An improved Facial System to detect the Criminal face for investigation using Machine learning technique

Dr. Geetha C. Megharaj , Ajay N, Ankitha V, Kalpesh M, Likith Nagendra A
Department of Computer Science Engineering,
Dr.T.Thimmaiah Institute of Technology,
(Affiliated by Visvesvaraya Technological University, Karnataka) KGF-563120, India

***Abstract**:* An improved machine learning technique called Automatic Criminal Face Recognition System. The proposed (ACFR) system automatically aims to identifies the criminal face using Machine Learning technique. The proposed (ACFR) system contains six stages, in the first stage, the Automatic criminal face recognition system gets the input as video and converts the video into sequence of frames using frame converter tool. Next stage, the proposed (ACFR) system will detect faces using Haar Casacade classifier Algorithm and preprocessing of the detected face is done to improve the quality and optimize size of the face using improved arithmetic operations. In third stage frame feature extraction involves identifying unique facial characteristics like eyes, nose and mouth. Fourth stage, training the face enables accurate identification which is crucial for criminal recognition. In fifth stage the proposed (ACFR) system classification categories data into classes based on its features or characteristics using Hamming Distance algorithm. Following the previous stages the final stage has the proposed system resulting whether the criminal is found or not.

Keywords: Machine Learning, Harr Casscsade Algorithm, feature extraction, Hamming distance algorithm.

I. INTRODUCTION

A person's face is a distinctive and essential feature of their body that helps to identify them. With the development of technology, CCTV has been installed in numerous public areas to record the face of the offender. The criminal face recognition technology can be used with the previously taken pictures and photographs of criminals that are stored in the database.The criminal that is visiting that area will be recognized by the system based on their face. The person's photos that were taken are compared to the criminal information that is stored in our database.In the event that a face is identified, the system will show that person's picture on the screen and announce that the offender has been located and identified.In order to improve, we suggest an automated criminal identification system in this project.

Face recognition-based criminal detection system employs sophisticated computer vision techniques. It processes video frames, applying steps like face detection, alignment, and illumination normalization. The frames that are pre-processed are matched against a database for potential identification. The system's output provides valuable leads for criminal identification, bolstering efforts to ensure public safety.The current system for finding criminals using face recognition involves using special cameras to watch and record videos. Then, powerful computers quickly look at these videos to find people's faces. If they recognize someone, they tell the security team. There's also a computer screen where the security team can see what's happening and keep track of things. They note down everything essential for later. But it's important to be careful and fair when using this technology to ensure it's used in the correct way. Problem Identified in this system if the crime rate has seen an unprecedented surge and also the incidence of criminal activity is on the rise, this leads towards a great concern about the security issues.These includes various obstacles like :Pose and angle, Changing Lighting Conditions, Poor Quality Image, Variability in Appearance; In Criminal Face detection it is necessary to minimize false positives and enhance law enforcement efficiency and public safety

With the help of machine learning techniques, facial recognition systems can be used to detect criminals and aid in investigations. This project aims to develop a facial recognition system to detect criminals for investigation purposes using machine learning techniques. The system will be able to identify and recognize the facial features of criminals from various sources of data, such as an image database, a video stream, or even a CCTV camera feed. Machine learning algorithms will be used to identify and process the facial features of the criminals and match them with the known criminals.

The system will be able to identify criminals even if they are wearing sunglasses, hats or if they are in motion. The system will also be able to distinguish between criminals and non-criminals by analyzing the facial features of the individuals. This system Automatic criminal face recognition (ACFR) will be able to provide law enforcement agencies with the necessary data to better investigate criminal activities.

Automatic criminal face recognition (ACFR) System is designed for video applications which are important .These systems are extensively employed in investigation and security contexts, where they analyze video feeds from cameras to identify and track individuals.In investigations, video-based ACFR aids in identifying and tracking individuals by analyzing footage from crime scenes or public spaces. Moreover, it contributes to crowd monitoring and public safety, detecting unusual behavior and potential security threats in crowded settings.

Archana Naik reported Criminal Detection Using Face Recognition.In this project Haar cascade algorithm is used to identify and detect face and to train face uses LBP (Local Binary Pattern)in which the exact face can be analysed by extracting the smaller features of the face such as eyes.When a crime happens without witness then, the facial recognition system can be used to identify the criminals.The system recognizes the criminal, useful to prevent the crime. Furthermore, the system's robustness against various disguises and its ability to function in different lighting conditions and angles adds to its versatility. This makes it suitable for deployment in a wide range of environments, from well-lit urban areas to dimly lit rural settings; However, the ethical implications of such a system are significant. While it can greatly aid in maintaining public safety, there's a risk of infringing on individuals' privacy rights. It's crucial to establish clear guidelines for when and how this technology can be used, he system should be designed to minimize false positives. Incorrect identification could lead to unnecessary distress for innocent individuals. Therefore, continuous improvement and validation of the machine learning algorithms used in the system are essential. public awareness and understanding of the system's operation and its limitations are important. This can help build trust and acceptance among the community, ensuring that the technology serves its purpose of enhancing public safety while respecting individual rights. the ACFR system represents a significant advancement in security technology. With careful implementation and regulation, it has the potential to be a valuable tool in the fight against crime.

