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Weapon Detection Using Deep learning model for Smart Surveillance System

[1]V.B.N. AJAY, [2]K. NAGABALA SULOCHANA RANI

[1]Assistant professor, Dept. of CSE, NVR College of Engineering & Technology, Tenali-Guntur (Dt)

vbnajaycse@gmail.com

[2]Assistant professor, Dept. of CSE, NVR College of Engineering & Technology, Tenali-Guntur (Dt)

nagabalarani4@gmail.com

Abstract: *Safety and protection are a massive difficulty for today's modern-day world. For a country to be economically robust, it must make sure safe and secure surroundings for traders and tourists. Having stated that, Closed Circuit tv (CCTV) cameras are getting used for surveillance and to display activities i.e., robberies but those cameras nonetheless require human supervision and intervention. We want a system which could automatically stumble on these unlawful activities. Regardless of State-of-the-art deep trendy algorithms, speedy processing hardware, and superior CCTV cameras, weapon detection in actual-time remains an extreme challenge. This paper implements weapon detection using a Faster RCNN algorithm. We have implemented Faster RCNN object detection model by training it on our customized dataset. Our proposed system can also be implemented in high-end surveillance and security robots to detect a weapon or unsafe assets to avoid any kind of assault or risk to human life.*

Keywords: *Object detection, CCTV, weapon detection, Artificial intelligence, deep learning, Faster RCNN.*

I. INTRODUCTION

Object detection techniques are useful to make processing faster and simpler. There are several areas where we can make use of object detection including surveillance, medical image analysis, human-computer interaction, and robotics. We can also make use of object detection at 3D space. It is necessary to detect or track all movements in that 3D space. We can depend on object detection algorithms to not only detect objects in an image but to do that with the speed and accuracy. We need object detection to improve workplaces, increase security, and automated vehicle systems. Object

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detection can useful in case of traffic management. Government can use object detection techniques to keep track of abnormal activities in various regions to maintain security [1].

The work of this program is to basically do what a human can do but with the speed and accuracy of a machine. This is very important especially in this use case as it is a life-or-death situation where even a split difference makes a difference of saving lives. A human who is responsible for monitoring the CCTV footage once finds a gun (slower than an AI) will first go into a state of shock no matter how skilled they are, then will have to contact the authorities about the attacker. This process will also be time consuming as the person has to verbally describe the attacker's clothing, face the weapon he or she carries and the time and location of the incident. While all this is happening, the attacker would have already fled the scene of crime. Plus, it does not help since it's all just eye evidence that the authorities have to take when the attack takes place as only the person responsible for monitoring has the access to the CCTV and can convey the message. This program aims to remove these disadvantages, it is done by simply taking the screenshot when a weapon is detected on the CCTV and send this message to all Security guards alerting them without panicking the public or alerting the attacker which will have catastrophic results. Since it is impossible for all the security guards on duty to have access to 24/7 CCTV access and monitor it all the time, it will be easier to just have the screenshot sent to them when there is an actual attack. This screenshot can also provide all the necessary information needed like the attacker's face, location, weapon carried etc. as a picture can convey a thousand words, also it is more reliable than eye evidence. Speaking of evidence this project can also help in court cases. Since court cases drag on for years, the evidence won't be waiting for that long. For example, if the case requires photo evidence of an attack that happened years ago, the CCTV storage in question might not have backed up footage fort years on as it is thousands of GB of footage. But instead using this program the screenshot after being identified as an attack can be stored as it is smaller in size [2].

Weapon or Anamoly detection is the identification of irregular, unexpected, unpredictable, unusual events or items, which is not considered as a normally occurring event or a regular item in a pattern or items present in a dataset and thus different from existing patterns. An

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anomaly is a pattern that occurs differently from a set of standard patterns. Therefore, anomalies depend on the phenomenon of interest. Object detection uses feature extraction and learning algorithms or models to recognize instances of various category of objects. Proposed implementation focuses on accurate gun detection and classification. Also concerned with accuracy, since a false alarm could result in adverse responses. Choosing the right approach required to make a proper trade-off between accuracy and speed. Figure 1 shows the methodology of weapons detection using deep learning. Frames are extracted from the input video. Frame differencing algorithm is applied and bounding box created before the detection of object [3].

