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CRIMINAL RECOGNITION AND TRACKING SYSTEM

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ABSTRACT - The main concept of our project is to experiment with using deep learning neural networks to detect and quickly respond to crimes in progress with effective Criminal Recognition and Person Tracking system to reduce the crime rate. Surveillance can be of different forms like malicious activity detection, identification of a particular entity particular individual in a CCTV video) or in general keeping tracks of movements of human beings. In our project, the focus has been given to find the trajectory/path of human through the grid of CCTV cameras also known as tracking. Also, manually doing tracking can be very difficult. This is done with the help of face recognition plus video processing. Current system in this field aims to search for an entity in video by extracting its face and matching (or running) it against a database of human faces that is in the interest. So, none of the systems solve the task if they do not have a predefined database against whom the matching is done. Our, Smart AI will do this in a smart way by first generating datasets from human faces taken from CCTV video and use it in a Face Recognition model we are using. The use of deep learning libraries like OpenFace along with some image processing tools like openCV with a cloud-based solution is done to achieve this task

KEYWORDS – Criminal Recognition and Tracking, Automated tracking, Convolutional-Neural-Network, face recognition, CCTV, OpenFace, OpenCV, Surveillance..

I. INTRODUCTION

We live in an age of information, where anything and everything is connected through the internet. Connecting and interfacing different devices has become easier than ever. Information is available at the tip of a finger. Yet, everything is not well. The crime rate is ever growing. The increase of fraudulent behavior in society has caused many professional institutions to turn to biometric measures for positive identification of their clients. There is thus a renewed interest in the collection of biometric measures of people to strengthen existing identity checks. Face recognition is one identification technique that employs biometric measures. Before dwelling further, we need to understand how face recognition works. In human beings, it is the temporal lobe of the brain which is responsible for recognition of faces. The neurons of the temporal lobe respond to certain features of the face and stores them eventually leading to face identification. In machine learning system, the machines are often fed a huge bank of images which the system absorbs and stores. When aface is to be matched, it tries matching it with the stored images using face recognition algorithm. A Grid OF CCTVs installed in an area can give information about human activities happening in the area. The existing network of Government and public sector-installed Closed Circuit Television Cameras can be virtually networked to create a system that will monitor key public arenas, financial institutions, tourism sites and key infrastructure. However, installing CCTV cameras and forgetting them until something happens, gives us a false sense of security.

The truth is most CCTVs cameras go unmonitored and unmaintained. Some even stop functioning and we find out this only when there is a manual intervention to try to access some footage. No Number of Human Being will be able to monitor the terabytes of information being generated on a second-to-second basis. Eyeballing petabytes of video is simply impossible for the eyeballs we employ in police. It also requires lots of patience. Manual video tracking (CCTV video analysis) mostly relies on teams of specially trained officers watching thousands of hours of footage, waiting for that one crucial second of evidence. But this is the problem we are trying to solve. Now, Advanced Computer Vision technology can monitor the footage (if not disapproved by law) for movement. We just need to bring these cameras online, and link them up in an encrypted grid using advanced Artificial Intelligence and Machine Learning technologies. The data from these live streams can be processed and analyzed in near-real time to produce a wealth of information, which will be a significant input when it comes to the topic of surveillance. The main concept of our project is to experiment with use of deep learning neural networks to detect and quickly respond to crimes in progress with effective criminal tracking system to reduce the crime rate. The idea behind the project is to being able to sort through a massive volume of data to find patterns that are useful for law enforcement. This kind of data analysis was technologically impossible a few decades ago, but the hope is that recent developments in deep learning neural networks are up to the task. The project uses computer vision and other techniques to spot potentially criminal anomalies on real-time surveillance video with facial recognition and gait analysis technology help us to use advanced intelligence concepts to find and track individuals.

