Face Recognition Using ANN

- ## Introduction and Overview:

Face recognition is the process of taking a face in an image and identifying who the face belongs to. Face recognition is thus a form of person identification.

Project idea and overview:

1. Data Collection and Preprocessing:

Dataset Acquisition: Gather a dataset containing images of individuals' faces. Ensure diversity in poses, expressions, lighting conditions, and backgrounds.

Face Detection and Alignment: Use face detection algorithms to detect and align faces within images consistently. Crop or resize images to focus on the face region.

Normalization: Normalize images for consistent lighting, contrast, and color to reduce variations that aren't related to facial features.

2. Feature Extraction:

Feature Representation: Extract features that represent facial characteristics robustly. Techniques like Histogram of Oriented Gradients (HOG.

3. Model Training: Using Neural Network.

input Layer: The input layer should match the dimensions of your facial images after preprocessing.

Hidden Layers: Experiment with various architectures. Common choices include convolutional layers followed by dense layers.

Output Layer: The output layer's dimensionality depends on the desired embedding size. This layer should output a compact representation of facial features.

4. Face Recognition:

Recognition or Verification: Use the trained model to recognize or verify faces. This involves comparing the encoded features of a new face against a database of known faces.

Applications that like Face Recognition:

1. Facial Unlock and Authentication:

Functionality: Enabling users to unlock their mobile devices or access secured apps using facial recognition as a biometric authentication method.

How It Works: The app uses the front-facing camera to capture the user's face.

Facial features are extracted and transformed into a unique facial template or embedding.

The template is compared with the stored template on the device for authentication purposes.

- A Literature Review of Academic publications:

- **Face recognition: A literature survey**
  As one of the most successful applications of image analysis and understanding, face recognition has recently received significant attention, especially during the past several years. At least two reasons account for this trend: the first is the wide range of commercial and law enforcement applications, and the second is the availability of feasible technologies after 30 years of research. Even though current machine recognition systems have reached a certain level of maturity, their success is limited by the conditions imposed by many real applications. For example, recognition of face images acquired in an outdoor environment with changes in illumination and/or pose remains a largely unsolved problem. In other words, current systems are still far away from the capability of the human perception system. This paper provides an up-to-date critical survey of still- and video-based face recognition research. There are two underlying motivations for us to write this survey paper: the first is to provide an up-to-date review of the existing literature, and the second is to offer some insights into the studies of machine recognition of faces. To provide a comprehensive survey, we not only categorize existing recognition techniques but also present detailed descriptions of representative methods within each category. In addition, relevant topics such as psychophysical studies, system evaluation, and issues of illumination and pose variation are covered.
  Reference
  1.Adini, Y., Moses, Y., and Ullman, S. 1997. Face recognition: The problem of compensating for changes in illumination direction. IEEE Trans. Patt. Anal. Mach. Intell. 19, 721--732.]] Google Scholar Digital Library 1.Akamatsu, S., Sasaki, T., Fukamachi, H., Masui, N., and Suenaga, enaga, Y. 1992. An accurate and robust face identification scheme. In Proceedings, International Conference on Pattern Recognition. 217--220.]]Google Scholar 2.Atick, J., Griffin, P., and Redlich, N. 1996. S

Handbook of Face Recognition: Stan Z. Li Anil K. Jain

FACE RECOGNITION IS ONE OF THE MOST IMPORTANT ABILITIES THAT WE USE IN OUR DAILY LIVES THERE ARE SEVERAL REASONS FOR THE GROWING INTEREST IN AUTOMATED FACE RECOGNITION, INCLUDING RISING CONCERNS FOR PUBLISECURITY,

THE NEED FOR IDENTITY VERIFIFICATION FOR PHYSICAL AND LOGICAL ACCESS, AND THE NEED FOR FACE ANALYSIS AND MODELING TECHNIQUES
IN MULTIMEDIA DATA MANAGEMENT AND DIGITAL ENTERTAINMENT, RESEARCH IN AUTOMATIC
FACE RECOGNITION STARTED IN THE 1960S. RECENT YEARS HAVE SEEN SIGNIFIFICANT PROGRESS
IN THIS AREA AND A NUMBER OF FACE RECOGNITION AND MODELING SYSTEMS HAVE BEEN DE
VEOPED AND DEPLOYED. HOWEVER, ACCURATE AND ROBUST FACE RECOGNITION STILL OFFERS A
NUMBER OF CHALLENGES TO COMPUTER VISION AND PATTERN RECOGNITION RESEARCHERS, ESPE
CIALLY UNDER UNCONSTRAINED ENVIRONMENTS. THIS BOOK IS WRITTEN WITH TWO PRIMARY MOTIVATIONS. THE FIFIRST IS TO COMPILE MAJOR APPROACHES, ALGORITHMS, AND TECHNOLOGIES AVAILABLE FOR AUTOMATED FACE RECOGNITION. The second is to provide a reference book to students, researchers, and practitioners. The book is intended for anyone who plans to work in face recognition or who wants to become familiar with the state-of-the-art in face recognition. It also provides references for scientists and engineers working in image processing, computer vision, biometrics and security, computer graphics, animation, and the
computer game industry.

