference. The predominant feature of the rover is that it can be controlled according to the user needs by steering the car left, right, forward and backwards via smartphone. The camera can be swiveled horizontally and vertically. The angle of tilting and panning can be varied according to the user. Fig. 1 depicts the features of intelligent rover asa block diagram. We organize this paper in five sections. In section II, we discuss about the detection of guns and persons.

1.2 History

The research paper "Intelligent Rover: An IoT Based Smart Surveillance Robotic Car for Military" was authored by Safa Mohammed Sali and Dr. K.R. Joy from Sahrdaya College of Engineering and Technology in India[1]. The paper was published in the 2023 2nd International Conference on Computational Systems and Communication (ICCSC) and outlines the creation of an intelligent surveillance robotic car, called the Intelligent Rover, for military applications.

The Intelligent Rover is designed to detect human beings and weapons while moving according to the user need. It is controlled via smart phone and uses raspberry pi and Arduino to achieve the mission of the rover. The rover captures live video using picamera and streams it, which can be viewedfrom a webpage. The camera can be swiveled horizontally and vertically.

The Intelligent Rover employs yolo V3 algorithms to detect weapons and persons individually. When it detects any objects, it notifies the user via an email. The rover is also capable of detecting metals via sensors and notifies the same to the user via email.

The paper is organized into five sections. Section II discusses the detection of guns and persons, while section III presents the hardware and other necessary technologies for the detection of metals. Section IV outlines the swiveling technique of the camera, movement of the rover, and unification of the features to be controlled via flask. The paper also includes results and a conclusion.

The Intelligent Rover is notable for its use of IoT technology and yolo V3 algorithms for object detection, as well as its potential applications in military surveillance and security. The authors discussthe detection of guns and persons in section II of the paper, and present the hardware and other necessary technologies for the detection of metals in section III. Section IV outlines the swiveling technique of the camera, movement of the rover, and unification of the features to be controlled via flask. The paper alsoincludes results and a conclusion.

The Intelligent Rover is notable for its use of IoT technology and yolo V3 algorithms for object detection, as well as its potential applications in military surveillance and security.

1.3 Leveraging IoT for Advanced Military Surveillance with theIntelligent Rover

The integration of Internet of Things (IoT) technology in the development of the Intelligent Rover has revolutionized military surveillance capabilities. By harnessing IoT, the Intelligent Rover can efficiently detect human beings, weapons, and metals, enhancing security measures in military operations. The utilization of IoT enables seamless control of the rover via smartphones, real-time video streaming, and automated notifications through email alerts. This innovative approach not onlyenhances surveillance efficiency but also ensures rapid and accurate detection of potential threats, ultimately bolstering military defense strategies.

The system's ability to detect human beings, weapons, and metals in real-time, coupled with its seamless control via a smartphone interface, exemplifies the convergence of advanced technologies to enhance military operations. The integration of object detection algorithms like yolo V3, with its speed and accuracy, empowers the rover to swiftly identify potential threats and notify users promptly,thereby bolstering security measures.

1.4 IoT-Enabled Control and Monitoring

The Intelligent Rover's IoT integration extends to its control and monitoring capabilities. Users can control the rover's movement and camera angles via a webpage, allowing for precise and flexible surveillance. Furthermore, the device can be transformed into an IoT vehicle using the flask micro web platform, enabling complete control via a webpage accessible through a smartphone.

In conclusion, the Intelligent Rover demonstrates the potential of IoT in enhancing military surveillance and security. By leveraging advanced technologies like YOLO V3 and metal detection sensors, this innovative device offers reliable, real-time surveillance and threat detection, providing military personnel with the tools they need to maintain situational awareness and ensure the safety of their operations.

The Intelligent Rover is an IoT-based smart surveillance robotic car for military applications. It isdesigned to detect human beings and weapons while moving according to the user's needs. The rover is controlled via smartphone and uses Raspberry Pi and Arduino to achieve its mission. It captures live video using picamera and streams it, which can be viewed from a webpage. The camera can be swiveledhorizontally and vertically.

1.5 Objectives

1. Object Detection with YOLO V3 Algorithm: The Intelligent Rover utilizes the YOLO V3 algorithm for object detection, specifically designed to detect weapons and persons individually. YOLO V3 is a fast and accurate object detection algorithm that enables real-time detection of potential threats.

2. Metal Detection Capability: The rover is equipped with sensors capable of detecting metals within a range of 60mm using an inductive proximity NPN sensor. This feature enhances the rover's ability to identify metallic objects, providing additional security measures.

3. Live Video Streaming: The Pi camera on the rover captures real-time video, which is then live-streamed using the YOLO V3 algorithm. This live streaming feature allows users to monitor the surroundings of the rover remotely via a webpage, enhancing situational awareness.

4. Rover Movement Control: The movement of the rover is controlled by two DC motors for the front wheels and two for the rear wheels, driven by an L293-D H connected to Arduino Nano. This setup enables precise control over the rover's movement, allowing it to navigate various terrains effectively.

5. Camera Swiveling Mechanism: Two servo motors are employed to swivel the camera horizontally and vertically, controlled by Arduino Nano. This mechanism provides flexibility in adjusting the camera angles, enhancing the rover's surveillance capabilities.

6. Flask Micro Web Control: The Intelligent Rover is transformed into an IoT vehicle with controls accessible through a webpage using the Flask micro web platform. This feature allows users to control the rover's functions, such as object detection, camera swiveling, and movement, remotely via a smartphone or any connected device, enhancing user interaction and operational efficiency.