1.1 Scope Of The Project

The scope of criminal detection using face recognition is wide-ranging and impactful. It encompasses applications in law enforcement, security, and public safety. This technology aids in identifying individuals from images or videos, contributing to investigations and security measures. It's employed in various contexts, including surveillance, access control, and border security. Additionally, face recognition enhances event security, public safety, and smart city initiatives. However, ethical and privacy considerations must be carefully weighed in its deployment to ensure responsible use and compliance with legal standards.

1.2 Objective

Accurately locate and isolate the facial region within an image or video frame using face detection algorithms to automatically detect Criminal face for Investigation.

1.3 Brief Outline of the Project

The works carried out at each project phase are outlined below :

Learning & Analysis Phase. This phase includes:
- Well understanding of the project design.

Designing the overall functional view i.e. system architecture of the project.
- Describing the language, platform used in the project implementation.
- Identification and design of the modules for implementing.

Testing Phase: This phase includes:
- Using test cases for testing the implemented modules.
- Executing the test cases, comparing and evaluating the actual result with the expected result

II. LITERATURE SURVEY

The author **Archana Naik et al**., in **[1]** have reported Criminal Detection Using Face Recognition.In this project Haar cascade algorithm is used to identify and detect face and to train face uses LBP (Local Binary Pattern)in which the exact face can be analysed by extracting the smaller features of the face such as eyes.When a crime happens without witness then, the facial recognition system can be used to identify the criminals.The system recognizes the criminal, useful to prevent the crime.

In **[2]** the author **Sanika Tanmay et al**., have designed Face Detection And Recognition for Criminal Identification System.In this paper the process of face recognition is divided into four parts they are Face Detection,Face Alignment,Face Extraction and face recognition.It also presents an innovative approach to face recognition and how it can be implemented for an important purpose which is Criminal Detection and identification.

K. Manideep Reddy et al., in **[3]** have developed Face Recognition for Criminal Detection. This paper includes an automated system to identify suspicious behavior using Machine Learning Algorithms and Convolution Neural Network.The use of Unified Modeling Language (UML) for creating models of object-oriented computer software is also included.Additionally, Python as commonly used multi-purpose programming language with a large collection of standard libraries.It also involves system testing process, including unit testing and integration testing, as a means to find errors and weaknesses in the work product.

The author **Rohit Alex et al.,** in **[4]** have implemented Criminal Identification System using Facial Detection and Recognition.This paper use Viola-Jones algorithm for detecting the face and for face recognition, the system uses the Local Binary Patterns Histograms (LBPH) algorithm.It explores the difficulties in identifying and recognizing criminals and the growing adoption of biometric-based techniques, particularly face recognition, to locate and apprehend criminals. The system works by analyzing facial traits to generate a distinct pattern for each face and then compares it to other images in a database to find a potential match.

In **[5]** the author **Nagnath Aherwadi et al.,** have reported Criminal Identification System using Facial Recognitio.This paper invovles the development of a criminal identification system using facial recognition technology. The system aims to improve the process of identifying criminals by utilizing CCTV footage and comparing it with images in police databases. This technology has the potential to enhance the efficiency and effectiveness of criminal identification for law enforcement agencies.

Ajay Kumar et al., in **[6]** have reported Futuristic study of a criminal facial recognition.This paper discusses the use of Haar cascade and Histograms of

Oriented Gradients (HOG) in criminal facial recognition.It emphasizes the need for accuracy and flexibility in recognizing criminals in various conditions such as illumination, occlusion, posture, etc.The results of face detection using Haar cascade are presented in a table, showing the recognition ability under different conditions.

In **[7] t**he author **Sumit Dinkar Borse etal.,** have developed Real Time Face Detection To Identify Criminals And Missing People. In this paper a real-time face detection system to identify criminals and missing people. The system uses facial recognition to track or search for a targeted individual from a continuous video feed. The proposed system can be used in government organizations, police, military, and large companies for tracking. The system uses image processing techniques and the Raspberry Pi Camera v2.The proposed system can be used in government organizations, police, military, and large companies for tracking. The system uses image processing techniques and the Raspberry Pi Camera v2. Python is used as the programming language for the system.

The author **Worawut Yimyam et al.,** in **[8]** have developed Face detection criminals through CCTV cameras.In this paper includes research on face detection and recognition using techniques such as eigenface, Haar-like features, and PCA. The proposed method involves a systematic process for detecting and analyzing criminals using CCTV cameras, with the system using image rescaling and facial recognition functions. The experiments showed successful detection of single and group faces, with some limitations related to tilted faces, low light, and night spots.

Lamiaa A.Elrefae et al., in **[9]** have implemented Real-time Face Detection and Tracking on Mobile Phones for Criminal Detection.This paper presents a criminal detection framework using face recognition, focusing on the client side development for face detection and tracking using Android mobile devices. It utilizes the Viola-Jones algorithm for face detection and the Optical Flow algorithm for face tracking. The system is implemented with Android studio and OpenCV library, demonstrating better performance using Optical Flow with Regular Features. The proposed system has been compared with other existing systems and references widely used algorithms such as Viola-Jones and Optical Flow for real-time face tracking. Additionally, it compares feature extraction methods including Fast Corner and Regular Features for use with the Optical Flow algorithm.

