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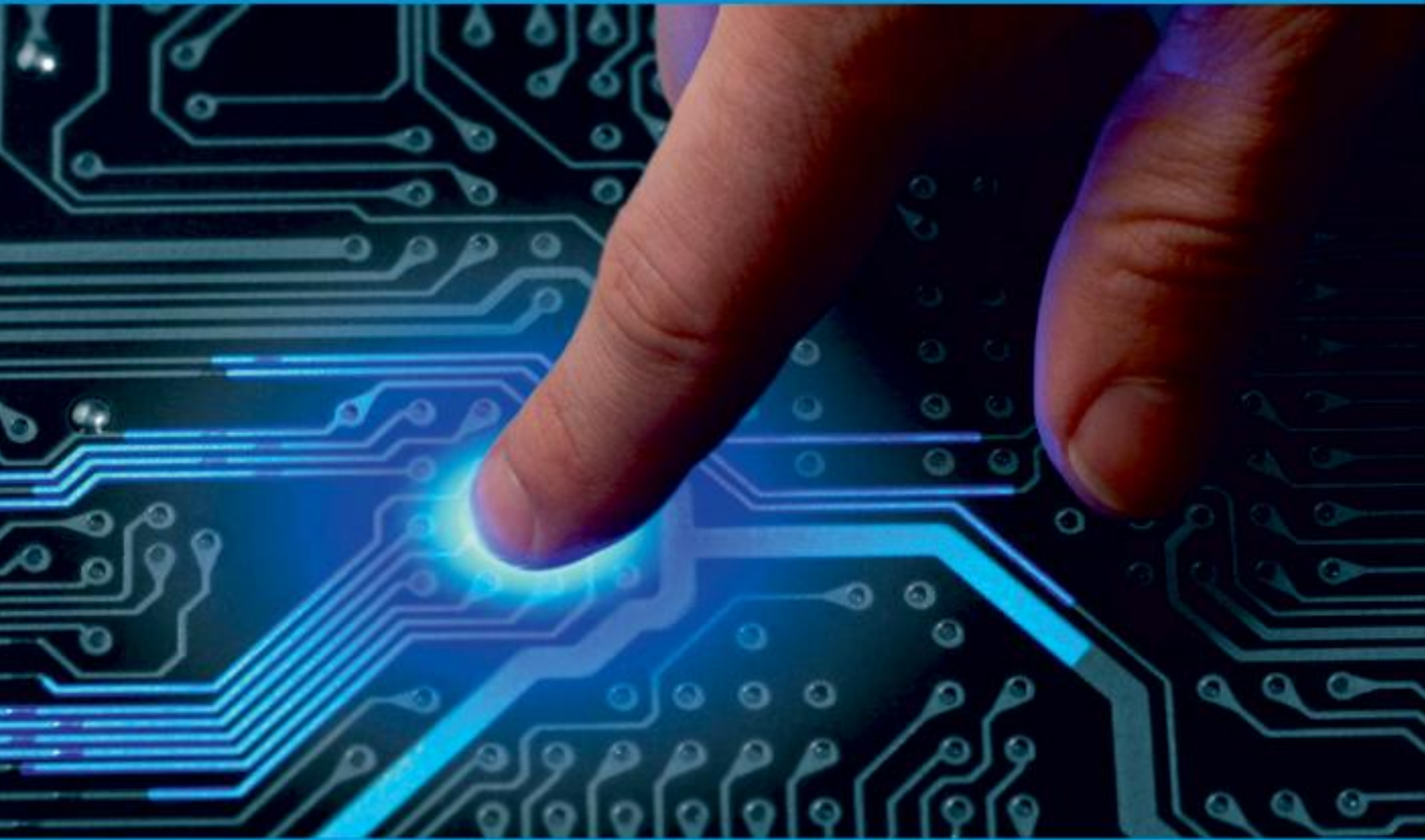

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# Detection of Enemy and Predict the Direction of Gunshot Using IoT and Image Processing

