

Weapon Detection Using Arduino

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Abstract: *This project presents an automated security solution designed to detect metallic weapons (such as handguns and knives) in high-risk indoor environments like banks, ATMs, and school entrances. The system utilizes an Arduino Uno integrated with an inductive proximity sensor or a custom metal detector circuit to identify the presence of metallic objects within a specific range.*

Upon detection, the Arduino triggers a multi-layered response: an audible buzzer alarm sounds to alert on-site personnel, and a GSM module (e.g., SIM800L) sends an emergency SMS to authorized mobile numbers. For enhanced security, the system can be interfaced with a DC motor to automatically lock entry/exit doors, effectively containing a potential threat. The proposed system offers a cost-effective, low-power alternative to expensive scanning equipment, making it suitable for deployment in resource-constrained environments.

A weapon detection system using Arduino is a project designed to enhance security by automatically identifying the presence of potentially dangerous objects, such as firearms or metallic knives, and alerting security personnel. This system typically uses Arduino as the central microcontroller to process inputs from sensors and activate alerts or security mechanisms in real-time.

Key Components & Modules

- **Microcontroller:** Arduino Uno (Central processing unit).
- **Sensing Unit:** Inductive proximity sensor for metal detection or Ultrasonic sensor (HC-SR04) for distance-based intrusion detection.
- **Alerting Unit:** Piezoelectric buzzer for local alarms and GSM/GPS modules for remote notifications.
- **Actuator Unit:** L293D H-bridge with DC motors for automated door control or sliding gate mechanisms.
- **Power Supply:** 9V-12V DC source.

Keywords: *automated security solution*

I. INTRODUCTION

1. Background & Motivation:

Rising security concerns in public spaces, schools, and restricted areas necessitate automated surveillance. Traditional manual monitoring is often inefficient and prone to human error. An Arduino-based weapon detection system provides a cost-effective, real-time solution to bridge this gap, allowing for early detection and rapid response to potential threats.

2. Objectives

Real-time detection: Identify weapons (guns/knives) instantly.

Automation: Reduce dependency on human operators for surveillance.



Alerting Mechanism: Trigger immediate alarms, buzzers, or notifications upon detection.

IoT Integration: Send alerts to authorized mobile numbers or cloud platforms using modules like GSM or ESP32.

INTRODUCTION

Security is one of the most important aspects of modern society. With the rapid increase in population and urbanization, the number of crimes such as robbery, violence, and terrorist activities has also increased. To ensure safety, surveillance systems are widely deployed in public places such as airports, railway stations, shopping malls, banks, and educational institutions.

Traditional surveillance systems use CCTV cameras to monitor activities. However, these systems rely heavily on human operators who must continuously observe video feeds. This leads to several problems such as fatigue, lack of attention, and delayed response. In large-scale environments, it becomes very difficult for humans to monitor multiple cameras simultaneously. Due to these limitations, there is a need for an intelligent and automated surveillance system that can detect suspicious activities in real time without human intervention. One of the most critical applications of such systems is weapon detection, as the presence of weapons poses a serious threat to public safety.

This project introduces a system that uses Arduino and image processing techniques to detect weapons in real time. The system captures video input, processes each frame, and identifies objects using predefined algorithms. If a weapon is detected, the system triggers an alert such as a buzzer or LED.

Arduino is used as a hardware controller to manage alert systems and interface with other components. Although Arduino has limited processing power, it is effective in handling real-time hardware operations. The detection process can be performed using a connected computer system.

The proposed system is cost-effective, efficient, and easy to implement. It reduces human effort, improves response time, and enhances security. It can be further improved by integrating Artificial Intelligence (AI), Machine Learning (ML), and Internet of Things (IoT) technologies.