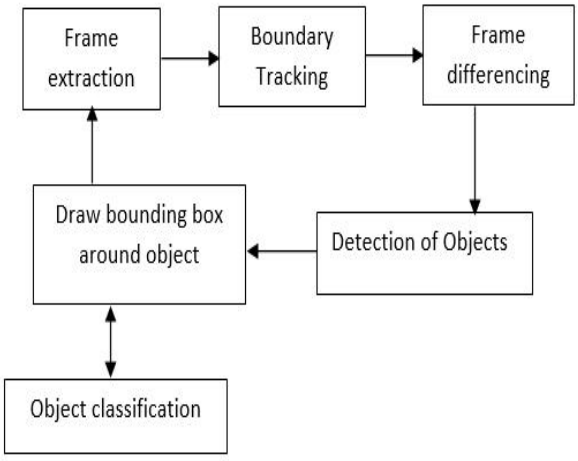

Fig.1 Object detection process

II. LITERATURE SURVEY

Weapon or Anamoly detection is the identification of irregular, unexpected, unpredictable, unusual events or items, which is not considered as a normally occurring event or a regular item in a pattern or items present in a dataset and thus different from existing patterns. An anomaly is a pattern that occurs differently from a set of standard patterns. Therefore, anomalies depend on the phenomenon of interest [4]. Object detection uses feature extraction and learning algorithms or models to recognize instances of various category of object.

Artificial intelligence (AI) and computer vision have enabled us to utilize video feeds in a way that we can detect and classify the objects of our interest in it. Therefore, it has been widely adopted and used in many applications such as autonomous vehicles, security feeds, etc. Many algorithms and architectural works have been done for the aforementioned tasks. In 2020, Murthy, Chinthakindi Balaram et al. [5] provided a detailed and comprehensive discussion and analysis of state-of-the-art techniques and algorithms used in the field of computer vision using deep learning technology, especially for the GPU-based embedded system. They covered many state-of-the-art algorithms that were trained and tested on COCO,

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PASCAL VOC datasets. The algorithms included RCNN, SPPNet, SSD, RetinaNet, Squeeze Det, and CornerNet; these algorithms were compared and analyzed based on accuracy, speed, and performance for important applications including pedestrian detection, crowd detection, medical imaging, and face detection. Moreover, we also previously implemented a real-time weapon detector model based on YOLOv4 trained with a custom dataset.

In [6] Conventionally used cement –a primary binder also a necessitate element in producing concrete rates first in the construction industry. Production of conventional cement requires a greater skill and is energy intensive. The usage of waste materials in the production of concrete and reduction in cement content was only the possible alternative in the past decade. Associated risks with the production of Ordinary Portland Cement are well known. A greener aided with a natural friendly claim can be made only with the usage of the waste materials and reduction in evolving respiration gas to the atmosphere. Almost all works are carried out using source material fly ash, with fine aggregate and coarse aggregate.

Erssa Ari et al. [7] The conventional Close circuit television (CCTV) cameras-based surveillance and control systems require human resource supervision. Almost all the criminal activities take place using weapons mostly a handheld gun, revolver, pistol, swords etc. Therefore, automatic weapons detection is a vital requirement now a day. The current research is concerned about the real-time detection of weapons for the surveillance cameras with an implementation of weapon detection using Efficient–Net. Real time datasets, from local surveillance department's test sessions are used for model training and testing. Datasets consist of local environment images and videos from different type and resolution cameras that minimize the idealism. This research also contributes in the making of Efficient-Net that is experimented and results in a positive dimension. The results are also been represented in graphs and in calculations for the representation of results during training and results after training are also shown to represent our research contribution. Efficient-Net algorithm gives better results than existing algorithms.

Akhil Addapa et al. [8] Efficient and accurate object detection has been a important topic in advancement of computer vision systems. With the advent of deep learning techniques, the cure for

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object detection has increased drastically. The project aims to incorporate state-of-the-art technique for object detection with the goal of achieving high accuracy with a real-time performance. A major challenge in many of the object detection systems is the dependency on other computer vision techniques for helping the deep learning-based approach, which leads to slow and non-optimal performance. In this project, we use a completely deep learning approach to solve the problem of object detection in an end-to-end fashion. The network is trained on the most challenging publicly available dataset (PASCAL VOC), on which a object detection challenge is conducted annually.