7. Live Video Streaming: The Pi camera on the rover captures real-time video, which is then live-streamed using the YOLO V3 algorithm. This live streaming feature allows users to monitor the surroundings of the rover remotely via a webpage, enhancing situational awareness.

CHAPTER 2
LITERATURE SURVEY

2.1 Introduction

The literature survey in the research paper "Intelligent Rover: An IoT Based Smart Surveillance Robotic Car for Military" explores the integration of Internet of Things (IoT) technology in military surveillance, emphasizing the detection of intruders, weapons, and metals. It discusses the evolution of IoT applications in enhancing security measures, particularly in military contexts, where existing systems are often complex and costly. The survey references various devices and algorithms used for military surveillance, such as an IoT-based smart sniper system for enemy detection and a device for processing war field information to alert troopers. Additionally, it introduces the YOLO V3 algorithm for object detection, highlighting its speed and accuracy in detecting weapons and persons individually. The survey also covers the concept of neural networks, including Recurrent Neural Networks (RNN), Deep Neural Networks (DNNs), and Convolutional Neural Networks (CNNs), focusing on the efficiency and speed of CNNs, especially in object detection tasks.

2.2 Literature review

The literature review in the research paper "Intelligent Rover: An IoT Based Smart Surveillance Robotic Car for Military" highlights the significance of IoT in military surveillance, specifically in detecting intruders, weapons, and metals. The review references various research works, including an IoT-based smart sniper system, a device for capturing and processing war field information, and a military-based object detection algorithm using hyperspectral imagery.

The review also discusses the use of object detection algorithms in military applications, focusing on the YOLO V3 algorithm. YOLO V3 is a fast and accurate algorithm for object detection, particularly in detecting weapons and persons. The review explains the architecture of YOLO V3, including the use of convolutional layers, residual blocks, skip connections, and up sampling. Additionally, the review touches on the use of metal detection sensors in military applications, highlighting their ability to detect metals with a range of 60mm using an inductive proximity NPN sensor.

The review also discusses the use of live streaming video in military applications, emphasizing the importance of real-time monitoring for situational awareness The literature review provides a comprehensive overview of the current state of IoT-based military surveillance systems, highlighting the potential benefits and challenges of implementing such systems in real-world scenarios. The review also emphasizes the need for further research in this area, particularly in developing more accurate and efficient object detection algorithms and metal detection sensors.

The literature review for "Intelligent Rover: An IoT Based Smart Surveillance Robotic Car for Military" highlights the significance of IoT in military surveillance, specifically in detecting intruders, weapons, and metals. The review references various research works, including an IoT-based smart sniper that detects and eliminates enemies, a device that captures and processes war field information, and a military-based object detection algorithm using hyperspectral imagery.

The review also discusses the use of object detection algorithms in military applications, focusing on the YOLO V3 algorithm. YOLO V3 is a fast and accurate algorithm for object detection, particularly in detecting weapons and persons. The review explains the architecture of YOLO V3, including the use of convolutional layers, residual blocks, skip connections, and upsampling. YOLO V3 is more than a thousand times faster than R-CNN and a hundred times faster than Fast R-CNN, making it an ideal choice for real-time object detection in military applications.

Moreover, the review touches on the use of metal detection sensors in military applications. The Intelligent Rover is capable of detecting metals with a range of 60mm using inductive proximity NPN sensors. This feature is particularly useful for identifying potential hazards or objects of interest, providing an extra layer of security and intelligence to the device.

Lastly, the review discusses the use of live streaming video in military applications. The Pi camera on the rover captures real-time video, which is then live-streamed using the YOLO V3 algorithm. This live streaming feature allows users to monitor the surroundings of the rover remotely via a webpage, enhancing situational awareness and providing real-time information for decision-making.

CHAPTER 3

WORKING OF THE SYSTEM

3.1 Problem Statement

Developing cost-effective and efficient military surveillance solutions leveraging IoT technology to overcome the complexities and expenses associated with traditional methods, ensuring enhanced detection and response capabilities for safeguarding personnel and assets.

3.2 Principle

The research paper "Intelligent Rover: An IoT Based Smart Surveillance Robotic Car for Military" introduces a surveillance robotic rover designed for military applications, utilizing IoT principles. The rover, controlled via smartphone, employs Raspberry Pi and Arduino to detect human beings, weapons, and metals. It captures live video using a Pi camera, streams it for remote viewing, and utilizes the YOLO V3 algorithm for object detection. The rover's capabilities include metal detection using sensors, email notifications upon detection, and versatile movement controlled via smartphone. The paper details the object detection process, emphasizing the YOLO V3 algorithm's speed and accuracy, and highlights the rover's ability to detect objects, save detected scenes, and notify users via email. Additionally, the rover's metal detection and live streaming functionalities enhance its surveillance capabilities, making it a valuable asset for military surveillance and security operations.

3.3 Technologies Used

The technology used in the research paper "Intelligent Rover: An IoT Based Smart Surveillance Robotic Car for Military" can be summarized as follows:

1. IoT (Internet of Things): The research paper leverages IoT principles to connect and share data between devices over the internet, enhancing surveillance capabilities in the military field.

2. Raspberry Pi and Arduino: The Intelligent Rover is controlled via a smartphone and utilizes Raspberry Pi and Arduino for its operations, enabling live video streaming, object detection, and user control.

3. YOLO V3 Algorithm: The rover employs the YOLO V3 algorithm for object detection, specifically to detect guns, people, and metals with speed and accuracy.

