IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

Online Criminal Detection System from Image Sketches using Machine Learning

Prof. (Dr.) Pranjali Deshmukh, Dipti Dhole, Prajwal Hattewar, Prachi Ambadkar, Vedant Lekurwale

Professor, Student, Student, Student, Student
Department of Information Technology,
Prof. Ram Meghe Institute of Research and Technology, Amravati, India

Abstract: Online Criminal Detection System from Image Sketches using Machine Learning aimed at decreasing crime rate by recognizing criminals from their image sketches and displaying relevant criminal details to the user.

This research paper proposes an automated system for online criminal detection from image sketches, leveraging machine learning technique. Subsequently, the paper delves into the introduction of the proposed system, proposed methodology, modules of the system, implementation where dataset will be generated.

Furthermore, the paper elucidates the library and machine learning algorithm i.e., OpenCV and CNN. It also discusses the image to sketch conversion using OpenCV, approaches, modules including admin panel, police admin, dataset generation, criminal detection and recognition.

The proposed system utilizes convolutional neural networks for feature extraction and classification, trained on a dataset of image sketches.

This research contributes to the advancement of criminal detection system, offering a valuable system for improving public system and security in the digital age.

Index Terms **- Component, formatting, style, styling, insert.**

INTRODUCTION

The advent of the digital age has ushered in both unprecedented connectivity and new avenues for criminal activity. Traditional methods of law enforcement often face challenges in keeping pace with the evolving nature of crime, particularly in the realm of identifying suspects from limited information such as image sketches.

However, recent advancements in machine learning and computer vision offer promising solutions to address these challenges. This research paper delves into the innovative application of machine learning algorithms for online criminal detection from image sketches. By harnessing the power of artificial intelligence, this study aims at revolutionize the process of identifying potential suspects from visual representations, thereby enhancing the efficiency of law enforcement efforts.

The significance of this research cannot be overstated. In an era where digital footprints leave traces across various platforms, the ability to rapidly and accurately identify individuals from sketches holds immense potential for preventing and solving crimes. Moreover, by leveraging machine learning algorithms, which excel at pattern recognition and analysis, this approach offers a scalable and efficient solution to a pressing societal need.

The scope of this paper encompasses a comprehensive exploration of the methodology, including data preprocessing, feature extraction, and the implementation of various machine learning models.

In summary, this research paper represents a significant contribution to the field of law enforcement and public safety. By marrying cutting-edge technology with the imperative of safeguarding communities, we strive to pave the way for a more secure and just society. Through collaboration and continued innovation, we can harness the potential of machine learning to combat crime and uphold the principles of justice and equity.

A. Literature survey –

The Literature review states various methods proposed for recognizing and matching face using sketches, particularly in criminal identification scenarios. This project is used to detect criminal immediately after crime. To recognize criminal from sketch which

is prepared by the criminal detection using image an online web application for police which will very helpful for police to find out the criminal details very fast.

Xiaoou Tang and Xiaogang Wang introduced a method base on a multiscale Markov random field model. This project could combine the given sketch that is generated by the given image and then search into the database and recognize the suitable match. The model generates the different type of sketch from the given image and divides the sketch of the face into patches to improve the overall performance of the recognition. The model by first synthesizing the available photos convert multiple sketches [15].

Anil K. Jain and Brendan Clare introduced a system that utilizes SIFT descriptors to compare face pictures with sketches stored in a database. The approach involves transforming the face picture using a linear transformation method suggested by Tang and Wang. Then, the system calculates the distance between the transformed face picture and the SIFT descriptor of the sketch. They enhance accuracy and it measures the distance between images stored in the database when necessary. This method helps in effectively matching face pictures with corresponding sketches in the database.[16]

P.C. Yuen and C.H. Man developed a method to identify individuals person's face using sketches which involved converting the sketch into a photograph and then comparing it to known face using face matching algorithm. Sometimes faced challenges when attempting to match faces in databases like FERET and the Japanese database, especially when the orientations of the faces is differed. A common issue with all proposed algorithms was their preference for matching front facing sketches and photographs. When faces were oriented differently, the matching accuracy decreased. There are some systems typically aimed to synthetic facial, but they often became overly complex. This system typically involved selecting facial features from photographs based on the eyewitness descriptions and then combining them into a human face. However, this method proved unreliable as each facial feature was sourced from different faces, making the result composite difficult to recognize. Matching the face of criminal using such an algorithm was challenging due to these limitations [17].

