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Smart Surveillance and Crime Control Using an AI-Based Model

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Abstract: The human face serves as a crucial characteristic for individual identification, as each person possesses a distinct facial appearance, even among twins. In this study, we have devised a criminal identification system tailored for law enforcement agencies, employing face detection and recognition technology. The implemented system adeptly discerns the countenance of a criminal, subsequently retrieving pertinent information from a comprehensive database. Subsequently, a notification containing detailed information, including the identified criminal's profile and the specific surveillance location, is promptly dispatched to the law enforcement officer.

Keywords: Face detection; Face recognition; Open-CV; Image Processing.

1. Introduction

Criminal activities are one of the most pervasive issues and preventing them without the help of technology is very difficult and time-consuming. Several types of crime can affect an individual's life and mental peace. In response to these issues, a major part of the world is installing CCTV cameras for surveillance. Hence this paper proposes an automatic system to identify criminals by their face, which will help law enforcement agencies to catch criminals in public places.

The system employs Python 3.5, leveraging OpenCV and advanced algorithms like Haar cascade classifier, LBPH, and face recognition. The project's backbone is a secure MySQL database storing images and pertinent details of known criminals. This strategic database ensures swift data retrieval and rapid deployment of results in real-world scenarios, contributing to the proactive tracking of history sheets and early recognition of unlawful activities.

2. Literature Review

In paper [1], the authors propose a system that can identify criminals based on their facial features using deep learning techniques. The system uses a Face-net Algorithm for recognition an Open CV python library for image process and Multi-Task Cascade Neural networks (MTCNN) to extract relevant features from facial images and then match those features against a database of known criminals to determine a match and send a message with location to the police. The paper highlights the potential benefits of using deep learning techniques for criminal identification, including increased accuracy and efficiency. The author also highlighted that to improve the performance of the model, other traits like age and gender could also be considered, rather than solely relying on facial features. This could help to narrow down the search and increase the accuracy of the system in identifying potential criminals. In short, by extending the use of the system beyond the academic realm and considering additional traits for identification, the proposed criminal identification system has the potential to become a valuable tool for law enforcement agencies in identifying and preventing criminal activities in various settings.

The author's in {2}, outlines a sophisticated real-time face detection and recognition system designed for both live webcam feeds and recorded videos. Leveraging the Haar features algorithm, known for its remarkable accuracy surpassing 94%, the system excels in detecting facial features and comparing them against a database of stored images for precise individual recognition. Future enhancements, such as the

planned addition of an eye detection technique, signify the authors' commitment to continual improvement, promising increased biometric accuracy and potential applications in crime prevention and heightened security measures. The system's adaptability and ongoing evolution position it as a robust solution in the realm of facial recognition technologies.

Sanjay et all, present a study comparing the accuracy of two facial recognition algorithms, CNN and HAAR Cascade. The CNN algorithm was found to be more efficient and accurate, with an accuracy rate of 90.30%, compared to HAAR Cascade's 84.50%. The study used statistical analysis and a dataset of facial images collected from Google. The CNN algorithm was developed using Python language and a computer with an AMD Ryzen 5 processor and 8GB of RAM. The study concludes that the CNN algorithm can be implemented for further development in criminal face detection systems {3}.

[4] In this paper, the authors describe a face recognition and identification system developed using deep learning and OpenCV in Python. The system involves face detection and identification using a classifier trained with many images per candidate. The accuracy of the system is affected by factors such as light intensity and the quality of the input images or videos. The proposed system achieved an accuracy of 91.7% in recognizing images and 86.7% in real-time video. The document includes a detailed discussion of the design methodology and experimental results.

[5] In this Paper, the authors developed a system using CCTV footage to identify criminals using a criminal database. The system consists of five stages: planning, requirement analysis, design, implementation and testing, and maintenance. The system uses PCA to identify similar features in images from the database and uses a database containing personal information to display the person's information. The system interface is implemented using Visual Studio Code and MATLAB R2013b, achieving 80% accuracy.

[6] This document describes a criminal face detection system using Python. The system uses automatic face recognition to identify suspects, which can be helpful when fingerprint identification is not possible. The document discusses various approaches to face recognition, including neural networks, template matching, and geometrical feature matching. The authors achieved an 80% match rate with their proposed system. The document concludes by suggesting that face recognition is a challenging problem in the field of computer vision, but it has many potential applications in various fields.

[7] This document discusses the challenges of face recognition in criminal investigations and proposes a solution that stores images of criminals segmented into four slices (forehead, eyes, nose, and lips) for easier identification. The document also provides an overview of current research and techniques in face recognition, including feature-based and holistic approaches, and the Viola-Jones face detector. The authors suggest that future work could improve the system's accuracy and robustness through the development of a more extensive feature set and a less error-prone face detection algorithm.

