**Project Title:** Automated Weapon Surveillance System using Deep Learning

**Title of Journal:** A Comprehensive Study towards High-level Approaches for Weapon Detection using Classical Machine Learning and Deep Learning Methods

**Authors:** Muhammad Tahir Bhatti, Muhammad Gufran Khan (Senior Member, IEEE), Masood Aslam, Muhammad Junaid Fiaz

**Published in:** Expert Systems with Applications, 2nd August 2022

**DOI:** 10.1016/j.eswa.2022.118551

**Abstract:**

The paper investigates high-level approaches for weapon detection using classical machine learning and deep learning methods, addressing the need for automated surveillance systems capable of identifying weapons in real-time. The study highlights the efficiency of deep learning models over classical methods and explores various datasets, focusing on enhancing detection accuracy for small objects like firearms.

**Methods:**

**Sliding Window/Classification**: An approach where a fixed-size window is moved across the image to detect objects.

**Region Proposal/Object Detection**: Techniques that generate region proposals to identify potential objects, followed by classification to confirm object presence.

Algorithms tested include:

* **Classical Machine Learning Models**: Various unspecified models for baseline comparison.
* **Deep Learning Models**: VGG16, Inception-V3, Inception-ResNetV2, SSDMobileNetV1, Faster-RCNN Inception-ResNetV2, YOLOv3, and YOLOv4.

**Dataset:**

A novel dataset of 8327 images was created, comprising images taken with cameras, extracted from YouTube CCTV videos, GitHub repositories, and the Internet Movies Firearms Database (IMFDB). The dataset was preprocessed using OpenCV filters to enhance images with low brightness and resolution. This dataset focuses on small object detection, particularly pistols.

**Results:**

The study found that deep learning models outperformed classical machine learning methods in both speed and accuracy. Among the tested models, YOLOv4 demonstrated the best performance, achieving a mean average precision (mAP) of 91.73% and an F1-score of 91%. This model proved effective in real-time weapon detection even under challenging conditions, such as varying angles and occlusions.

**Contributions:**

* Development of a comprehensive real-time weapon detection system.
* Creation of a novel, extensive dataset for weapon detection.
* Introduction of confusion objects to reduce false positives and negatives.
* Evaluation of state-of-the-art deep learning models for weapon detection in real-time CCTV footage.

**Conclusion:**

The study successfully implemented a real-time weapon detection system using deep learning, significantly improving over previous methods. Future work will focus on enhancing the system's robustness and extending its application to other types of weapons.