II. LITERATURE SURVEY

Face Recognition and Detection using Neural Networks [1] is one of the latest technologies being studied area in biometric as it has wide area of applications. But Face detection is one of the challenging problems in Image processing. The basic aim of face detection is to determine if there is any face in an image & then locate position of a face in an image. Evidently face detection is the first step towards creating an automated system which may involve other face processing. The neural network is created & trained with training set of faces & non-faces. Neural network has a feature of adaptive learning i.e. an ability to learn how to do tasks. Also it can create its own organization. It has a remarkable ability to derive meaning from complicated or imprecise data.Limitation: The number of subjects has to be increased in the training set.

Face Recognition Using Neural Networks [2] is an approach to the problem of face recognition using a discrete cosine transform (DCT) and neural networks is presented. The DCT is used to extract features from the high dimensional facial data. Two different neural networks are used. The standard backpropagation neural network is used in a "network per person" implementation, while the counter propagation network is used in a database implementation. Two types of networks were used for the classification for the data a standard backpropagation (for person identity) with momentum and a counter propagation network (for determining database membership). The database comprised 83 distinct subjects, with ten views per subject (830 images). Using the standard backpropagation algorithm with momentum (for determining identity), 83 networks were trained separately. A single network was trained using the counter propagation algorithm for feed-forward networks (for determining database membership). No attempt was made to control the light that filtered in through the blinds in the laboratory. The fluorescent lights were switched on and off at random.Limitation: The system is not feasible with 500 or more subjects.

Real Time Face Authentication Using Convolutional Neural Network [3] the face analysis is the recent and challenging technology for authentication and recognition. Researchers have been developing new techniques for face analysis for the past decades. This paper deals with the real time face authentication using Deep learning based Convolutional Neural Network (CNN) for high True Acceptance Rate (TAR). Face analysis in computer vision technology has two modes of operation Face identification (Recognition) and Face Authentication (verification), where face identification is the one to many mapping, compares the unknown query image to the group of known images in the database whereas face authentication is the one to one mapping, compares the query image to the person's image. The process involved in the face verification using Convolutional Neural Network (CNN) and Constrained Local Model (CLM) for alignment of the faces. The class of 10 images for each user is trained by deep neural network; features are matched against the query image and provide the confidence score for that person.Limitation: The system fails to recognize the person in different poses and at different lighting levels.

Real Time Face Detection Using Neural Networks [4] is an active interdisciplinary area of research that uses techniques from computer vision, image processing and pattern recognition. On the other hand, neural networks have been widely used to address problems in feature extraction, pattern recognition, and in general, the same kind of problems. The proposed system here uses neural networks in the development of a face detection system capable of operating in real time. The system performs a guided face search on interest regions exhibiting human skin color properties. These properties are detected in a pixel by pixel basis. The proposed system can be used as a module of face recognition systems, video surveillance systems, access control systems.

The system combines two methods, one based in features and another based on image to detect more accurately faces and to provide a faster response in order to be able to perform in real time.Limitation: The image that have the same color properties than the skin color model difficult to identify and the robustness of the system can be improved by using larger training sets.

FaceNet: A Unified Embedding for Face Recognition and Clustering [5] the face analysis is the recent and challenging technology for authentication and recognition. The proposed system uses a system called FaceNet, which directly learns a mapping from face images to a compact Euclidean space where distances directly correspond to a measure of face similarity. Once this space has been produced, tasks such as face recognition, verification and clustering can be easily implemented using standard techniques with FaceNet embedding's as feature vectors. The system uses a deep convolutional network trained to directly optimize the embedding itself, rather than an intermediate bottleneck layer as in previous deep learning approaches. To train, it uses triplets of roughly aligned matching / non-matching face patches generated using a novel online triplet mining method. The benefit of this approach is much greater representational efficiency. On the widely used Labeled Faces in the Wild (LFW) dataset, the system achieves a new record accuracy of 99.63%. On YouTube Faces DB it achieves 95.12%. This method is based on learning a Euclidean embedding per image using a deep convolutional network.Limitation: The system requires huge model and high end CPU, also requires long training time.

