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Firearm Recognition Using Convolutional Neural Network

T. H. Deepthi[1], R. Gaayathri[1], S. Shanthosh[1], A. Sahaya Gebin[1], R. Anitha Nithya[2]

[1]UG Scholar, Department of Computer Science, Sri Krishna College of Technology Kovaipudur, Coimbatore, Tamil Nadu, India

[2]Assistant Professor, Department of Computer Science, Sri Krishna College of Technology Kovaipudur, Coimbatore, Tamil Nadu, India

ABSTRACT

Closed circuit television systems (CCTV) are becoming more popular and are being deployed in many offices, housing estates and in the most public spaces. Monitoring systems have been implemented in many foreign cities. This makes for an enormous load for the CCTV operators, as the number of camera views a single operator can monitor is limited by the human factors. The projects focus on the task of automated detection and recognition of dangerous situations for CCTV systems. We propose algorithms that are able to alert the human operator when a firearm is visible in the image and also have focussed on limiting the number of false alarms, in order to allow a real life application of the system. Managed to propose a version of a firearm detection algorithm that offers a near zero rate of false alarms and have shown that it is possible to create a system that are capable of an early warning in a dangerous situation, which may lead to faster and more effective response times and a reduction in the number of potential victims.

Keywords : OpenCV, Convolutional Neural Network (CNN), Infrared Radiation, Firearm Detection, Camera.

I. INTRODUCTION

The project aims in detecting the weapons using Image Classification algorithm. The image detection previously implemented in the CCTV video analysis detects pedestrians, animals and vehicles. These algorithms extended further to detect a person holding weapons like firearm in public places or restricted areas. As a weapon in the hands of a human is considered to be a great threats. In the proposed system the detection of human in an image prior to a weapon detection has been found advantageous. The system detects firearm even when the firearm is placed inside the persons clothes. This can be done by using Infrared Radiation. After detecting the weapon, the code of the gun is scanned and compared with already fed licensed gun code. Depending on the match and mis-match of the code, actions are taken accordingly.

II. AIMS AND OBJECTIVES

The aim of the project is to propose a method to detect a particular kind of weapon carried by a person in a low resolution image. The objectives of the project are:

1. Detecting a human in an image.
2. Detecting a segment containing weapon in the detected human image.
3. Extracting features from the segment.
4. Designing a neural network based classifier.
5. Computing time required to detect the weapon in an image.
6. Identifying the licensed and unlicensed gun.

III. RELATED WORKS

The concept of automated image understanding from video for public security applications are well known and well explored in many domains. Automated CCTV image analysis and detection of dangerous situations have been proposed and analysed in several studies. Marbach et al. proposed a system for automated fire detection based on the temporal variations of fire intensity [1]. This is similar solutions and research direction, while dealing with a less complex problem. This is also the case for systems designed for observations and deduction based on human and pose estimation.

An example of an approach of FISVER, a framework for smart public safety in video-surveyed vehicles, which has the ability of general object detection, including objects such as firearm[2]. Arslan et al. proposed a solution for threat assessment using visual hierarchy and conceptual firearm ontology[4].

The approach based on various tools designed for object detection and recognition that has been applied in MPEG-7 visual descriptors, directed towards safety related application. Example include the INACT Tool (an intelligent, advanced image cataloguing tool for combating child abuse[3]).
Automated detection of firearms and knives in a CCTV image using OpenCV and fuzzy classifier, to create a system that is capable of early warning in dangerous situations [6].

IV. TOOLS USED AND ITS DESCRIPTION

4.1 OpenCV

Open Source Computer Vision is a programming library functions, aims at real life computer vision. The library is a cross-platform and it is free for use under the open source BSD licence. OpenCV supports deep learning frameworks like TensorFlow, Torch, Caffe and etc. It was written in programming languages such as C and C++. Some of the applications of OpenCV are:

- 2 Dimensional and 3-Dimensional feature toolkit.
- Facial Recognition system.
- Human and Computer interaction.
- Mobile robotics.
- Object Identifications.

4.2 TensorFlow

TensorFlow is an open source software library function for high performance numerical computation. It is a expandable architecture that allows easy deployment of computation, across a variety of platform such as CPUs, GPUs.,and from desktops to clusters of servers to mobile devices. TensorFlow has strong support for machine learning and deep learning. The use cases of TensorFlow are:

- Voice or Sound Recognition.
- Text Based Applications.
- Image Recognition.
- Time Series.
- Video Detection.

