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Intelligent Spying and Bomb Detection

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***Abstract*: Today, keeping an eye on the military's border zones is a difficult chore. The border guarding forces take their responsibility for securing the border very seriously, but it is very challenging to watch the border at all times, which frequently results in the tragic death of an army soldier. To avoid these consequences, we use a surveillance that automatically detects people, animals, people carrying weapons, people carrying bombs, and people in control areas. The goal of this research work is to replace army personnel at the line of control on border areas with intelligent, automated robots that can be destroyed. These robots will also protect our nation by blocking the passage of unauthorized trespassers and any other potential sources of damaged army vehicles. The main goal of this research is to design and construct a surveillance robot that can reduce casualties on the battlefield. The robot serves as a surveillance robot to take pictures of the intruder's surroundings before the soldiers assault.**

***Keywords*: YOLO, Object detection, Bomb detection, Metal detection sensor, ESP-32, Surveillance robot, IoT.**

1. Introduction

With the automation of robots, it has been demonstrated in recent generations that the world is heading toward innovation. Robots not only assist with day-to-day necessities but also play a crucial part in the defence sector by taking the place of people. They are considerably simpler to put into action and move much more quickly than a human with all of its necessary parts in order to preserve mankind. Particularly in the military field, robots are far superior at surveillance and destruction.

Current applications on software with required optimizations carry out the task by default. To extract the trespasser perspective of the image in this case, the camera is employed as the primary hardware input.

Robots are becoming increasingly important in human lives as a result of the numerous and rapid breakthroughs in the fields of automation and robotics, which reduce human error and labour. The process of routinely keeping a close eye on a target or suspected person is known as surveillance. This robot's primary benefit in the surveillance industry is that it eliminates the need for humans, thereby lowering the chance of casualties. This robot also gets over the disadvantage of short-range technologies by employing IoT technology to direct its motion.

The three main steps in object detection are feature extraction, feature processing, and object categorization. Object detection generated excellent results using a variety of traditional techniques, including feature coding, feature aggregation, bottom feature extraction, and feature classification.

Object detection is essential in numerous applications, including surveillance, cancer diagnostics, vehicle detection, and underwater item identification. The item has been accurately and successfully detected by a variety of methods for varied reasons. But there are still issues with accuracy and efficiency with these proposed methods. To solve these problems, machine learning and deep neural network algorithms are more successful in correcting object detection.

2. Related Work

The research work "Intelligent Spying and Bomb Detection" involves the use of advanced technologies for detecting and identifying potential threats in public areas, particularly in situations where the presence of explosives may be a concern. As such, the research work draws on a range of existing research in the fields of surveillance, artificial intelligence, computer vision, and explosives detection.

In the area of surveillance, previous research has focused on the development of advanced sensor networks and intelligent monitoring systems capable of detecting and tracking suspicious behavior. One notable example is the work of T. Truong et al. (2018), who developed a system for detecting violent behavior in crowds using video data and machine learning techniques. Another relevant study is the work of N. G. Bourbakis et al. (2017), who developed a sensor network for detecting and tracking suspicious vehicles in urban environments.

In the field of artificial intelligence and computer vision, there have been many advancements in recent years that are relevant to the research work. One particularly relevant area of research is the development of deep learning algorithms for image and video analysis, which have been shown to be effective in detecting and classifying objects and people in real-world environments. For example, the work of K. He et al. (2016) on the development of the "Faster R-CNN" algorithm for object detection has been widely cited and adopted by researchers in the field.

Finally, in the area of explosives detection, there has been a great deal of research into the use of various sensors and imaging techniques for detecting the presence of explosive materials. For example, the work of T. K. Kim et al. (2018) on the use of terahertz spectroscopy for detecting explosive

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materials has shown promise in laboratory settings. Other research has focused on the development of chemical sensors and other specialized detection technologies, such as the work of L. A. Stern et al. (2019) on the development of a portable mass spectrometer for explosive detection.

Overall, the research work "Intelligent Spying and Bomb Detection" draws on a range of existing research in several related fields to develop a novel approach to detecting and identifying potential threats in public areas.

