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VIDEO ANALYSIS FOR WEAPON DETECTION AND ALERTING

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ABSTRACT

Security and safety is a big concern for today's modern world. For a country to be economically strong, it must ensure a safe and secure environment for investors and tourists. Having said that, Closed Circuit Television (CCTV) cameras are being used for surveillance and to monitor activities i.e. robberies but these cameras still require human supervision and intervention. We need a system that can automatically detect these illegal activities. Despite state-of-the-art deep learning algorithms, fast processing hardware, and advanced CCTV cameras, weapon detection in real-time is still a serious challenge. Observing angle differences, occlusions by the carrier of the firearm and persons around it further enhances the difficulty of the challenge. This work focuses on providing a secure place using CCTV footage as a source to detect harmful weapons by applying the state of the art open-source deep learning algorithms. We have implemented binary classification assuming pistol class as the reference class and relevant confusion objects inclusion concept is introduced to reduce false positives and false negatives. No standard dataset was available for real-time scenario so we made our own dataset by making weapon photos from our own camera, manually collected images from internet, extracted data from YouTube CCTV videos, through GitHub repositories, data by university of Granada and Internet Movies Firearms Database (IMFDB) imfdb.org. Two approaches are used i.e. sliding window/classification and region proposal/object detection. Some of the algorithms used are VGG16, Inception-V3, Inception-ResnetV2, SSDMobileNetV1, Faster-RCNN Inception-ResnetV2 (FRIRv2), YOLOv3, and YOLOv4. Precision and recall count the most rather than accuracy when object detection is performed so these entire algorithms were tested in terms of them. Yolov4 stands out best amongst all other algorithms and gave a F1-score of 91% along with a mean average precision of 91.73% higher than previously achieved.

INTRODUCTION

In recent years, the increasing number of security threats and violent incidents in public and private spaces has raised the need for advanced surveillance systems. Traditional monitoring methods, which rely heavily on human observation, are often inefficient, time-consuming, and prone to errors due to fatigue and limited attention span. With the rapid advancement of artificial intelligence and computer vision technologies, automated video analysis systems have emerged as a powerful solution to enhance security and threat detection.

Video analysis for weapon detection and alerting focuses on identifying dangerous objects such as guns, knives, and other weapons in real-time video streams. By utilizing deep learning models, particularly Convolutional Neural Networks (CNN) and advanced object detection algorithms like YOLO (You Only Look Once), the system can accurately detect and classify weapons within video frames. These models are capable of learning complex visual patterns and distinguishing between normal objects and potential threats, even in dynamic and crowded environments.

The integration of automated alert mechanisms further strengthens the system by enabling immediate notification to security personnel when a weapon is detected. This reduces response time and helps prevent potential incidents before they escalate. Such systems can be widely applied in areas like airports, railway stations, shopping malls, educational institutions, and other public places where continuous monitoring is essential.

Despite its advantages, challenges such as varying lighting conditions, occlusions, low-resolution video, and the need for large annotated datasets remain. However, ongoing advancements in deep learning and real-time processing technologies continue to improve the efficiency and reliability of these systems.

Overall, video analysis for weapon detection and alerting represents a significant step toward intelligent surveillance systems, contributing to enhanced safety, faster threat response, and reduced reliance on manual monitoring.

LITERATURE SURVEY

1. Title: **Real-Time Weapon Detection Using Deep Learning**

Authors: A. Jain et al. (2020)
Merits:

- Real-time detection using CNN models
- High accuracy in detecting firearms
- Suitable for surveillance systems

Demerits:

- Requires high computational power
- Performance affected by low-quality video

2. Title: **Weapon Detection in CCTV Using YOLO Algorithm**

Authors: R. Singh et al. (2021)
Merits:

- Fast object detection using YOLO
- Works efficiently for real-time applications
- High detection speed

Demerits:

- Accuracy decreases in crowded scenes
- Struggles with small or hidden weapons

3. Title: **Automated Gun Detection Using Computer Vision**

Authors: M. Tiwari et al. (2019)
Merits:

- Uses image processing techniques

- Easy to implement

Demerits:

- Lower accuracy compared to deep learning models
- Not suitable for complex environments

4. Title: **Deep Learning-Based Surveillance System for Weapon Detection**

Authors: K. Patel et al. (2022)
Merits:

- Uses CNN and transfer learning
- Improved detection accuracy
- Can detect multiple weapon types

Demerits:

- Requires large labeled datasets
- Training is time-consuming

5. Title: **Smart Security System Using AI for Weapon Detection**

Authors: S. Verma et al. (2023)
Merits:

- Automated alert system integration
- Real-time notifications
- Improves public safety

Demerits:

- High system cost
- Dependence on network connectivity

6. Title: **Video-Based Threat Detection Using Deep Neural Networks**

Authors: J. Lee et al. (2021)
Merits:

- Detects threats from continuous video streams
- High accuracy using deep neural networks

Demerits:

- High processing requirements
- Latency in real-time systems

7. Title: **Weapon Detection Using Transfer Learning Models**

Authors: P. Kumar et al. (2022)
Merits:

- Reduces training time

- Improves performance with pre-trained models

Demerits:

- Limited generalization
- Requires fine-tuning

8. Title: **Object Detection for Security Surveillance Using CNN**

Authors: L. Wang et al. (2020)
Merits:

- Accurate object detection
- Handles multiple object classes

Demerits:

- Computationally expensive
- Needs GPU support

SYSTEM ANALYSIS

EXISTING SYSTEM

The crime rate across the globe has increased mainly because of the frequent use of handheld weapons during violent activity. For a country to progress, the law-and-order situation must be in control. Whether we want to attract investors for investment or to generate revenue with the tourism industry, all these needs is a peaceful and safe environment. The crime ratio because of guns is very critical in numerous parts of the world. It includes mainly those countries in which it is legal to keep a firearm. The world is a global village now an what we speak or write has an impact on the people. Even if the news they heard is crafted having no truth but as it gets viral in a few hours because of the media and especially social media, the damage will be done. People now have more depression and have less control over their anger, and hate speeches can get those people to lose their minds. People can be brainwashed and psychological studies show that if a person has a weapon in this situation, he may lose his senses and commit a violent activity.

DISADVANTAGES

- High computational and hardware requirements
- Performance depends on video quality and lighting conditions
- Possibility of false positives/false negatives
- Requires large labeled datasets for training
- Privacy concerns in surveillance systems
- High implementation and maintenance cost

PROPOSED SYSTEM

The problem of detection and classification of objects in realtime started after major developments in the CCTV field, processing hardware, and deep learning models. Very little work has been done in this field before and most of the previous effort was related to concealed weapon detection (CWD).

ADVANTAGES

- Enables **real-time weapon detection** in surveillance systems
- Improves **public safety and security**

- Reduces manual monitoring effort
- Provides **instant alert notifications**
- Detects multiple weapon types (guns, knives, etc.)
- Scalable for smart city and security applications

IMPLEMENTATION

1.1 Data Collection

The system uses datasets containing images and videos of weapons such as guns and knives. These datasets can be collected from:

- Public datasets (Open Images, Kaggle weapon datasets)
- CCTV footage (for real-time scenarios)

The data includes both **weapon and non-weapon images** to train a balanced model.

1.2 Data Preprocessing

- **Image Resizing:** All images are resized to a fixed dimension
- **Normalization:** Pixel values are scaled between 0 and 1
- **Data Augmentation:** Rotation, flipping, zooming to improve model generalization
- **Annotation:** Bounding boxes are created around weapons for object detection

1.3 Feature Extraction

- Automatic feature extraction using deep learning models
- Extraction of:
  - Shape features
  - Edge features
  - Texture patterns

1.4 Model Development

The system uses deep learning-based object detection algorithms such as:

- YOLO (You Only Look Once)
- Convolutional Neural Networks (CNN)
- Transfer Learning models (e.g., ResNet, MobileNet)

YOLO is preferred for real-time detection due to its speed and accuracy.