THE MATERIAL CONTAINED IN THE BOOK FIFITS THE FOLLOWING CATEGORIES: ADVANCED TUTORIAL, STATE-OF-THE-ART SURVEY, AND A GUIDE TO CURRENT TECHNOLOGY. THIS SECOND EDITION CONSISTS OF TWENTY-SEVEN CHAPTERS, WITH ADDITIONS AND UPDATES FROM THE SIXTEEN CHAPTERS IN THE FIFIRST EDITION. IT COVERS ALL THE SUBAREAS AND MAJOR COMPONENTS NECESSARY FOR DEVELOPING FACE RECOGNITION ALGORITHMS, DESIGNING OPERATIONAL SYSTEMS, AND ADDRESSING RELATED ISSUES IN LARGE SCALE APPLICATIONS. EACH CHAPTER FOCUSES ON A SPECIFIFIC TOPIC OR SYSTEM COMPONENT, INTRODUCES BACKGROUND IN FORMATION, REVIEWS UP-TO-DATE TECHNIQUES, PRESENTS RESULTS, AND POINTS OUT CHALLENGES

Reference: Face recognition using Laplacian faces (ieee.org)

Facial Recognition for medical purposes

Diseases not only manifest as internal structural and functional abnormalities, but also have facial characteristics and appearance deformities. Specific facial phenotypes are potential diagnostic markers, especially for endocrine and metabolic syndromes, genetic disorders, facial

neuromuscular diseases, etc. The technology of facial recognition (FR) has been developed for more than a half century, but research in automated identification applied in clinical medicine has exploded only in the last decade. Artificial-intelligence-based FR has been found to have superior performance in diagnosis of diseases. This interdisciplinary field is promising for the optimization of the screening and diagnosis process and assisting in clinical evaluation and decision-making. However, only a few instances have been translated to practical use, and there is need of an overview for integration and future perspectives. This review mainly focuses on the leading edge of technology and applications in varieties of disease and discusses implications for further exploration. Contain sinners Unless you need to edit, it's safer to stay in Protected Vies Search Enable Editing

Facial Recognition for medical purposes

Reference:

1.Kaur, P.; Krishan, K.; Sharma, S.K.; Kanchan, T. Facial-Recognition Algorithms: A Literature Review. Med. Sci. Law 2020, 60, 131-139. [Google Scholar] [Cross Ref]

2. Fontaine, X.; Achanta, R.; Süsstrunk, S. Face Recognition in Real-World Images. In Proceedings of the 2017 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), New Orleans, LA, USA, 5-9 March 2017; pp. 1482-1486. [Google Scholar] [Cross Ref][Green Version]

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3.Kosilek, R.P.; Frohner, R.; Würtz, R.P.; Berr, C.M.; Schopohl, J.; Reincke, M.; Schneider, H.J. Diagnostic Use of Facial Image Analysis Software in Endocrine and Genetic Disorders: Review, Current Results and Future Perspectives. Eur. J. Endocrinol. 2015, 173, M39-M44. [Google Scholar] [Cross Ref][Green Version]

4.Gurovich, Y.; Hanani, Y.; Bar, O.; Nadav, G.; Fleischer, N.; Gelbman, D.; Basel-Salmon, L.; Krawitz, P.M.; Kamphausen, S.B.; Zenker, M.; et al. Identifying Facial Phenotypes of Genetic Disorders Using Deep Learning. Nat. Med. 2019, 25, 60-64. [Google Scholar] [Cross Ref]

Review on self-supervised image recognition using deep neural networks.

ABSTRACT

DEEP LEARNING HAS BROUGHT SIGNIFICANT DEVELOPMENTS IN IMAGE UNDERSTANDING TASKS SUCH AS OBJECT DETECTION, IMAGE CLASSIFICATION, AND IMAGE SEGMENTATION. BUT THE SUCCESS OF IMAGE RECOGNITION LARGELY RELIES ON SUPERVISED LEARNING THAT REQUIRES HUGE NUMBER OF HUMAN-ANNOTATED LABELS, TO AVOID COSTLY COLLECTION OF LABELED DATA AND THE DOMAINS WHERE VERY FEW STANDARD PRE-TRAINED MODELS EXIST, SELF-SUPERVISED LEARNING COMES TO OUR RESCUE. SELF-SUPERVISED LEARNING IS A FORM

OF UNSUPERVISED LEARNING THAT ALLOWS THE NETWORK TO LEARN RICH VISUAL FEATURES THAT HELP IN PERFORMING DOWNSTREAM COMPUTER VISION TASKS SUCH AS IMAGE CLASSIFICATION, OBJECT DETECTION, AND IMAGE SEGMENTATION. THIS PAPER PROVIDES A THOROUGH REVIEW OF SELF-SUPERVISED LEARNING WHICH HAS THE POTENTIAL TO REVOLUTIONIZE THE COMPUTER VISION FIELD USING UNLADELED DATA. FIRST, THE MOTIVATION OF SELF-SUPERVISED LEARNING IS DISCUSSED, AND OTHER ANNOTATION EFFICIENT LEARNING SCHEMES. THEN, THE GENERAL PIPELINE FOR SUPERVISED LEARNING AND SELF-SUPERVISED LEARNING IS ILLUSTRATED. NEXT, VARIOUS HANDCRAFTED PRETEXT TASKS ARE EXPLAINED THAT ENABLE LEARNING OF VISUAL FEATURES USING UNLABELED IMAGE DATASET, THE PAPER ALSO HIGHLIGHTS THE RECENT BREAKTHROUGHS IN SELF-SUPERVISED LEARNING USING CONTRASTIVE LEARNING AND CLUSTERING METHODS THAT ARE OUTPERFORMING SUPERVISED LEARNING. FINALLY, WE HAVE PERFORMANCE COMPARISONS OF SELF-SUPERVISED TECHNIQUES ON EVALUATION TASKS SUCH AS IMAGE CLASSIFICATION AND DETECTION. IN THE END, THE PAPER IS CONCLUDED WITH PRACTICAL CONSIDERATIONS AND OPEN CHALLENGES OF IMAGE RECOGNITION TASKS IN SELF-SUPERVISED LEARNING REGIME. FROM THE ONSET OF THE REVIEW PAPER, THE CORE FOCUS IS ON VISUAL FEATURE LEARNING FROM IMAGES USING THE SELF-SUPERVISED APPROACHES.