3. Proposed Model

The research work aims to facilitate the movement around the military base using camera. The plan defines a vision-based platform for the identification of real-life indoor and outdoor detection to safe guard military person. Using Python and Open CV library functions, the software is developed and eventually ported to a PC.

The main objectives of the proposed system are, to study and understand the existing vision module systems, working of different frameworks for the image acquisition system, to study how to Classify person using YOLO. Detection of animal, Bomb Detection using metal sensor, Weapon detection, Programming what so ever detected output to convert it into voice using text-to-speech convert.

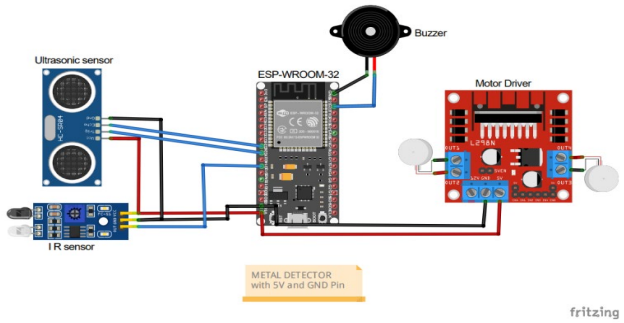

Fig. 1. System architecture

Image Capturing in this stage, the text image is captured using a PC camera. The captured image is not flawless in shape and scale, nor is the captured image in an acceptable state for text extraction data. Thus, the captured image is first applied to the image processing module. The picture taken is in jpg format.

Image Processing: In the image processing, unnecessary noise is eliminated by using the image filters.

Image sharpening increases the contrast between the light and dark regions of the image.

Person Detection: Many artefacts are present in the captured shot. All persons are identified using the YOLO library, but not all objects are interpreted, although the one with more precision can be read.

Weapon Detection: Image captured from the camera, identifies and classify the weapon.

Animal Detection: Image captured from the camera, identifies quite a few animals namely (elephant, bear, sheep etc.).

When the electromagnetic field from the search coil is transferred to the robot's front side, the metal detector sensor is in operation. Metals will strengthen and reflect their own electromagnetic waves when exposed to an electromagnetic field.

The search coil in the metal detector picks up the retransmitted electromagnetic wave and alerts the controller to the presence of metal. This is used to find ground-level bombs.

A. Intelligent Spying and Detection using YOLO

One of the best real-time object identification algorithms, YOLO (You Only Look Once), incorporates several of the most cutting-edge concepts being explored in the field of computer vision research. The object detection involves figuring out exactly which things are present in a given image and where in the image they are located. Object detection is a more challenging task than classification, which can also identify items but does not tell the viewer where they are in the image. Additionally, classification fails for photos with several objects.

YOLO adopts a very distinct strategy. To distinguish things in real time, a clever convolutional neural network (CNN) dubbed YOLO is used. The algorithm applies a single neural network to the entire image, divides it into regions, forecasts bounding boxes and probabilities for each region. These bounding boxes are weighted using anticipated probabilities. Yolo is well-liked since it can operate in real-time and achieve high precision. The method "only looks once" at the image in the sense that it only needs to execute one forward propagation run through the neural network to generate predictions. Following non-max suppression (which guarantees the object detection algorithm only detects each object once), it outputs the identified items together with the bounding boxes. With YOLO, a single CNN simultaneously predicts multiple bounding boxes and class probabilities for those boxes. While training on entire pictures, YOLO directly optimizes detection performance.

B. Bomb and Obstacle Detection

As previously mentioned, we have established a secure data channel/tunnel for our proposed model using the inbuilt Wi-Fi module of the microcontroller, which provides us with internet connectivity. This data channel/tunnel is facilitated through the use of the Blynk cloud platform, which is a cloud-based solution that enables the creation of custom user interfaces for controlling and monitoring various IoT devices.

