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FACE DETECTION AND RECOGNITION FOR CRIMINAL IDENTIFICATION SYSTEM

[1]Prof. Kiran Yesugade, [2]Apurva Pongade, [3]Shruti Karad, [4]Divya Ingale, [5]Shravani Mahabare
[1]Professor, [2]Student, [3]Student, [4]Student, [5]Student
[1]Department of Computer Engineering
[1]Bharati Vidyapeeth's College of Engineering for Women-Pune, India

Abstract: The human face serves as a fundamental and unique identifier, especially in the context of criminal detection and law enforcement. The increasing challenges posed by highly populous urban environments demand automated solutions for efficient and timely identification of individuals. This research introduces an innovative real-time criminal identification system that integrates deep learning, specifically Convolutional Neural Networks (CNN), and Haar Cascade classifier for face detection and recognition. The system utilizes live camera feeds in urban environments, enhancing law enforcement capabilities by combining facial recognition with historical criminal activity data. The proposed approach focuses on extracting detailed facial features through CNN, ensuring robust detection in challenging scenarios. The integration of Haar Cascade enables high-precision real-time face detection. our research contributes to the advancement of criminal identification systems by introducing a real-time approach that harnesses the power of deep learning and live camera feeds. The proposed system holds significant potential for enhancing law enforcement capabilities, enabling proactive identification, and contributing to the overall safety and security of urban environments. As a forward-looking solution, our research not only addresses current challenges but also anticipates future needs in the ongoing evolution of urban security. By incorporating real-time data analytics, our system aids authorities in making informed decisions, reinforcing its role as a proactive and intelligence-driven asset for ensuring public safety.

Keywords: Real-time criminal identification, Deep learning, Convolutional Neural Networks (CNN), Haar Cascade classifier, Facial recognition

1. INTRODUCTION

In today's world, technology plays a crucial role in law enforcement, and facial recognition has become a key tool for identifying individuals. This paper introduces a new way of identifying potential criminals by combining facial recognition with their past criminal activities. The idea is to make the identification process faster and more accurate, especially in busy urban areas where manual identification is challenging.

Facial recognition technology relies on the uniqueness of a person's face, and our approach takes this a step further by considering the individual's history of criminal activities. The aim is to provide law enforcement with a more comprehensive tool for quickly identifying and apprehending suspects. Traditional methods are often slow and impractical in crowded places, so our system uses advanced techniques like Convolutional Neural Networks (CNN) and Haar Cascade algorithms to detect and recognize faces in real-time. What makes our research unique is the integration of historical criminal activity data into the identification process. By combining facial recognition with a person's criminal history, our system enhances accuracy and provides a proactive means of identifying potential threats. This holistic approach not only improves identification but also gives law enforcement a more nuanced understanding of an individual's risk level. The need for an intelligent and automated criminal identification system is clear, especially when manual methods fall short. Our system is designed to work seamlessly with live camera feeds, continuously updating a dataset used to train the CNN and Haar Cascade algorithms.

This ensures the system remains adaptable and responsive to changing situations, making it a scalable solution for real-world scenarios.

This prototype system represents a significant step forward in criminal identification. Beyond its technical complexity, the system has the potential to revolutionize law enforcement by offering a tool that speeds up identification processes and takes a proactive stance in preventing criminal activities. By combining deep learning with historical criminal data, our approach aims to contribute to the ongoing evolution of criminal identification systems, making urban environments safer and more secure. As we delve into the technical details in the following sections, we'll explore the system's architecture, algorithms, and methodology. Through this detailed examination, our goal is not only to showcase the capabilities of our prototype system but also to inspire further discussion and innovation in the field of real-world criminal identification. The fusion of technology with practical applications has the potential to reshape the future of law enforcement, making communities safer and better protected.

2. LITERATURE REVIEW

The face detection system uses a deep neural network using a machine learning algorithm which can be introduced as a hassle-free criminal identification system. The hardware requirement includes a camera module mainly CCTV. The main focus of the project is on mapping special feature that includes beard, hair, lips, etc. The recognition of face includes two major steps 1. Face verification 2. Face identification. [1]

The major impact of face detection interconnected with other features results in face identification. It includes face extraction, face net is the library that is used for face identification. It uses deep CNN for training the feature. [2]

The paper presents an innovative approach by using facets to identify criminals in real time. [3]

The paper demonstrates the use of criminal and missing children identification using face recognition and web scraping. It includes the process of a haar cascade classifier for filtering humans into various stages as a result it determines detected face is criminal or not.[4]

The feature extraction from the image is done by using OpenCV. The feature extraction is classified with the help of a feature vector and trained using web scraping.[5]

The proposed system can recognize more than one face in a single frame and it makes the application more reliable and faster. [6]

An investigation of face recognition for criminal identification in surveillance video described the importance of video graphics technology to identify criminals behind the crime scene.[7]