The author **Atharv Somani et al.,** in **[10]** have designed A Survey Paper On Live Criminal Detection Using Facial Recognition And Tracking Algorithms.This papers involves the advancements in facial recognition technology for live criminal detection. It discusses the use of computer vision to detect and track individuals within a scene, with the ability to identify and distinguish between individuals based on their unique characteristics. This also highlights the proposed machine's capability to retrieve personal information from a database for criminal identification.

III. PROPOSED SYSTEM

This proposed system will use a combination of machine learning techniques and the Haar Cascade Classifier to detect a criminal’s face for investigation purposes. Additionally, the system will also employ the use of Hamming Distance for classification. The objective of this system is to accurately identify a criminal’s face for investigation purposes.

A machine learning method called the Haar Cascade Classifier employs a sequence of cascades to identify faces in images or videos. The criminal's face will be identified from the picture using this method. The classifier Haar Cascade will Examine the photograph to identify the criminal's face by identifying characteristics like the lips, nose, and eyes.The number of places at which two strings of identical length differ is known as the Hamming Distance 7. It is employed to compare two photos and ascertain whether they are same.

The implementation of the proposed system will involve the following steps:First, the Haar Cascade Classifier will be used to detect the criminal's face and perform feature extraction.Next, the Hamming Distance will be used to compare the criminal's face from the image with the criminal's face from the test frame.Finally, if the criminal's face is identified, the proposed system displays 'criminal found', otherwise 'not found'."

3.1 Methodology

An improved machine learning technique called Automatic Criminal Face Recognition System (ACFR), has been developed to automatically identify criminal faces. The proposed (ACFR) System, utilizes advanced machine learning techniques and consists of six stages, each playing a crucial role in the overall process. The ACFR system is designed to accurately and efficiently identify the faces of criminals, aiding law enforcement agencies in their investigations. These six stages are illustrated in detail in figures 1 and 2. By automating the process of identifying criminal faces, the ACFR system aims to improve the efficiency and accuracy of criminal investigations. With its advanced technology and multi-stage approach, the ACFR system has the potential to greatly benefit law enforcement agencies in their efforts to combat crime.

The facial recognition process for criminal investigation initiates with the input of an image or video, the latter being transformed into frames. These frames undergo preprocessing to enhance facial features, including face detection and normalization. Extracted features, like facial landmarks and texture patterns, are then utilized to train a machine learning model, typically a Convolutional Neural Network. Trained on a labeled dataset, the model learns patterns and relationships crucial for identification. In application, the model classifies faces into relevant categories, such as potential suspects or known criminals. The final result provides information on detected individuals, aiding investigative efforts. The accuracy of this process relies on effective preprocessing, quality training data, and the robustness of the trained model, collectively contributing to the system's efficacy in criminal face detection within images or videos.

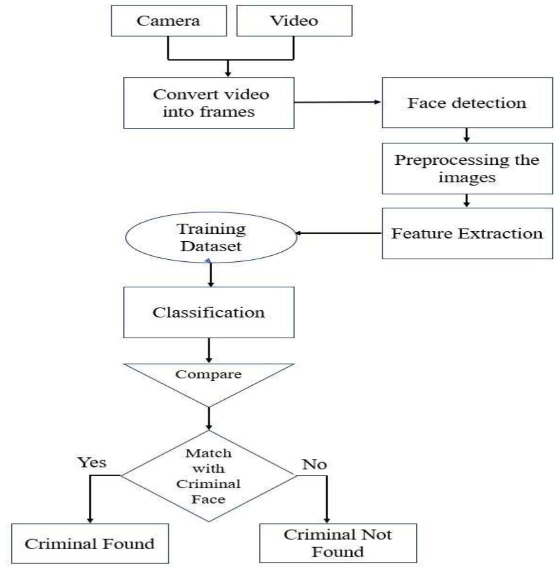


Fig 1 Data Flow Diagram

The propsoed system facial system to detect the criminal face for investigation using machine learning technique follows a specific data flow. First, the facial recognition system acquires data from a variety of sources, such as CCTV cameras, social media, and other public databases. This data is then preprocessed to extract facial features such as eyes, nose, and mouth. After a feature vector is extracted, it is then fed to the machine learning algorithm. The algorithm will then search for a match of given test frame of known criminal faces. If a match is found, the algorithm will alert the system showing the result as criminal found else criminal not found.

3.2 Data Collection

Data collection in criminal face detection is the process of gathering information for use in the identification of criminal suspects. This may include image and video. It is important that the data collected is accurate and up to date, as this can be crucial in identifying a criminal suspect. Data collection can be done through various methods, including manual methods such as manual entry of data, or automated methods such as facial recognition and biometric scans. In addition, data can be collected from public