4. Neural Networks: The paper discusses various neural networks like Recurrent Neural Network (RNN), Deep Neural Networks (DNNs), and Convolutional Neural Network (CNN), highlighting their role in machine learning and object detection.

5. DC Motors and Servo Motors: The rover's movement is controlled by DC motors for the wheels and servo motors for swiveling the camera horizontally and vertically, enhancing its mobility and surveillance capabilities.

6. Flask Micro Web Platform: The Intelligent Rover is transformed into an IoT vehicle by enabling controls through a webpage using the Flask micro web platform, providing users with complete authority to control the rover's features remotely.

These technologies collectively enable the Intelligent Rover to detect objects, stream live video, notify users via email, and offer versatile control options through a smartphone or other devices, enhancing its effectiveness in military surveillance and security operations.

3.4 System Architecture and Design

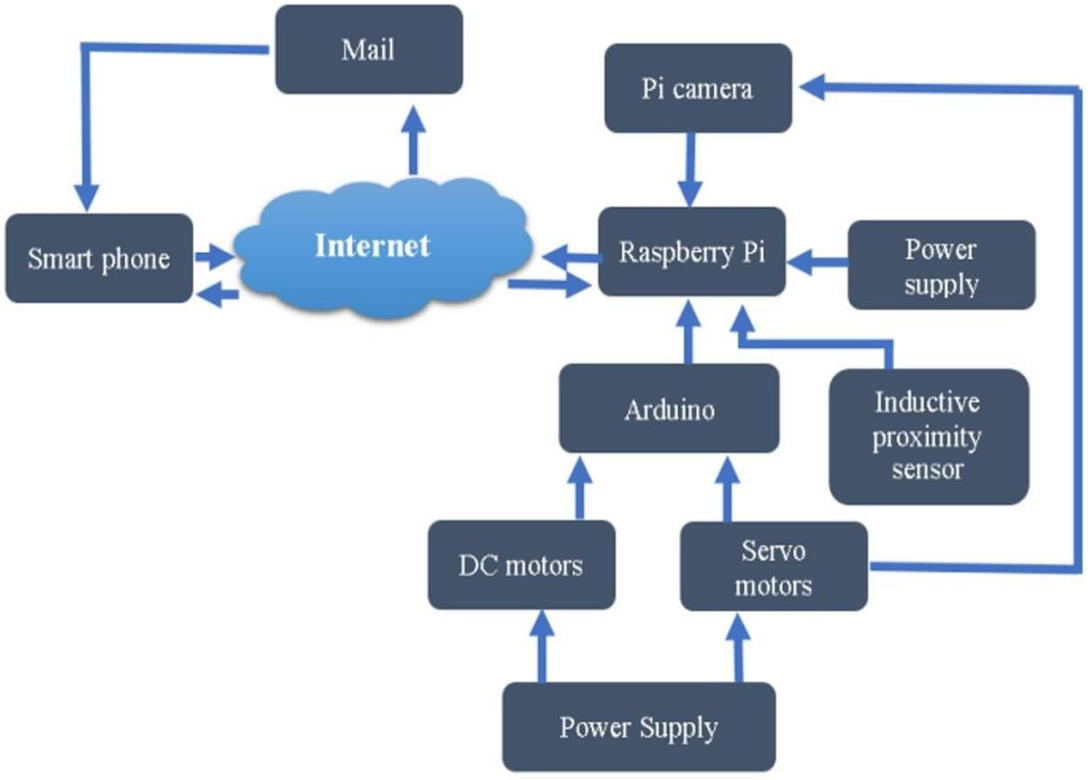

Fig 3.1: Block diagram of Smart Buggy

STEPS

1. Define requirements and specifications for an intelligent surveillance robotic rover including surveillance capabilities, mobility, communication, and integration with existing systems.
2. Select appropriate hardware components such as sensors (e.g., motion detectors, metal detectors), cameras (high-resolution, infrared), and IoT modules for connectivity.
3. Develop an efficient IoT communication protocol for reliable data transmission and remote control functionalities.
4. Implement the YOLOv3 algorithm for robust detection of guns and people in surveillance footage.
5. Integrate sensors for metal detection and develop algorithms for accurate processing of metal detection data.
6. Design and implement a user-friendly smartphone interface for remote control, live streaming, and receiving email notifications, ensuring seamless interaction with the robotic rover.

3.5 Methodology

The methodology for the research paper "Intelligent Rover: An IoT Based Smart Surveillance Robotic Car for Military" involves the following steps:

1. Object Detection: The paper employs object detection, a crucial component of the Intelligent Rover, to detect guns and persons. The concept of neural networks, such as Recurrent Neural Network (RNN), Deep Neural Networks (DNNs), and Convolutional Neural Network (CNN), is discussed, with a focus on the YOLO V3 algorithm for object detection. YOLO V3 is a class of DNNs that consists of an input layer, multiple hidden layers, and an output layer. Convolutional layers convolve the input and forward the result to the succeeding layer. YOLO V3 is categorized as a Fully Convolutional Network (FCN) and is used to detect guns and persons.

2. Metal Detection: The Intelligent Rover is capable of detecting metals with the range of 60mm using an inductive proximity NPN sensor. This section can be activated with live stream with or without object detection.

3. Live Stream: The Pi camera captures real-time video and streams it, which can be viewed from a webpage. The codes for swiveling the camera are programmed in Arduino and the mechanism is controlled through the commands sent from the raspberry pi.