1.5 Model Training

- Dataset split into training (80%) and testing (20%)
- Model trained using labeled images
- Optimization techniques:

  - Backpropagation
  - Adam optimizer
- Loss functions:
  - Classification loss
  - Localization loss

1.6 Model Evaluation

Performance is evaluated using:

- Accuracy
- Precision
- Recall
- F1-Score
- Intersection over Union (IoU)

1.7 Alert System Integration

- When a weapon is detected, the system triggers alerts:
  - Alarm sound
  - SMS/Email notification
  - Real-time dashboard alert

1.8 Tools and Technologies

- Programming Language: Python
- Libraries: TensorFlow, Keras, OpenCV, PyTorch
- Frameworks: YOLO implementation
- Platform: Jupyter Notebook / Google Colab

METHODOLOGY

The system follows a real-time video analysis pipeline:

Step 1: Video Input

- Capture live video stream from CCTV cameras or upload recorded video

Step 2: Frame Extraction

- Video is divided into frames at regular intervals
- Each frame is processed independently

Step 3: Preprocessing

- Resize and normalize frames

- Enhance image quality if required

Step 4: Object Detection

- Apply YOLO model
- Detect objects and identify weapons using bounding boxes

Step 5: Classification

- Classify detected objects as:
  - Weapon (Gun/Knife)
  - Non-weapon

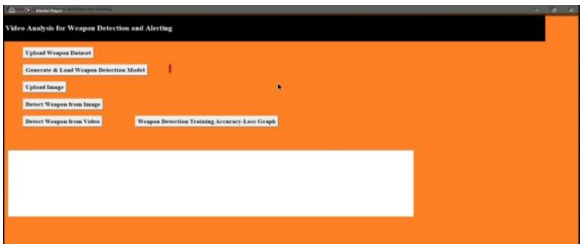
Step 6: Decision Making

- If weapon detected:
  - Trigger alert system
- Else:
  - Continue monitoring

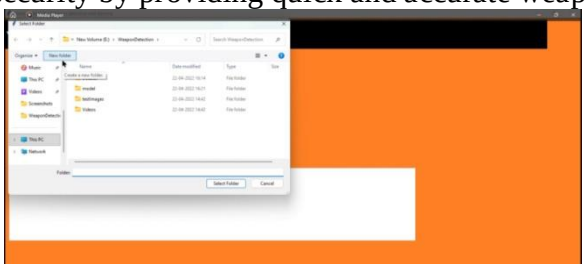
Step 7: Alert Generation

- Send notification to authorities
- Highlight detected weapon in video feed

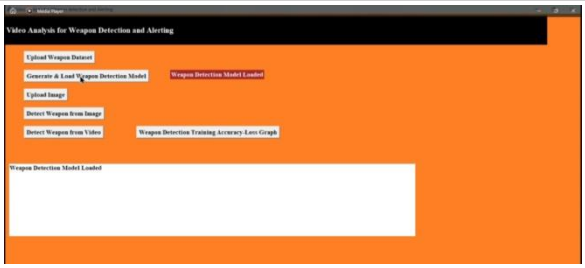
RESULTS



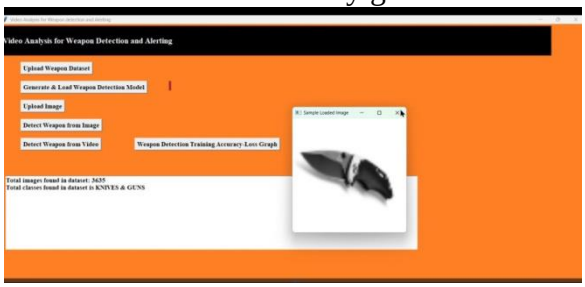
1.This interface detects weapons from images and videos using a trained AI model.
2.It helps enhance security by providing quick and accurate weapon detection alerts.