III. METHODOLOGY

In the proposed system the first feature is to detect the Face in real time. At the time the face is detected the system will try to recognize the face, if the recognized face is a wanted criminal or person missing, the system will automatically notify the concerned officials. The data of the victim's face will be initially stored in the server where each camera with the system will receive this data. And other primary focus is given to the tracking down the victim by getting the previous records and successive switching between the cameras to find the last known location of the victim.

A. Advantages of Proposed System

- Reduced human effort.
- Tracking criminals at faster rate.
- Completely autonomous system.
- Footage is available at all times.
- Provides efficient surveillance.

Using the manual way of finding out the criminal and tracking is highly time consuming. Hence better to make an automated system that hunts or searches for the criminal all time. The criminal recognition system will search for the criminal all the time, provided the picture of the criminal is uploaded to the server, and when criminal turns up in any one of the cameras the concerned official will be notified. Every year 80,000 children go missing in India. Many notorious criminals are found absconding. The proposed work is to alert the officials on finding the missing people or criminals, providing better surveillance and data access and reducing human effort and time.

IV. DESIGN

A. System Architecture

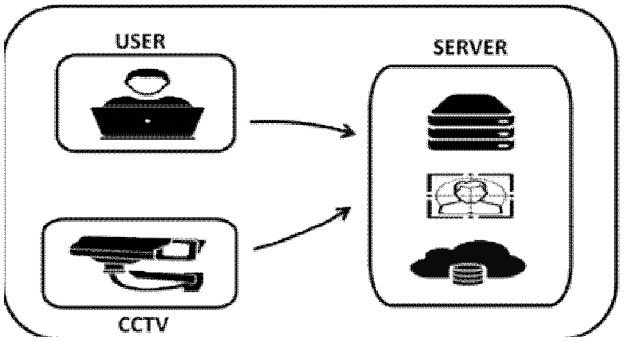

Figure 1. System Architecture

The Figure1 describes the System Architecture where there three components- User, Server and CCTVs. The CCTV provides continuous video stream to the server. The server monitors each CCTV video stream hunting for the required person. The User provides information about the person to be tracked and gets a notification from server when person is identified.

B. Use Case Diagram

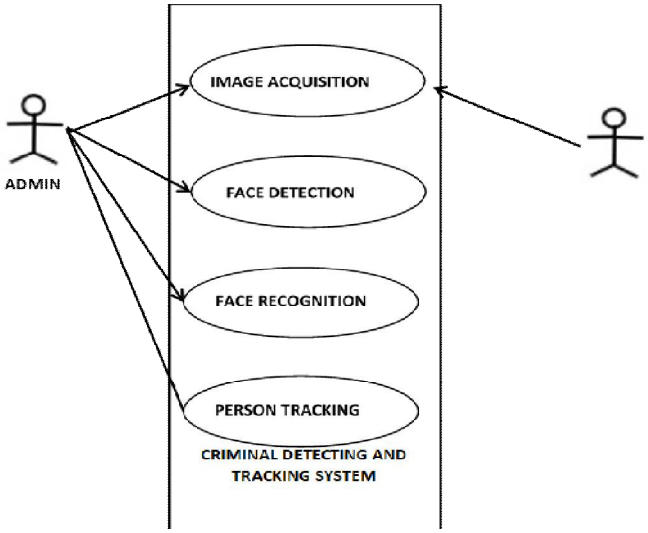

Figure 2. Use Case Diagram

A use case diagram is a dynamic or behavior diagram in UML. Use case diagrams model the functionality of a system using actors and use cases. The Figure 2. describes the use case of the system where there are two actors- Admin (Server), Camera (CCTVs). Admin performs all the modules to in order for each frame from the CCTV camera. The Camera only inputs the video to the system.

- Image Acquisition acquires the frame from camera streams.
- Face Detection detects the face in acquired images, resizes and records it.
- Face Recognition module compares selected facial features from image and compare with the faces it already knows.
- Person Tracking module notifies the User with an email containing the snapshot of the victim.

C. Data Flow Diagram

A data-flow diagram (DFD) is a way of representing a flow of a data of a process or a system (usually an information system).