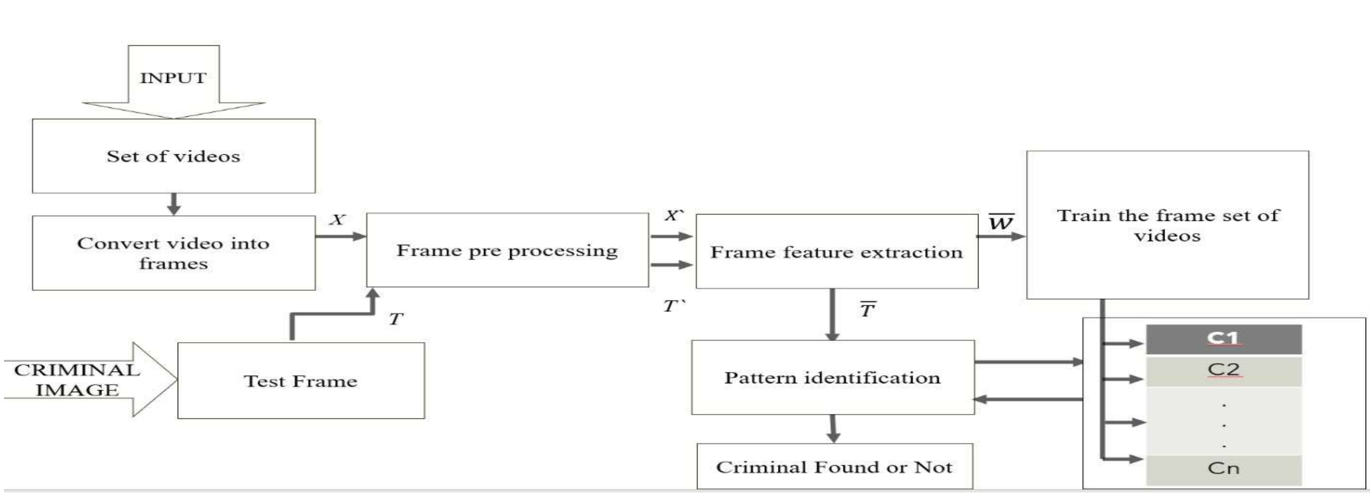


Fig 2 Proposed (ACFR) System Architecture

sources such as police databases and social media. The data collected should be stored securely in an encrypted format to protect its integrity. It is also important to ensure that the data is only collected when absolutely necessary, as to protect the privacy of individuals.

- Set of video's
- Convert video into frames

Set of video's: A set of videos for criminal detection consists of multiple video clips that may hold key information for tracking down suspects in criminal cases, Collect a diverse set of videos. It is important to collect videos from different angles, lighting, and environments to ensure that the system can accurately detect the criminal faces.

Diverse Angles: Faces can appear differently based on the angle from which they are captured. Frontal views, side views, and views from above or below can all provide unique information. Collecting videos that capture faces from various angles can help the system learn to recognize a face regardless of its orientation.

Different Lighting Conditions: Lighting can significantly impact how a face appears in a video. It can create shadows, alter colors, and affect the visibility of facial features. By collecting videos under different lighting conditions (daylight, artificial light, low light, etc.), the system can be trained to recognize faces even under challenging lighting conditions.

Various Environments: Faces can be captured in a wide range of environments, each with its unique characteristics. These could include indoor environments, outdoor environments, crowded places, or isolated areas. Collecting videos from various environments can help the system learn to detect faces in any setting.

Different Expressions and Accessories : Faces can have different expressions (smiling, frowning, etc.) and may be partially obscured by accessories like glasses or hats. Videos capturing these variations can help improve the system's robustness.

Temporal Information: Videos also capture temporal information, showing how a face changes over time as a person talks, blinks, or changes expression. This can provide additional valuable data for the system.
By ensuring diversity in the video data collected, the system can be trained to accurately detect and recognize criminal faces under various real-world conditions[12]. However, it's important to note that the use of such systems must be done responsibly, considering ethical and privacy concerns.

Convert video into frames: In criminal face detection, Haar Cascade Classifier can be used to convert video into frames. This is done by analyzing each frame of the video in order to detect features that correspond to a face. The Haar Cascade Classifier uses a set of pre-defined features and patterns to detect a face in the video. Once the face is detected, the frame is stored in a separate file and can be used for further analysis. To convert a video into frames, you need to extract each frame at a specific time interval. The frame number (n) at a given time (t) can be calculated using the formula:

$$X = [\, n = t * F \,] = X_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where:(n) is the frame number, (t) is the time in seconds, and (F) is the frame rate in frames per second (fps).To calculate the total number of frames in a video, you will need to know the duration of the video in seconds and the frame rate. The frame rate refers to the number of frames (or images) that are shown per second in the video. This can vary depending on the type of video and the quality of the video.

For example, let's say you have a video that is 2 minutes long (120 seconds) and has a frame rate of 24 fps. The total number of frames in this video would be: Number of Frames = 120 seconds x 24 fps = 2880 frames.On the other hand, if you have a high-definition video that is 1 minute long (60 seconds) and has a frame rate of 60 fps, then the total number of frames would be: Number of Frames = 60 seconds x 60 fps = 3600 frames.the actual number of frames may vary depending on the frame rate of your video. You can usually find this information in the video file's properties or by using a video editing software.It is important to note that the higher the frame rate, the smoother and more fluid the motion will be in the video. However, this also results in larger file sizes. So, when choosing a frame rate for your video, consider the balance between the quality of the video and the file size.the number of frames in a video is determined by the duration of the video and the frame rate. You can calculate the exact number of frames using the formula provided. Remember to consider the balance between quality and file size when choosing the frame rate for your video