4. Flask Micro Web: The Intelligent Rover is transformed into an IoT vehicle by enabling the controls through a webpage using the flask micro web platform. Flask is a lightweight WSGI web application framework that enables applications to be accessed and operated via a webpage. Using flask micro web, a webpage is created that provides the user complete authority to control the Intelligent Rover.

5. Implementation: The heart of the Intelligent Rover is Raspberry Pi 4B+, which comes with high RAM, making it suitable for smooth object detection. Raspberry Pi was installed with Raspbian Buster, and the OpenCV4 library was installed for object detection. All the codes associated with the movement of the rover and camera were implemented on Arduino IDE and uploaded into Arduino Nano.

The research paper "Intelligent Rover: An IoT Based Smart Surveillance Robotic Car for Military" presents an intelligent surveillance robotic car that is designed for military applications. The rover is equipped with a range of features, including object detection, metal detection, live streaming, and movement control, all of which are accessible via a webpage that can be accessed through a smartphone.

The object detection feature of the rover is based on the YOLO V3 algorithm, which is a class of deep convolutional neural networks that are designed for object detection. YOLO V3 is known for its speed and accuracy, making it well-suited for real-time object detection in surveillance applications. The rover is capable of detecting guns and people individually, and when it detects any objects, it notifies the user via email.

The metal detection feature of the rover is based on inductive proximity NPN sensors, which are capable of detecting metals within a range of 60mm. This feature is particularly useful for identifying potential hazards or objects of interest.

The live streaming feature of the rover is based on the Pi camera, which captures real-time video and streams it via the YOLO V3 algorithm. This allows users to monitor the surroundings of the rover remotely via a webpage, enhancing situational awareness.

The movement of the rover is controlled by two DC motors for the front wheels and two for the rear wheels, driven by L293-D H connected to Arduino Nano. The L293-D H and thus the DC motors are connected to Arduino Nano, which is connected to Raspberry Pi via the USB port. The rover can be steered left, right, forward, and backward, providing flexibility and precision in surveillance operations.

The Intelligent Rover is transformed into an IoT vehicle by enabling the controls through a webpage using the flask micro web platform. This allows users to control the rover's movements and camera angles via a smartphone, providing a versatile surveillance solution for military applications.