Akash Sahu, Jyoti Sah and others proposed a system that is a standalone application enabling users to create precise composite face sketches. This application providing predefined facial features as tools. Which users can adjust in sized and position according to their needs or as described by an eyewitness. Additionally, the created composite face sketch can be compared with databases of law enforcement departments using deep learning and the fast and effective cloud infrastructure to recognize and confirm the identity of criminal [18].

Andre Teixeira Lopes, Edilsonde Augier and others introduced a novel approach called "Deep Comprehensive Multi-Patches Aggregation Convolutional Neural Networks (DCMACNNs)" to address Facial Expression Recognition (FER) challenges. The proposed technique is a profound based system, this method involves deep learning framework consisting mainly of two branches of Convolutional Neural Networks (CNNs). One branch focuses on extracting local features from patches of facial images, while the other branch captures global features from the entire facial expression image. In this model, local features represent facial expressions, while global features capture high level semantic information. Our model can speak to articulations all the more completely.

Also, in the preparation organize, a novel pooling methodology named Expressional Transformation-invariant pooling (ETI-pooling) to handle variations such as rotations and changes in illumination. They conducted experiments like extensive using popular datasets like "CK+" and "JAFFE expression datasets," demonstrating that their model outperforms most existing FER techniques in terms of recognition accuracy [12].

A. T. Lopes, E. de Aguiar proposed a novel approach called Part-based Hierarchical Bidirectional Recurrent Neural Network (PHRNN) aimed at analyzing transient facial expressions. Their model, utilizing PHRNN, focuses on capturing facial morphological variations and the dynamic evolution of expressions by extracting transient features based on facial landmarks (geometric data) across consecutive frames. Additionally, to complement this analysis with still appearance data, they propose a Multi-Signal Convolutional Neural Network (MSCNN) to extract spatial features from static frames.

The authors utilize recognition and verification signals as supervision to compute different loss functions, aiming to enhance the variety of expressions and reduce differences among similar expressions. By combining PHRNN and MSCNN into a deep Evolutional Spatial Temporal Network, they effectively enhance facial expression recognition performance. Experimental results demonstrate significant improvements over state-of-the-art methods. On three widely used facial expression databases, their proposed method reduces error rates by 45.5%, 25.8%, and 24.4%, respectively, compared to previous top-performing approaches [11] [14] [11]

PROBLEM STATEMENT AND PROPOSED METHODOLOGY

In this paper, we proposed online criminal detection system from sketches using machine learning algorithm. Project administrator of the website will register city wise police stations and create login for police station administrator. The userid and password will be sent to the police administrator's registered email id, with the help of that userid and password police admin will log in into the system. Police admin will register new criminals with their photos. Criminal photos will be converted to sketches and the sketch images will be stored on server in thumbnail format.

When any crime occurs, police admin will upload sketch image and our model will detect matching criminal with details using CNN algorithm.

The below Fig.1 shows an outline of the proposed methodology.