It uses the viola-jones algorithm and three basic features including an edge feature, a line feature, and a rectangle feature.[8]

The system uses a combination of CNN and DNN algorithms for neural recognition.[8]

The project compares the dataset with match data frames and generates the result based on the classification algorithm.[9]

The paper demonstrates the use of a criminal detection system using a history of criminal activities done by criminals. The model uses the CNN algorithm for neural recogization for the simulation, model used labeled faces in the wild dataset. The automatics system is operative to identify the criminal. [10]

The mapping of images with the database is the main aspect of the proposed system. The image is generally taken through the CCTV cameras. [11]

The accuracy of the model is around 87% however the accuracy loss becomes a significant issue for verification purposes.[12]

The drawback of the prototype is the redundancy of names stored in the database as a result it may have duplicate data with criminal names.[13]

The proposed project automatic recognizes faces of criminals based on their criminal activities. The project has the efficient use in public places.[14]

The project uses CNN algorithm and the Labeled Faces in the Wild dataset.[14]

The main purpose of proposed system is to develop an effective criminal identification system employing face detection and alignment.[15]

The system makes the use of multi-task cascaded convolution neural networks and FaceNet for harnesses the power of Convolution neural networks.[16]

3. METHODOLOGY

3.1. PROPOSED SYSTEM

The architecture of our system has been designed to integrate deep learning methodologies with CNN and Haar Cascade algorithms. The following introduction provides a overview of the key components and their working within the system.

- **Input as a Live Camera:**

Camera Access:
The first step is to access the camera device. This is done using OpenCV video capture object using python programming languages.

Frame Capture:
Once the camera is accessed, the live video stream is broken down into individual frames. These frames represent several moments and store it in backend database.

- **Data Collection:**

Gather a diverse dataset of criminal faces for training your model. Ensure the dataset represents various races, ages, and genders.

- **Data Preprocessing:**

This phase involves cleaning and transforming raw data into a format that is suitable for training models.

Remove Noise:
Eliminate any irrelevant or distracting elements from the images that might hinder the model's learning process.

Consistent Lighting:
Ensure consistent lighting across images to avoid biases caused by variations in brightness and contrast.

Uniform Size:
Resize all images to a uniform size. This step ensures that the model can handle images of consistent dimensions during training.

Pixel Value Normalization:
Normalize pixel values to a standard scale (e.g., 0 to 1 or -1 to 1). Normalization helps in speeding up convergence during training and improves the model's ability to generalize across different images.

Generate Augmented Data:
Augment the dataset by applying transformations such as rotation, flipping, and zooming. Data augmentation helps improve model robustness and prevents overfitting by exposing the model to a broader range of scenarios.

- **Feature Extraction:**

Feature extraction in your project is primarily performed by a Convolutional Neural Network (CNN). CNNs are deep learning architectures designed for processing structured grid data, such as images. The architecture typically consists of convolutional layers, pooling layers, and fully connected layers.

Convolutional Layers:
Convolutional layers apply filters or kernels to the input image, capturing patterns and features. These filters detect edges, textures, and more complex structures in the image.

Pooling Layers:
Down sampling:
Pooling layers down sample the spatial dimensions of the feature maps, reducing the computational load and focusing on the most important features. Pooling helps create spatial hierarchies, allowing the network to recognize features at different scales.

Fully Connected Layers:
After several convolutional and **pooling** layers, the feature maps are flattened into a vector, and this vector serves as input to fully connected layers. Fully connected layers capture global features and relationships among different parts of the input, combining the knowledge acquired from convolutional layers.

Feature Vectors:
The output of the last fully connected layer is a feature vector that represents the essential characteristics of the input facial image. The feature vector is a compact representation that captures the distinctive features of the face while reducing the dimensionality of the input data.

- **CNN and Haar Cascade algorithm working:**

Convolutional Neural Networks (CNNs) have revolutionized the field of computer vision, particularly in tasks like image recognition, object detection, and facial analysis. CNNs are a type of deep neural network designed to automatically and adaptively learn hierarchical representations of data. They excel in capturing intricate patterns and features from images, making them highly effective for tasks such as facial recognition.

Haar Cascade is a machine learning-based object detection method introduced by Viola and Jones. It is a cascade of classifiers trained to identify objects, such as faces, by analyzing features in a hierarchical manner. Haar Cascade has been widely used for real-time face detection due to its efficiency and speed.

- **Identification and Detection:**

Use facial landmark detection to align the detected faces, addressing variations in pose and expression. Extract features from the aligned faces using the trained CNN. Use a matching mechanism, such as Siamese networks or triplet loss networks, to determine the similarity between the extracted features and those in the criminal database.

- **Display Output to User:**

Implement an alert system to notify relevant authorities or security personnel about the potential identification.