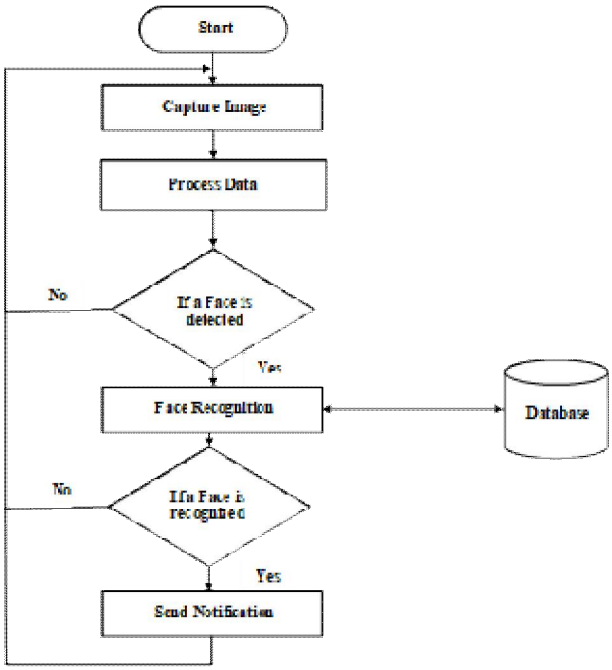

Figure 3. Dataflow Diagram

The DFD also provides information about the outputs and inputs of each entity and the process itself. A data-flow diagram has no control flow, there are no decision rules and no loops. When the system is started, the first process to be carried out is the image capture, where a live camera feed is used as input. The camera feed is processed, and passed to the Face detection and recognition module, here as and when a face is detected it is matched against the database to see if there is match. If and when a match is found with confidence more than the set threshold value a notification is sent to the admin. The Figure 3. describes the data flow of the system.

V. IMPLEMENTATION

A. The Pipeline

The Criminal Recognition and Tracking System Pipeline as shown in Figure 4, consists the Image Acquisition, Face Detection, Face Recognition and Person Tracking Modules. Pipelining is the process of accumulating instruction from the processor through a pipeline. It allows storing and executing instructions in an orderly process. It is also known as pipeline processing. Pipelining is a technique where multiple instructions are overlapped during execution. Pipeline is divided into stages and these stages are connected with one another to form a pipe like structure. Instructions enter from one end and exit from another end. Pipelining increases the overall instruction throughput.

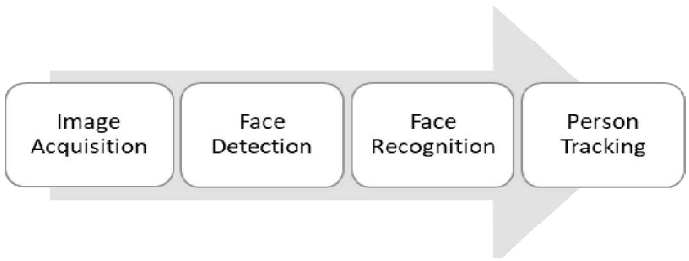

Figure 4. Criminal Recognition and Tracking System Pipeline

B. Image Acquisition

This module acquires the frame from camera streams. For Image Acquisition module, OpenCV library is used. OpenCV (Open Source Computer Vision Library) is an open source library of programming functions mainly aimed at real-time computer vision. The acquired frames are converted to gray scale. Digital imaging or digital image acquisition is the creation of a digitally encoded representation of the visual characteristics of an object, such as a physical scene or the interior structure of an object. The term is often assumed to imply or include the processing, compression, storage, printing, and display of such images. A key advantage of a digital image, versus an analog image such as a film photograph, is the ability make copies and copies of copies digitally indefinitely without any loss of image quality. This is showed in the Figure 5

