Machine Learning based Evidence Analysis in Digital Forensic Investigation

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Abstract—**Now a days visual data are massively increasing due to popularity of a smart devices and low cost surveillance system, that data is utilized in investigation of digital forensic. Whenever crime occurs for finding criminal, evidences a digital videos have been hugely utilized as a main source of evidence. By using digital videos police are able to identify, analyze, present and report evidences. Here key objective is to develop enhanced forensic video analysis technique for helping process of forensic investigation. For that forensic video examination framework need to propose which will act as an efficient video improving algorithm forexamination of low quality footage. For enhancing the CCTV footage quality introduced an adaptive video enhancement algorithm depends on a CLAHE. And for helping the video based forensic investigation Convolution neural network (CNN) algorithm proposed that can identify and recognize suspects, tools used from footage. CNN utilized for detecting knife, blood and gun to prediction whether crime has occurred.**

Index Terms: Forensics Investigation, Forensic Video Analysis, Video/Image Enhancement, Convolution Neural Network.

I. Introduction

Crime scene prediction from a camera is very crucial task while working on a computer vision. In modern technology, people setup surveillance cameras in numerous areas to get rid of crime or protect from criminal, thief, unknown peoples and stokers. Still, it cannot help people as quick as people want to respond but help to cops after crime occurs. Usually after occurring a crime scene, law enforcement agencies come to this place and collect the footage from the video that was recorded at the time of crime scene. Then, law enforcement agencies examine the video and take required evidence of crime scene from footage if it is helpful. We believe this is very slow process to act on a crime scene. For this reason, we wanted to make a system that can quickly act on a crime scene to detect the criminal.Moreover, there are a number of cameras being installed in various areas by law enforcement agencies or by any company. They have to monitor all the cameras at a time with human being. If a computer system can detect the threatening objects and give alert to the authority just after detection of threatening objects, the proper authority can quickly take action to stop the potential criminal before he commits any crime. Hence such system can prevent crime to occur. Some dangerous incident helped us to think more deeply to make a system that can be learned to identify threatening objects. Here for detecting revolver, machine gun, shot gun, blood and knife utilized convolutional neural network.

To implement this utilized a convolutional neural network. Because a simple neural network cannot give desired result. Therefore, utilized convolutional neural network to get better result.

The section I explains the Introduction. Section II presents the literature review of existing systems and Section III present proposed system architectureSection VI concludes our proposed system. While at the end list of references paper are presented.

II. Literature Review

M. F. E. M. Senan, S. N. H. S. Abdullah, W. M. Kharudinet al [1] utilized Closed-circuit television (CCTV) for surveillance recordings and it act as digital device for collecting digital evidence. In forensic analysis CCTV recording utilized for examining the footage with target is extracted from CCTV. Because of numerous reasons quality of this recording is poor these reason consist of type of camera and its configuration and location where it is installed. Hence the face recognition in forensic analysis is based on CCTV recording quality. If quality of recording is poor then it would decrease confidence in criminal detection and hence it affect in evidence collection where the experiment was done depends on various types of CCTV cameras using distinct resolutions, and distances among the subject and the camera. In the second part, comparison between the face of the subjects and the face taken during the enrolment task takes place. The score generated from the forensic face recognition system would be totally depends on the camera resolutions, types of camera, distance among them, and also on the changes of ranking score after applying the enhancement process like Bicubic to the facial images.

G. Gilboa, N. Sochen, and Y. Y. Zeevi, et al [2] present image enhancement and denoising by utilizing complex diffusion processes.

S. Park, S. Yu, M. Kim, K. Park, and J. Paik et al [3] presents a model of dual autoencoder network which is depends on the retinex theory to perform the low-light enhancement and noise reduction and is done by combining the stacked and convolutional autoencoders. This method calculate illumination component utilizing a stackedautoencoder and then utilized convolutional autoencoder which deals with 2-D image information for reducing noise in brightness enhancement process.

W. Fan, K. Wang, F. Cayre, and Z. Xiong et al. [4] proposed an image variational de-convolution framework for quality enhancement and anti-forensics of median filtered (MF) images. The proposed optimization based framework contains a convolution term, a fidelity term w.r.t the MF image, and prior term. Median filtering utilized by anti-forensic researchers for distinguishing traces. The proposed method act as MF image quality enhancement technique.

C. Li, J. Guo, R. Cong, Y. Pang, and B. Wang et al[5] proposedmethod known asa systematic underwater image enhancement, this method consist of underwater image dehazing algorithm and contrast enhancement algorithm. Images clicked under water are normally degraded because of effects of scattering and absorption. For mitigating the limitations of underwater images author proposed image enhancement method. Dehazing algorithm is proposed for restoration of the color visibility and appearance of under water images and contrast enhancement algorithm is proposed for enhancing the brightness and contrast of underwater images.