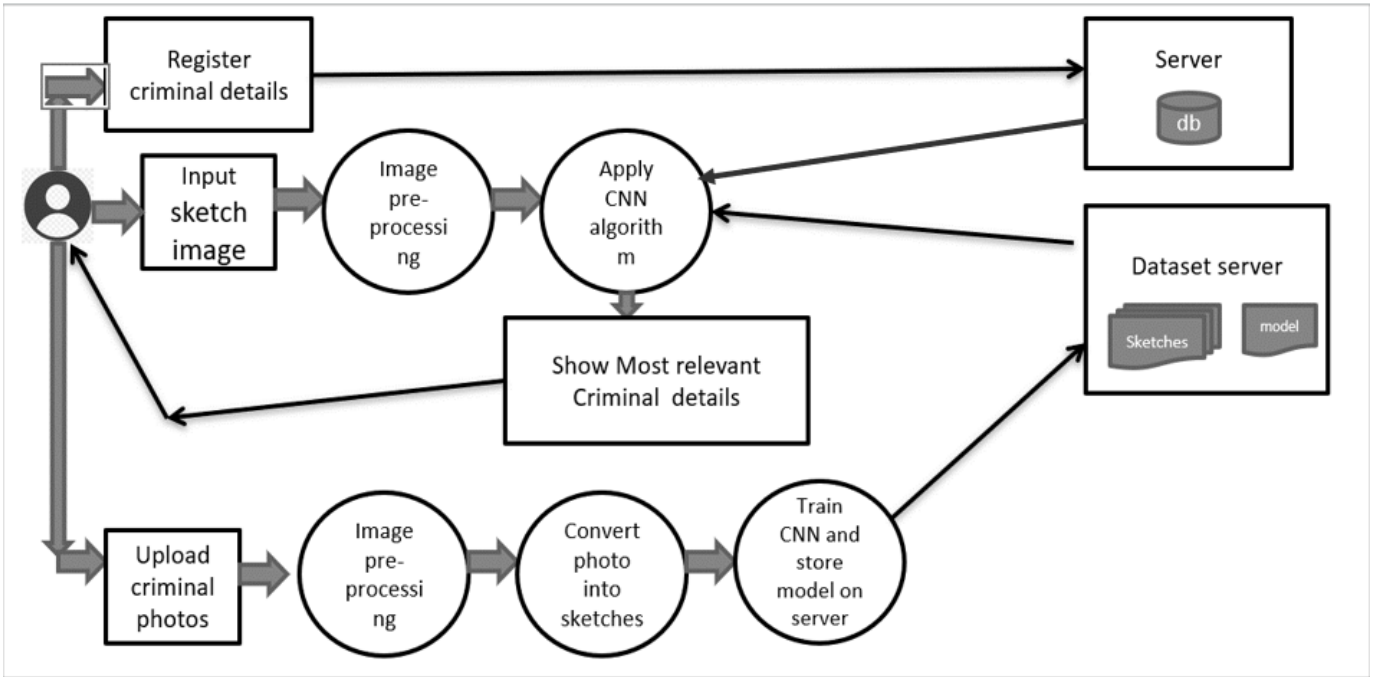

Fig 1. Working diagram

A. OpenCV

OpenCV is the huge open-source library for the computer vision, machine learning, and image processing and now it plays a major role in real-time operation which is very important in today's systems. By using it, one can process images and videos to identify objects, faces, or even handwriting of a human. When it integrated with various libraries, such as NumPy, python is capable of processing the OpenCV array structure for analysis. To Identify image pattern and its various features we use vector space and perform mathematical operations on these features.

The first OpenCV version was 1.0. OpenCV is released under a BSD license and hence it's free for both **academic** and **commercial** use. It has C++, C, Python and Java interfaces and supports Windows, Linux, Mac OS, iOS and Android. When OpenCV was designed the main focus was real-time applications for computational efficiency. All things are written in optimized C/C++ to take advantage of multi-core processing.

B. Image-Processing

Image processing is a method to perform some operations on an image, in order to get an enhanced image and or to extract some useful information from it. If we talk about the basic definition of image processing then **"Image processing is the analysis and manipulation of a digitized image, especially in order to improve its quality".**

C. Digital-Image:

An image may be defined as a two-dimensional function f (x, y), where x and y are spatial(plane) coordinates, and the amplitude of fat any pair of coordinates (x, y) is called the intensity or grey level of the image at that point. In another word an image is nothing more than a two-dimensional matrix (3-D in case of coloured images) which is defined by the mathematical function f (x, y) at any point is giving the pixel value at that point of an image, the pixel value describes how bright that pixel is, and what colour it should be. Image processing is basically signal processing in which input is an image and output is image or characteristics according to requirement associated with that image.