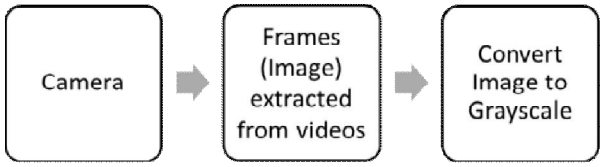

Figure 5. Image Acquisition Pipeline

C. Face Detection

This module detects the face in the acquired image, resizes and records it. Face Detection Module uses Haar Cascade to achieve face detection in a given frame. Haar Cascade is basically a classifier which is used to detect the object(face) for which it has been trained for, from the source. This module adopts 2 sub classifiers in Haar Cascade: Frontal Face and Profile Face Frontal classifiers detects frontal faces in the frame obtained from the stream, when the face is completely faced to the camera. Profile classifier detects partial faces in the frame obtained from the stream, when the face is partially faced to the camera. Once the Face is detected, labels are assigned to the detected face region in the frame. The frame is resized to that detected region. Frames are recorded in the hard disk in .jpeg format. Detecting faces with high accuracy is a difficult task due to orientation and angle of the faces in the video. However, high accuracy systems such as DLIB provides high accuracy by using HOG features form images. But, as our system is based on real concept as video processing is continuous we have used Haar Cascade for our task which is a machine learning based approach where a cascade function is trained from a lot of positive and negative images. It is then used to detect objects in other images. This can be explained in the Figure 6

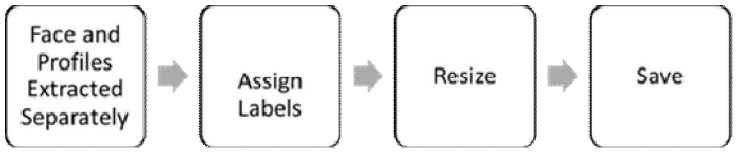

Figure 6. Face Detection Pipeline

D. Face Recognition

The System compares selected facial features from the image and compare with the faces it already knows. The OpenFace package uses deep neural network to represent (or embed) the face on a 128-dimensional unit hypersphere. Unlike other face representations, this embedding has the nice property that a larger distance between two face embeddings means that the faces are likely not of the same person. This property makes clustering, similarity detection, and classification tasks easier than other face recognition techniques where the Euclidean distance between features is not meaningful. During the training portion of the OpenFace pipeline, 500,000 images are passed through the neural net. OpenFace trains these images to produce 128 facial embeddings that represent a generic face. OpenFace uses Google's FaceNet architecture for feature extraction and uses a triplet loss function to test how accurate the neural net classifies a face.

E. Person Tracking

Once the person is recognized in the particular camera, the system takes a snapshot of the Person recognized in the respective camera. The system, sends an email notification to the registered email. The notify email includes the name of the person recognized, the snapshot and the camera number.

F. Programming Languages and Packages

a. Python

Python is a general-purpose, interpreted, high-level programming language. Python allows programmers to use different programming styles to create simple or complex programs, get quicker results and write code almost as if speaking in a human language. Some of the popular systems and applications that have employed Python during development include Google Search, YouTube, Bit Torrent, Google App Engine, Eve Online, Maya and iRobot machines.

b. OpenCV

OpenCV (Open Source Computer Vision Library) is released under a BSD license and hence it's free for both academic and commercial use. It has C++, Python and Java interfaces and supports Windows, Linux, Mac OS, iOS and Android. OpenCV was designed for computational efficiency and with a strong focus on real-time applications. Written in optimized C/C++, the library can take advantage of multi-core processing. Enabled with OpenCL, it can take advantage of the hardware acceleration of the underlying heterogeneous compute platform.

- cv2.VideoCapture(URL) :Video Capture object used to capture frames from IP camera.Video capturing from video files, image sequences or cameras.Parameter – Camera URL.
- cv2.CascadeClassifier("cascades/haarcascade_frontalface_alt2.xml"): This is applied to an input image. The classifier outputs a "1" if the region is likely to show the object, and "0" otherwise.Parameter – xml File

c. OpenFace

OpenFace is an open source framework that implements state of the art facial behavior analysis algorithms including facial landmark detection, head pose tracking, eye gaze and facial action unit estimation. It is also able to perform all of these tasks together in real time. Main contributions of OpenFace are, It implements and extends state of the art algorithms; It is the open source tool that includes model training code; It comes with ready to use trained models; It is capable of real-time performance, without the need of a GPU; This also includes a messaging system allowing for easy to implement real time interactive applications; This is available as a Graphical User Interface (for Windows) and as a command line tool (for Ubuntu, Mac OS X and Windows).

