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Eye Spy

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ABSTRACT—

Crime is a significant societal issue, impacting citizens' quality of life and necessitating preventive measures. With the rising crime rate and the burden on the police force, exploring the potential of artificial intelligence (AI) and blockchain technology can be beneficial. Surveillance cameras, initially deployed for safety concerns, can also contribute to crime prevention. By implementing facial recognition systems, a criminal identification framework can identify individuals with criminal records, triggering appropriate alerts. Additionally, a deep learning model for weapon detection enables cameras to identify individuals with criminal history or carrying weapons in public spaces, sending alerts and live footage to the security team for immediate action. A data system records activities and enables coordinated responses in urban emergencies, including an SMS notification feature with GPS coordinates of camera locations. Monitoring EyeSpy cameras is facilitated through an IoT panel specifically developed for this purpose.

Keywords: Criminal, Face recognition, Weapon detection, Deep learning, IoT panel, SMS notification.

Introduction:

The process of identifying and apprehending criminals can be challenging when no biological evidence or fingerprints are left at the crime scene. State-of-the-art face identification systems offer a quick and effective solution to this problem. Surveillance cameras, such as CCTV cameras, are widely installed for surveillance purposes in buildings and traffic lights. These cameras capture video footage that can be utilized to identify suspects, criminals, missing persons, and runaways.

Eyewitness testimonies often play a crucial role in identifying criminals, and face identification is one method used. Faces are central to social interactions and hold valuable information about identity and emotions. Although facial appearance doesn't directly reflect intelligence or character, humans have a remarkable ability to remember and recognize faces.

As population density increases, crowd behavior analysis has gained significant interest in scientific research. Preventing accidents, such as pushing, mass panic, stampedes, and loss of control, requires the detection of critical and unusual situations within dense crowds. Overcrowded environments like malls and universities pose challenges for visitors and students, but effective solutions are limited.

Face recognition is essential in law enforcement, banking, security system authentication, and personal identification. While humans excel at face recognition, it remains a challenge for computers. The specific mechanisms of human face recognition, including how our brains analyze and encode facial images and the utilization of inner or outer features, are not fully understood. Neurophysiologists have discovered specialized nerve cells in the brain that respond to specific local features of a scene, combining them into meaningful patterns.

Automatic face recognition involves extracting meaningful features from an image, representing them effectively, and performing classifications. Geometric features of a face are commonly used for human identification, involving three major steps: acquiring a face database, detecting faces in the images to train the recognizer, and testing its ability to recognize trained faces.

This project aims to develop "Eye Spy," an intelligent criminal identification and suspicious activity detection system. It utilizes a deep learning-based hardware and software framework, leveraging camera feeds in public places for facial recognition of criminals and weapon detection. Whenever suspicious activities are detected, the system promptly alerts the relevant authorities**.**

LITERATURE REVIEW

The authors in Harsh Jain et.al[1] in Aug, 2020 has proposed a system i.e. Weapon Detection using Artificial Intelligence and Deep Learning for Security Applications. This is implements automatic gun (or) weapon detection using a convolution neural network (CNN) based SS D and Faster RCNN

lgorithms. Proposed implementation uses two types of datasets. One dataset, which had pre-labelled images and the other one is a set of images, which were labelled manually. Results are tabulated, both algorithms achieve good accuracy, but their application in real situations can be based on the trade-off between speed and accuracy.

The authors in TuzhiXu et.al.[2] in has proposed a system i.e. Multisensory Concealed Weapon Detection Using the Image Fusion Approach. In this , an efficient concealed weapon detection (CWD) algorithm based on image fusion is presented. First, the images obtained using different sensors are decomposed into low and high frequency bands with the double-density dualtree complex wavelet transform (DDDTCWT). Then two novel decision methods are introduced referring to the characteristics of the frequency bands, which significantly improves the image fusion performance for CWD application. The fusion of low frequency bands coefficients is determined by the local contrast, while the high frequency band fusion rule is developed by considering both the texture feature of the human visual system (HVS) and the local energy basis. Finally, the fused image is obtained through the inverse DDDTCWT. Experiments and comparisons demonstrate the robustness and efficiency of the proposed approach and indicate that the fusion rules can be applied to different multiscale transforms. Also, our work shows that the fusion result using the proposed fusion rules on DDDTCWT is superior to other combinations as well as previously proposed approaches.