This formula helps you determine which frame corresponds to a particular time in the video.Video is converted into set of frames using video to jpg convertor tool which is deployed in ACFR system and it has been defined as $X = X_i$ for, $X_i = X_{ijr}$, $j= 1,2,\ldots\ldots,h$, $r = 1,2,\ldots\ldots,$w, where X_i indicates the i^{th} reference frame from the image frame deposit X with n frames, X_{ijr} is the j^{th} row and r^{th} Column in the i^{th} image frame X_i. as $= \{X_0 \ldots . . X_n\}$ where i=1,2, 3…, n and $X_i = X_{ijr}$ where $j=1, 2, 3,\ldots..,h$; $r=1 ,2, 3,\ldots..,w$

[Where, $X_i \rightarrow i^m$ image in video X; $X_{ijr} \rightarrow j^m$ row & r^m $column\ in\ i^m\ image\ in\ video\ X$]

3.3. *Data Preprocessing*

Preprocessing in a criminal face recognition system involves a number of steps to improve the quality and brightness of the facial images. Firstly, the images may be cropped to ensure that only the face is visible. Secondly, the image may be enhanced, such as by increasing the brightness or contrast. Thirdly, any blurriness or noise in the image may be removed. Finally, the image may be resized to a standard size. All these steps can help improve the accuracy of the facial recognition system by providing better quality images. Feature selection or extraction might be employed to reduce dimensionality and focus on the most relevant aspects of the data. Additionally, encoding categorical variables into numerical representations and handling outliers are also part of data preprocessing.

A Haar classifier, or a Haar cascade classifier was proposed by Paul Viola and Michael Jones, it is a machine learning object detection program that identifies objects in an image and video. by having X' $= \{X'_0 \ldots . . X'_n\}$ where i=1,2,3,…,n $X'_i = X'_{ijr}$ j=1, 2, 3,….,h; r=1 ,2, 3,…..,w

[Where, $X'_i \rightarrow i^{th}$ image in ';$X'_{ijr} \rightarrow$denoting the j^{th} row & r^{th} column in i^{th} image of X'_i]

3.4 *Feature Extraction*

Feature extraction in facial recognition using the Haar Cascade Classifier algorithm is a crucial process. It begins with the calculation of Haar features, which are specific calculations performed on adjacent rectangular regions within a detection window. To speed up this process, integral images are created. These integral images allow for quick computation of Haar features by creating sub-rectangles and array references for each sub-rectangle. However, among the numerous Haar features calculated, many are irrelevant. To determine the best features that represent an object, the Adaboost method is used. The final classifier is a weighted sum of these weak classifiers, forming a strong classifier when combined. This strong classifier is then used for the subsequent steps of face detection and recognition.In feature extraction we are going to extract any of the feature including edge, line and smoothing over the each window using Haar wavelet $X'_i = W_r$ where r = 1, 2, 3……., N

$$X'_i = window^{|X'i|}{}_{size} = 24^{h} \times {}_{\times}{}^{w}24 \quad \text{……………………………………(2)}$$

$W_r = W'_r$ [where r = 1, 2, 3……., N]; $W'_i = W'_{ir}$; $W'_{ir} = W'_{irkl}$ [where $W_i \rightarrow$ window set of i[th] image X'_i;where $W'_{ir} \rightarrow r^{th}$ window in the i[th] image window set W'_i] $W'_{ir} = W'_{irkl}$ [where k = 1, 2, 3……., h; where l = 1, 2, 3……., L] $\overline{\overline{\overline{W_i}}} = \overline{\overline{\overline{W_{ir}}}}$.

3.4.1 Haar Cascade Classifier Algorithm

The Haar Cascade Classifier is a machine learning algorithm based on the concept of Haar-like features. The classifier operates by training a model using a set of positive and negative images. Positive images contain the object of interest such as face, while negative images do not. During the training process, the classifier learns to identifies the most effective Haar-like features for object detection.The Haar Cascade classifier algorithm lies at the first four modules of our facial system. In the context of facial systems for criminal investigation, the Haar Cascade Classifier can be used in conjunction with other techniques to detect and recognize faces.

The steps of Haar cascade clasifier algorithm for detecting faces is as follows:

INPUT: Frames

OUTPUT: Detected face

Begin

1.Split the images into number of window with the size (24*24).

2.Extract any feature including edge, line, smoothing over the each window using haar wavelet.

3.Identify the face is their or not in the feature or window size over the trained dataset.

4.If the window is containing face then say directly face in them. **End**

Split the images into number of window with the size (24*24).

To split images into window-size content means breaking down the image into smaller sections or window. It's dividing a large picture into several smaller pieces, making it easier to analyze or process specific parts of the image separately. This can be useful in various applications like image processing, computer vision, or analysis of large datasets.

$$X_{ijr}{}' = x_0[r \times 24: (r + 1) \times 24, j \times 24: (j + 1) \times 24] \quad \text{………………(3)}$$

Where r: represents a row index or a variable that iterates through rows in the matrix,j: represents a column index or a variable that iterates through columns in the matrix ,x_0: could be the value of a specific element in the matrix X at position (r, j),$[r \times 24: (r + 1) \times 24, j \times 24: (j + 1) \times 24]$: This will define a range or slice of elements in the matrix X. The notation [start:end, start: end] in general describes a subsection of a matrix or an array. It will be selecting elements based on certain ranges of rows and columns, $\times$ 24: $(r + 1) \times 24$: Indicates a range of rows starting from r *24 and ending at (r+1)*24 (exclusive). This might represent the vertical slicing of the matrix, $j \times 24$: $(j + 1) \times 24$: Represents a range of columns starting from j* 24 and ending at (j+1)*24 (exclusive). This might represent the horizontal slicing of the matrix.