3.2. ARCHITECTURE

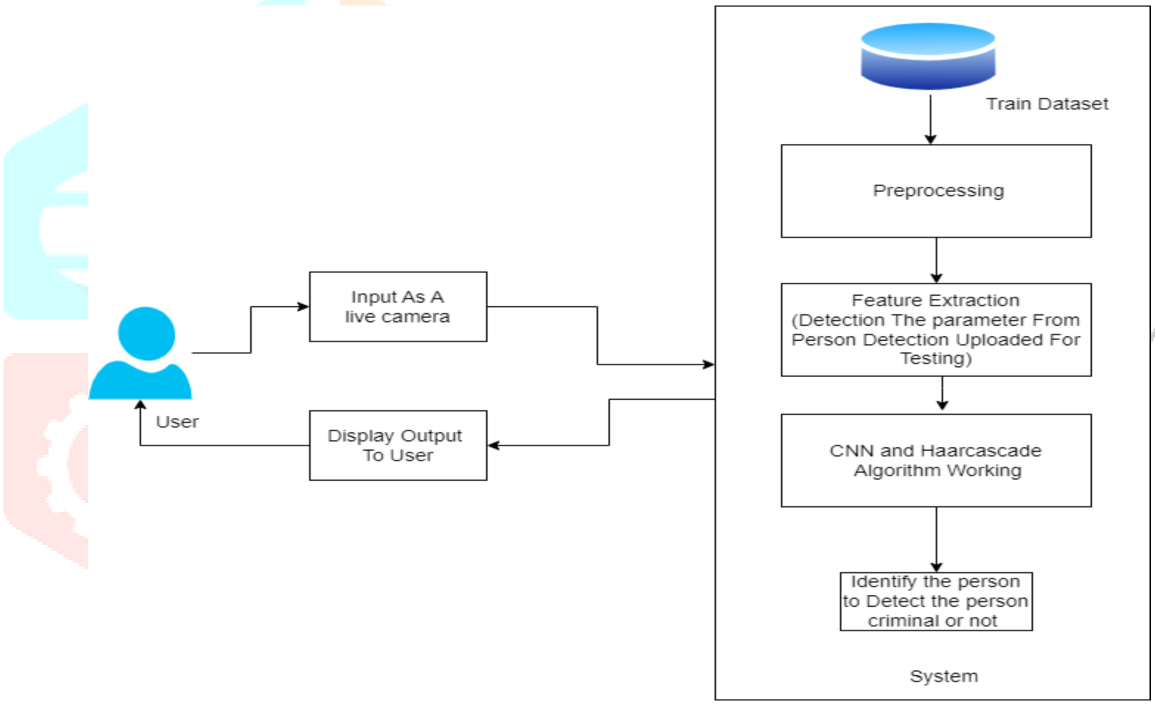

Fig.3.2 System Architecture

3.3. ALGORITHMS

3.3.1. CNN

A Convolutional Neural Network (CNN) operates by systematically processing images through layers of specialized filters. In the initial convolutional layer, these filters scan small portions of the image, detecting basic features like edges and colors. Following this, the Rectified Linear Unit (ReLU) activation layer introduces non-linearity to the model, enhancing its ability to discern complex patterns. Subsequently, a pooling layer reduces the spatial dimensions of the data by retaining key information, such as the maximum values in localized regions. The processed data is then flattened into a vector and fed into fully connected layers, where intricate analyses take place to make sense of the learned features. The final output layer produces predictions, with each node representing a potential object category. During training, the network refines its internal parameters through backpropagation, continuously improving its ability to recognize and categorize images over multiple iterations. In essence, the CNN's hierarchical structure and convolutional operations enable it to transform raw pixel data into meaningful and accurate predictions