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**ABSTRACT:** IoT is incorporating smartness in the working of almost all areas of technology. Relevant feedback is collected by the IoT nodes distributed in the dynamic field environment which has to be controlled smartly. This aggregate information helps to achieve effective decision making and intelligent working of IoT systems. Internet of Battlefield Things (IoBT) is aimed to introduce intelligence in the functioning of security forces and military operations. In this scenario, the soldiers and their equipments are most flexible and important information sources for predictive analysis. Soldier wearables and equipment are enabled with heterogeneous sensors to collect the multidimensional battlefield information in real-time. This collected information has enormous potential to create SA, which is highly beneficial for critical battlefield operations. Enemy position during live combat operation can provide great help to plan a good war strategy and response to the emergencies. Real-time ground zero information of the battlefield is collected by the command station with help of the IoBT network connected to the soldiers and their equipments. Collective analysis of this raw information results in important feedback like real-time enemy localizations. These intelligence inputs are extremely beneficial to the commander for smart and accurate decision making to predict the enemy's location.

**KEYWORDS:** Internet of Battlefield Things (IoBT), Enemy Localization Algorithm, Defence Internet of Things (IoT), Real-time, Smart Wearables and Gunshot Direction.

## I.INTRODUCTION

The evolution of iot and its smartness is used in all fields of technology.The aggregate information helps to achieve effective decision making and the intelligent working of IoT systems. Defence and public safety are important domains where IoT incited transformation in the functioning of conventional battlefield scenarios. This is also commonly known as a defence Internet of Things or the Internet of Battlefield Things (IoBT) which aimed to introduce intelligence in the functioning of security forces and military operations. In the entire IoBT scenario, the soldiers and their equipment are the most flexible and important information sources for predictive analysis.

The primary objective is to develop enemy location systems that can be useful to both police and military forces. The real-time information of enemy locations is capable to transform the outcome of combat operations. Such information gathered using connected soldiers on the Internet of Battlefield Things (IoBT) is highly beneficial to create Situational Awareness (SA) and to plan an effective war strategy. The paper presents the novel enemy localization method that uses the soldier's own locations and their gunshot direction. The hardware prototype has been developed that uses a triangulation for an enemy localization.

## II.LITERATURE REVIEW

**Title:** Robust doa estimation of heavily noisy gunshot signal
**Author:** Angelo M.C.R. Borzino, Jose A. Apolin ario Jr , and Marcello L.R. de Campos
- We combine exhaustive search for selecting pairs of microphones from the array to attain the best DOA estimation results and fast response time for different shooting scenarios. We are particularly interested in highly corrupted signals for which state-of-the-art algorithms fail.

**Title:** A Novel Approach for the Detection of Gunshot Events using Sound Source Localization Techniques
**Author:** Ajay Kumar Bandi, Maher Rizkalla, and Paul Salama

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-This paper deals with the detection of gunshots, using microphone sensor arrays placed in different locations which are processed using MATLAB. The time difference of arrivals of acoustic signals at different sensors is used to determine the direction of arrival, elevation and the location of the shooter. The aim of the project is to develop a high speed and low power sensor array.

**Title:** Shooter localization using Microphone Arrays on elevated platforms.
**Author:** D. M. Paredes, and J. A. Apolinário Jr
-This paper discusses a technique to estimate the position of a sniper using spatial array located on a raised platforms. Shooter location is estimated from topographic information of the area and the direction of arrival of the gunshot signal.

## III.PROBLEM STATEMENT

A key component of combat readiness is achieving proficiency in rifle marksmanship. Marksmanship is defined as "the application of the fundamental skills of firing a weapon with precision and accuracy". Proficient riflemen use their marksmanship skills to deliver accurate fire under the most complex and ambiguous environments in an effort to eliminate the threat. The Army requires each Soldier to attain marksmanship proficiency through Basic Rifle Marksmanship (BRM) training. Typically, the only time Soldiers are objectively assessed is during the qualification event at the end of training. Therefore, research is required to develop formative assessments that can identify skill deficiencies and predict marksmanship proficiency. The current study aims to identify those measures that predict the Army BRM qualification score.