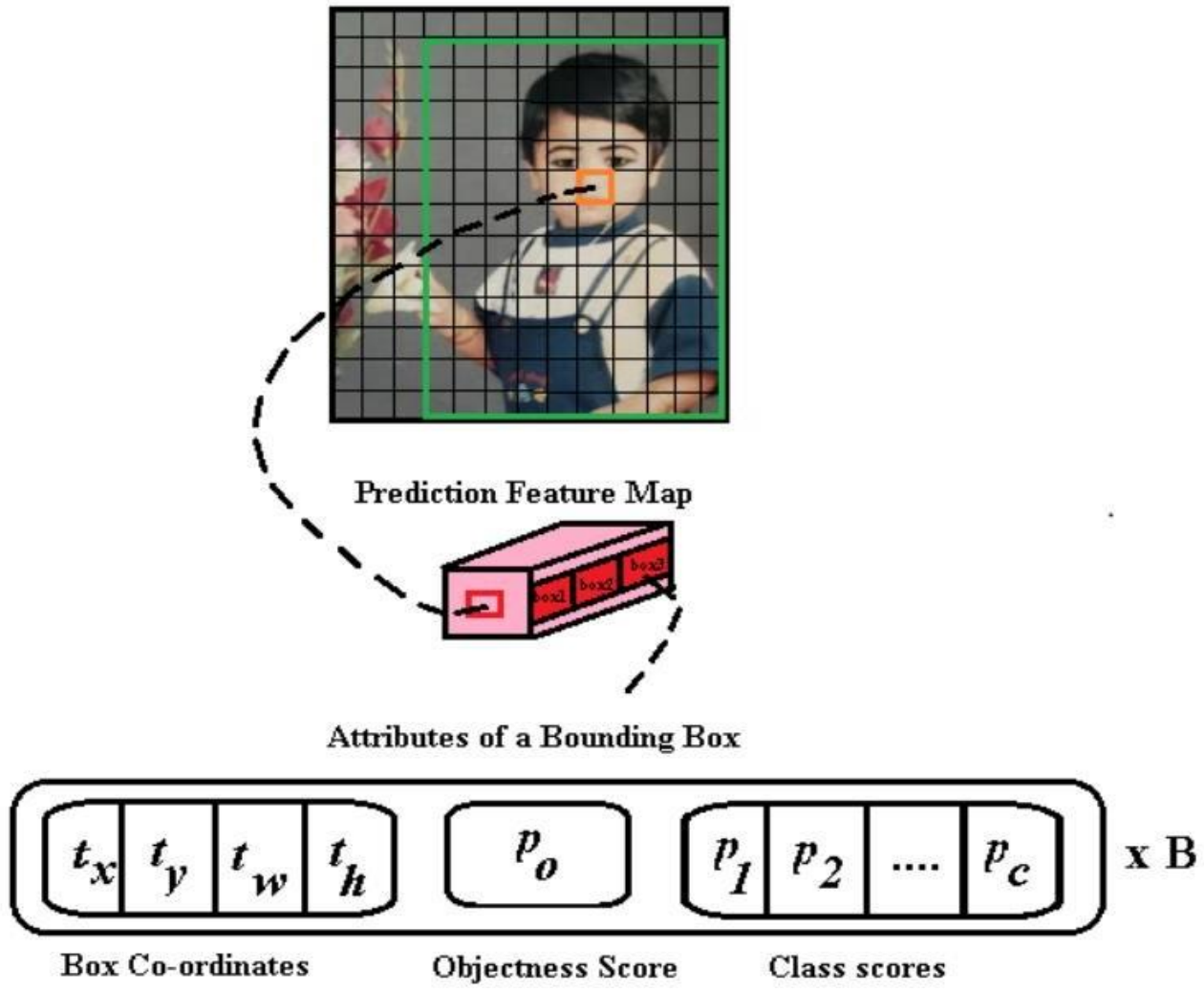

Fig3.2: Detection of person using YoloV3

In summary, the Intelligent Rover is an IoT-based smart surveillance robotic car that is designed to provide real-time monitoring, object detection, and notifications to users. The rover's features include object detection, metal detection, live streaming, and movement control, all of which are accessible via a webpage that can be accessed through a smartphone. The rover's YOLO V3-based object detection algorithm is particularly effective for detecting potential threats, providing superior accuracy and speed in detecting weapons and people. The integration of IoT technology in the Intelligent Rover enhances its capabilities, making it a valuable tool for military surveillance and security.

Fig 3.3: Metal Detection

The research paper presents an intelligent surveillance robotic rover that operates on the principles of IoT, designed for military applications, with the potential to detect guns, people, and metal, live stream these, and notify the user about the same through an email. The system is implemented using Raspberry Pi, Arduino, and YOLO V3 for object detection, with a focus on detecting guns and persons. The rover can be controlled via a webpage, providing the user complete authority to control the Intelligent Rover. The system is designed to assist the troopers in detecting the enemy and traps using the yolo V3 algorithm and sensors, thereby saving their precious lives.

3.6 Implementation

The implementation for the research paper "Intelligent Rover: An IoT Based Smart Surveillance Robotic Car for Military" involves the following key steps:

1. Raspberry Pi Setup: The heart of the Intelligent Rover is the Raspberry Pi 4B+, which is equipped with high RAM to facilitate smooth object detection. The Raspberry Pi is installed with Raspbian Buster, and the OpenCV4 library is installed for object detection purposes.

2. Arduino Programming: All the codes associated with the movement of the rover and camera are implemented on Arduino IDE and uploaded into Arduino Nano. The Arduino is responsible for controlling the movement of the rover and the camera angles.

3. Training Data: Images used to train the model are sourced from the Open Images v6 dataset, which provides a wide range of images across different categories. These images are labeled and annotated using coding referenced from GitHub.

4. Wireless Conversion: The rover is converted into a wireless robotic device by replacing all wired external power supplies with batteries. The Raspberry Pi is powered using a 3A, 5V power bank, while the servo and DC motors are powered using 8 AA batteries.

5. Webpage Control: The Intelligent Rover is transformed into an IoT vehicle by enabling controls through a webpage using the Flask micro web platform. Flask allows users to access and operate the rover via a webpage, providing complete authority to control the rover's features.

6. Remote Control: By port forwarding the network, the Intelligent Rover can be controlled from any location worldwide using a smartphone. The user can steer the rover left, right, forward, and backward, swivel the camera horizontally and vertically, and activate features like object detection and metal detection.