Extract any feature including edge, line, smoothing over the each window using haar wavelet.

Haar wavelet is used by a Haar cascade classifier to extract features from an image. The classifier uses a set of trained Haar features to detect specific patterns in an image, such as edges, lines, and rectangles, which are commonly found in facial features.

There are three types of Haar wavelet formations that are used by the classifier:

1.Edge feature: This feature is used to detect abrupt changes in brightness or color, such as the edges of facial features like the eyebrows, nose, or mouth it helps to accurately identify and distinguish between different facial features.

II. Line feature: This feature is used to detect straight lines, which are commonly found in facial features like the jawline, cheeks, or forehead. It plays an important role in mapping out the overall structure and proportions of a person's face.

III. Four rectangle feature: This type of feature is used to detect a combination of different rectangle shapes, which can represent features like the eyes, nose, or mouth. By analyzing the size, position, and orientation of these rectangles, facial recognition algorithms can accurately identify facial features and match them to a specific individual. This feature is especially useful in crowded or low-quality images where traditional features may not be as effective.

The Haar cascade classifier uses a series of these features to scan an image in a specific pattern, starting with larger features and gradually moving to smaller ones. If a specific feature is found, it is marked as a positive detection. The classifier then combines all the positive detections to determine if the image contains a face or not.To train the classifier, a large dataset of positive images (images of faces) and negative images (images without faces) is required.Haar wavelet is an important part of the Haar cascade classifier, which uses specific features to detect faces in images.

$$X'_{ijr}=\sum^{12}{}_{i=1} X'_{ijr}(i)- \sum_{i}{}^{24}{}_{=13} X'_{ijr}(i) \quad \ldots\ldots\ldots\ldots(4)$$

This formula calculates the Haar-like edge feature by computing the difference between the sums of pixel intensities in the top half (rows 1 to 12) and the bottom half (rows 13 to 24) of the 24x24 window $'_{ijr}$.This feature calculation helps capture certain edge-like characteristics within the window.

Identify the face is their or not in the feature or window size over the trained dataset. After obtaining detail coefficients through the Haar wavelet transform or feature extraction, The Haar wavelet transform is a mathematical tool that can be used to extract features from an image. In the context of face detection, the Haar wavelet transform is used to extract detail coefficients from an image. These detail coefficients are then used to train a cascade of classifiers using AdaBoost or similar techniques. This cascade, organized into stages, is used in face detection employing a sliding window technique across different image scales and positions. At each window, the extracted coefficients undergo evaluation through the cascade of classifiers. Face detection involves setting a threshold on the cascade's output values. If the cascade output surpasses the threshold, the region is considered a potential face; otherwise, it's discarded as a non-face. Determining the threshold value typically involves empirical tuning or validation to ensure the desired confidence level for accurate face detection. The Haar wavelet transform is a powerful tool for feature extraction in image processing. The cascade of classifiers, trained using AdaBoost or similar techniques, is an effective method for face detection. The threshold value for the cascade's output is determined through empirical tuning or validation to ensure accurate face detection.

3.5 Training Stage

In the training stage of the facial recognition system for criminal detection using Convolutional Neural Networks (CNNs), the process begins with the collection and preparation of a diverse dataset comprising facial images of both criminals and non-criminals. These images are then preprocessed to standardize their size, enhance their quality, and augment the dataset for improved learning. A suitable CNN architecture is selected, and the network undergoes training where it learns to automatically extract relevant features from the input images through successive layers. During training, batches of preprocessed images are passed through the network, and the model's weights are iteratively adjusted to minimize the discrepancy between predicted and actual labels using optimization algorithms like Stochastic

ISSN [Online]: 2583-2654

Gradient Descent. Hyperparameters are tuned to optimize the model's performance, and its effectiveness is evaluated on a separate test set to ensure its ability to generalize to unseen data. Through this training process, the CNN becomes proficient in discerning criminal and non-criminal facial features, laying the groundwork for accurate classification during the inference stage.

3.6 Classification

Criminal identification through facial recognition using machine learning, particularly Convolutional Neural Networks (CNNs). These systems are trained on extensive datasets containing images of individuals with and without criminal records, enabling the CNN to learn intricate facial features and patterns distinguishing between the two categories. During inference, the CNN processes new facial images, determining the likelihood of the individual being a criminal based on learned features. This typically involves assigning probabilities to each class (criminal/noncriminal), enabling the system to make informed decisions. However, challenges such as image quality, lighting conditions, and ethical considerations regarding privacy and bias need careful attention. Despite these challenges, facial recognition with CNNs offers promising tools for law enforcement, providing additional insights and aiding in crime prevention efforts when used responsibly and in conjunction with other investigative techniques. Continued research and development are essential for advancing the accuracy, fairness, and ethical standards of facial recognition systems in criminal identification.