Remote Sensing Image Recognition Based on Multi-attention Residual Fusion Networks

ABSTRACT SINCE EACH SAMPLE IN A HYPERSPECTRAL REMOTE SENSING IMAGE IS MADE UP OF HIGH-DIMENSIONAL FEATURES AND CONTAINS A WEALTH OF REMOTE SENSING FEATURES, FEATURE SELECTION AND MINING BECOME MORE DIFFICULT. TO ADDRESS THIS ISSUE, A MULTI-ATTENTION RESIDUAL INTEGRATED NETWORK (MARB-NET) ALGORITHM IS PROPOSED, WHICH REDUCES REDUNDANT FEATURES WHILE INCREASING FEATURE FUSION AND, AS A RESULT, IMPROVES HYPERSPECTRAL IMAGE RECOGNITION. FIRST, ASSIGN MULTIPLE WEIGHTS TO EACH FEATURE USING MULTIPLE ATTENTION MECHANISM MODELS; THEN, DEEP MINE AND INTEGRATE THE FEATURES USING THE RESIDUAL NETWORK; AND FINALLY, PERFORM CONTEXTUAL SEMANTIC INTEGRATION ON THE DEEP FUSION FEATURES USING THE BI-LSTM NETWORK. THE RECOGNITION TASK SHOULD BE COMPLETED BY THE SOFTMAX CLASSIFIER. THE NET EXPERIMENTAL RESULTS ON THREE MULTI-CLASS PUBLIC DATA SETS SHOW THAT THE MARB-NET ALGORITHM PROPOSED IN THIS PAPER IS EFFECTIVE.

REFERENCES

SU M. VANG, K., & VAN, X. N. (2019, JULY). ESTIMATING OCEAN SUBSURFACE SALINITY FROM REMOTE SENSING DATA BY MACHINE LEARNING, IN IGARSS 2019-2019 IEEE INTERNATIONAL GEOSCIENCE AND REMOTE SENSING SYMPOSIUM (PP. 8139-8142).

YOU, H, TIAN, S., YU, L., & LV. V. (2019), PIXEL-LEVEL REMOTE SENSING IMAGE RECOGNITION BASED ON BIDIRECTIONAL WORD VECTORS, IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING, S8(2), 1281-1293.

SHUMILO L, VAILYMOV, B., KUSSUL, N., LAVRENIUK, M., SHELESTOV, A., & KORSUNSKA, Y. (2018, APRIL), RIVNE CITY LAND COVER AND LAND SURFACE TEMPERATURE ANALYSIS USING REMOTE SENSING DATA. IN 2019 IEEE 39TH INTERNATIONAL CONFERENCE ON ELECTRONICS AND NANOTECHNOLOGY (ELNANO) (PP. 813-016).

YOU 2. LL., LOW, M., LOBELL, D., & ERMON, S. (2017, FEBRUARY). DEEP GAUSSIAN PROCESS FOR CROP YIELD PREDICTION BASED ON REMOTE SENSING DATA, IN PROCEEDINGS OF THE AAAI CONFERENCE ON ARTIFICIAL INTELLIGENCE (VOL. 31, NO. 1).