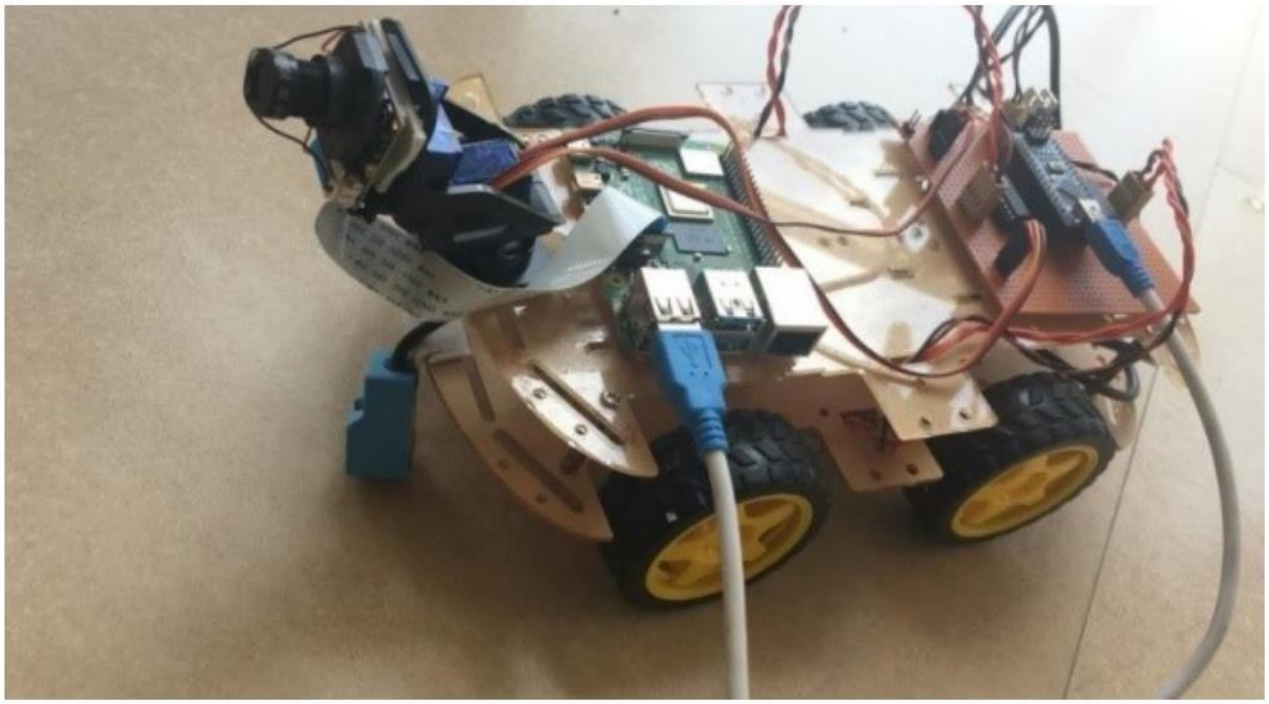

Fig 3.4: Model of Intelligent Rover

The Intelligent Rover is a military-based surveillance robotic car that operates on the principles of IoT. It is designed for surveillance in the military field, with the potential to detect guns, people, and metal, live stream these, and notify the user about the same through email. The rover is equipped with YOLO V3 algorithms for object detection, which can detect weapons and people individually. The camera can be swiveled horizontally and vertically, and the rover can be controlled via a smartphone or other devices. The Intelligent Rover is an IoT-based smart surveillance robotic car that can be controlled via a webpage using the Flask micro web platform, providing complete authority to the user to control the Intelligent Rover.

In conclusion, the implementation of the Intelligent Rover involves setting up the Raspberry Pi with the necessary software, programming the Arduino for rover movement, training the model with labeled images, converting the rover to a wireless device, enabling control through a webpage using Flask, and allowing remote control via a smartphone. This comprehensive implementation ensures the functionality and usability of the Intelligent Rover for military surveillance applications.

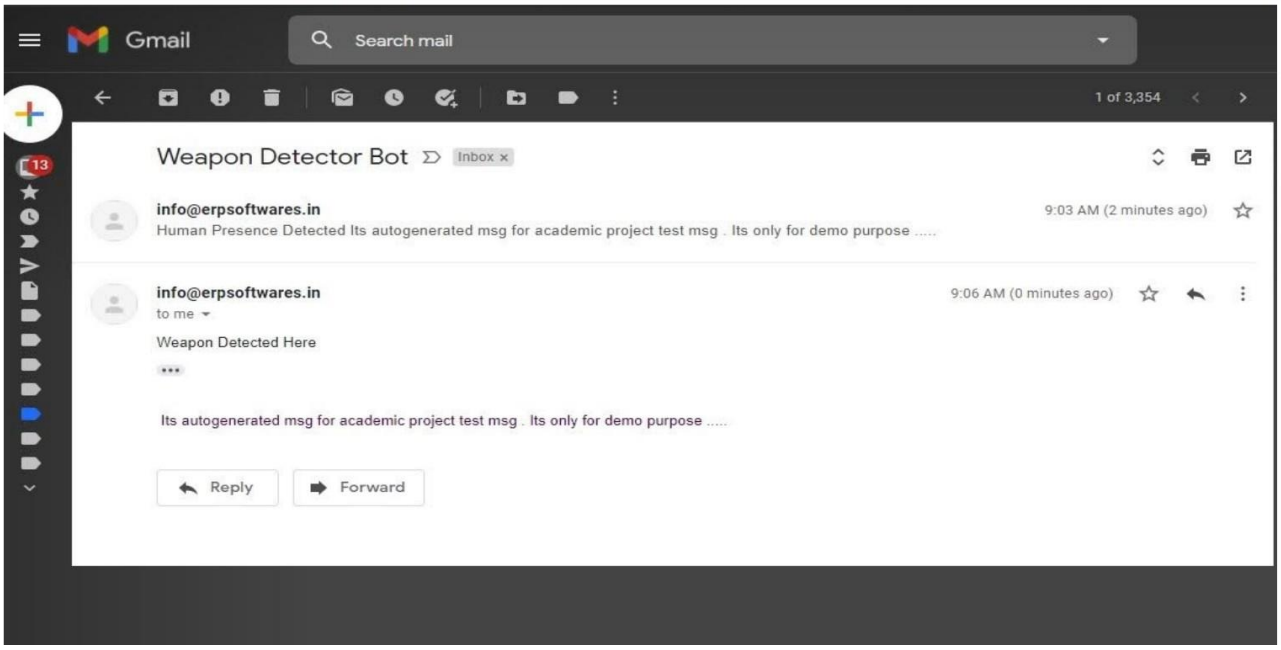

Fig 3.5: Email received that shows the presence of weapon and human.

The email received that shows the presence of a weapon and a human is a crucial feature of the Intelligent Rover system. When the rover detects objects, specifically weapons and humans, using the YOLO V3 algorithm, it promptly notifies the user via email. This notification serves as an alert to inform the user about the detected objects, enhancing situational awareness and enabling timely responses to potential threats. The email notification feature adds an extra layer of security and surveillance capability to the Intelligent Rover, ensuring that users are promptly informed about any detected weapons or individuals in the monitored area.

CHAPTER 4

MERITS, DEMERITS AND APPLICATIONS

4.1 Merits

Based on the detailed information provided in the research paper "Intelligent Rover: An IoT Based Smart Surveillance Robotic Car for Military," the merits of the Intelligent Rover system can be summarized in points as follows:

1. Object Detection Capability:

- Utilizes YOLO V3 algorithm for accurate detection of guns and persons.
- Real-time detection and notification to the user via email.
- Ability to save detected objects for future reference.