S. Mandal, X. L. Deán-Ben, and D. Razansky, et al[6] proposed active contour segmentation priors for enhancing Visual quality in optoacoustic tomography. Segmentation is very essential task in biomedical images and also it is helpful in study of anatomical structures.

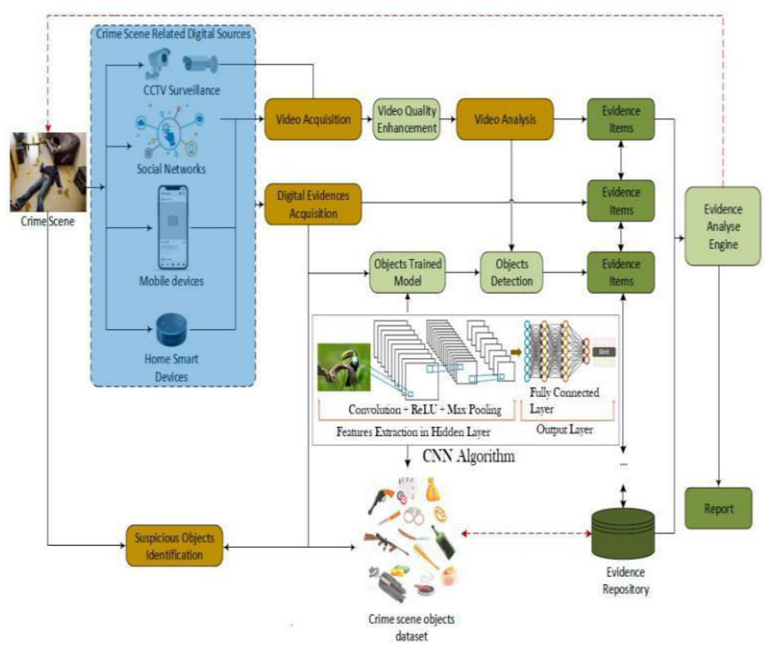
H. Walker and A. Tough et al [7] studied investigation process by using CCTV footage, it is commonly utilized in court for presenting crime and t help to identify criminal. It is difficult to identify the criminal because quality of images produced by surveillance cameras. The objective of this research is to determine the task of recognizing the offender in CCTV footage was one which a jury should be proficient to do or whether expert evidence would be beneficial in such cases. Here online survey is taken and role of jury is performed by participant.

E. Verolme and A. Mieremet et al [8] studied applications of forensic image analysis in accident investigations. Forensic investigations are mainly for collecting objective answers that can be utilized for criminal prosecution. Accident analysis are generally done to gain knowledge from similar events and utilized to prevent occurring similar incident in future. The use in accident inquiry means that more evidence can be generated from the present information than when utilized in criminal investigations, hence the latter need a higher evidence level. Here author studied cases of same field for accident investigation. The information is gathered from CCTV footage utilizing forensic image analysis techniques. This gathered information act as very crucial in detecting events. Hence this technique learn from accident and preventing future accidents.

III. SYSTEM ARCHITECTURE

A. *System Architecture*

Fig 1. System Architecture



Following Fig. 1 Shows the proposed system architecture. First digital source related to crime scene are find and collected information from that sources. These digital sources consist of CCTV surveillance, mobile devices and smart devices. Then acquisition of evidences from these sources takes place in the form of video or digital. Then quality of video is enhanced using enhancement algorithm. Then evidence are collected and objects are identified using CNN algorithm.

Convolutional Neural Networks

CNN is a type of profound, feed-forward neural artificial network used to achieve exact output in computer vision tasks , such as image classification and detection[5]. Unlike the traditional neural network, CNNs are also deeper in layers. It has weights, distortions and results by non-linear activation. The CNN's neurons are organized in a volumetric manner including height , width and depth.

A fig. 2 displays CNN architecture, it consists of a convolutionary, pooling and fully connected layer. Convolutionary layer and pooling layer are usually altered, and from left to right, the depth of each filter is increased while output size (height and width) is reduced. The fully linked layer is the last step close to traditional neural networks.

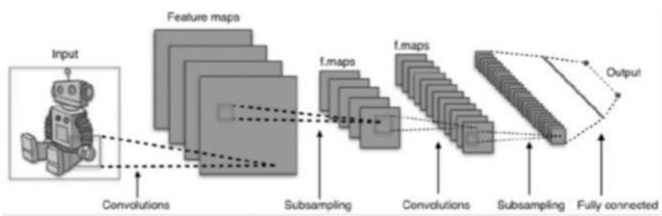


Figure 2. CNN Architecture

The input is an image containing pixels. The three-dimensional model is [50 x 50 x 3], such as width , height and depth (RGB channels) [13]. The convolutionary layer measures the output of neurons attached to the input local areas. The layer parameters are composed of a series of learning filters (or kernels), which covers the width and height of the input volume that extends across the depth of the layer. This produces a two-dimensional activation map of the filter, so the network learns to activate filters when it detects certain features in a certain space position in the input. The function called Rectified Linear Unit (ReLU) layer will perform elementwise activation function. ReLU is defined in (1),

$$f(x)=max(0,x) \qquad …….(1)$$

For negative values, this function is no and grows for positive values on a linear basis. The volume size is not affected. The layer of pooling produces the maximum activation in a region. This shows spatial dimensions like height and width. The output layer is a fully attached layer close to the neural network final layer. The softmax activation is used for the distribution of probability over the number of output classes in this layer.