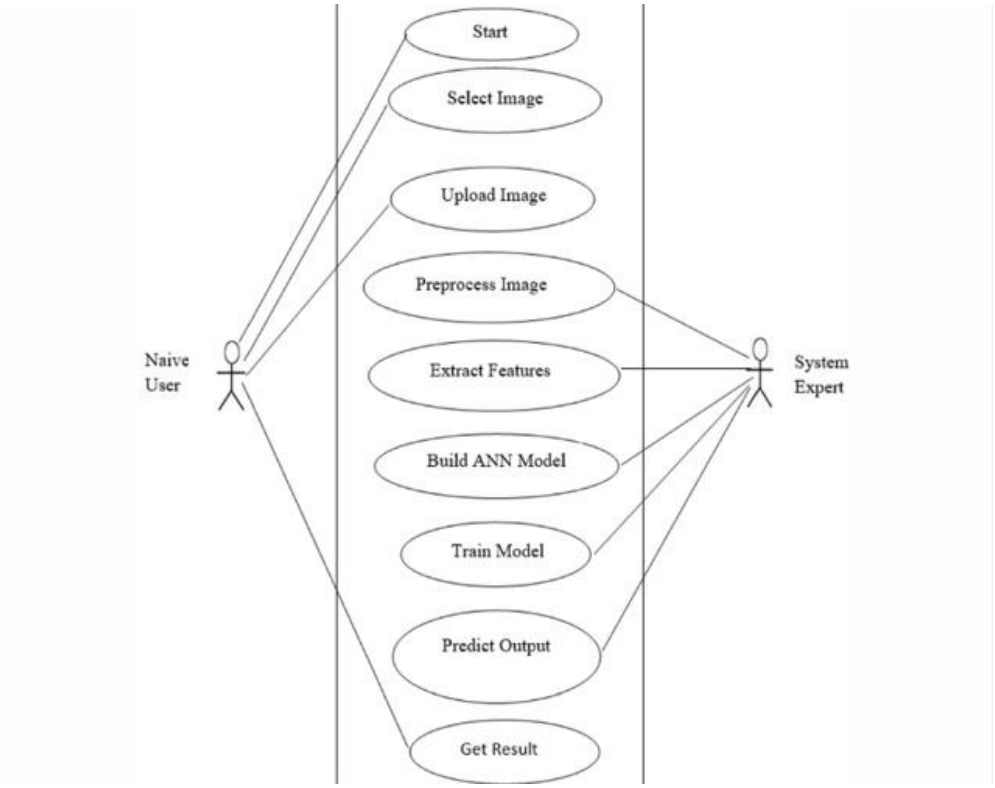
Proposed Solution & Dataset:

FEATURE #1: The first step in face recognition is to select the digital image on which, the algorithms are applied.

FEATURE #2: The second step is Face detection is concerned with finding whether there are any faces in each image and if the face is present, return the image location and content of each face.

FEATURE #3: After the face detection, the face extraction process is done, to provide effective information that is useful for distinguishing between faces of different people.

Main functionalities/features Using Use Case:



Dataset That Uses: Avengers face recognition!

Link of The Dataset: https://www.kaggle.com/datasets/rawatjitesh/avengers-face-recognition

- # Applied Algorithms:

Artificial neural networks (ANNs), usually simply called neural networks (NNs) or neural nets, are computing systems inspired by the biological neural networks that constitute animal brains. An ANN is based on a collection of connected units or nodes called artificial neurons, which loosely model the neurons in a biological brain. Each connection, like the synapses in a biological brain, can transmit a signal to other neurons. An artificial neuron receives signals then processes them and can signal neurons connected to it. The "signal" at a connection is a real number, and the output of each neuron is computed by some non-linear function of the sum of its inputs. The connections are called edges. Neurons and edges typically have a weight that adjusts as learning proceeds. The weight increases or decreases the strength of the signal at a connection. Neurons may have a threshold such that a signal is sent only if the aggregate signal crosses that threshold. Typically, neurons are aggregated into layers. Different layers may perform different transformations on their inputs. Signals travel from the first layer (the input layer) to the last layer (the output layer), possibly after traversing the layers multiple times. Neural networks learn (or are trained) by processing examples, each of which contains a known "input" and "result," forming probability- weighted associations between the two, which are stored within the data structure of the net itself. The training of a neural network from a given example is usually conducted by determining the difference between the processed output of the network (often a prediction) and a target output. This difference is the error. The network then adjusts its weighted associations according to a learning rule and using this error value. Successive adjustments will cause the neural network to produce output which is increasingly like the target output. After number of these adjustments the training can be terminated based upon certain criteria. This is known as supervised learning.

Documentation of the Algorithm:

Data Collection and Preprocessing:

The algorithm loads images of five different celebrities from a directory and resizes them to a uniform size (IMG_SIZE = 120) using OpenCV.

It shuffles the collected images and assigns labels to create a training dataset.

Feature Extraction using HOG (Histogram of Oriented Gradients):

Utilizes the hog function from skimage.feature to extract HOG features from the grayscale images.

Generates HOG features for each image in the training dataset.

Model Building and Training:

Constructs a Sequential model using Keras with several dense layers and BatchNormalization.

Compiles the model using Adam optimizer and sparse categorical cross-entropy as the loss function.

Trains the model on the extracted HOG features for 50 epochs.

GUI Implementation (Tkinter):

Creates a graphical user interface using Tkinter to upload images and display predictions.

Includes buttons for uploading photos and exiting the interface.

Upon uploading an image, the algorithm predicts the celebrity name using the trained model and displays it on the GUI**.**

Real-time Face Recognition using Webcam:

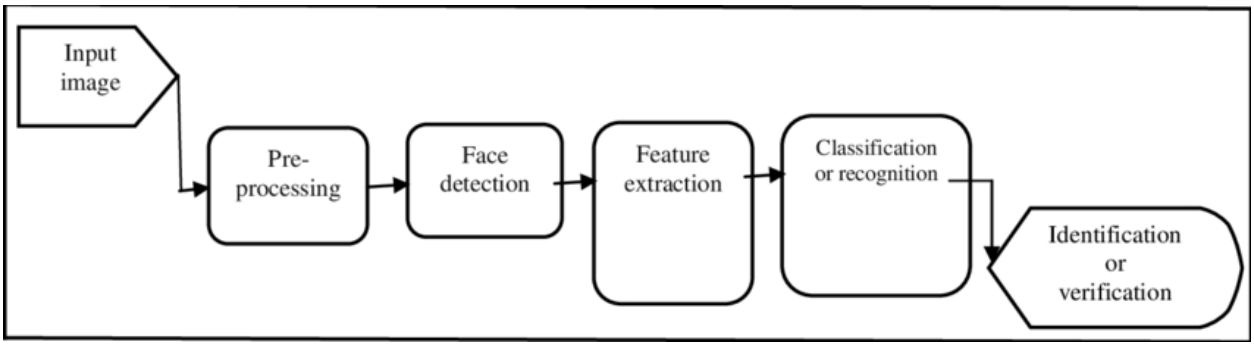
Implements live face recognition using the OpenCV library.