Bomb detection using metal detection sensor interfaced to ESP WROOM 32 and connected to Blynk IOT to move the rover using motor driver and DC motors can be achieved by following the below methodology:

1. Setting up the Hardware: The first step in the process is to set up the required hardware. The following hardware components will be required for this project:
    - ESP WROOM 32 microcontroller
    - Metal detection sensor
    - Motor driver
    - DC motors
    - Breadboard
    - Connecting wires

The metal detection sensor needs to be connected to the ESP WROOM 32 through the breadboard. The motor driver is connected to the ESP WROOM 32 through GPIO pins. The DC motors are connected to the motor driver through the breadboard.

2. Interfacing the Metal Detection Sensor with ESP WROOM 32: The metal detection sensor is interfaced with the ESP WROOM 32. The sensor detects metal objects and sends the signal to the ESP WROOM 32. The sensor is connected to the analog input pin of the ESP WROOM 32.
3. Programming ESP WROOM 32: The ESP WROOM 32 is programmed to receive the signal from the metal detection sensor and send the signal to Blynk IOT. The programming of ESP WROOM 32 can be done using the Arduino IDE. The programming code should include the following steps:
    - Set up the Wi-Fi connectivity of the ESP WROOM 32.
    - Configure the metal detection sensor to send the signal to the ESP WROOM 32.
    - Send the signal to Buzzer to make sound.
4. Connecting ESP WROOM 32 to Blynk IOT: The ESP WROOM 32 is connected to Blynk IOT using Wi-Fi connectivity. The Blynk app can be downloaded from the app store. The Blynk app should be configured to receive the signal from the ESP WROOM 32.

Controlling Rover using Blynk IoT: The Blynk IOT app is used to control the rover. The app sends the signal to the ESP WROOM 32, which in turn controls the motor driver and DC motors to move the rover. The Blynk app should be programmed to perform the following steps:

- Receive the signal from the ESP WROOM 32.
- Interpret the signal and convert it into a command for the motor
- driver.
- Send the command to the motor driver to move the rover.

The system can be tested by placing a metal object in front of the metal detection sensor. The sensor should detect the object and send a signal to the ESP WROOM 32. The ESP WROOM 32 should then send the signal to the Blynk IOT app, which should move the rover.

The other two sensors interfaced are,

- Ultrasonic Sensor: The ultrasonic sensor is responsible for measuring the distance between the rover and any obstacle in front of it.
- IR Sensor: The IR sensor is responsible for detecting the presence of objects or obstacles on the ground.

In conclusion, the above methodology can be followed to achieve bomb detection using metal detection sensor interfaced to ESP WROOM 32 and connected to Blynk IOT to move the rover using motor driver and DC motors.