II. LITERATURE SURVEY

Wenbo Lan and his team, worked on Pedestrian Detection Based on YOLO Network Model [1]. They have modified the network structure of the YOLO algorithm and created a new structure called YOLO-R to extract information about shallow pedestrian features to include pass-through layers with the original YOLO network. Using the INRIA dataset as test set, YOLO V2 and yolo-R were evaluated. The result showed that the YoloV3 network model is better than the YoloV2 network model. Obstacle detection technique [2] for interior environments used the light field camera and yolo object detection algorithm to classify items according to the groups and those items were marked in the image. The training images of obstacles were labeled and unnecessary obstructions were removed using the object filter. The efficiency of this algorithm is proved by several scene types, such as pedestrian, charge books, and others.

The Author Zhimin Mo and his team, worked on the Identification and Detection of Automotive Door Panel Solder Joints based on YOLO [3]. A technique based on the yolo algorithm that displays location of solder joints and the type in real time to identify more precisely detect the tiny solder connections. Using many levels of prediction, it predicts the location using different size feature maps and integrates the results to get the outcome. This shows that flexibility and real-time of welding of automotive door panels, help to boost the efficiency of the manufacturing line. In End-to-End Object Detection with Transformers [4], they have observed that when recurrent neural networks are employed for object deduction projects, the accuracy is worst and the model runs slower due to the sequential nature of processes. So, they obtained a model that is absolutely faster because these processes are performed in parallel using transformer topologies. Faster CNN-based vehicle detection and counting strategy for fixed camera scenes [5], they developed a surveillance system that uses advanced digital data infrastructure that allows for the monitoring of traffic with the identification of incidents and the prior raising of alarms.

The goal of the vehicle detection and classification system was for traffic scene is to direct surveillance operations and reduce the need for human resources to monitor hundreds of cameras during traffic surveillance, which can lower the



rate of traffic accidents for drivers, which also increase the success of driverless cars. The YOLO V2 classifier detector was used in this study together with effective vehicle identification and counting technique based on convolution neural networks (CNNs) and the KLT tracker. Mahdi Hashemzadeh and his team contributed Smoke detection in video using convolutional neural networks [6] and efficient spatio-temporal features aim to detect regions which are containing smoke in an image. The image can be in any format like a frame of a video or a frame of a stream received from a surveillance camera. They have created an accurate smoke detection solution without any false alarms by applying a combination of deep, spatial, and spatio-temporal features. It uses the features that are extracted from the visual and dynamic characteristics of the smoke. This is to separate the real smoke regions from the non-real ones. The proposed method was a combination of motion detection method with a customized lightweight CNN to find the smoke regions and then introduced a set of spatio-temporal features to build an SVM model to filter out the non-smoke or smoke-like objects from the real smoke regions. Single shot multi-box detector (SSMBD) [7] algorithm used for higher detection precision with real-time speed. However, the single shot multi-box detector (SSMBD) algorithm is not appropriate to detect tiny objects, since it overlooks the context from out of the boxes. Their proposed approach uses a new architecture as a combination of Faster R-CNN with convolutional features and SSMBD with multi-scale contexts in additional layers. Though multi-scale feature extraction may improve accuracy for detecting big object, it does not exhibit a good precision of speed to detect small object. FCOS: Fully Convolutional One-Stage Object Detection [9], they have reformulated object detection in a per-pixel prediction fashion. They show that how they make use of multi-level prediction to improve the recall and resolve the ambiguity resulted from overlapped bounding boxes in training. The two possible issues of the proposed FCOS can be resolved with multilevel prediction with FPN and a large stride. FCN-based FCOS is still able to produce a good BPR, and it can even be better than the BPR of the anchor-based detector RetinaNet.