[8] In this paper, the authors propose the implementation of a real-time criminal face identification system, emphasizing its potential in assisting law enforcement to curb crime rates. They suggest that future enhancements in face recognition techniques could further optimize results. Additionally, they recommend the establishment of a secure login page to facilitate remote access for any police personnel. The developed application is designed to be simple and user-friendly. Furthermore, the system should be equipped to generate alert messages to nearby police stations when a criminal is identified in a specific zone. This application offers multifaceted benefits, aiding law enforcement in various ways. The continual advancement in security technology, coupled with widespread camera installations in public areas, will enable police personnel to efficiently monitor, track, and apprehend criminals through the utilization of this application from centralized control rooms.

[9] In this paper, the author explores the challenges of face detection and recognition systems. Emphasizing the significance of effective face detection as a precursor to recognition, the authors propose a hybrid algorithm integrating a skin color model for face detection and a fuzzy neural network for recognition. The paper reviews related work, citing examples of various algorithms and methods employed by researchers in the domain. The proposed hybrid algorithm is outlined in the experimental design, encompassing steps such as skin color model application, Zernike Moments for feature extraction, fuzzy set pre-processing, and artificial neural network-based face recognition. The authors conclude by noting the implementation of the algorithm in MATLAB and suggest future work to assess its performance. The research contributes to advancements in face processing systems, aiming for heightened accuracy, and reduced false positives in face recognition applications.

[10] The research presented in this paper focuses on the development of a Criminal Face Detection System using Python. The authors, Shiva Tamrkar and Ayush Gupta from the Department of Computer Science and Engineering at Galgotias University, address the limitations of traditional criminal identification methods such as fingerprinting by proposing an automatic face recognition system. They leverage Principal Component Analysis for face recognition and emphasize the importance of CCTV footage in identifying suspects. The proposed system aims to aid law enforcement in cases where fingerprints are not available, potentially enhancing criminal identification. The authors discuss the methodology involving preprocessing, face detection using the Viola-Jones algorithm, and feature extraction with Haar-cascade. The paper also explores different face recognition techniques, including neural networks, template matching, and geometrical feature matching. The research concludes with the authors achieving an 80% match rate using the proposed system and highlights its potential significance in criminal investigations.

[11] In this paper, the authors address the limitations of traditional criminal identification methods such as fingerprinting by proposing an automatic face recognition system. They leverage Principal Component Analysis for face recognition and emphasize the importance of CCTV footage in identifying suspects. The proposed system aims to aid law enforcement in cases where fingerprints are not available, potentially enhancing criminal identification. The authors discuss the methodology involving preprocessing, face detection using the Viola-Jones algorithm, and feature extraction with Haar-cascade. The paper also explores different face recognition techniques, including neural networks, template matching, and geometrical feature matching. The research concludes with the authors achieving an 80% match rate using the proposed system and highlights its potential significance in criminal investigations.

[12] In this paper, the author addresses the rising concerns of crime rates and security challenges by leveraging machine learning algorithms. The system utilizes Haar Cascade algorithm for face detection, and Local Binary Patterns Histograms (LBPH) for face recognition. The proposed technology aims to identify offenders in real-time through CCTV footage, sending notifications to law enforcement. The study compares various face recognition approaches, emphasizing the importance of accuracy and reaction times. The authors discuss the limitations and benefits of their system, providing a comprehensive solution for criminal identification through facial recognition in surveillance scenarios.

3. Methodology

3.1. Modules/ Techniques

The modules for this system are as follows.

3.1.1. Open-CV surveillance

We incorporated OpenCV (Open-Source Computer Vision Library) in our project. OpenCV is an open-source computer vision and machine learning library, offering an extensive suite of tools for image and video processing. Its functionalities span diverse applications such as facial detection, photo editing, advanced robotic vision, security analysis, stereo vision (3D vision), and more. This versatile library supports multiple programming languages, including C++, Python, Java, and Matlab interfaces. Additionally, it is compatible with various operating systems, namely Windows, Linux, Android, and Mac OS.

OpenCV proves instrumental in performing a wide array of tasks, ranging from object recognition and feature extraction to motion analysis and seamless integration with machine learning. Notably, it places a strong emphasis on real-time applications, enhancing the efficiency and effectiveness of vision-related projects.

3.1.2. Face detection

We utilized OpenCV, incorporating a Haar cascade classifier for face detection. This classifier leverages the AdaBoost algorithm to identify various facial features. The process begins by reading the target image and converting it into a grayscale image. Subsequently, the Haar cascade classifier is loaded to determine the presence of a human face. Upon confirmation, the system proceeds to scrutinize the facial features and outlines the detected face with a rectangular frame. In cases where no face is detected, the system moves on to analyze the next image.