## IV.EXISTING SYSTEM

Localization of the enemy using acoustic sensors has proved fruitful with good accuracy but with certain limitations. Because of heavy audio processing requirements, these systems became computationally intensive that end up into the power-hungry systems. The quality of acoustic signals is reduced significantly after 50 meters, results in the limited detection range. The presence of echoes and change in microphone orientation makes detection considerably difficult in practical battlefield scenarios some of the systems are dealing with coverage issues because they are stationary in nature. Microphone placement and variation in the atmospheric temperature affect the localization accuracy that can be compensated by periodic calibration of the sensor system.

## V.PROPOSED SYSTEM

We have proposed the novel enemy localization method in network-centric warfare, which uses the real-time soldier's locations and their gunshot directions as inputs. In the initial stage, we developed and tested the hardware prototype for a simple scenario consisting of 1soldier and 1 enemy. The Arduino , ADXL sensor along with Node MCU modules are used to determined gunshot direction and soldier location respectively. CNN is used to detect the enemies in front of the soldier. The gun is embedded with an OLED display ,Arduino , ADXL sensor, Node MCU ,Wi-Fi enabled camera and a 9V battery for power supply.
Camera fitted with the gun captures live video and AI engine detects the enemy.The Arduino unconnected with ADXL sensor senses the gun movement (left /right) and it compares it with the server instruction and displays the suggestion (left,right,shoot messages) on the OLED display. This enables the solider to never miss his shot to kill the enemy.

**Advantages:**

- This system can prove to be of great use for strategic planning and feedback to aerial vehicles.
- The collective analysis of this raw information results in important battlefield feedback like real-time enemy localizations.
- The comparative analysis shows that the proposed algorithm is faster, computationally simple, consistent and reliable compared with others.

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***A.System Architecture:***

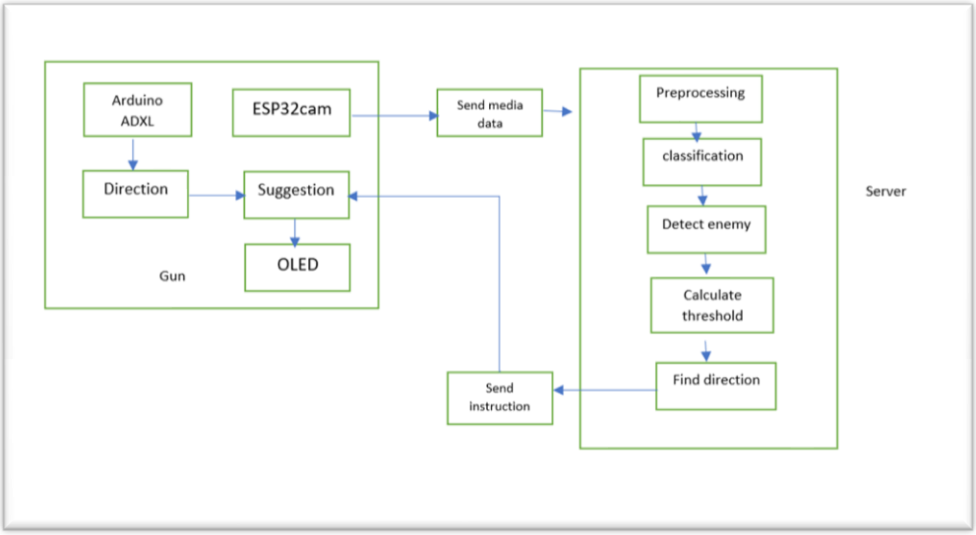


**Fig 1: System Architecture**

The system architecture consists of a gun embedded with a WIFI enabled ESP32 camera, Arduino connected with ADXL senor, ESP8266 Node MCU, OLED display.

The camera collects media data and sends it to the server where a series of operations takes place based on CNN algorithm. The server detects the enemy, finds the direction and sends the instruction to the gun. The Node MCU receives this instruction and compares it with the Arduino Nano data. Based on this the final suggestion is made and Left/right/shoot messageis displayed on the OLED display.