The authors in Naimah Mat Isa et. Al.[3] has proposed a system i.e. object Detection: Harmful Weapons Detection, in which a revolutionary method to enhance the application of CCTVs in Malaysia. The purpose of this study is to develop an Artificial Intelligence (AI) based weapons detection that helps people in identifying violent crimes that are currently happening. This study focuses on detecting harmful weapons such as handguns and knives using the custom trained object detection model that has been trained . Two sets of training have been done to test the effectiveness of this system. The first training was done on a single class custom object detection model while the second was done on a multiple class custom object detection model. Based on the results obtained, the single class object detection only managed to achieve 66.67% to 77.78% accuracy on average whilst the multiple class object detection managed to achieve up to 100% accuracy on most of its input images.

The authors in ShenghaoXuet. Al.[4] has proposes a system, Development of an AI-based System for Automatic Detection and Recognition of Weapons in Surveillance Videos. The aim of this work is to develop a low-cost, efficient, and artificial intelligence-based solution for the real-time detection and recognition of weapons in surveillance videos under different scenarios. The system was developed based on Tensorflow and preliminarily tested with a 294-second video which showed 7 weapons within 5 categories, including handgun, shotgun, automatic rifle, sniper rifle, and submachine gun. At the intersection over union (IoU) value of 0.50 and 0.75, the system achieved a precision of 0.8524 and 0.7006, respectively.

The authors in Nurul AzmaAbdullah et.al[6] are taking help of the CCTV footage and comparing the images from the footage with criminal database if they didn't find any fingerprint from the crime scene. This system consists of five stages where the first stage is planning in which the why and how the system is made are discussed. The second stage of Requirement analysis discussed the requirement to design the system. Design, the third stage where they defined system design and its workflow. The fourth ultimate important stage is Implementation and testing, system is implemented using Principal Component Analysis (PCA) Technique and tested. The last stage is maintenance; this phase hadn't undertaken due to this system was developed in a controlled environment. For criminal identification, authors had used PCA Technique for finding similar features of images available in the database with captured images of footage. The machine will use a database that contains the person's personal information so that if FRCI identifies a face, it can display the person's information. The system interface is implemented using Visual Studio Code and database and coding using MATLAB R2013b. They achieved 80% accuracy using the proposed model.

The authors in Apoorva. P, Impana et.al[7] proposed four steps, the first one is real-time image training and the second one is Harr-classifier using for face detection. The third step is the comparison of Surveillance camera captured images with real-time images and last, is the result part based on the comparison. The authors are using the Haar-classifier on Open-CV for face detection; Haar-cascading is one of the algorithms for face detection. On the open-CV platform, face tracking is taken with help of Harr-like classifiers. More than one person is identified in this system and it can be used to find the suspects whom we are finding. The accuracy of the proposed system is very high as compared to the previous model. They also told us that we use or Adhar database we can easily identify the Indians and foreigners and further can investigate whether a person is a criminal or not. We can use this system by taking the citizenship database which is already available.

The authors in Prof. Rupali T. Umbare et.al [8] carried out research Using the Passport database, they are identifying whether the traveler is an authorized passport holder or not. In this, they are using image processing techniques as well as LBPH mathematical model. This method consists of six steps for airport security purpose that are: a) Capture image using webcam b) Captured image is sent to the Django server c) Using LBPH feature set is taken from image d) Image is compared with database image by applying classifier e) If matching is done user details are fetched from database f) The predicted details of the user are sent to the admin via mail. They are using webcam images for LBPH processing and then applying the classifiers comparing them with database images. This will also help to catch the criminals who travel from one country to another and also detect if the traveler having a loan from the bank then traveler's detailed information will be sent for verification to the police station.