4.3 Anaconda

Anaconda is an open-source platform written in the Python and R programming languages which are used for scientific computing that aims to simplify package management and deployment. The package versions are managed by the package management system which is termed as conda. The Integrated Development Environment (IDE) used in Anaconda is Spyder.

4.3.1 Spyder

Spyder is an open source cross platform. It is an Integrated Development Environment (IDE) used for scientific programming in Python. Spyder integrates with a number of packages in the scientific Python stack that contains NumPy, SciPy, Matplotlib, pandas, IPython, SymPy and Cython, as well as other open source software. It is released under the MIT license.

V. IMAGE DATABASE OF FIREARM

For training a neural network to detect the firearm, both positive samples and negative samples of firearms are collected. As there is no public database with images of firearm, a nominal database containing 319 training and 348 test images were collected for the work. All the images of firearm were collected from Google images. Fig1. shows the examples of training and testing samples used. Table1. Shows the number of images used for training and testing the classifier.

Fig-1: Training and Testing samples

Table-1: Dataset division for classifier

Type	Training	Test
Positive samples of gun	319	348
Negative samples of gun	7012	3325

VI. CLASSIFICATION WITH NEURAL NETWORK

After extracting of features, convolutional neural networks are used for classification. Neural Network theory was motivated by neural network in human brain, which performs complex computations in no time. Human brain organizes its components called neuron in certain way to perform many computations like pattern recognition much faster than modern computers. The ability of neural network is to learn from its environment is carried out in iterations. For each iterations, the neural network becomes more knowledgeable.

6.1 Feed Forward Neural Network

A neural network is a circuit of neurons. A feed forward neural network is a network in which connections are between nodes and those connections do not form loops or cycles. They propagate information in a single direction. The neural network usually has an input layer, an output layer and one or more hidden layers. If the hidden layer is more than one, then it is multilayer neural network. If the hidden layers are greater than two, then it is a deep neural network. The performance of neural network increases as the number of hidden layer increases.

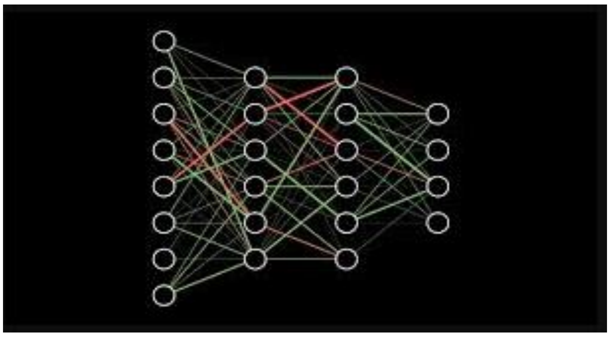

FIg-**2:** Neural Networks

6.2 Convolutional Neural Network

Convolutional neural network is similar to the neural networks. Convolutional neural network is a deep learning algorithm, commonly applied to analysing visual imagery. It was inspired by biological processes in which the connectivity pattern between neurons resembles the organization of the animal visual cortex. CNN uses a relatively little preprocessing compared to other image classification algorithms. Image recognition, video analysis, natural language processing, drug discovery, checkers game are some of the applications of CNN.

VII.OVERVIEW OF THE WORK

The detection of firearm and authorization is done in four stages. Each stage has its own importance. The description of each stages are as follows:

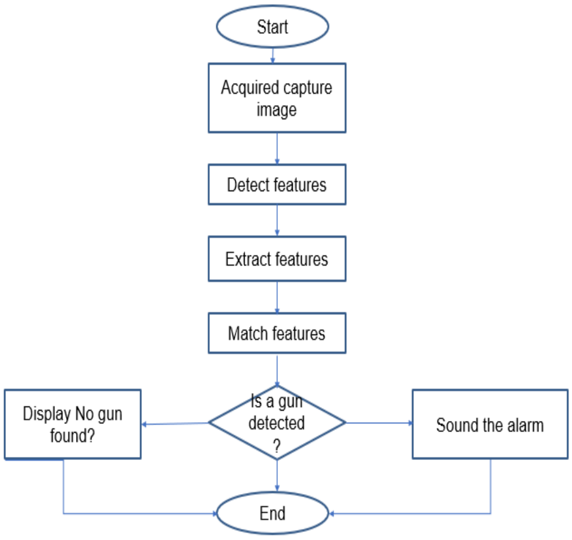

Fig-3: Flow diagram of the overall process

7.1 Developing Classification Model

A classification model draw conclusion from the determined values. From one or a lot of inputs a classification model can predict the worth of 1 or a lot of outcomes. Outcomes are labels that will be applied to a dataset. Classification is taken into account as associate instance of supervised learning that's learning wherever a coaching set of properly known observations is offered within the word of machine learning. The unattended procedure is understood as agglomeration, and involves grouping knowledge into classes supported some live of similarity or distance.

We have enforced CNN mistreatment OpenCV. OpenCV was designed for method efficiency and with a robust focus on amount applications. Written in optimized C or C++, the library will cash in of multi-core process. Enabled with OpenCL, it will cash in of the hardware acceleration of the underlying heterogeneous cipher platform. The foremost common type of filters square measure linear, within which associate output pixel's price that's set as a weighted total of input pixel values (i.e. $f(i+k, j+l)$):

$$g(i,j) = \sum_{k,l} f(i+k, j+l)h(k,l)$$

$h(k,l)$ i.e called the *kernel*, which is nothing more than the coefficients of the filter.

7.2 Training and Testing

During training, the only pre-processing step is to get the mean value of RGB, which is on the computed training data. After that the images are moved to the stack of convolutional layers. Three fully connected layers follow the stack of convolutional layers. The FeatureDetector interface is used to find interest points. The SurfFeatureDetector and its function will perform the detection process. The function drawKeypoints is used to draw the detected keypoints. The DescriptorExtractor is an interface used to find the feature vector correspondent to the keypoints. Use SurfDescriptorExtractor and its function computes the performance of the required calculations. Use a BFMatcher to match the features vector. The function drawMatches is used to draw the detected matches. The CascadeClassifier class is used to detect objects in the video stream. Initially we have to load the.xml classifier file which contains the images that are to be loaded. DetectMultiScale function is used to perform detection.

Testing at test time in order to classify the input image that are pre-loaded. Initially it is resized to the shortest image size which is predefined and symbolised. After that the objects that are detected are tested with the images that are fed into the system.

7.3 Integrating in cameras

The cameras are integrated using the TensorFlow object detection API. To manage to run the object-detection API in real-time with the webcam, we have used the threading and multiprocessing python libraries. A thread is used to read the stream of the webcam. Frames are put into queue, to be processed by a pool of workers. For video processing purpose, it is not possible to use threading, since all video frames which are read before workers are able to apply object detection on first one and then put in the input queue. Frames which are read when input queue is full or lost. Maybe huge queues and using a lot of workers may resolve the problem. Another problem is that with simple queue frames are not published in output queue with the same order, due to the changing analysis time. Frames are read and put into the input queue with their along frame numbers. Then, workers take frames from the input queue, treat them and put them into the first output queue along with their relative frame number.

7.4 Authorization

In authorization we have a dataset which contains the authorized unique identification number of the licensed guns. When an object that is the firearm is detected the number of that gun will be checked with the dataset. If the number matches then further process will be taken by the concerned authorities.

VIII. RESULT

The evaluation was performed with an image classification manner, where the maximum detection score for a firearm is set as the total score for the image. This denotes that the localization part of the detection is discarded during evaluation, and focusses only on whether the image as a whole contains any firearms. Multiple detections of the same object are not false, for example. A rifle that is classified as a handgun is considered as a correct detection.

Fig-4: Detection of firearm with low accuracy

Fig-5: Detection of firearm with high accuracy

IX. CONCLUSION

This work presented an automatic fire arm detection approach for surveillance and alert system. Implementation of fire arm detection on real time image was implemented successfully using Convolutional neural network. The two specific tasks are automated detection and recognition of dangerous situations. It proposes implements and tests algorithms for the detection of a dangerous tool held in a hand. A firearm held in a person's hand is an example of a sign of danger. The algorithm is processed in real time. The algorithm does not miss a significant number of frames with dangerous objects. It will not generate false alarms. The gun is detected effectively and as a result of detection an alarm is generated.

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