***B.WORKING:***

The steps start from capturing data from camera, processing data, feature extraction, match captured data, givevalues of matched data, generate suggestion and display it . This is summarized in the following steps:

1. The Wi-Fi enabled ESP32 camera is connected to the gun.
2. Arduino, ADXL sensor and Node MCU are connected with the gun.
3. A 9V battery is used as a power supply.
4. The camera setup is positioned at the tip of the gun and connected to the server. Anaconda Navigator is used to collect the output to detect the enemy and sends the instruction to Arduino Nano.
5. The Arduino software is used to configure the Arduino and to view the live streaming video.
6. The machine is trained with datasets which are based on boots,caps,uniforms,photograpghs ,logos etc. When the server receives the media data, it compares with the dataset by undergoing various steps like pre-processing, feature extraction, classification using CNN algorithm.
7. Based on this, the server detects the enemy, calculates the threshold, finds the direction and sends it back to the gun.
8. The node MCU Node MCU receives this instruction and compares it with the Arduino Nano data. Based on this the final suggestion is made and Left/right/shoot message is displayed on the OLED display.

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## VI. HARDWARE REQUIREMENTS

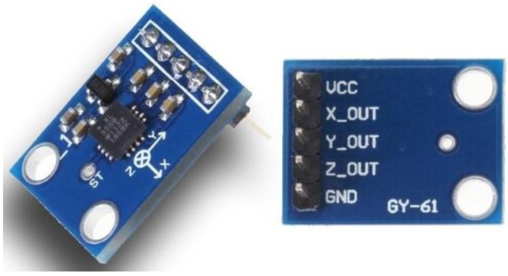


**Fig 2: ADXL sensor**

The ADXL Sensor gives complete 3-axis acceleration measurement. It shows acceleration, only due to cause of gravity i.e. g force. This module measures acceleration within range ±3 g in the x, y and z axis. ADXL335 accelerometer provides analog voltage at the output X, Y, Z pins; which is proportional to the acceleration in respective directions i.e. X, Y, Z.

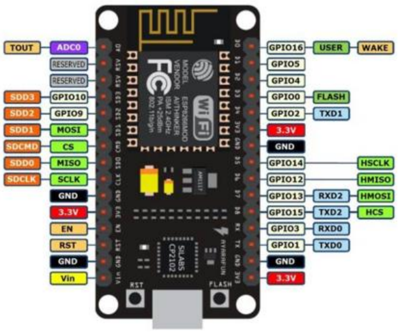


**Fig 3: Node MCU 8266**

Node MCU is a low-cost open source IoT platform. It initially included firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which was based on the ESP-12 module. Later, support for the ESP32 32-bit MCU was added.

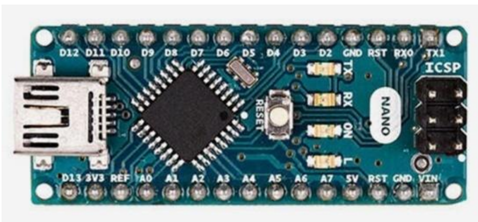


**Fig 4: Arduino Nano**

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It is used to produce a clock of precise frequency using constant voltage. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one.

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**Fig 5: ESP32 Wi-Fi enabled camera**

The ESP32-CAM is a full-featured microcontroller that also has an integrated video camera and microSD card socket. It's inexpensive and easy to use, and is perfect for IoT devices requiring a camera with advanced functions like image tracking and recognition.