The authors in VikramMohantyet. al[9] proposed a research which Portraits of Soldiers from the Civil War of America in 1861-65 are identified by creating a web-based platform i.e., Photo Sleuthing. They told that this identification system is taken as finding a needle in the haystack. Where it contains 1) haystack building 2) the haystack narrowed down and 3) needle is finding in the haystack. Work is by combining automated face recognition and crowd-sourced human expertise. When this method was launched it helped to identify the unknown portraits and authors discussed implications for person identification pipelines. They show how Photo Sleuth's pipeline has helped to identify thousands of unknown images and also encouraging long-term volunteer contribution.

The authors in Dr.AsifAli et. al [10] presented an automatic face recognition system for attendance monitoring. They are capturing faces by using a camera and the captured image is compared with images that are already present in their database. They are using machine learning technology with an SVM classifier for name detection and gradient-oriented Histogram for face detection. They are using open-CV for image detection & recognition, Tkinter

for GUI application creation, and Numpy to work with arrays as those are libraries of python. To develop and test the application using the Xampp server, as it is a free open source server. There proposed model has achieved an accuracy of 99.38%. Using Cloud feasibility of the system can be increased.
The authors in KianRaheemQasim et.al [12] presented a face identification system that uses the fast algorithm. This model uses two datasets: 1) Olivetti Research Laboratory (ORL), 2) Unconstrained Facial Images (UFI). ORL contains 400 images of 92X92 pixels where 9 images are used for training purposes and 1 image for testing of each person. UFI contains 401 images of 128X128 pixels where 7 images are used for training purposes and 1 image for testing of each person. Captured image converted to HSV system and after that force field features is extracted from that image. Classification is done by using three distance methods that are: Manhattan, Euclidean, and Cosine. By comparing these methods they got the best resolution and achieved an accuracy of 99.9% for the datasets ORL and UFI.

METHODOLOGY

3.1 Existing System

After studying the literature review the following approaches were found in the existing system.

1. Most of the CCTV or surveillance cameras do not run any Prediction system on them.
2. Few Surveillance cameras have motion detection system and can be used to determine just the motion.
3. The research has been done and proposed on the detection of weapons in the CCTV feed but requires high end computational hardware as suggested in the research papers.
4. Few research scholars proposed the Face recognition and criminal identification but do not take into account the suspicious activity or weapon detection.
5. The majority of the existing system proposed is a software system and cannot be implemented on the edge hardware.

None of the existing system handles the criminal identification and weapon detection in a single system.

3.2 Proposed System

The proposed surveillance system is fully automated, eliminating the need for human monitoring and enabling efficient and effective surveillance. It utilizes facial recognition to identify suspects, criminals, and other individuals of interest, while also detecting weapons like guns and knives.

Privacy and security are prioritized in the design of the system, ensuring that only the faces of potential threats are captured and stored. This approach safeguards individuals' privacy while maintaining a focus on security. The system is suitable for deployment in high-security areas such as airports, train stations, and government buildings, enhancing security measures and reducing the risk of terrorist attacks or other violent incidents..

3.3 Proposed Methodology

The diagram below is a data flow diagram.