2. Metal Detection Feature:

- Capable of detecting metals like iron, steel, copper, and aluminum using inductive proximity NPN sensors.
- Metal detection range of 60mm without direct contact with the metal.

3. Live Streaming Functionality:

- Pi camera captures real-time video and streams it using the YOLO V3 algorithm.
- Enables live streaming of the surveillance scene for remote monitoring.

4. Rover Movement Control:

- Controlled by two DC motors for front wheels and two for rear wheels, driven by L293-D H connected to Arduino Nano.
- Allows precise movement control, including forward, backward, left, and right motions.

5. Camera Swiveling Mechanism:

- Two servo motors enable horizontal and vertical swiveling of the camera.
- Controlled through Arduino Nano, providing flexibility in camera angles.

6. Flask Micro Web Platform:

- Transforms the Intelligent Rover into an IoT vehicle accessible via a webpage.

- Enables users to control the rover's features, such as object detection, camera swiveling, and rover movement, through a smartphone or other devices.

7. Wireless Conversion:

- Converted into a wireless robotic device by replacing wired power supplies with batteries.

- Enhances mobility and operational flexibility of the Intelligent Rover system.

8. Training Data and Model Implementation:

- Trained on images from the Open Images v6 dataset, ensuring a diverse range of training data.

- Implemented on Raspberry Pi 4B+ with Raspbian Buster and OpenCV4 library for efficient object detection.

4.2 Demerits

Based on the information provided in the research paper "Intelligent Rover: An IoT Based Smart Surveillance Robotic Car for Military," the demerits of the Intelligent Rover system can be summarized in points as follows:

1. Detection Speed During Streaming:

- The detection process using the YOLO V3 algorithm is slow during streaming, impacting real-time object detection speed.

- Although YOLO V3 runs faster than other algorithms on Raspberry Pi, there is a trade-off between speed and accuracy during streaming.

2. Complexity in Training:

- The training process for the rover requires high RAM and GPU systems, making it challenging to set up and train the model effectively.

- The complexity of training the system can be a barrier for users without access to advanced computing resources.

3. Limited Object Detection Scope:

- The Intelligent Rover system is primarily focused on detecting guns, people, and metals, limiting its scope to a few specific objects.

- There is a lack of versatility in object detection capabilities, restricting its application to a broader range of surveillance scenarios.

4. Dependency on Network Connectivity:

- The control of the Intelligent Rover relies on network connectivity for remote operation, which can be a limitation in areas with poor network coverage.

- Unreliable network connections may hinder the real-time control and monitoring of the rover, affecting its effectiveness in remote surveillance.

5. Hardware Limitations:

- The rover's functionality is dependent on the hardware components like Raspberry Pi, Arduino, and sensors, which may have limitations in terms of processing power and capabilities.

- Hardware constraints could impact the overall performance and reliability of the Intelligent Rover system in demanding military surveillance environments.

6. Single-Object Detection Limitation:

- The system is designed to detect one object at a time, which may limit its efficiency in scenarios where multiple objects need to be detected simultaneously.

- The inability to detect and track multiple objects concurrently could reduce the system's effectiveness in complex surveillance situations.

7. Email Alert System:

- The reliance on email notifications for object detection alerts may introduce delays in receiving critical information, potentially impacting the real-time response to detected objects.

- Email alerts may not be the most efficient or immediate method of notification in high-stakes military surveillance operations.

These demerits highlight some of the limitations and challenges associated with the Intelligent Rover system, including detection speed issues, training complexity, limited object detection scope, network dependency, hardware constraints, single-object detection limitation, and the email alert system's potential drawbacks.

4.3 Applications

The Intelligent Rover is a military-based surveillance robotic car that is designed to detect human beings and weapons while moving according to the user's needs. It is controlled via a smartphone and uses Raspberry Pi and Arduino to achieve the mission of the rover. The rover captures live video using a Pi camera and streams it, which can be viewed from a webpage. The camera can be swiveled horizontally and vertically. The rover employs YOLO V3 algorithms to detect weapons and persons individually. When it detects any objects, it notifies the user via email. The DC motors connected to the wheels set the rover into motion that is controlled through the webpage from a smartphone or any other devices. This robotic automobile is also capable of detecting metals via sensors and notifies the same to the user via email.

The Intelligent Rover is an IoT-based smart surveillance robotic car that operates on the principles of IoT. This robotic device is used for the surveillance in the military field with the potential to detect guns, people, and metal, live stream these, and notify the user about the same through an email. This device assists the troopers in detecting the enemy and traps using YOLO V3 algorithm and sensors, thereby saving their precious lives. The scene of detected objects is saved for future reference. The predominant feature of the rover is that it can be controlled according to the user's needs by steering the car left, right, forward, and backwards via a smartphone. The camera can be swiveled horizontally and vertically. The angle of tilting and panning can be varied according to the user.

The Intelligent Rover has several applications in the military field, including:

1. Surveillance of military bases, camps, and installations
2. Detection of weapons and intruders in restricted areas
3. Monitoring of border crossings and checkpoints
4. Search and rescue operations in hazardous environments
5. Reconnaissance and intelligence gathering in combat zones
6. Perimeter security and intrusion detection in military facilities
7. Remote monitoring of critical infrastructure and assets
8. Rapid deployment in emergency situations for situational awareness
9. Integration with other military systems for enhanced situational awareness and decision-making.