FCOS compares the popular anchor-based one stage detectors including Retina Net, YOLO and SSD, however with much less design complexity. FCOS completely avoids all computation and hyper-parameters about anchor-boxes and solves the object detection in a per-pixel prediction fashion, like other dense prediction tasks such as semantic segmentation. Weapon Detection using Artificial Intelligence and Deep Learning for Security Applications has been implemented SSD and quicker RCNN algorithms [8] simulated for pre labelled and self-created image dataset for weapon (gun) detection. SSD formula provides higher speed with 0.736 s/frame. Whilst quicker RCNN provides speed 1.606s/frame, that is poor compared to SSD. SSD provided real time detection to a quicker speed but quicker RCNN provided superior accuracy. Helmet detection [10] was done using SSD to extract feature maps and applied a convolutional filter for detecting objects. Detects bike riders without helmet and saves picture in a folder. The result obtained a precision 98% for all the parameters and this study could help the police control room.

System Development:-

Developing a weapon detection system with Arduino generally follows two paths: Sensor-Based Prototypes (detecting physical properties like metal) or AI-Assisted Systems (using computer vision for visual recognition).

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Key Components:

Microcontroller: [Arduino Uno](#) or [Arduino Nano](#).

Metal Sensor: Inductive proximity sensor (e.g., LJ12A3-4-Z/BX) to detect metallic objects like guns or knives.

Ultrasonic Sensor (HC-SR04): Used to detect the presence of a person or measure distance.

Alert Module: Buzzer, LED, or a GSM Module (SIM800L) to send SMS alerts.

Workflow:

Detection: The ultrasonic sensor triggers when a person enters a designated zone.

Scanning: The metal sensor scans for metallic signatures within range.



Action: If metal is detected, the Arduino activates a buzzer and can trigger a locking mechanism (via a relay and solenoid lock) to prevent entry.

IV. TECHNICAL SPECIFICATIONS

HARDWARE:

Microcontroller: Arduino uno controller
 Crystal: 16 MHz
 LCD: 16x2 LCD display
 GSM: SIM800C
 Relay: 12V DC electromagnetic
 Siren: 12V DC
 H-bridge: L293D
 DC motor: 5V
 DC Camera: ESP32 camera
 Power Source: 12v 1 amp DC battery

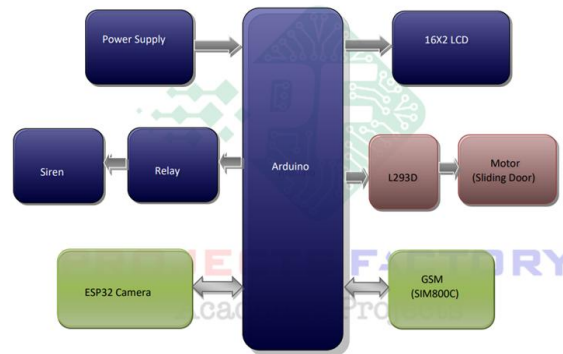


Fig No -3.1 Block Diagram of System

DESCRIPTION:

ESP32 camera and GSM (Sim800c) modules interfaced with Arduino UART port. 12v Siren enabled by relay. Relay connected to Arduino digital pin. DC motor controls sliding door and it was controlled by L293d H-bridge.

WORKING:

ESP32 camera can detect weapons like guns and grenades. This camera installed at public areas, banks, ATMs and many more public crowded areas. This project mainly meant for indoor areas like ATMS and banks. If weapon detected by camera then door will be closed and SMS will send to authorised mobile numbers. Also siren will be ON. This project helps in detecting weapons like handguns and provides a user-friendly, reliable, and accessible system to reduce crime by monitoring CCTV in real-time. We can even find the person who is containing the weapon. We have built our own custom dataset for weapons of classes by combining the gun pictures to find the accuracy of the dataset by testing and training it. Nowadays, we can see in shopping malls and airports when a person entering into it they will be checking if anything objects is found like a gun just sounds alarming. So, by knowing this alarm the people who are near him can understand he might be a thief or terrorist and move far away from them. Similarly, we have collected the images of weapons, which are taken in different angles, and trained and tested them in the YOLOV4 algorithm.



Developed code for users to take input as webcam, where if a weapon is detected, it automatically saves frame of the weapon detected. An alerting System is developed for emailing the admin, with the captured weapon image.