Deepika B et al. [9] An object needs to be detected. This is done by the use of first and foremost Computer vision Technology YOLO i.e., you Look Only Once. It finds several applications due to its tremendous speed in detecting objects. These object needs to be tracked down, also using YOLO algorithm. YOLO object detection in images means not only to identify what kind of object is included, but also localize it inside the co-ordinates of the "bounding box" containing the Object. YOLO uses deep learning and Convolution Neural Networks (CNN) for object detection. It needs to "see" the image only once and identifies the image. It creates a unique ID for each of initial detections. And then tracking each of the objects as they move around the frames in a video, maintaining the assignment of Unique ID's. This project will be robust to occlusion. It can also be used to detect missing object that has been lost in between frames also

Devaki et al. [10] The object detection is used in almost every real-world application such as autonomous traversal, visual system, face detection and even more. This paper aims at applying object detection technique to assist visually impaired people. It helps visually impaired people to know about the objects around them to enable them to walk free. A prototype has been implemented on a Raspberry PI 3 using OpenCV libraries, and satisfactory performance is achieved. In this paper, detailed review has been carried out on object detection using region conventional neural network (RCNN) based learning systems for a real-world application. This paper explores the various process of detecting objects using various object detections methods and walks through detection including a deep neural network for SSD implemented using Caffe mod.

III. PROPOSED METHODOLOGY

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A wide variety of data sets that contain both negative sets and positive sets were acquired.to improve the accuracy of the system it is imperative to have greater negative sets than positive. keeping this in mind two times the wide variety of bad statistics units (500 datasets) had been used in comparison to the superb statistics unit's present (250 datasets). this feature doubtlessly leads to greater accuracy to detecting the desired weapons which is the ultimate end purpose of the system. For the analysis of the video footage from the CCTV, OpenCV module became installed place, in which a convolution neural network is used to photo processing, category, segmentation and also different associated sports. The CNN acts as a feature extractor and the output dense layer includes the features extracted from the image and the extracted capabilities are fed into an SVM to categories the presence of the object inside that candidate region proposal.in addition to predicting the presence of an object inside the region proposals, the algorithm also predicts 4 values that are offset values to increase the precision of the bounding area. for instance, given a location notion, the set of regulations ought to have expected the presence of someone however the face of that man or woman inside that place concept ought to have been reduce in half of. consequently, the offset values help in adjusting the bounding field of the area idea. R-CNN set of rules starts off evolved with making many small windows or filters and makes use of the grasping algorithm to broaden the vicinity. Then it locates the equal shades in the regions and merges them collectively. The version maintains to merge all the areas together to enhance the dimensions of the regions. The picture is an illustration of a selective seek algorithm manipulate the spined phrases as you need.

Faster R-CNN

In faster R-CNN instead of performing maximum pooling, we carry out ROI pooling for utilizing a single characteristic map for all the areas. This warps ROIs into one single layer; the ROI pooling layer makes use of max pooling to convert the features. in view that max pooling is likewise operating here, that’s why we are able to recall fast R-CNN as an upgrade of the SPPNet. rather than generating layers in a pyramid form, it generates only one layer.The bounding field is further refined with linear regression. faster R-CNN is faster than SPPNet faster R-CNN makes use of a region proposal method to create the sets of regions. faster R-CNN possesses an extra CNN for gaining the local proposal, which we call the regional

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proposal network. in the training region, the proposal network takes the feature map as input and outputs region proposals. And these proposals go to the ROI pooling layer for similarly manner. Image processing entails manipulating virtual snapshots with a view to extracting extra statistics. we have seen a lot of evolutions in pc hardware in the beyond decade resulting in faster processors and GPUs. That enabled us to resolve new and emerging problems using image processing. Essentially, image processing entails the following fundamental steps: importing image using image acquisition tools, image Pre-processing / Analyzing and manipulating images, Output in which either you can modify an image or make some analysis out of it. We used the OpenCV library for all the image pre-processing obligations. OpenCV reads records from a contiguous memory place. we can use OpenCV library for resizing the pics and developing feature vectors out of it, that may be accomplished through converting the image data to NumPy arrays. We used one of the extensions of Deep Neural Nets named CNN (Convolutional Neural community) for training the version.