3.1.3. Face Recognition

The Face Recognition component employs Local Binary Pattern Histograms (LBPH) to accentuate the extraction of local features from images. Unlike considering the entire image as a high-dimensional vector, LBPH focuses solely on describing the local characteristics of an object. This methodology employs the

Local Binary Patterns (LBP) operator, summarizing the local structure in an image by comparing each pixel with its neighborhood. Notably, the LBP operator demonstrates robustness against monotonic grayscale transformations.

We utilized OpenCV, which incorporates a Haar cascade classifier for face detection. The Haar cascade classifier utilizes the Ada Boost algorithm to identify multiple facial features. Initially, it reads the image to be detected and converts it into a grayscale image, subsequently loading the Haar cascade classifier to determine the presence of a human face. If confirmed, the system proceeds to analyze the facial features and delineate the detected face with a rectangular frame. In cases where no face is detected, the system advances to assess the next image.

3.1.4. LBPH

LBPH focuses on extracting local features from images. The idea is to not look at the whole image as a high-dimensional vector but to describe only the local features of an object. The basic idea of Local Binary Patterns is to summarize the local structure in an image by comparing each pixel with its neighborhood. LBP operator is robust against monotonic grayscale transformations.

Local Binary Pattern (LBP) histogram is a popular texture descriptor used in image processing and computer vision. It encodes the local structure of an image by comparing the intensity of each pixel with its surrounding neighbors.

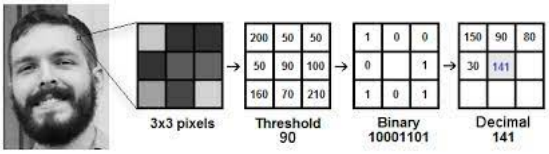

Figure 1. Facial mapping on a captured image.

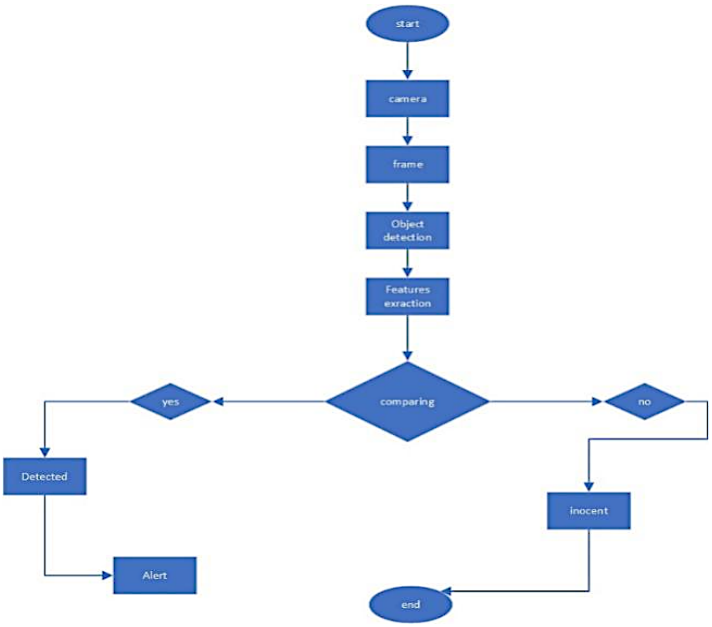

Figure 2. Facial mapping Flow chart

3.2. Implemantation

The System is implemented by extracting the face from video and images and comparing them with images from the database. If the criminal is identified, the system will show a detailed record of the criminal. Once trained, the system compares these features with the records in the database to see if there are any matches. If it finds a match or a possible match, it sends an alert so, then their SIM and Bank account will be blocked by the authorities. The whole process is designed to be easy for police officers to use.

4. Experimental Results

In the proposed system we can register a criminal's record in a database which we can fetch while detecting a criminal through face recognition.

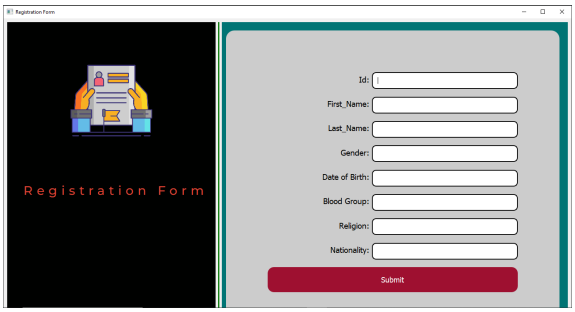

Figure 3. Criminal Registration

This proposed system compares CCTV camera images and database images to detect whether a criminal is found or not.