Applications:

A weapon detection system using Arduino utilizes sensors (sound, metal detectors) or computer vision (ESP32-Cam) to identify threats. The Arduino acts as the controller to trigger alarms, close doors, or send alerts via GSM modules. Common applications include enhanced security for banks, ATMs, schools, and airport.

Public Security: Real-time weapon identification in malls, airports, and stadiums to alert security staff immediately.

School Safety: Low-cost metallic weapon detection systems at school entrances to prevent armed intruders.

Border Surveillance: Unmanned systems that detect intruders and trigger automated targeting or alerting in remote areas.

Indoor Security (ATMs/Banks): Automated door-locking mechanisms that trap an armed intruder until law enforcement arrives.

V. ADVANTAGES

A weapon detection system using Arduino, often paired with cameras (like ESP32-CAM) and AI/machine learning models (like YOLO), offers a low-cost, automated approach to security. These systems are designed to identify weapons such as guns or knives and alert authorities in real-time.

Here are the key advantages of a weapon detection system using Arduino:

1. Low Cost and High Accessibility

Affordable Components: Arduino boards, ESP32-CAM modules, and sensors are inexpensive compared to industrial security systems.

Educational/Prototyping Friendly: Ideal for rapid prototyping and deployment in small-scale environments (e.g., school projects, small offices).

2. Real-Time Detection and Automated Alerts

Instant Notification: When a weapon is detected, the system can instantly send alerts via IoT platforms, email, or Telegram, providing crucial, immediate information.

Reduced Response Time: By automating the detection, the time between a threat appearing and security personnel being alerted is drastically reduced.

3. Proactive Security and Threat Mitigation

Preventative Action: Unlike traditional CCTV that requires post-incident analysis, these systems work in real-time to allow for intervention before a situation escalates.

Automated Security Protocols: The system can trigger external hardware, such as activating a 12V siren or locking a motorized door, when a weapon is detected.

4. Scalability and Customization

Custom Dataset Training: The system can be trained on specific datasets (e.g., using YOLOv4 or YOLOv8) to recognize various types of weapons, including handguns, knives, and rifles.

Easy Integration: These systems can be integrated into existing CCTV networks as an added layer of intelligence.

5. Edge Computing Capabilities

Offline Functionality: By using edge devices like Raspberry Pi or ESP32-CAM, the system can process video feeds locally without relying on internet connectivity, ensuring reliability.

Data Privacy: Local processing means sensitive video data does not need to be sent to a public cloud, enhancing privacy.

6. Reduced Human Error and Labor

Continuous Monitoring: Unlike human guards who experience fatigue, an automated system provides 24/7, vigilant monitoring.



High Accuracy: Modern AI-driven models can achieve high accuracy rates, reducing the false alarm fatigue associated with older, manual surveillance techniques

VI. CONCLUSION

The conclusion of a weapon detection system project using Arduino highlights the successful integration of low-cost hardware with sensing technology to create a functional, real-time security alert system. These projects typically demonstrate that Arduino can efficiently process sensor data to identify potential threats and activate alerting mechanisms, making it a viable tool for safety applications.

Key conclusions from this project include:

- **Feasibility of Low-Cost Security:** The system proves that utilizing an Arduino board, along with metal detectors (inductive proximity sensors) or ultrasonic sensors, provides an affordable, accessible solution for security screening in schools, banks, or restricted areas.
- **Effective Threat Detection:** The prototype effectively identifies metallic weapons, distinguishing them from non-metal items, and triggers a buzzer or LED alert instantly.
- **Real-Time Monitoring:** The system successfully operates in real-time, providing immediate feedback (such as turning on a 12v siren or activating a relay) upon detecting a threat, as seen in projects utilizing ESP32 camera modules or PIR sensors.
- **Future Enhancement Scope:** While efficient, conclusions often note the need to improve the system by integrating IoT technology to send remote alerts, integrating AI for better classification, and increasing the sensor's range for better reliability

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