- self.net.forward (alignedFace): The function uses the location of a face to detect facial landmarks and perform an affine transform to align the eyes and nose to the correct position. The aligned face is passed through the neural net which generates 128 measurements which uniquely identify that face.

VI. RESULTS

The Criminal Recognition and Tracking(CRPT) dashboard after successful login is shown in figure 7. This Dashboard contains sections namely,

- Face Detected section: Displays the Real time Camera Stream.
- Camera Control Panel: Adds multiple cameras and displays the undetected face.
- Create New Alerts: This section allows the User to select the trained face to be detected and the appropriate message with the authorized email id to which the system has to send the email alerts if any face recognized.
- Add New Face: In this section, the user is allowed to upload the image file of the new face that the system should detected.

Figure8 Criminal Recognition and Tracking(CRPT) dashboard

The Figure 9 shows the Criminal Recognition and Tracking dashboard with real time Criminal Recognition and Tracking pipeline implementation, where the streams of the multiple cameras are fed and the image acquisition, face detection, face recognition and person tracking modules are executed simultaneously without any user intervention, thereby making it a most secure application. The User can make the selection and give the input to the system only through the respective sections that are defined above.

Figure 9 Criminal Recognition and Tracking dashboard when person is recognized

The Figure 10 shows the email from the system after the person is recognized. This is the alert mail that the system sends to the email and the message that is defined in the Create a New Alert section along with the camera number through which the person can be tracked and snapshot of the person recognized.

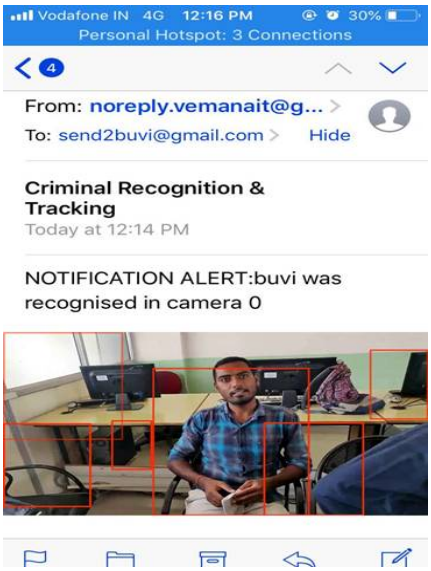

Figure 10 Email From the system

VII. CONCLUSION

The computational models, which were implemented in this project, were chosen after extensive research, and the successful testing results confirm that the choices made by the researcher were reliable. This system was tested under very robust conditions in this experimental study and it is envisaged that real-world performance will be far more accurate. The fully automated frontal view face detection system displayed virtually perfect accuracy. The most suitable real-world applications for face detection and recognition systems are for surveillance. There are better techniques such as iris or retina recognition and face recognition using the thermal spectrum for user access and user verification applications since these need a very high degree of accuracy. The real-time automated pose invariant face detection and recognition system proposed would be ideal for crowd surveillance applications. If such a system were widely implemented its potential for locating and tracking suspects for law enforcement agencies is immense. The implemented fully automated face detection and recognition system could be used for simple surveillance applications such as ATM user security, while the implemented manual face detection and automated recognition system is ideal of criminal recognition and tracking.

A. Applications

- Quick notifications about criminal location.
- Better approach to find missing and suspicious people.
- Better scan to run facial recognition to search for potential criminals or missing people.
- Reduced human effort.
- Tracking criminals at faster rate.
- Footage is available at all times.
- Provides efficient surveillance.

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