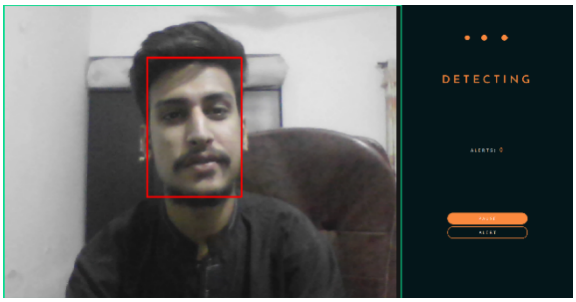

Figure 4. Criminal Identification.

In fig 3, the system detects whether a criminal is found or not. When the criminal is detected, it will give an alert message shown in fig 4.

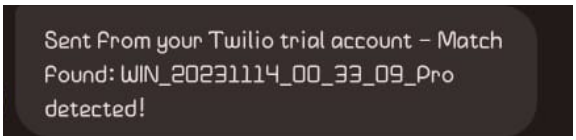

Figure 5. Alert on detecting a criminal.

5. Conclusions and Future Work

We successfully implemented real-time face detection and recognition for identifying criminals in both images and video streams captured by a camera. Our approach involves the utilization of Haar feature-based cascade classifiers in OpenCV for face detection. This method employs machine learning, training a cascade function with a substantial dataset of positive and negative images. Additionally, we incorporated Local Binary Patterns Histograms (LBPH) for face recognition.

The project represents a significant milestone in the realm of video-based face identification and surveillance systems. As part of potential future enhancements, we suggest exploring light normalization to potentially optimize the threshold value. Further improvements in face recognition can be achieved by considering specific facial features, such as the distance between the eyes. Additionally, a promising avenue for future work involves analyzing faces in 3D using multiple cameras. Combining these approaches is anticipated to reduce the probability of errors and enhance the overall accuracy of the system.

References

1. D.Nagamallika1,P.Vandana2, P.Dakshayani3 , R.Aravinda Manikanta4 , K.Kranthi Kumar5," CRIMINAL IDENTIFICATION System Using Deep Learning " International Journal of Emerging Technologies and Innovative Research (www.jetir.org UGC and issn Approved), ISSN:2349-5162, Vol.8, Issue 7, page no. ppb707-b711 (2021).
2. Md. Mohibullah, Chowdhury Shahriar Muzammel , Khalil Ahammad , MD. Sakhawat Hosen , MD. Rakibul Islam " Face Detection and Recognition from Real Time Video or Recoded Video using Haar Features with Viola Jones Algorithm and Eigenface Approach with PCA" (2022).
3. T. Sanjay1 ,W.Deva Priya2 "Criminal Identification System to Improve Accuracy of Face Recognition using Innovative CNN in Comparison with HAAR Cascade"
4. KH Teoh2, RC Ismail1,2, SZM Naziri2, R Hussin2, MNM Isa2 and MSSM Basir3 " Face Recognition and Identification using Deep Learning Approach"(2020).
5. Nurul Azma Abdullah, Md. Jamri Saidi, Nurul Hidayah Ab Rahman, Chuah Chai Wen, and Isredza.
6. Rahmi A. Hamid's "Face Recognition For Criminal Identification: An Implementation Of Principal Component Analysis For Face Recognition", Aip Conference Proceedings 1891, 020002 (2017); Https://Doi.Org/10.1063/1.5005335.
7. Alireza Chevelwalla[1] , Ajay Gurav[2] , Sachin Desai[3] , Prof. Sumitra Sadhukhan[4 " Criminal Fae Recognition System" International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Vol. 4 Issue 03, (2015)
8. Mr.R.Prashanth Kumar 1 Abdul Majeed 2 Farhan Pasha2A Sujith2 " Real-Time Criminal Identification System Based On Face Recognition".
9. Ravinder Pal Singh1 , Daljit Kaur2 " Face Detection Using Skin Colour Model and Face Recognition Using ANN ". IJCSMC, Vol. 4, Issue. 9, September 2015, pg.237 – 241 (2015).
10. Shiva Tamrkar1 , Ayush Gupta2 " Criminal Face Detection System Using Python ". © July 2020| IJIRT | Volume 7 Issue 2 | ISSN: 2349-6002 (2020).
11. Vishwanath D. Chavan1 , Anil A Bharate " A Review Paper on Face Detection and Recognition in Video " . INTERNATIONAL Journal Of Innovative Research In Electrical, Electronics, Instrumentation And Control Engineering. Vol. 4, Issue 1, January 2016
12. Prof. R. A. Nikam, Varankar Vrushali, Pawar Shubham, Mali Prayag, Jadhao Rucha "Automatic Face Recognition and Detection For Criminal Identification Using Machine Learning" . Vol-9 Issue-2 (2023).