Image processing basically includes the following three steps:

1. Importing the image
2. Analyzing and manipulating the image
3. Output in which result can be altered image or report that is based on image analysis.

D. Image to Sketch Conversion using OpenCV:

Python language and OpenCV module have been introduced first. Further, the need for image processing, its methods and techniques have been described. After that, the decisive act regarding this project is that we are relating with a small amount of info

for ML and use up rare ciphering ability to act as image transition is fairly small. Some functions having general algorithms and approaches to accomplish the finest precision on image conversion have been incorporated. An image is to be converted to a pencil sketch.

OpenCV module plays an important role in identifying the details and scales of an image, so OpenCV library is used in order to achieve objectives successfully. Conversion of image to pencil sketch involves various steps like importing the libraries, loading the image, conversion in to a gray scale image, inversion, smoothening, and obtaining the final sketch. The result shows that it's an effective method to show a more realistic pencil sketch as compared with the recent base methods. Proposed approach shows impressive/good results in synthesizing realistic texture, and maintaining the geometric composition for various categories of open-domain sketches/drawings. The noise removal has been done by employing low pass filter. Further proposed approach requires less memory/space and is less time consuming in comparison to existing approaches.

In Python, an image is just a two-dimensional array of integers. So, one can do a couple of matrix manipulations using various python modules in order to get some very interesting effects. In order to convert the normal image to a sketch, we will change its original RGB values and assign its RGB values similar to grey, in this way a sketch of the input image will be generated.

Approach 1:

- Import all required modules (*numpy*, *imageio*, *scipy.ndimage*, *OpenCV*)
- Take Image input
- Check RGB value of image and convert into according to RGB values
- Show finale image output using *cv2.imwrite()*

Approach 2:

Import cv2:
Then we will import cv2 inside our code, after that, we will use some of the following functions:

1. **imread ()-** This function will load the image i.e., in the specified folder.

2. **cvtColor ()-** This function takes color as an argument and then changes the source image color into that color.

3. **bitwise_not ()-** This function will help the image to keep the properties as same by providing the masking to it.

4. **GaussianBlur ()-** This function is used to modify the image by sharpening the edges of the image, smoothen the image, and will minimize the blurring property.

5. **divide ()-** This function is used for the normalization of the image as it doesn't lose its previous properties. Finally, will save the image using **imwrite ()** function.

