R.M.D ENGINEERING COLLEGE

Department of Computer Science and Business Systems

# FACE IDENTIFICATION AND CATEGORIZATION

## WITH AND WITHOUT MASK

## UTILIZING MTCNN AND OPENCV

FOR ACCESSING BANK LOCKER FACILITY

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# ABSTRACT


- Face recognition is a widely used technology with various applications in security, surveillance, and identity verification systems.
- However, the emergence of face masks, particularly during the COVID-19 pandemic, poses a challenge to accurate face recognition.
- This project focuses on developing a face recognition system using MTCNN, Facenet, and OpenCV, capable of detecting faces and recognizing individuals even when they are wearing masks.
- When the face is verified, they will be allowed to access the locker. Else, access would be denied.

# OBJECTIVE

- Face recognition technology has gained significant importance in various domains, including security, surveillance, and identity verification systems.

- However, the widespread use of face masks, particularly during the COVID-19 pandemic, has posed challenges to accurate face recognition. Masks obscure critical facial features, making it difficult for traditional face recognition systems to perform effectively.

- The aim of this project is to develop a face recognition system using MTCNN, Facenet, and OpenCV that can accurately detect and recognize individuals even when they are wearing masks and then enable respective access to the bank lockers.

# EXISTING SYSTEM AND ITS DISADVANTAGES

Traditional face recognition algorithms heavily rely on facial features, such as the nose, mouth, and chin. As a result, the performance of existing face recognition systems significantly deteriorates in scenarios where mask usage is prevalent.

To overcome this limitation, some approaches have been proposed, such as using face alignment techniques to estimate the position of facial landmarks under the mask or employing face reconstruction methods to recover the occluded facial regions. However, these techniques often require additional computational resources and may not yield satisfactory results.

The disadvantages are :

- Computational Complexity
- Privacy Concerns
- Dependence on Other Biometrics
- Reduced Accuracy
- Increased False Matches
- Mask Detection Limitations

# PROPOSED SYSTEM AND ITS ADVANTAGES

The proposed system is a face recognition system incorporates mask detection to enhance accuracy in scenarios where individuals are wearing masks.

The process begins with the use of ***face detection algorithms*** like MTCNN to detect and localize faces within the stream. Once the faces are detected, an ***alignment process*** is employed to normalize the orientation and scale of each detected face. Then, ***feature extraction*** using a deep learning model such as Facenet is done. This model transforms each aligned face into a high-dimensional vector representation called an ***embedding***. Finally, a classifier, often implemented as a ***softmax classifier and cosine similarity*** can be utilized to measure the similarity between embedded vectors, enabling ***face identification***.

The advantages are :

- Improved Accuracy.
- Enhanced Security.
- Contactless Interaction.
- User Convenience.
- Public Health Compliance.
- Robustness and Flexibility.

# SYSTEM SPECIFICATION

## SOFTWARE :

- An x64-based processor.
- Anaconda Distributor.
- Python - 3.7 or later versions.
- Visual Studio Code.
- Windows 7 or later versions. (64 bit)
- Text editor such as Notepad, MS Word.

## HARDWARE :

- 4 GB of RAM.
- 80 GB of hard disk capacity.
- 15 inch color monitor.
- 52x CD-ROM drive.
- Full HD webcam.
- Core i3 processor and above.

# SYSTEM ARCHITECTURE

# FRAMEWORKS EMPLOYED

## Multi-task Cascaded Convolutional Networks (MTCNN)

- It is a face detection algorithm that efficiently detects and localizes faces in images or video frames.
- It consists of three stages: face proposal network, bounding box regression network, and facial landmark detection.
- PNet (Primary Network): It is responsible for feature extraction.
- RNet (Refinement Network): Refines features extracted by the PNet for improved accuracy.
- ONet (Output Network): Produces the desired output or prediction based on refined features from previous layers

# FRAMEWORKS EMPLOYED

## FaceNet

- Embedding is a numerical representation of a face extracted from an image.
- FaceNet uses embedding to map similar faces together and dissimilar faces further apart.
- It uses triplet loss function to compare the similarity of three images : anchor image, positive image, and negative image.
- The model is trained to minimize the distance between the embeddings of the anchor and positive images while maximizing the distance between the embeddings of the anchor and negative images.

# LIST OF MODULES

- **Data Collection**

  Utilizing the webcam to gather images of the individual and storing it in the respective named directory.

- **Training and Calibration**

  This module involves two stages namely, image augmentation and image embedding.

- **Face Detection**

  It detects the face using MTCNN which extracts a list of bounding boxes, coordinates of smallest possible rectangles around faces.

- **Face Identification**

  It is done using FaceNet. The embeddings are compared using any distance metrics to determine the similarity between the extracted features and the ones in the database.

# MODULE 1 : DATA COLLECTION

- Data collection is a crucial step in developing a face recognition system.
- The process involves gathering relevant data to train the face detection, and face recognition algorithms.
- Collect a diverse dataset of face images representing different individuals. These images should cover variations in age, gender, ethnicity, and facial expressions.
- The images are collected using the webcam. Position the subject clearly in front of the camera in good lighting to achieve accurate pictures.
- This results in the collection of around 100 images by the system. Name the directory with the respective name of the person, this name would be displayed during the identification process.