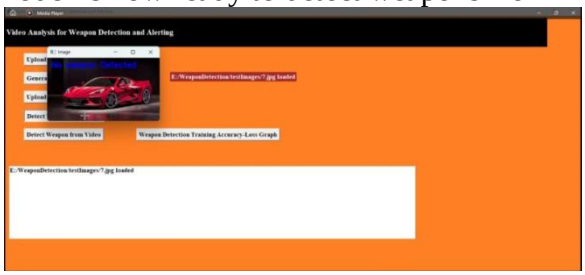
1.This screen allows the user to select and upload the weapon detection dataset from the system.
2.The uploaded dataset is used to train the AI model for accurate weapon detection.



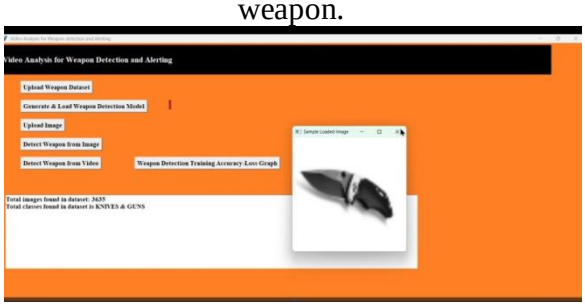
1.The weapon detection model is successfully generated and loaded for analysis.



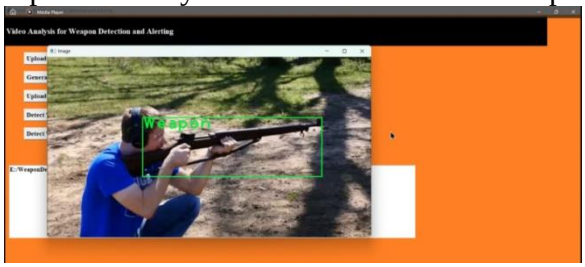
1. The system successfully loads the weapon dataset containing images of knives and guns for training.
2. The uploaded dataset is used to build an accurate AI model for weapon detection.
3.The loaded AI model is now ready to detect weapons from images and videos.



1.The uploaded image is processed by the AI model to identify the presence of weapons.
2.The system displays “No Weapon Detected”, indicating that the image does not contain any weapon.



1.The user selects a video file from the system for weapon detection analysis.
2.The uploaded video is processed by the AI model to detect weapons and generate alerts.



1.The AI model successfully detects the weapon in the uploaded image and highlights it with a bounding box.

2.The system labels the detected object as "Weapon", enabling quick identification and security alerting.

CONCLUSION

The video analysis system for weapon detection and alerting using artificial intelligence and deep learning techniques provides a powerful and efficient solution for enhancing security in public and private environments. By leveraging advanced models such as Convolutional Neural Networks (CNN) and real-time object detection algorithms like YOLO, the system can accurately identify weapons such as guns and knives in live video streams. This capability significantly reduces the dependency on manual monitoring and enables faster response to potential threats.

The integration of automated alert mechanisms further enhances the effectiveness of the system by providing immediate notifications to security personnel, thereby helping prevent incidents and ensuring timely action. The use of transfer learning and hybrid deep learning models improves detection accuracy and reduces training time, making the system more practical for real-world deployment.

However, challenges such as high computational requirements, dependency on high-quality datasets, and issues related to privacy and false alarms still need to be addressed. Future advancements may focus on improving model efficiency, reducing false positives, and integrating the system with IoT and smart surveillance infrastructure.

Overall, the proposed system demonstrates the significant potential of AI-driven video analytics in strengthening modern security systems and contributing to safer environments.

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