Original Images

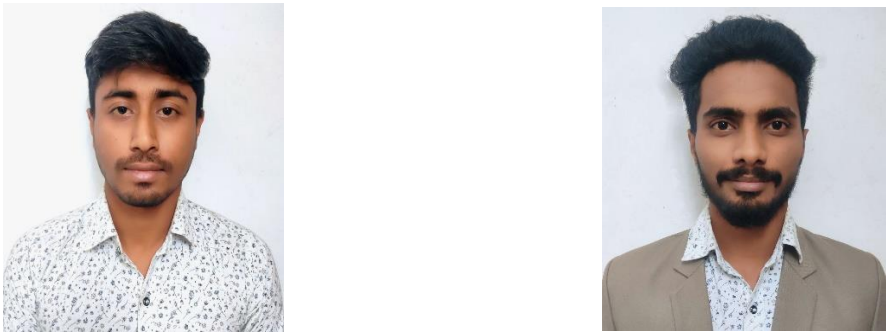

Fig 2. Original Images

Sketches

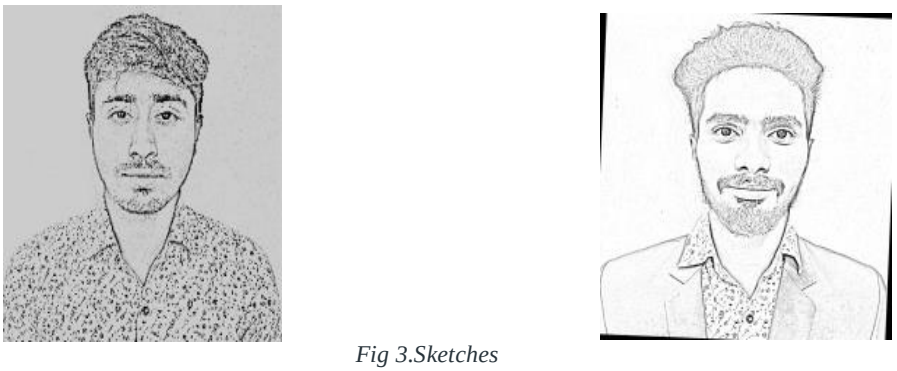

Fig 3.Sketches

Fig 4. Sketches

Fig 5. Sketches

E. CNN (Convolutional Neural Network)

CNN uses filters on the pixels of any image to learn detailed patterns compared to global patterns with a traditional neural network. To create CNN, we have to define:

A convolutional Layer: Apply the number of filters to the feature map. After convolution, we need to use a relay activation function to add non-linearity to the network.

Pooling Layer: The next step after the Convention is to down sampling the maximum facility. The objective is to reduce the mobility of the feature map to prevent overfitting and improve the computation speed. Max pooling is a traditional technique, which splits feature maps into subfields and only holds maximum values.

Fully connected Layers: All neurons from the past layers are associated with the other next layers. The CNN has classified the label according to the features from convolutional layers and reduced with any pooling layer.

F. Modules to use in creating a CNN:

Conv2d (): Construct a two-dimensional convolutional layer with the number of filters, filter kernel size, padding, and activation function like arguments.

max_pooling2d (): Construct a two-dimensional pooling layer using the max-pooling algorithm.

Dense (): Construct a dense layer with the hidden layers and units

G. Modules

Following are the modules in our system:

- **Admin panel**
  Admin can log in with the help of username and password, it can register city wise police station, create police admin login, admin can view police stations and train dataset.

- **Police admin**
  Police admin gets log in with their credentials. It can register criminal details, view criminal details and upload sketch to search criminal.

- **Dataset generation**
  In this criminal photo is uploaded, photo gets converted into sketch, sketch into thumbnail image, stores thumbnail images on the server and training gets done with the help of CNN algorithm.

- **Criminal detection**
  Upload sketch image then convert image into thumbnail image. Apply CNN and view matching criminal details.

IMPLEMENTATION

A. DataSet Generation

- **Image Acquisition**
  Police administrator will upload criminal photos. The photos can be of any format and any size. Upload image will be sent to python server for further processing

- **Image Preprocessing**
  Uploaded images will be preprocessed by using OpenCV. Preprocessing includes following steps
  - Convert input image into sketch using OpenCV
  - Convert sketch image into thumbnail image

- **Train Dataset**
  After dataset collection, the dataset will be trained using CNN algorithm and trained model will be stored on python server for prediction.

B. Sketch Recognition

- **Upload Input image**
  Police admin will upload sketch image prepared by sketch artist.

- **Image preprocessing**
  Uploaded image will be preprocessed and converted into thumbnail image

- **Recognition**
  Preprocessed image will be sent to recognition model and the model will recognize the matching criminal if any and show the details to the police.

CONCLUSION

In conclusion, the development of an online criminal detection system utilizing image sketches through machine learning represents a significant advancement in the field of law enforcement and public safety. The implementation of machine learning techniques, such as convolutional neural networks (CNNs) has facilitated the automatic recognition and classification of facial features depicted in sketches, enabling the system to match them with existing databases of known individuals. Moreover, the integration of online capabilities allows for real-time analysis and comparison, enhancing the responsiveness and effectiveness of law enforcement agencies in apprehending suspects and preventing further criminal activity.

References-

[1] H. Li, K. Ota, and M. Dong, "Learning IoT in edge: Deep learning for the Internet of Things with edge computing," IEEE Netw., vol. 32, no. 1, pp. 96_101, Jan./Feb. 2018.