The Intelligent Rover is a military-based surveillance robotic car that operates on the principles of IoT and is designed for military applications, including:

1. Surveillance of military bases, camps, and installations: The Intelligent Rover can be used for real-time monitoring and surveillance of military bases, camps, and installations, ensuring the safety and security of the personnel and assets.

2. Detection of weapons and intruders in restricted areas: The Intelligent Rover is equipped with YOLO V3 algorithms to detect weapons and persons individually, making it an ideal tool for detecting weapons and intruders in restricted areas.

3. Monitoring of border crossings and checkpoints: The Intelligent Rover can be used for monitoring border crossings and checkpoints, ensuring the security and safety of the border areas and preventing illegal activities.

4. Search and rescue operations in hazardous environments: The Intelligent Rover can be used for search and rescue operations in hazardous environments, such as disaster-affected areas, where human intervention may be risky.

5. Reconnaissance and intelligence gathering in combat zones: The Intelligent Rover can be used for reconnaissance and intelligence gathering in combat zones, providing real-time information about the enemy's movements and positions.

6. Perimeter security and intrusion detection in military facilities: The Intelligent Rover can be used for perimeter security and intrusion detection in military facilities, ensuring the safety and security of the facilities and preventing unauthorized access.

7. Remote monitoring of critical infrastructure and assets: The Intelligent Rover can be used for remote monitoring of critical infrastructure and assets, ensuring their safety and security and preventing any potential damage or theft.

8. Rapid deployment in emergency situations for situational awareness: The Intelligent Rover can be rapidly deployed in emergency situations for situational awareness, providing real-time information about the situation and helping in decision-making.

9. Integration with other military systems for enhanced situational awareness and decision-making: The Intelligent Rover can be integrated with other military systems for enhanced situational awareness and decision-making, providing real-time information and helping in making informed decisions.

The Intelligent Rover is equipped with YOLO V3 algorithms for object detection, which can detect weapons and persons with high accuracy. It also has a metal detection feature that can detect metals with a range of 60mm using an inductive proximity NPN sensor. The Intelligent Rover can be controlled via a smartphone, and the camera can be swiveled horizontally and vertically, providing a 360-degree view of the surroundings. The Intelligent Rover is also equipped with a live streaming feature that can stream real-time video, which can be viewed from a webpage. The Intelligent Rover is an IoT-based smart surveillance robotic car that can be controlled via a webpage using the flask micro web platform, providing complete authority to the user to control the Intelligent Rover. The Intelligent Rover is a powerful tool for military surveillance and security, providing real-time information and ensuring the safety and security of military personnel and assets.

CONCLUSION

The conclusion of the document on the Intelligent Rover, an IoT-based smart surveillance robotic car for military applications, highlights the significance of this technology in aiding defense and security personnel. The Intelligent Rover, controlled via a smartphone and utilizing Raspberry Pi and Arduino, is designed to detect human beings, weapons, and metals, providing real-time information and enhancing surveillance capabilities. The system employs the YOLO V3 algorithm for object detection, enabling the detection of guns, people, and metal, with notifications sent to the user via email. The document emphasizes the versatility of the Intelligent Rover, allowing for remote control through a webpage and smartphone, as well as features like camera swiveling and rover movement.

In conclusion, the Intelligent Rover serves as a valuable tool for military surveillance, offering features such as object detection, live video streaming, metal detection, email alerts, and controllable movements. The device's ability to detect intruders and weapons enhances security measures, while its adaptability for various applications, from surveillance to rescue operations, underscores its utility in safeguarding lives and assets. Despite some limitations in detection speed during streaming, the Intelligent Rover stands out for its accuracy and potential to operate in diverse environments, making it a valuable asset for defense and security operations.

GLOSSARY

The glossary for this paper includes the following terms:

1. IoT (Internet of Things): A network of interconnected devices that can collect, share, and process data over the internet.

2. Raspberry Pi: A series of small, low-cost, single-board computers developed in the UK.

3. Arduino: An open-source electronics platform based on easy-to-use hardware and software.

4. Object Detection: The process of identifying and locating objects in images or videos.

5. YOLO (You Only Look Once): A real-time object detection system that treats object detection as a regression problem.

6. Deep Neural Networks (DNNs): A class of neural networks with multiple hidden layers.

7. Convolutional Neural Networks (CNNs): A type of neural network commonly used for image processing and object detection.

8. Fully Convolutional Network (FCN): A type of CNN that replaces the fully connected layers with convolutional layers.

9. Region-Based CNNs (R-CNN): A type of CNN that uses regions of interest to detect objects.

10. Non-maximum Suppression (NMS): A technique used to eliminate overlapping bounding boxes in object detection.

11. Inductive Proximity Sensor: A type of sensor used for detecting the presence of metals.

12. Flask: A lightweight web application framework for Python.

13. WSGI (Web Server Gateway Interface): A standard interface for web servers and web applications.

ACRONYMS

- IoT: Internet of Things
- RNN: Recurrent Neural Network
- DNNs: Deep Neural Networks
- CNN: Convolutional Neural Network
- FCN: Fully Convolutional Network
- R-CNN: Region-Based CNNs
- ConvLSTM: Convolutional-LSTM
- LSTM: Long Short-Term Memory Networks
- FFNNs: Feed Forward Networks
- YOLO: You Look Only Once
- HSI: Hyperspectral Imagery
- NMS: Non-maximum Suppression
- URL: Uniform Resource Locator
- IP: Internet Protocol

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