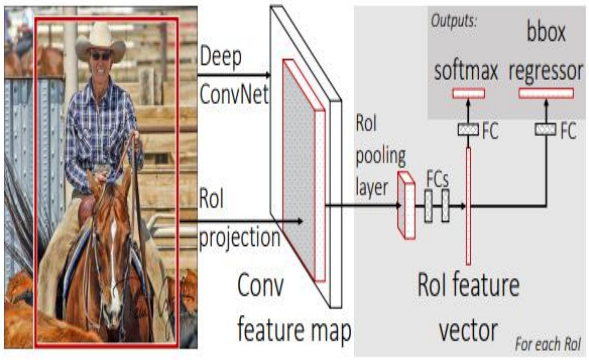

Fig.2 Faster RCNN architecture for object detection

An input image and multiple regions of interest (RoIs) are input into a fully convolutional network. Each RoI is pooled into a fixed-size feature map and then mapped to a feature vector by fully connected layers (FCs). The network has two output vectors per RoI: softmax probabilities and per-class bounding-box regression offsets. The architecture is trained end-to-end with a multi-task loss.

SYSTEM ARCHITECTURE

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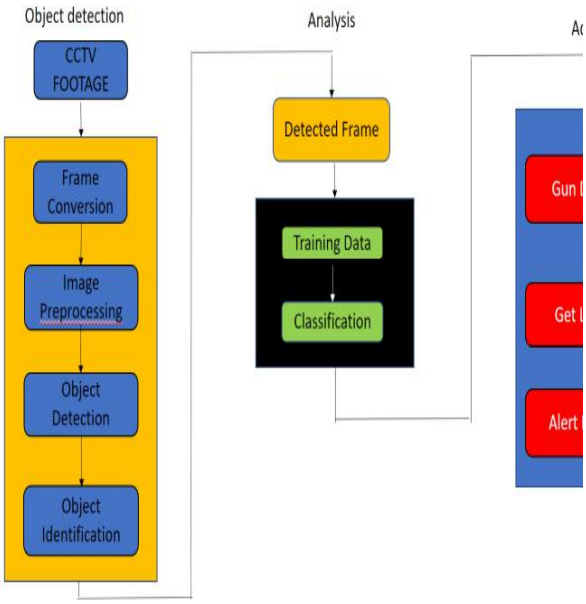

Fig.3 System architecture

IV. RESULTS AND DISCUSSIONS

Dataset Creation and Training

Image classification includes, for example, the class of one object in a picture. However, object localization is to recognize the area of at least one article in a picture and drawing a proliferating box around their degree as shown in Figure 4. Moreover, Figure 5 illustrates the detection of rifle from an animated video.