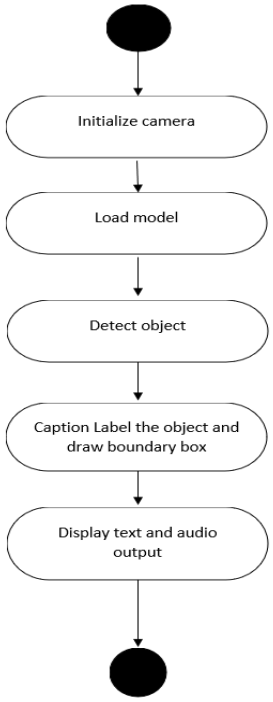

Fig. 2. Flowchart of the object detection

4. System Implementation

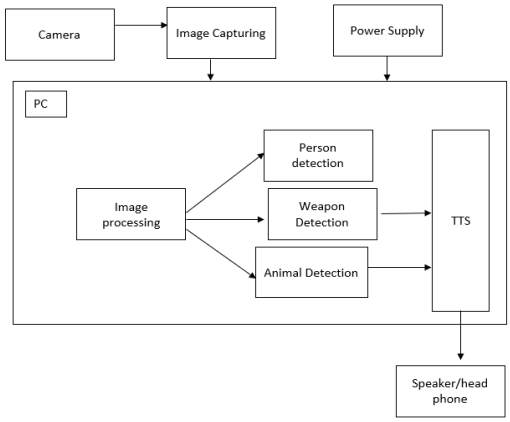

Fig. 3. Proposed block diagram of object detection

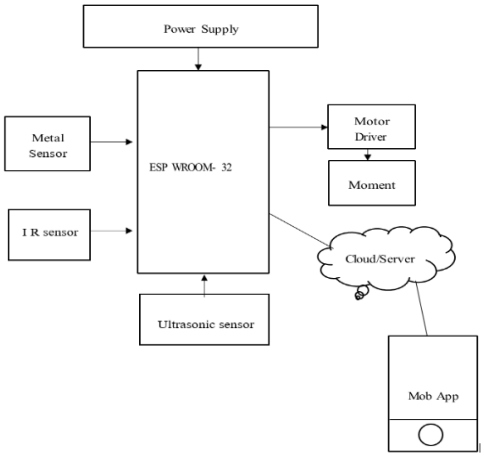

Fig. 4. Proposed block diagram of bomb detection

A. Arduino IDE

An open-source company called Arduino creates computer hardware and software for development boards with microcontrollers. Open-source prototype systems known as Arduino Modules are offered in a variety of development board configurations. These boards offer a condensed microcontroller and are made to be applied to a variety of projects. The most popular programming method, the Arduino IDE, uses the C programming language to programme these boards. This gives users access to an Arduino library that is constantly expanding as a result of the vibrant and helpful open-source community. The Arduino Integrated Design Environment (IDE) is the software tool used to program the boards. It is the latest version of the software, currently version 1.6.5, and it opens into a blank sketch where the user can start programming immediately. To upload the code, the board and port settings need to be configured correctly. To begin programming, the user should connect the Arduino board to the PC via a USB cable. This will allow the Arduino IDE to communicate with the board and upload the code to it. By configuring the board and port settings, the user can ensure that the code is uploaded correctly and that the board functions as expected.

B. Blynk Platform

Blynk is an IoT platform created to store and visualize data, show sensor data, and remotely control gear. It is made up of three main parts. The first is the Blynk App, which offers a simple interface for building projects that can be customized using a variety of widgets. The second is that Blynk Server is in charge of facilitating all inter-device communication. It is constructed using open-source technology that can support thousands of devices and may be hosted on either the Blynk Cloud or a private server. The third Blynk library is built for common hardware platforms, enables seamless communication with the server, and processes incoming and outgoing commands. It can also run on a Raspberry Pi.

C. Python Programming

Python is a dynamically semantic, high-level, object-oriented, interpreted programming language. With an emphasis on readability, its syntax is made to be straightforward and simple to learn, which lowers the cost of programme maintenance. Python also allows packages and modules, which encourage the modularity and reuse of code in programmes. The offline Python 3.7 interpreter, one of the capabilities of the Python environment, enables users to run Python programmes without the need for an internet connection. Complete GUI capability enables programmers to design user interfaces for their programmes. A readline-compatible, full-featured terminal emulator that may be downloaded through pip. Due to features like auto-completion and command history, users are able to interact with the Python interpreter using a command-line interface.

D. ESP32

The ESP32 is a potent, reasonably priced microcontroller that has grown in popularity in recent years because of its adaptability and simplicity. The ESP32, created by Espressif Systems, is the ESP8266's replacement and offers more memory, computing power, and Bluetooth functionality. The ESP32 is excellent for a variety of uses, such as Internet of Things (IoT) devices, robotics, and automation. The ESP32 is a great option for tasks requiring wireless connectivity because it has integrated Wi-Fi and Bluetooth, allowing it to interface with other devices and the internet.

E. Metal Detection Sensor

Metal sensors—also referred to as metal detectors—are electronic devices that are used to find the presence of metallic items. Depending on the use, metal detector sensitivity can be changed, and some models also have discriminating functions that let users remove undesired metals from the search. When an electromagnetic field comes into contact with a metallic object, metal detectors produce changes in the field and look for them. A metal object that is brought close to the metal detector disrupts the electromagnetic field and generates an electrical signal, which the machine detects. The detector then notifies the user of the presence of metal by producing sound.