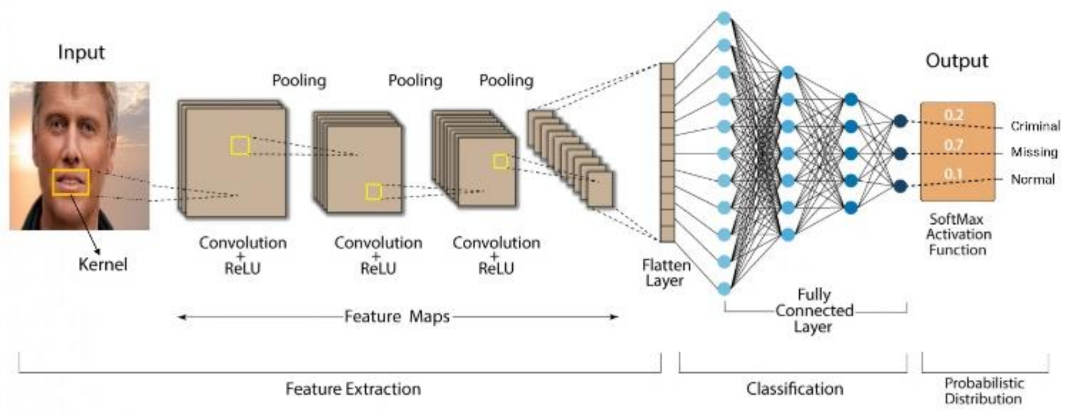

Fig. 3.3.1. Convolutional Neural Network

3.3.2. Haar Cascade

The Haar Cascade algorithm operates as a machine learning-based object detection method, commonly employed for tasks like face detection. It relies on Haar-like features, which are rectangular patterns of contrasting light and dark regions in an image. During the training phase, the algorithm is presented with positive images containing the target object (e.g., faces) and negative images without it. To accelerate computations, an integral image is used, enabling swift calculation of pixel value sums in rectangular regions. The algorithm constructs a cascade of classifiers, each comprising multiple stages housing weak classifiers based on Haar features. The Adaboost algorithm is employed to select the most effective weak classifiers at each stage, with a focus on correcting errors made by preceding classifiers. The cascade structure enhances efficiency by swiftly rejecting image regions not containing the object, and only subjecting promising regions to more intricate checks in subsequent stages. Utilizing a sliding window approach, the algorithm scans the image at various scales and positions, ultimately classifying regions that successfully pass all stages as containing the desired object. In essence, Haar Cascade excels in real-time object detection by intelligently prioritizing and efficiently processing image regions through a cascading hierarchy of classifiers.

4. DATASET

The dataset utilized in this project plays a pivotal role in training and evaluating the effectiveness of the proposed criminal identification system. The process begins with the implementation of a registration module designed to capture 41 images of an individual's face and label them accordingly as "criminal" or "not criminal." This dataset generation step serves as the foundation for training the subsequent live detection module, contributing to the system's ability to make real-time assessments of individuals entering monitored areas.

4.1. Dataset Collection through Registration Module: The registration module is responsible for capturing a set of 41 facial images for each individual. This module incorporates user-friendly interfaces for efficient data collection, ensuring that the dataset encompasses a diverse range of facial expressions, lighting conditions, and orientations. During this process, each image is meticulously labelled to indicate whether the person is flagged as a potential criminal or deemed non-criminal.

4.2. Labelling Scheme: The labelling of the dataset is a critical step in creating a supervised learning environment for the subsequent modules. Each facial image is associated with a binary label, classifying the individual as either "criminal" or "not criminal." The labelling process involves a systematic approach, potentially incorporating insights from law enforcement or utilizing existing criminal databases to simulate real-world scenarios.

4.3. Dataset Size and Diversity: To ensure the robustness and generalization capability of the system, the dataset should be sufficiently large and diverse. The inclusion of a substantial number of individuals, representing various demographic groups is crucial to training the system to handle diverse populations encountered in real-world scenarios. Additionally, the dataset should encounter in real-world scenarios. Additionally, the dataset should encompass variations in environmental conditions, such as lighting and background, to enhance the system's adaptability.

4.4. Dataset Security and Privacy Considerations: Given the sensitive nature of criminal identification data, the reference paper should address security and privacy considerations associated with dataset creation. Measures such as anonymization of individuals, adherence to ethical guidelines, and compliance with privacy regulations must be outlined to ensure responsible and ethical use of the collected data.

4.5. Live Detection Module Training: The dataset generated through the registration module serves as the training dataset for the live detection module. The paper should elucidate the specific methodologies employed for training the Convolutional Neural Networks (CNN) and Haar Cascade algorithms using this dataset, highlighting any data augmentation techniques or preprocessing steps employed to enhance model performance.

The dataset generation process outlined in the reference paper serves as a critical foundation for the proposed criminal identification system. The details provided should offer transparency regarding the dataset's composition, labelling methodology, security measures, and its integral role in training the subsequent live detection module.

5. CONCLUSION AND FUTURE WORK

This research is based on face detection and recognition of criminals using CNN algorithm and Haar Cascade classifier. CNN algorithm helps learning hierarchical features and enabling tasks like image classification, object detection and facial recognition. Haar Cascade classifiers helps to detect faces efficiently. Here we are using dynamic dataset to train our model and predict if the person is criminal or not criminal. Once the person is being predicted as the criminal the message will be send to the registered mobile number to notify that the criminal has been found. This proposed model will also increase the accuracy in face detection and recognition using the above-mentioned algorithms. Up till now we are using this model on small places like jeweler shop, ATM machines etc., but in future it can expand to banks, airports, shopping mall and for Law Enforcement agencies. In future we can also expect that face recognition will get better by combining all different ways for identifying people by using their voice, or behavior. By including improved deep learning models, it may help to enhance the accuracy and robustness of our model.

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