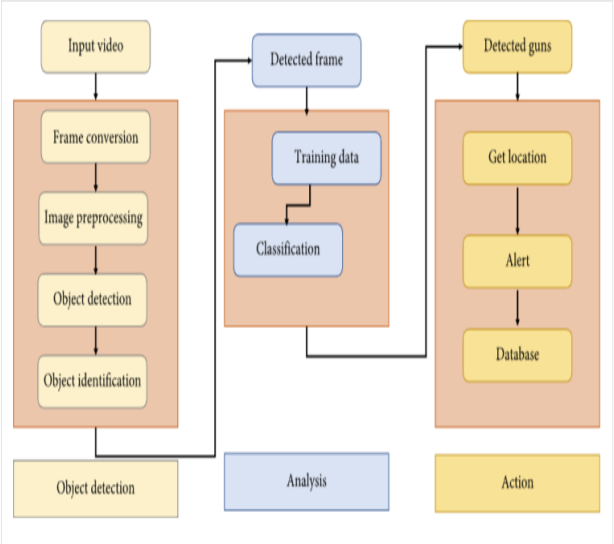


Fig.3.3 Data Flow Diagram

- Data Collection:

The data collection phase is crucial in this project as it requires a significant amount of data for machine learning. Data related to guns, knives, and rifles is collected, along with criminal records based on facial images. Two separate models are trained: one for criminal identification and another for face recognition.

- Data Pre-processing:

Once the data is collected, it undergoes pre-processing to prepare it for model training. This involves tasks such as train-test splitting and scaling.

- Framework Selection:

The appropriate framework is selected for model training after comparing different options.

- Deep Learning-based Face Detection and Identification:

Deep learning techniques are implemented for facial detection, identification, and recognition of facial features. The model is trained using criminal data, and when users are registered, their facial features are extracted and used for training.

- Training the Weapon Detection Model:

Once data pre-processing is completed, the model is trained using Python and TensorFlow to implement the weapon detection system.

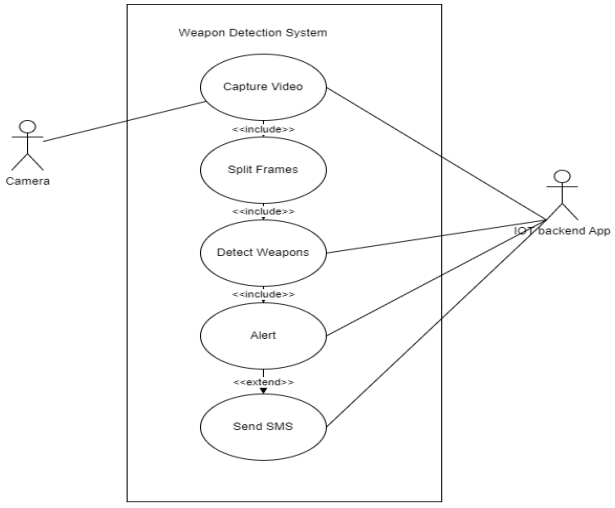
- Inference:

After the model is trained, Python code is developed for running inference on the model.

- IoT Surveillance Application and SMS Notification System:

A cloud-hosted IoT surveillance application is developed, allowing concerned authorities to visualize live video streams and proof of detection. Additionally, an SMS notification system is implemented to alert the authorities in case of weapon detection or identification of criminals.

3.4 Use Case Diagram



3.5 Use Case Description

- **Use Case: Capture Video**

  The camera is used to capture live photos and videos, which are then fed into the system for weapon detection. A camera connected to the system continuously captures live video for detecting suspicious activity.

- **Use Case: Split Frames**

  Once the video is captured, it is split into frames. These frames are then inputted into the trained model to detect suspicious activity.

- **Use Case: Detect Weapons**

  The trained model in the form of a graphdef is utilized to detect weapons frame by frame within the developed system. Each frame is processed by the trained model, and the detection results are provided as a dictionary containing details of the weapons detected in the frame.

- **Use Case: Alert**
  If a weapon is detected, the alert system is activated. It sends the details of the detection results to the IoT backend.

- **Use Case: Send SMS**
  Alongside the alert on the IoT backend panel, an optional SMS notification is triggered to alert the concerned authorities about the weapon detection.