F. IR Sensor

Electronic devices that are used to detect infrared radiation are known as IR sensors, also known as infrared sensors. Every object with a temperature above absolute zero emits some form of electromagnetic radiation known as infrared radiation. Although infrared radiation cannot be seen with the naked eye, it can be picked up by IR sensors. Infrared sensors function by identifying changes in the amount of infrared radiation present in their surroundings. They typically consist of an IR emitter and a detector that are positioned across from one another. The detector measures any variations in the amount of infrared radiation reflected back to it from the emitter, which emits an infrared beam.

G. Ultrasonic Sensor

A device that measures distance or detects the presence of objects by using ultrasonic waves is known as an ultrasonic sensor. Ultrasonic waves are high-frequency sound waves that are audible to animals but not to humans. The sensor sends out a burst of ultrasonic waves, and by timing how long it takes for the waves to return after striking an object, it can determine how far away the object is from the sensor. Ultrasonic sensors are frequently employed in obstacle detection and distance measurement. For object positioning and detection, they are also used in robotics and automation. Ultrasonic sensors have the advantage of being able to detect clear or opaque objects, and they perform well in situations with dust, smoke, or other airborne particles that can interfere with other types of sensors. The output LED stays inactive if there are no objects within the IR receiver's detection range. The LED, however, activates and emits light when the IR sensor detects any foreign objects nearby.

H. Power Supply

A power supply is a piece of electronics that transforms electrical energy from a source into the precise voltage, current, and frequency needed by the associated load. Another name for

it is an electric power converter. A power supply can be a separate piece of hardware or be integrated into the appliance it powers. An example of a power supply is the 12V 2A Power Adapter, which transforms an AC voltage input with a range of 100V to 240V into a 12V DC output with a maximum current of 2A. Electronic equipment that requires 12 V DC power can be powered by this output.

5. Results and Discussion

The results of the research work is as follows,

This is user interface where we have three buttons namely, select image, capture image and quit.

- *Select image:* It is used to select the image from the target.
- *Capture image:* It captures the image from the real time camera.

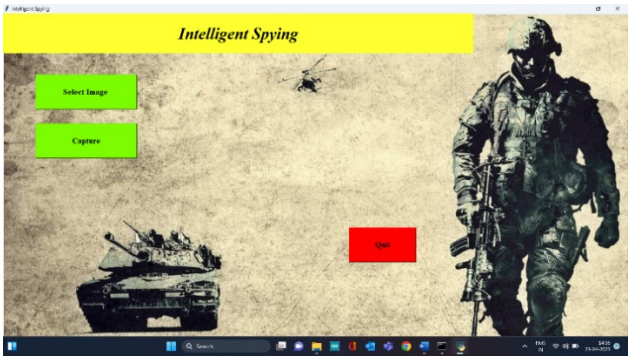

Fig. 5. User interface for object detection

The selected and captured image is analysed. Where the analyse image is used to detect all the objects in the image and analyse weapon is used to detect weapon in the image. Clear is used to clear the selected image and by selecting another image we can analyse another image. Below diagram shows the selection of image from the files.

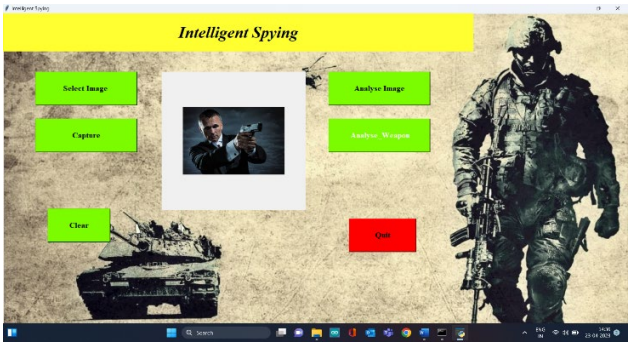

Fig. 6. Selection of image and analysis of object

The selected image is analysed and the weapon is detected in the image.