IV. RESULT

Output: **Fig 3: Start Page**

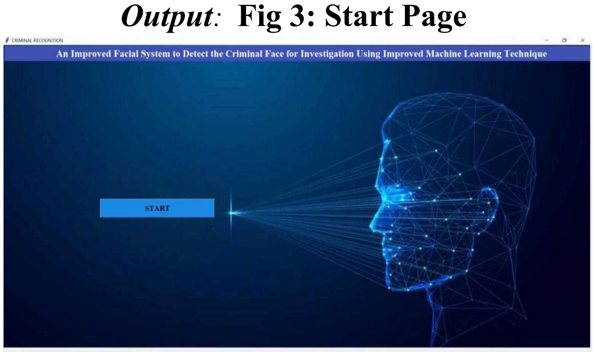


Fig 4: Selection of Video path

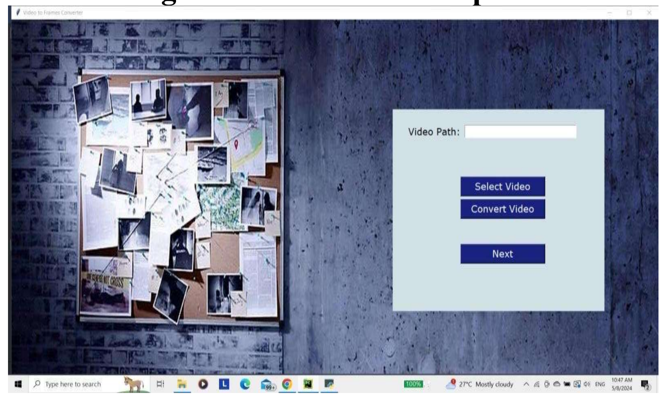


Fig 5: Selection of Video

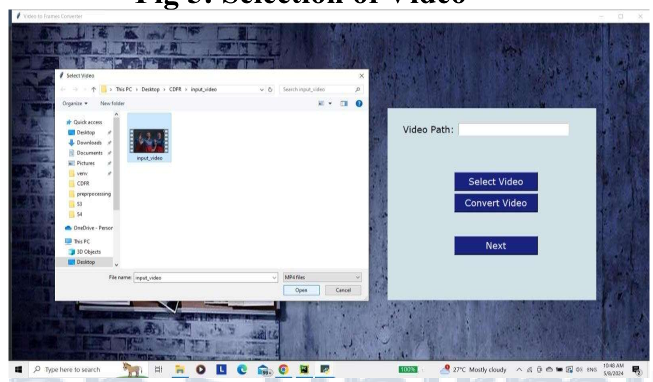


Fig 6: Convertion of Video into frames

Fig 7: Preprocessing

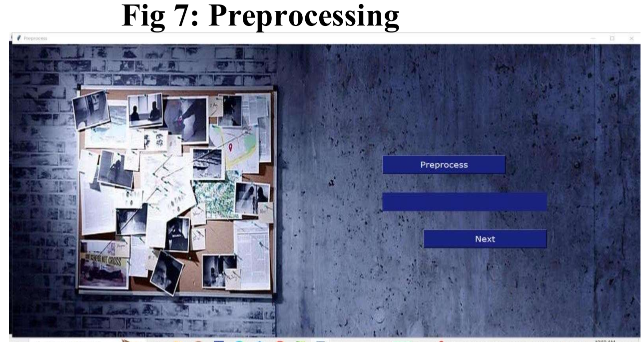


Fig 8: Completion of Preprocessing

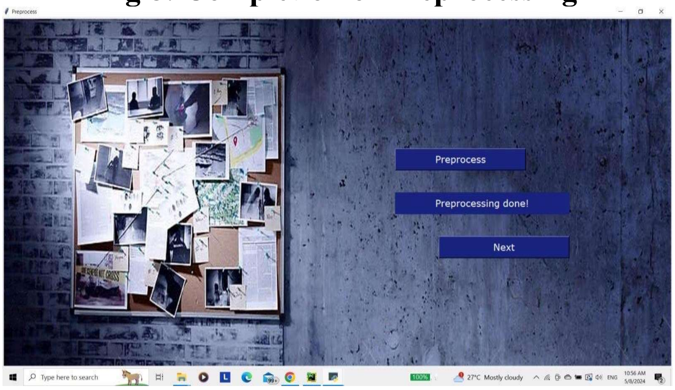
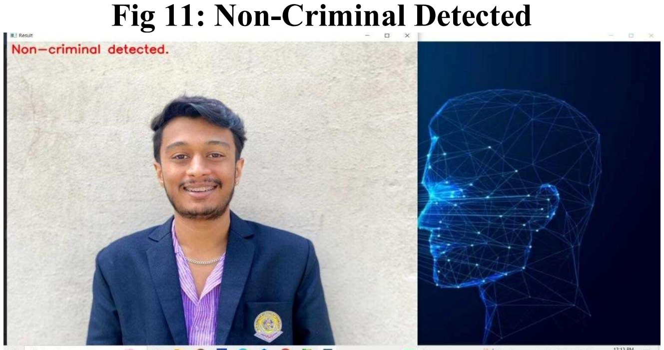