# MODULE 2 : TRAINING AND CALIBRATION

- This module features two stages, namely image augmentation and embedding.

- The goal of image data augmentation is to create new variations of the training images to train the model to become capable of handling different conditions.

- When a face recognition system processes an image, it uses a deep learning model to extract features from the face, transforming it into a compact numerical high-dimensional vector representation or embedding.

- The above results are used to train the model to identify faces later.

# MODULE 3 : FACE DETECTION

- MultiTask Cascaded Convolutional Neural Network is a modern tool for face detection, leveraging a 3-stage neural network detector.

- First, the image is resized multiple times to detect faces of different sizes. Then the P-network (Proposal) scans images, performing first detection.

- The proposed regions (containing many false positives) are input for the second network, the R-network (Refine), which, as the name suggests, filters detections (also with NMS) to obtain quite precise bounding boxes.

- The final stage, the O-network (Output) performs the final refinement of the bounding boxes. This way not only faces are detected, but bounding boxes are very right and precise.

# MODULE 4 : FACE IDENTIFICATION

- FaceNet is a facial recognition framework that operates by encoding faces into a high-dimensional vector space, where similar faces are located close to each other.
- When a face is detected in an image, FaceNet preprocesses the image and then feeds it into the neural network to generate a numerical representation, known as an embedding, for that face.
- These embeddings are then compared using cosine similarity or other distance metrics to determine the similarity between faces.

# RESULT AND DISCUSSION

- ACCURACY

Accuracy refers to the ability of the system to correctly identify or verify individuals from their facial features. It is typically measured as the percentage of correct identifications out of the total number of attempts. Without masks, both systems exhibit comparable accuracy levels, but the new system demonstrates its adaptability, effectiveness in the presence of facial coverings.

- ELAPSED DURATION

It refers to the amount of time it takes for the system to process and analyze a given image or video frame to identify faces. When considering the presence of masks, traditional systems struggle to accurately identify individuals, requiring additional steps such as manual verification. In contrast, the new facial recognition systems have adapted to accommodate mask-wearing, effectively reducing the time.

- F1 SCORE

F1 score is the harmonic mean of precision (proportion of true positives among all instances classified as positive) and recall (proportion of true positives among all actual positive instances) to evaluate the facial recognition system. The score decreases significantly when individuals wear masks due to occlusion of facial features. With all-new facial recognition systems, the score remains robust even in masked scenarios.

# RESULT AND DISCUSSION

- RESOURCE CONSUMPTION

Resource consumption refers to the amount of computational resources required for the system to operate effectively. Traditional facial recognition systems rely on processing the entire facial structure, consuming considerable computational resources. The proposed facial recognition system equipped with mask detection algorithms can process facial features even when partially covered, thereby reducing computational overhead.

- ENVIRONMENTAL RESILIENCE CAPABILITY

It involves the system's capacity to adapt and function effectively despite the environmental variables. Traditional systems struggle in environments where factors like lighting changes or partial obstructions, such as masks are present making them less resilient. The proposed system, especially designed to adapt to these challenges, demonstrates superior environmental resilience.

- CROSS DOMAIN PERFORMANCE

Cross-domain performance refers to the assessment of a system's effectiveness when deployed across various domains or applications. This evaluation is crucial for understanding how well the system performs in different contexts and scenarios, such as surveillance, access control, or user authentication.This involves assessing its ability to achieve consistent and reliable results across diverse environments, datasets, and plenty of real time use cases.

# SCREENSHOTS

*Fig. Identification of face with mask*

*Fig. Identification of face with mask*

*Fig. Untrained Face*

*Fig. Identification of face without mask*

*Fig. Identification of face without mask*

*Fig. Untrained Face*

# SCREENSHOTS

*Fig. Accuracy and Loss Graph Generation*

*Fig. Accuracy and Loss Epoch Calculation*

*Fig. Restricted Access*

*Fig. Access Granted with Classification results*

# CONCLUSION

- The face recognition system with mask detection presents a solution to the challenges posed by masks in accurate identification and verification.

- By integrating mask detection with face recognition algorithms, the system improves the overall accuracy and reliability of recognizing individuals, even when they are wearing masks.

- The proposed system respects privacy considerations and can be customized and adapted to different environments, ensuring its versatility.

- Overall, the face recognition system with mask detection using MTCNN, Facenet, and OpenCV is a valuable tool for ensuring accurate and reliable identification, enhancing security measures, and adapting to the challenges presented by masks in today's environment.

# FUTURE ENHANCEMENT

- **Improved Mask Detection** : Enhance the accuracy and robustness of the mask detection algorithm by incorporating advanced machine learning techniques, such as deep learning models or ensemble methods.

- **Multi-Modal Fusion:** Investigate the integration of multiple biometric modalities, such as facial features, voice recognition, gait analysis, or even thermal imaging, to further enhance the identification accuracy.

- **Integration with Bank Locker Access System :** Integrate the face identification system with the existing bank locker access control infrastructure, for seamless integration and interoperability.

- **Real-time Monitoring and Logging:** Implement real-time monitoring of individuals entering the bank locker facility, capturing their faces and mask status.

- **Scalability and Robustness:** Ensure that the system is scalable to handle a large number of users and robust enough to perform reliably in real-world conditions.

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