SYSTEM REQUIREMENTS SPECIFICATION

4.1 Software Requirements:

Software requirement specifies the minimum software that is required for the application to run smoothly. The following are the software requirement for our project:

1. Python

The entire project is developed using Python, which is an interpreted, object-oriented, and high-level programming language known for its dynamic semantics. Python offers a range of built-in high-level data structures and supports dynamic typing and dynamic binding, making it suitable for rapid application development and scripting purposes. Its simplicity and easy-to-learn syntax prioritize code readability and reduce the cost of program maintenance. Python promotes modularity and code reuse through support for modules and packages. The Python interpreter and comprehensive standard library are freely available in source or binary form for major platforms, enabling widespread distribution.

2. PYCHARM IDE

PyCharm is a feature-rich integrated development environment (IDE) specifically designed for Python programming. It offers various functionalities such as code analysis, a graphical debugger, integrated unit testing, seamless integration with version control systems, and support for web development using Django framework. Developed by the Czech company JetBrains, PyCharm is compatible with Microsoft Windows, macOS, and Linux, making it a cross-platform IDE. There are two editions available: PyCharm Professional Edition, which is distributed under a proprietary license, and PyCharm Community Edition, which is released under the Apache License. The Professional Edition provides more extensive features compared to the Community Edition.

3. Easy EDA:

EasyEDA is a fantastic web-based Electronic Design Automation (EDA) tool that caters to the needs of electronics engineers, educators, students, market professionals, and enthusiasts. It provides a user-friendly interface and is available online, offering free access to create circuit schematics, design printed circuit boards (PCBs), and simulate electronic circuits. EasyEDA is a valuable resource for individuals involved in electronics design and provides a convenient platform for various design tasks.

4. Arduino IDE

The Arduino IDE is utilized for programming the ESP32 microcontroller. Arduino is an open-source company, project, and community that focuses on designing and manufacturing kits for creating interactive objects and digital devices capable of sensing and controlling the physical world. Arduino boards can be obtained either as preassembled units or in do-it-yourself kits. Moreover, the hardware design information is openly available for individuals interested in assembling an Arduino board from scratch. The Arduino IDE serves as the software platform for writing and uploading code to Arduino-compatible microcontrollers, including the ESP32.

5. Anaconda Navigator

Anaconda Navigator is a user-friendly graphical user interface (GUI) designed for the Anaconda distribution. It provides a convenient way to launch applications and manage Anaconda packages, environments, and channels without the need for command-line usage. With Anaconda Navigator, users can easily navigate and access the features and functionalities of the Anaconda distribution through a visual interface. To install Anaconda Navigator, one can refer to the Navigator Cheat Sheet and proceed with the installation of the Anaconda distribution.

4.2 Hardware Requirements:

Hardware requirement specifies the minimum hardware that is required for the application to run smoothly. The following are the hardware requirement for our project:

1. ESP32 chip

Figure 4.1 ESP32 chip

The ESP32 Chip is the heart of the project and acts as a central controller which will be used for interfacing different devices in the project.

2. Camera Module

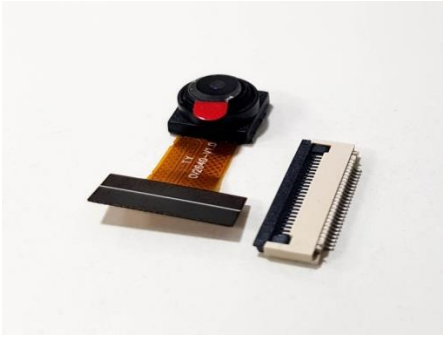


Figure 4.2 Camera

- The camera module used is OV2640 2 mp camera module.
- OV2640 is a 1/4-inch CMOS UXGA (1632*1232) image sensor
- Standard SCCB interface

3. AI edge NPU

The AI NPU is a system-on-chip (SoC) that integrates machine vision and machine hearing. Using TSMC's ultra-low-power 28nm advanced process with dual-core 64-bit processors for better power performance, stability and reliability. The program strives for zero threshold development and can be deployed in the user's products in the shortest time, giving the product artificial intelligence.