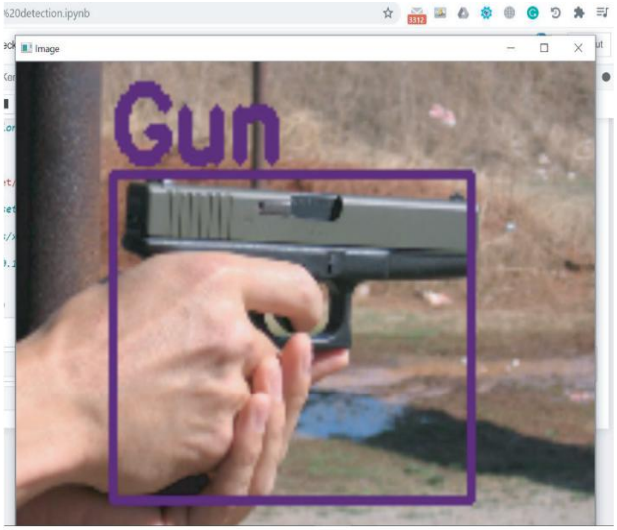

Fig.4 Image along with its label

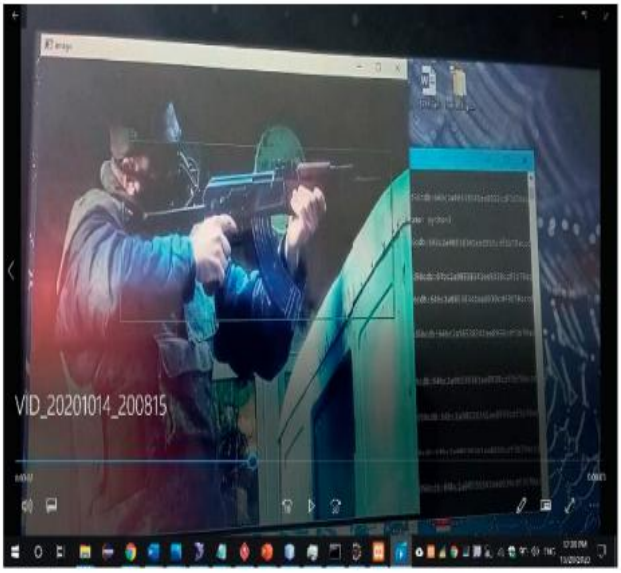

Fig.5 Real-time weapon detected from a video surrounded by bounding box. Weapon category rifle

Sample dataset

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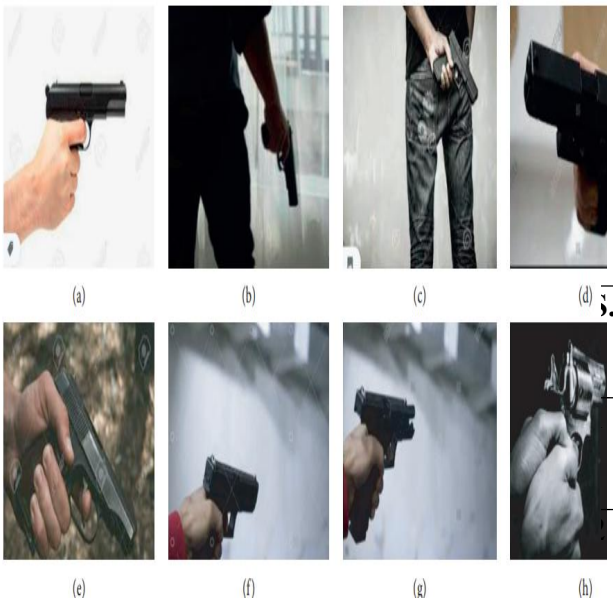

Fig.6 Sample images from collected dataset

Fig.7 Cumulative result of detecting weapon with precision value

V. PERFORMANCE ANALYSIS

TABLE I. Performance Analysis: Faster R-CNN Algorithm

S. No	Models	Dataset used	Accuracy(%)
	Traditional CNN	IMDB	95
	SSD	Streaming video	96.6
	(Yolo) V3	Gun video database	98.89
	Faster RCNN	Image dataset collected for current research	99.1

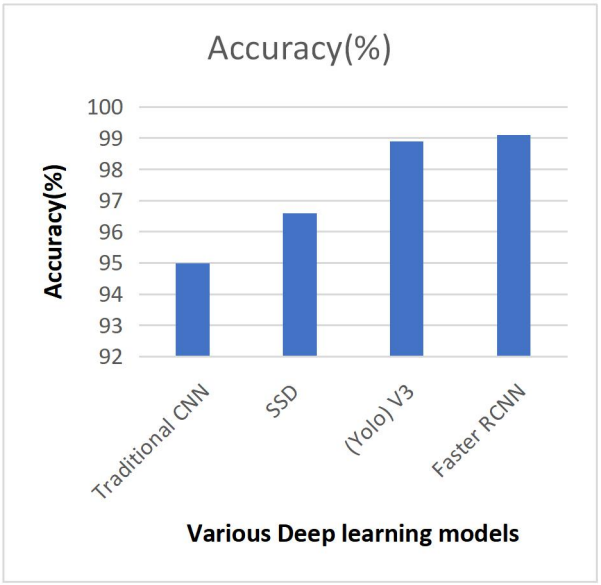

Fig.8 Performance Analysis of deep learning models with proposed algorithm

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VI. CONCLUSION

Faster RCNN algorithms is simulated for pre labelled and self-created image dataset for weapon (gun) detection. In this study, the state-of-the-art Faster RCNN object detection model was implemented and trained over our collected dataset for weapon detection. We propose a model that provides a visionary sense to a machine or robot to identify the unsafe weapon and can also alert the human administrator when a gun or a firearm is obvious in the edge. The experimental results show that the trained Faster RCNN has better performance compared to the Traditional CNN model, yolo v3, and SSD is less expensive computationally. Smart surveillance systems would fully replace current infrastructure with the growing availability of low-cost storage, video infrastructure, and better video processing technologies.

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