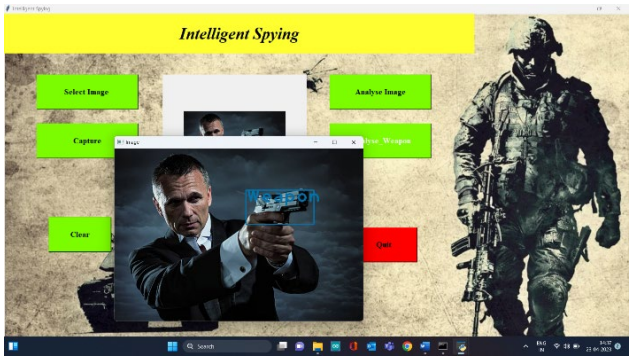

Fig. 7. Detection of weapon in the picture

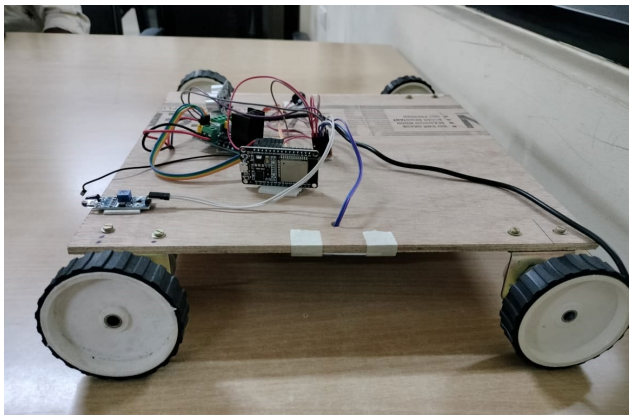

Fig. 8. Implementation of sensors in the rover

Above figure shows the interface of the sensors used in the bomb detection rover mainly it has Metal Detection sensor, IR sensor, Ultrasonic sensor interfaced to the ESP WROOM-32 microcontroller it has motor driver and DC motors to move the rover. The micro-controller is connected to the mobile app Blynk IOT by Wi-Fi means and the movement of the rover can be controlled by the user using Blynk app.

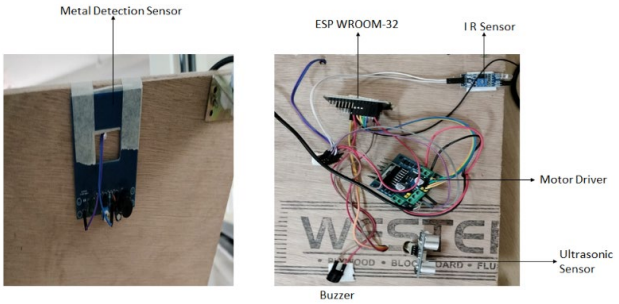

Fig. 9. Illustration of the components used

Above figures shows the illustrations of the sensors used, if the Metal Detection sensor detects any metals or bomb it sends signal to ESP WROOM-32 micro-controller and it sends signal to the Buzzer and the Buzzer starts making sound indicating the detection. Ultrasonic sensor is used to detect the obstacle presence, if obstacle is present then it sends signal to the micro-controller then it sends signal to Buzzer. IR sensor is used to calculate the distance from device to the obstacle. Motor driver and DC motors are used to move the rover and controlled by the

user using mobile app Blynk IoT.

6. Conclusion

Intelligent spying and bomb detection are two critical areas where advancements in technology and machine learning have played a significant role in enhancing security measures.

In the case of intelligent spying, ML algorithms are used to analyze large volumes of data to identify potential threats and suspicious activities, which may not be detectable by human operators. These technologies have the potential to improve national security and prevent potential terrorist attacks.

Similarly, in the case of bomb detection, the devices and systems can identify and alert security personnel to the presence of explosives in a more efficient and accurate manner than traditional detection methods. This can help prevent loss of life and property in public places such as airports, train stations, and stadiums.

In conclusion, intelligent spying and bomb detection are two areas where the application of AI technology has significantly improved security measures. With further advancements in AI and related technologies, we can expect these capabilities to continue to improve, leading to safer communities and nations.

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