## SOFTWARE REQUIREMENTS

**Anaconda Navigator:**

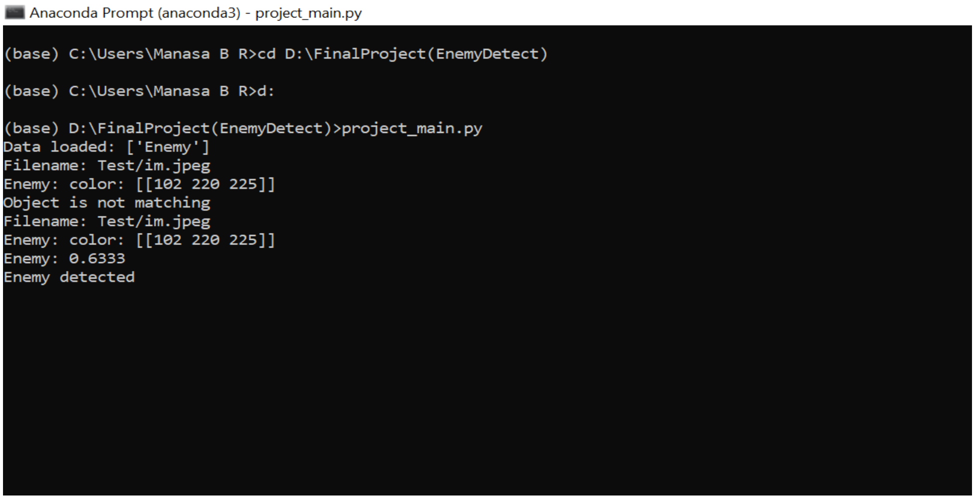


**Fig 6: Anaconda Command Prompt (Anaconda Navigator)**

In the figure, Anaconda Navigator is used to collect the output to detect the enemy and sends the instruction to Arduino Nano.

**Arduino Software:**

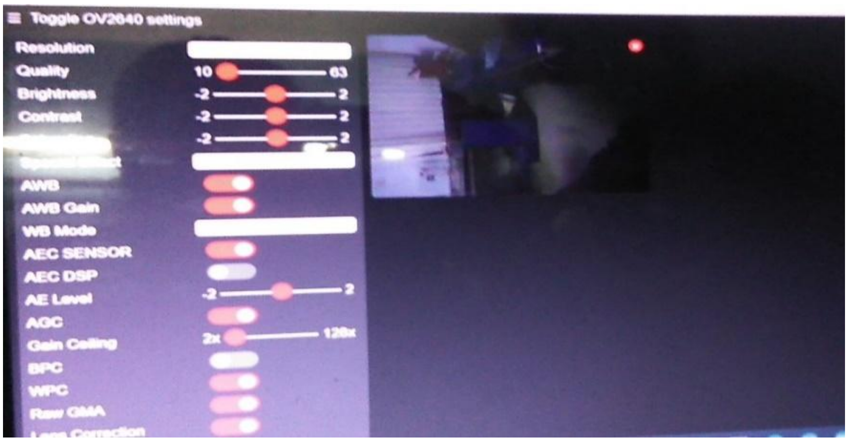


**Fig 7: Arduino Software**

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The Arduino software is used to configure the Arduino and to view the live streaming video.

## VII.RESULT AND IMPLEMENTATION

**IMPLEMENTATION**

1. **Training the Model:**

- We train the model by training the machines through images captured.
- The images can be obtained by the government military database or the images of the enemies can be obtained through spies. (in real time)
- We train the machine based on parameters like: enemy's uniforms, enemy's caps, boots, flags,logo etc so that it is trained in such a way that it can predict the enemy solider.

**VGG16 Architecture (ImageNet):**

- The input dimensions of the architecture are fixed to the image size, (224 × 224). In a pre-processing step the mean RGB value is subtracted from each pixel in an image.

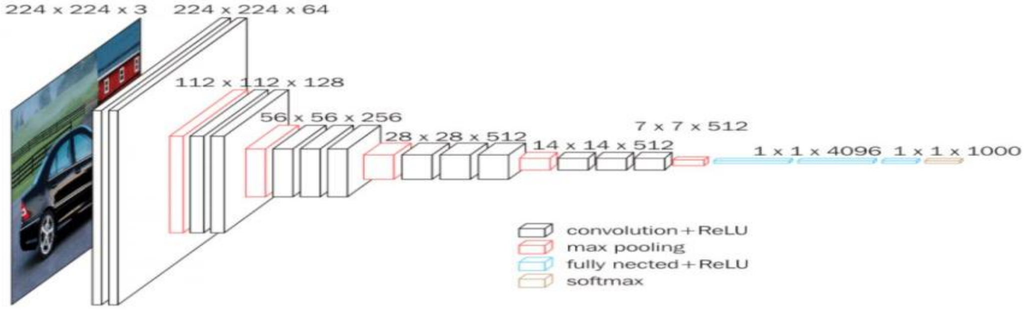


**Fig 8:Architecture of Neural network (VGG16)**

**Algorithm works Steps:**

**Step1:** Feature Extraction: Convolution
**Step2:** Feature Extraction: padding
**Step3:** Feature Extraction: Non-Linearity
**Step4:** Feature Extraction: Pooling
**Step5:** Classification — Fully Connected Layer (FC Layer