4.Battery

Figure 4.3 Battery

- The entire project is powered by 3.7 V battery to keep it compact.
- Voltage: 3.7V
- Capacity: 1000mAh
- Approx Size : 48mm x 30mm x 4.2mm

5.GPS modem

Figure 4.4 GPS modem

Ublox neo6m GPS modem is used in the project.

Here are complete specifications:

Receiver Type	**50 channels, GPS L1(1575.42Mhz)**
Horizontal Position Accuracy	**2.5m**
NavigationUpdate Rate	**1HZ (5Hz maximum)**
C Capture Time	**Cool start: 27sHot start: 1s**
Navigation Sensitivity	**-161dBm**

SIM800 L GSM Modem

Figure 4.5 SIM800 L GSM Modem

In this project SIM800 L GSM modem is used. It is used to send SMS. The SIM800L module supports quad-band GSM/GPRS network, available for GPRS and SMS message data remote transmission. The SIM800L communicates with microcontroller via UART port, supports command including 3GPP TS 27.007, 27.005 and SIMCOM enhanced AT Commands. It also has built-in level translation, so it can work with microcontroller of higher voltage than 2.8V default. Besides, the board also supports A-GPS technique which is called mobile positioning and gets position by mobile network. This features make it can also be a tracker module.

7.AI NPU DEVELOPMENT BOARD

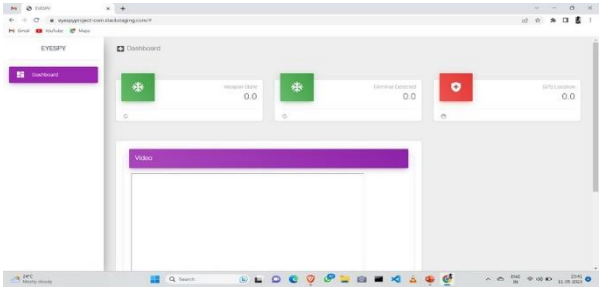
The AI NPU is a system-on-chip (SoC) that integrates machine vision and machine hearing. Using TSMC's ultra-low-power 28nm advanced process with dual-core 64-bit processors for better power performance, stability and reliability. The program strives for zero threshold development and can be deployed in the user's products in the shortest time, giving the product artificial intelligence. The is located in the SoC of the AI and IoT markets and is a very convenient MCU

RESULT AND CONCLUSION

In conclusion, the rapid progress in artificial intelligence and deep learning has paved the way for highly effective weapon detection and face recognition systems using surveillance cameras. These advancements have immense potential in enhancing security and public safety across various applications. Weapon detection systems, employing convolutional neural networks (CNN) and image fusion techniques, have exhibited promising outcomes in automatically identifying firearms and other dangerous objects. The utilization of diverse datasets and fusion rules has significantly improved detection

accuracy and overall robustness. However, it is important to carefully consider the trade-off between speed and accuracy for practical implementation in real-world scenarios.

Face detection and recognition systems have emerged as vital tools in identifying individuals captured in surveillance footage. The combination of deep learning algorithms and image processing techniques enables the extraction of meaningful facial features, leading to accurate identification. Such systems have proven successful in numerous contexts, including criminal identification, attendance monitoring, and airport security.



FUTURE SCOPE

In the future, there is ample potential for advancements and expansions in weapon and face detection using surveillance cameras. As technology progresses, we anticipate enhancements in the accuracy, speed, and efficiency of these detection systems.

An exciting future direction involves integrating artificial intelligence and machine learning algorithms into surveillance camera systems. By harnessing deep learning models and advanced image processing techniques, we can improve the capabilities of cameras to swiftly and accurately identify and classify weapons and faces in real-time. This has the potential to enhance threat detection, enabling automated and reliable identification, and facilitating prompt responses to prevent potential crimes.

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