[2] W. Shi, J. Cao, Q. Zhang, Y. Li, and L. Xu, "Edge computing: Vision and challenges," IEEE Internet Things J., vol. 3, no. 5, pp. 637_646, Oct. 2016.

[3] G. B. Huang, M. Mattar, T. Berg, and E. Learned Miller, "Labeled faces in the wild: A database forstudying face recognition in unconstrained environments," in Proc. Workshop Faces `Real-Life' Images, Detection, Alignment, Recognit., Oct. 2008, pp. 1_11.

[4] R. G. Cinbis, J. J. Verbeek, and C. Schmid, "Unsupervised metric learning for face identi_cation in TV video," in Proc. ICCV, Nov. 2011, pp. 1559_1566.

[5] C. Lu and X. Tang, "Surpassing human-level face veri_cation performance on LFW with gaussianface," in Proc. AAAI, 2015, pp. 2307_2319.

[6] T.M. Nithya, J. Ramya and L. Amudha, (2019) "Scope Prediction Utilizing Support Vector Machine for Career Opportunities", International Journal of Engineering and Advanced Technology, Volume-8 Issue-5, June 2019.

[7] R. Sasikumar, B. Kiran Bala, "Identification of Cancer from the Mammogram Images by using Frequency Domain Approaches", International Journal of Chem. Tech Research, Vol.10, No.5, 2017, PP 615-618.

[8] R. Sasikumar, R. Ramesh, R. Meena, "Deep learning for Informatics using Fuzzy Logic", International Journal of Innovative Research in Science, Engineering and Technology, Vol.8, Issue.6, June 2019, pp 7376-7382.

[9] B. K. Bala and I. I. Raj, "Comparative and identification of exact frequency domain approaches by using mammogram images," 2017 IEEE International Conference on Power, Control, Signals and Instrumentation Engineering (ICPCSI), Chennai, 2017, pp. 2536-2538.

[10] B. Kiran Bala, "Enhanced palm vein recognition algorithm with equalizer Technique", 2019, International Journal of Engineering and Advanced Technology, Vol.8, Issue.5.

[11] Shi, Y., Lv, Z., Bi, N. et al. "An improved SIFT algorithm for robust emotion recognition under various face poses and illuminations." Neural Comput & Applic (2019). https://doi.org/10.1007/s00521-019-04437-w.

[12] Lopes, Andre & Aguiar, Edilson & De Souza, Alberto & Oliveira-Santos, Thiago. (2016). "Facial Expression Recognition with Convolutional Neural Networks: Coping with Few Data and the Training Sample Order. Pattern Recognition." 61. 10.1016/j.patcog.2016.07.026.

[13] Kiran Bala B, Audithan S, Kannan G, Raja, K, "Frequency Domain Approaches for Breast Cancer Diagnosis", Australian Journal of Basic and Applied Sciences, Vol. 10, No. 2, pp. 93-96, 2016.

[14] Kiran Bala B, Balakumar A, „The Combination of Steganography and Cryptography for Medical Image Applications", Biomedical and Pharmacology Journal, Volume 10, Issue 4, Year 2017.

[15] W. Zhang, X. Wang and X. Tang, "Coupled information-theoretic encoding for face photo-sketch recognition," CVPR 2011, 2011, pp. 513-520, doi: 10.1109/CVPR.2011.5995324. MathWorks "what is deep learning" [2022] (online). Available: https://www.mathworks.com/discovery/deep-learning.html

[16] Klare, Brendan, and Anil K. Jain. "Sketch-to-photo matching: a feature-based approach." Biometric technology for human identification VII. Vol. 7667. International Society for Optics and Photonics, 2010.

[17] P. C. Yuen and C. H. Man, "Human Face Image Searching System Using Sketches," in IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans, vol. 37, no. 4, pp. 493-504, July 2007, doi: 10.1109/TSMCA.2007.897588.

[18] Patil, Abhijit, et al. "Forensic Face Sketch Construction and Recognition." International Journal of Information Technology (IJIT) 6.4 (2020).