Mathematical Formulation

System S is represented as
S = {ID, P, F, T, CNN, M}
1. Input Dataset
ID = {i1, i2, i3…in}
Where ID is the input image dataset and i1, i2…in are the number of images.
2. Preprocessing PR
= {pr1, pr2, pr3}
PR is preprocessing and pr1, pr2 and pr3 are the steps to be carried out during preprocessing.
pr1 be the reading of input dataset
pr2 be the enhancement of image input and
pr3 be the removal of hair from image.
3. Feature Extraction
F= {f1, f2, f3…fn}
Where F is the set of features extracted from the image and f1, f2, f3… fn are the extracted features such as border, thickness, color, etc.
4. Training and Testing file generation
T = {T1, T2}
Where T is the set of Training and Testing file and T1 is Training file and T2 is Testing file both the files contains various extracted features values while training file contains class of each image as 0 or 1.
5. Convolutional Neural Network (CNN).
CNN = {C, RL, PO, FC, LS}
Where CNN is algorithm consisting of various stages
as C is convolutional operation
RL be the ReLU activation layer
PO be the Pooling layer
FC be the Full Connection layer and
LS be the Loss function.
6. Object Detection
O= {0,1}
O is the set of Class having value 0 or 1
0 be the absent of object and
1 be the present of object

IV. RESULT ANALYSIS

The picture. The performance analysis graph is shown in 3 and 4. Figure 3 shows the accurate graph that can be found to be the most accurate, while the current mechanism provides a lower percentage, while the proposed CNN algorithm is more exact compared to the other algorithms in terms of accuracy. Different classification algorithms appear on the following graphs while the y- axis shows the percentage.

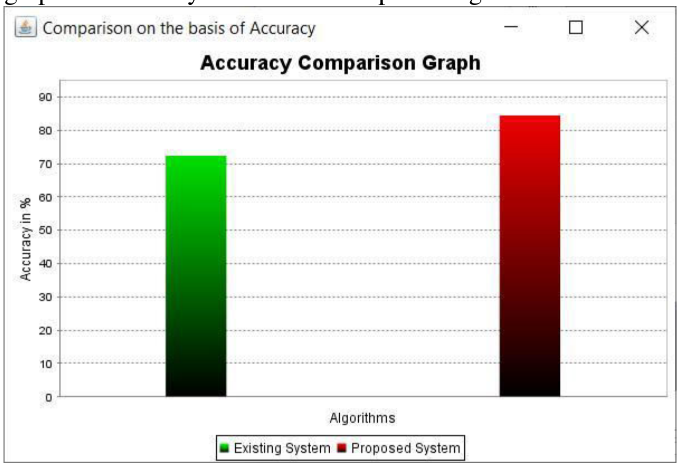


Figure 3. Accuracy Graph

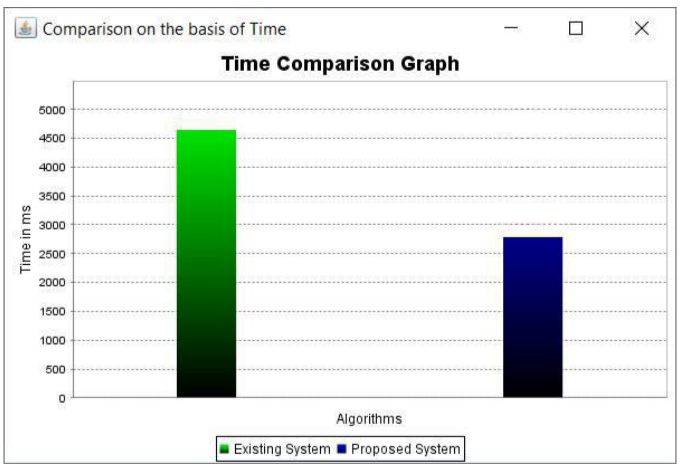


Figure 4. Time Efficiency Graph

V. Conclusion

Enhanced forensic analysis video technology to support the forensic investigation process was discussed here. Low quality CCTV film has an effect on the process of collecting evidence. CCTV film is used to collect criminal records. An adaptive video improvement algorithm is presented here to improve the quality of CCTV footage based on CLAHE. CNN is proposed as an algorithm for promoting forensic video-based investigations that are able to recognize and track offenders, methods used in the perpetration of film crime. CNN used knife, blood and weapon to detect whether or not a crime occurred.

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