Fig 9: Run Classification

Fig 10: Criminal Detected

Fig 11: Non-Criminal Detected



V. CONCLUSION

The Project Phase-2 work of An Improved Facial System to Detect the Criminal Face for Investigation Using Machine Learning Technique has come to a successful conclusion with the completion of the Introduction, Literature Survey, System Requirement Specification and System Design. The requirements for the system have been effectively identified and the design of the system has been formulated. The literature survey conducted for the project provides a clear overview of the existing Machine Learning techniques and how they can be used to detect criminal faces. With the completion of this phase of the project, the groundwork has been laid for the development of the system. The next phase will involve implementation of the system, followed by testing and evaluation of the system. After successful completion, it is expected that the system will be able to help in criminal investigations by accurately detecting criminal faces.

REFERENCES

[1] Archana Naik, Rohan Basukala, Santosh Tiwari, Tanka Prasad Tiwari, Prajwal Deep Bhandari and Asha H. V, "Criminal identification using facial recognition", International Journal of Advance Research, Ideas and Innovation in Technology (IJARIIT),Vol 5, pp 1936-1940, 2019 .

[2] Sanika Tanmay Ratnaparkhi, Aamani Tandasi and Shipra Saraswat, "Face Detection And Recognition For Criminal identification System", International Conference Oncloud Computing,Data Science and Engineering, pp 773-777, 2021.

[3] K. Manideep Reddy, V. Varun Reddy, B. Vinay Goud and Dr. Y. Sreenivasulu, "Face Recognition for Criminal Detection", International Journal for Research in Applied Science & Engineering Technology,Vol 10, pp 28562860, June 2022.

[4] Rohit Alex Badana, Lohith Morishetty, Mounika Chekuri, Vijaya Bharathi Manjeti And Abhiraj Singh Chauhan, "Criminal Identification System Using Face Detection And Recognition", Journal of Engineering Science, Vol 13, No 03, Pp 792- 798, March 2022.

[5] Nagnath Aherwadi, Deep Chokshi, Sagar Dhanraj Pande and Aditya Khamparia, "Criminal Identification System using Facial Recognition", ResearchGate, pp 1-7,July 2021.

[6] Ajay Kumar and Rishi Gupta, "Futuristic study of a criminal facial recognition A open-source face image dataset", ELSEVIER, pp 1-4, April 2023.

[7] Sumit Dinkar Borse, Krutishil Vijay Purkar, Mayur Ganesh Patil and Prof. D. S. Shingate, "Real Time Face Detection to Identify Criminal and Missing People", International Journal of Scientific Development and Research (IJSDR), Vol.4, pp47-50,December 2019.

[8] Worawut Yimyam, Thidarat Pinthong, Narumol Chumuang and Mahasak Ketcham, "Face detection criminals through CCTV cameras" International Conference on Signal-Image Technology & Internet-Based Systems (SITIS), pp 351-357, 2018.

[9] Lamiaa A. Elrefaei, Alaa Alharthi, Huda Alamoudi, Shatha Almutairi and Fatima Al- rammah, "Real-time Face Detection and Tracking on Mobile Phones for Criminal Detection" International Conference on Anti-Cybercrime (ICACC), IEEE Xplore, pp 1-6, 2017.

[10] Atharv Somani, Sarthak Sonpatki, Soham Kasture, Abhimanyu Kshirsagar and Naved Raza Q. Ail, "A Survey Paper on Live Criminal Detection Using Facial Recognition And Tracking Algorithm" International Research Journal of Modernization in Engineering Technology and Science, Vol 5, pp 3291-3295, May 2023.

[11] Apoorva.P, Impana.H.C, Siri.S.L, Varshitha.M.R and Ramesh.B, "Automated Criminal Identification By Face Recognition Using Open Computer Vision Classifiers" Proceedings of the Third International Conference on Computing Methodologies and Communication, pp 775-778,June 2019.

[12] Shefiu Ganiyu, Olayemi Mikail Olaniyi, Olawale Surajudeen Adebayo and Terfa Daniel Akpagher, "Systematic Review of Facial Recognition Algorithms and Approaches for CrimeInvestigations" ResearchGate,Vol-8, No. 1, pp 55-69, May 2020.

[13] Samit Shirsat, Aakash Naik, Darshan Tamse, Jaysingh Yadav, Pratiksha Shetgaonkar and Shailendra Aswale, "Proposed System for Criminal Detection and Recognition on CCTV Data Using Cloud and Machine Learning" International Conference on Vision Towards Emerging Trends in Communication and Networking (ViTECoN), pp 1-6, 2019.

[14] Hyun-Bin Kim, Nakhoon Choi, Hye-Jeong Kwon And Heeyoul Kim, "Surveillance System for Real-Time HighPrecisionRecognition of Criminal Faces From Wild Videos" IEEE Access,Vol-11, pp 56066-56082, June 2023.

[15] Alireza Chevelwalla, Ajay Gurav, Sachin Desai and Prof. Sumitra Sadhukhan, "Criminal Face Recognition System" International Journal of Engineering Research & Technology (IJERT),Vol 4, pp 47-50, March 2015.