**2. Find direction**

- ADXL sensor is connected with Arduino Nano which is 3 axis magnetometer which detects left or right hand movement of the gun.
- Camera is fitted at the tip of the gun. The distance from centre of the camera and enemy's location is calculated and sent to server.
- Based on ADXL data and server instruction, the suggestion is made in Arduino Nano. ¬ Instructions can be left, right or shoot based on enemy's location.
- If the enemy is found, then shoot message is displayed on OLED display.
- Find the direction

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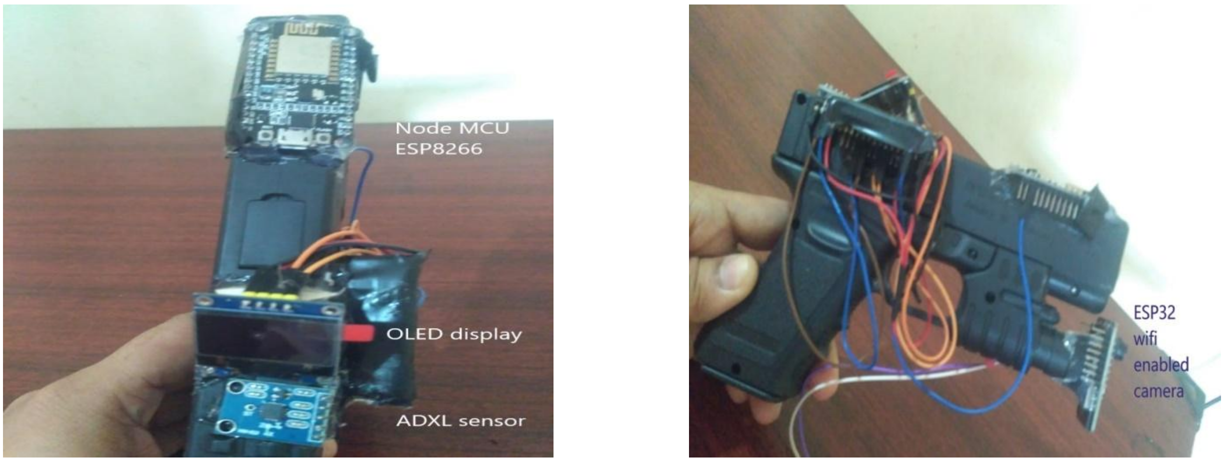


**Fig 9: Hardware Prototype**

Anaconda Prompt (anaconda3) - project_main.py

```
(base) C:\Users\Manasa B R>cd D:\FinalProject(EnemyDetect)

(base) C:\Users\Manasa B R>d:

(base) D:\FinalProject(EnemyDetect)>project_main.py
Data loaded: ['Enemy']
Filename: Test/im.jpeg
Enemy: color: [[102 220 225]]
Object is not matching
Filename: Test/im.jpeg
Enemy: color: [[102 220 225]]
Enemy: 0.6333
Enemy detected
```

**Fig 10: Anaconda Command Prompt (Enemy is detected)**


**Fig 11: Enemy is detected hence “shoot”message is displayed on the OLED Display**

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## VIII.CONCLUSION AND FUTURE WORK

We were able to detect the enemy and predict the direction of gunshot. In the entire IoBT scenario, the soldiers and their equipment are the most flexible and important information sources for predictive analysis. In this system, we have aimed to introduce intelligence in the functioning of security forces and military operations.

In future we would like to improve the accuracy further and add more parameters to detect the enemy. Finally we target to extend our domain IoBT using image processing scenarios on elevated platform. We also aim to extend this mechanism to wide range of enemies.

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