Utilizes the Haar Cascade Classifier for face detection and extracts the detected face.

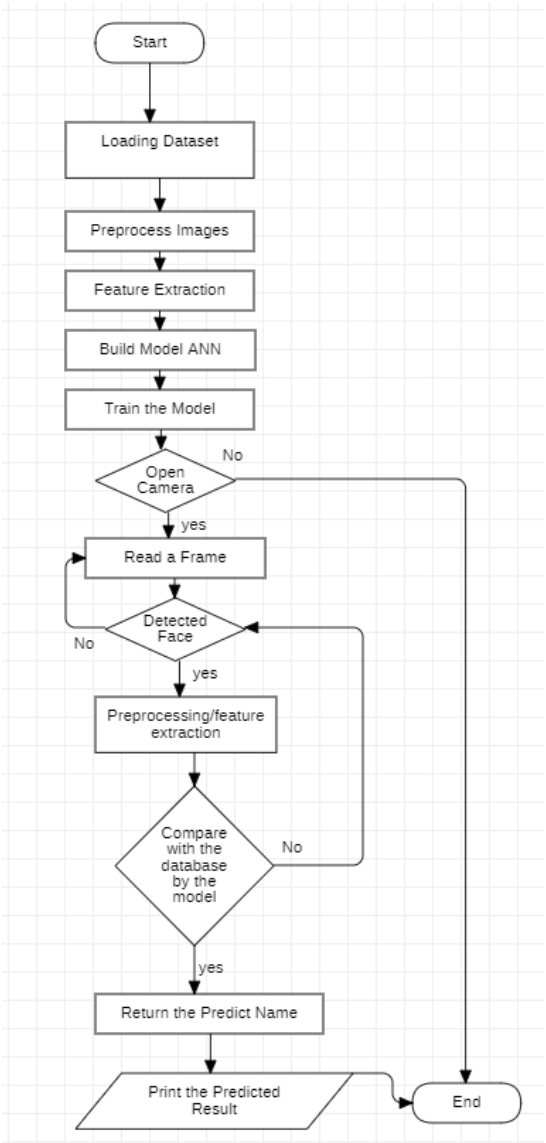
Converts the detected face to grayscale, resizes it, extracts HOG features, and predicts the celebrity using the trained model.

Displays the recognized celebrity's name on the video feed.

Block Diagram:

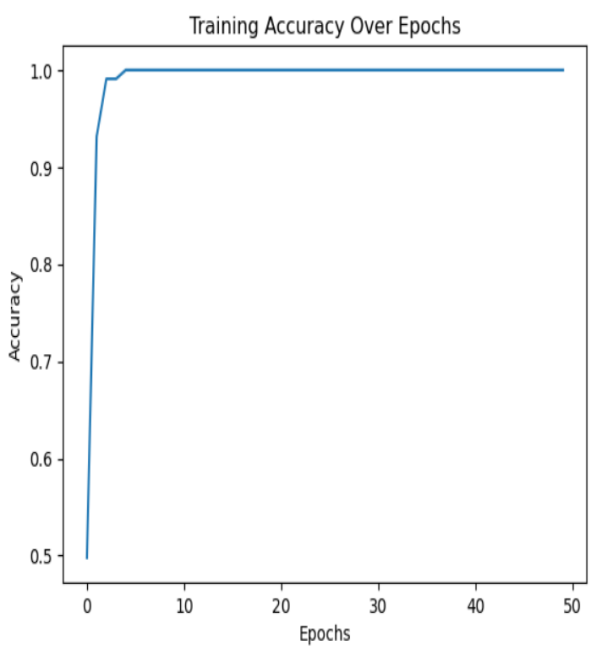


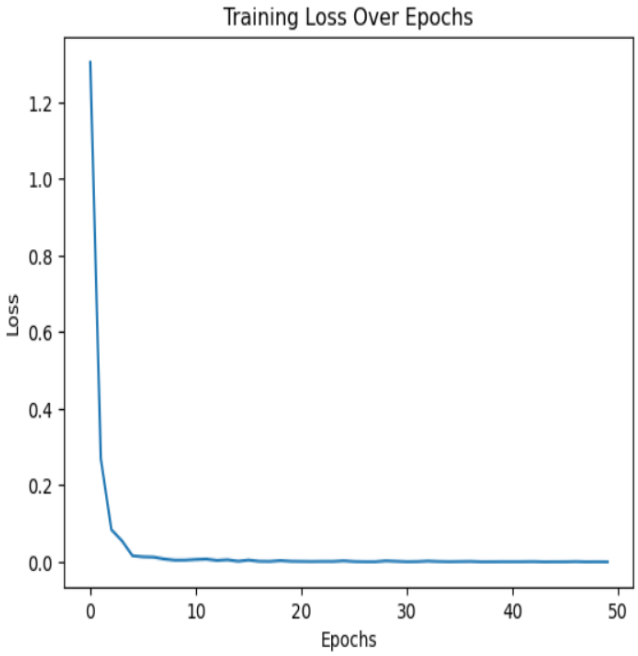
Flowchart Diagram:



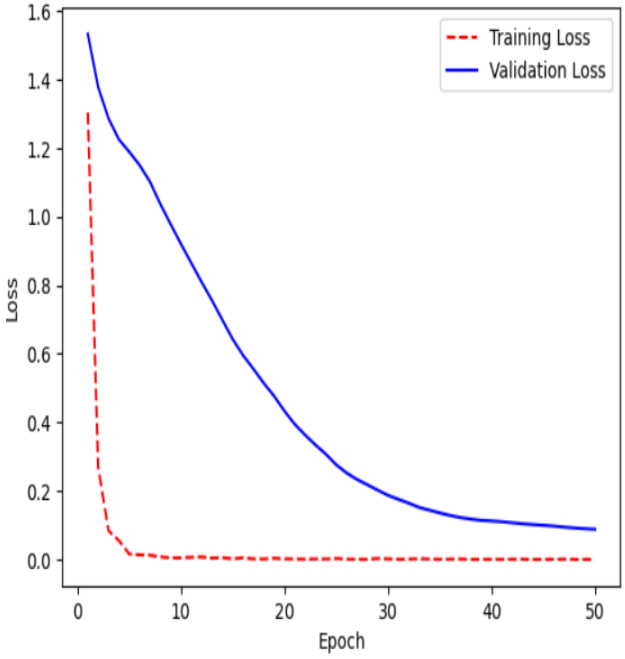
Experiments & Results:

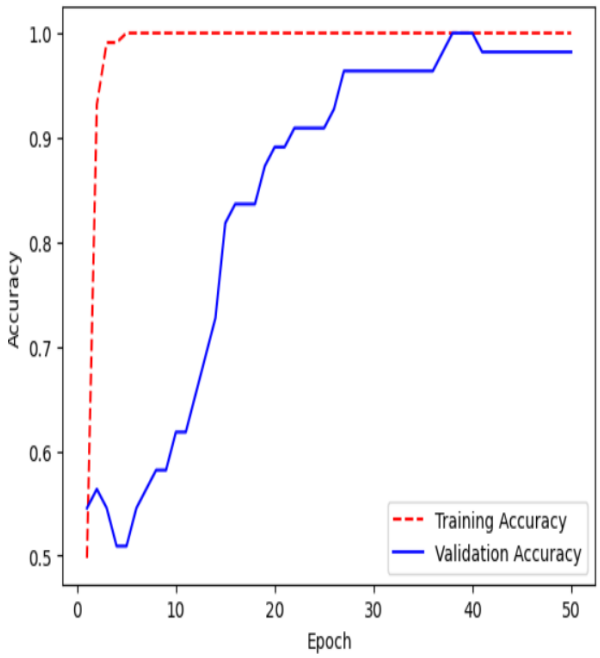
Plots For Training:



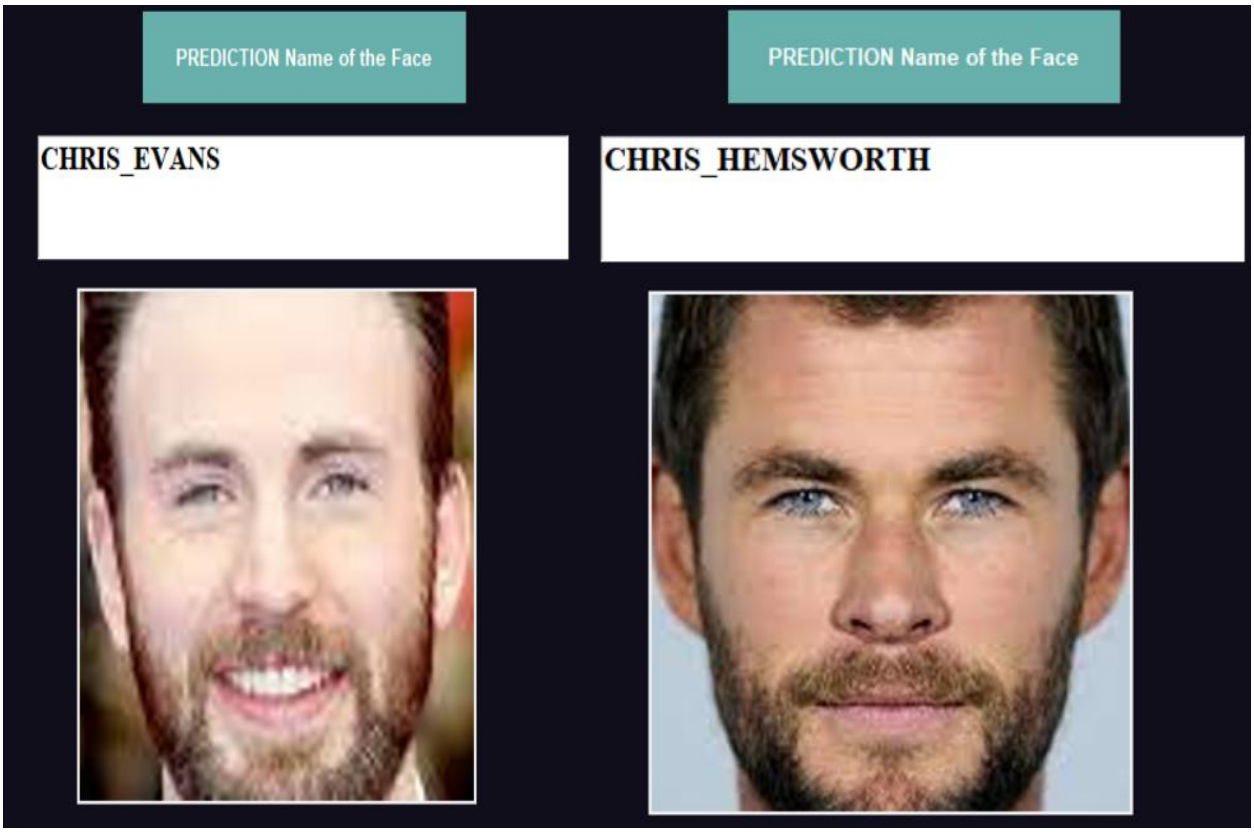


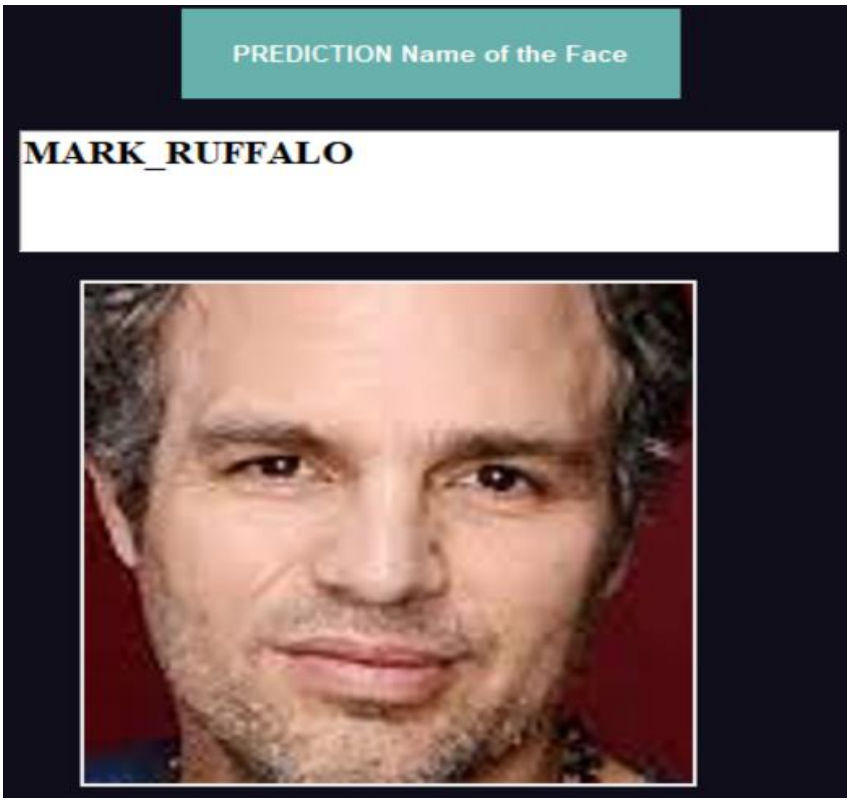
Plots For Training/ Validation:



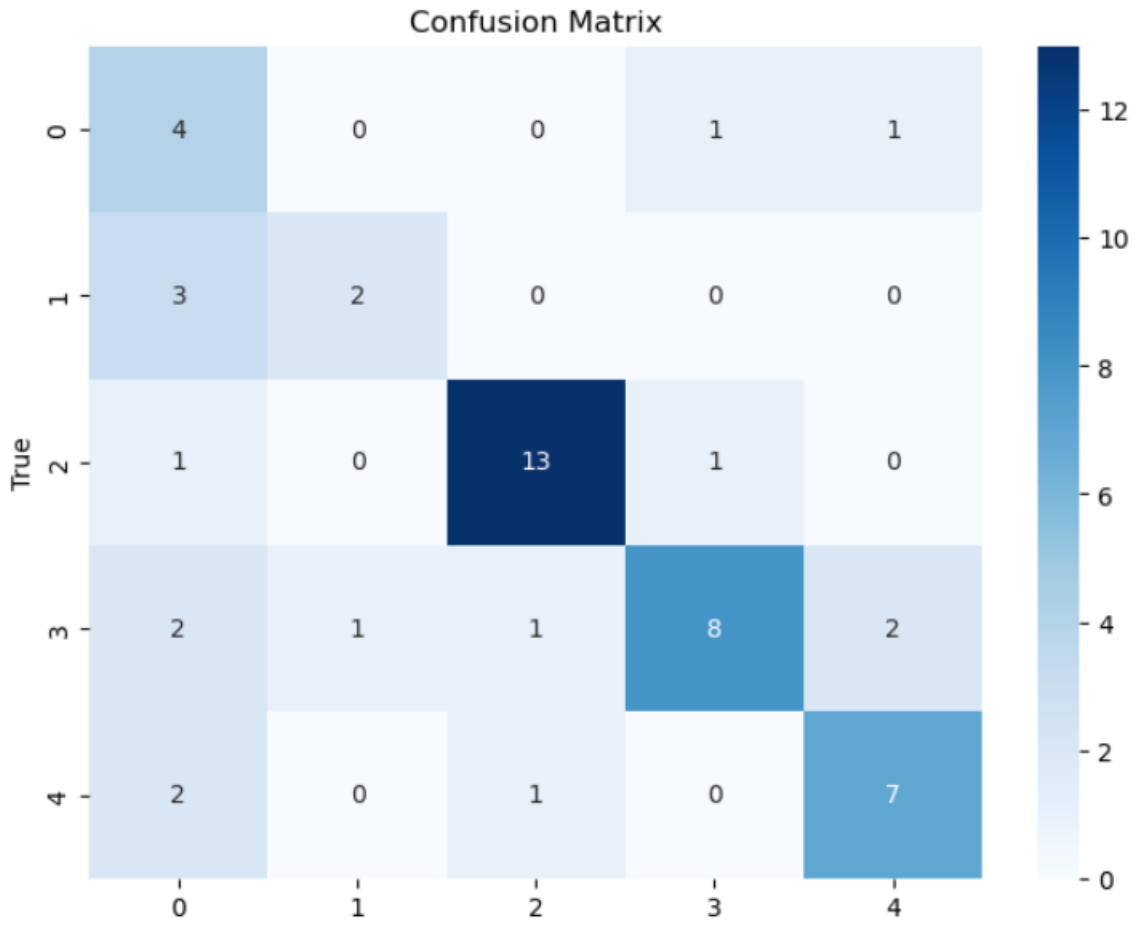


Samples of the Output:





Confusion Matrix of Testing:



N Fold Cross Validation:

	Fold	Accuracy
0	1	1.000000
1	2	1.000000
2	3	1.000000
3	4	1.000000
4	5	0.909091

```
Mean Accuracy: 0.9818
Standard Deviation: 0.0364
```

ANN Advantages

An ANN has several advantages but one of the most recognized of these is the fact that it can learn from observing data sets. In this way, ANN is used as a random function approximation tool. These types of tools help estimate the most cost-effective and ideal methods for arriving at solutions while defining computing functions or distributions.

ANN takes data samples rather than entire data sets to arrive at solutions, which saves both time and money. ANNs are considered simple mathematical models to enhance existing data analysis technologies.

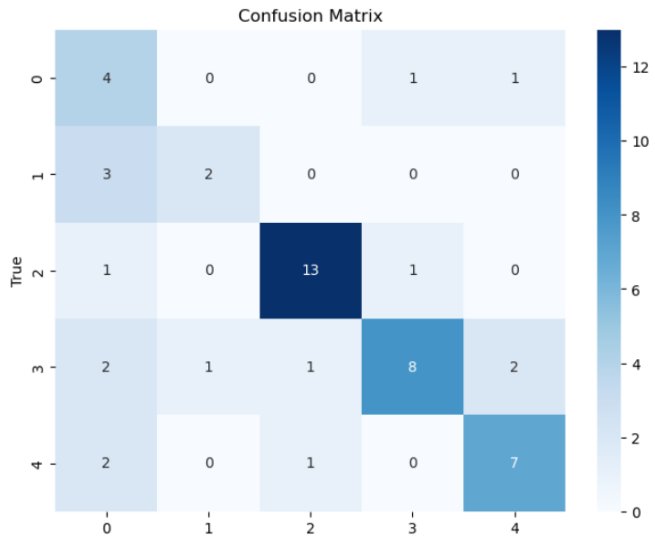
They can be used for many practical applications, such as predictive analysis in business intelligence, spam email detection, natural language processing in chatbots, and many more.

Performance Metrics Insights:

Accuracy and Error Rates:

Understanding the overall accuracy helps gauge the system's reliability in correctly identifying or verifying faces.

Confusion Matrix Analysis:



Algorithm Behavior:

Model Complexity:

Reason: Overly complex models could result in overfitting, especially with limited data.

Modification: Consider regularization techniques, model pruning, or architectural adjustments to improve generalization.

Limited Diversity in Training Data:

Reason: Insufficient diversity in the training dataset may cause bias or lower performance on diverse test data.

Modification: Gather more diverse facial data to ensure the model learns from a broader range of demographics and conditions.

Challenges in Pose or Occlusions:

Reason: Difficulty in handling poses or occlusions could lead to misclassifications in challenging scenarios.

Modification: Explore advanced techniques (e.g., pose normalization, attention mechanisms) to enhance the model's robustness.

Future Modifications:

Augmented Data Collection:

Collect additional data with diverse poses, lighting conditions, ages, and ethnicities to improve model generalization.

Advanced Preprocessing Techniques:

Experiment with novel preprocessing methods (illumination normalization, data augmentation) tailored to handle specific challenges faced in real-world scenarios.

Model Architectural Enhancements:

Explore advanced architectures (e.g., attention-based models, capsule networks) that are better suited to learn intricate facial features or handle occlusions.

- **Development Platform**:
  Tools: Anaconda, Jupyter Notebook.
  Programming Languages: Python.
  Libraries: NumPy, Panadas, Computer Vision, TensorFlow, Matplotlib, Sklearn and Tkinter.

Artificial Intelligence

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Short Link for the Project: https://shorturl.at/pLZ02