A REPORT

ON

PROCTORING TECHNIQUES DURING VIRTUAL INTERVIEWS

BY

Ayush Purbey 2021A8PS2921G

AT

iQuadra Information Services Pvt. Ltd.(Online)

A Practice School-I Station of

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI

(July,2023)

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Name of the Student	**ID.No.**	**Discipline**
Ayush Purbey	2021A8PS2921G	B.E. Electronics & Instrumentation Engineering

Prepared in partial fulfilment of the
Practice School-I Course No.
BITS F221

AT

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A Practice School-I Station of

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI

(JULY,2023)

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI (RAJASTHAN)

Practice School Division

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Title of the Project: PROCTORING TECHNIQUES DURING VIRTUAL INTERVIEWS

Name of the Student	ID.No.	Discipline
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Name of the PS Faculty: Dr Arnab Guha

Key Words:
AI, ML, Deep Learning, PYTHON, Facial Recognition, AWS

Project Areas:

1: Given still or video images of a scene, identify or verify one or more persons in the scene using a stored set of faces (images).

2: A video is being recorded by the system camera. Check how many times a person looked away from the camera.

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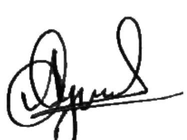
Abstract:

Techniques for proctoring exams online and in distance learning are becoming more and more crucial. By keeping an eye on students while they take tests, these strategies hope to maintain the integrity of the examinations and prevent cheating. Utilizing cutting-edge technologies like facial recognition, proctoring software can authenticate test-takers' identities and keep an eye on their movements to look for any unusual behavior. The facial recognition technology has revolutionized a number of industries, including retail, law enforcement, user identification, and security. FRT uses sophisticated algorithms and deep learning approaches to identify people from digital photos or video frames by analyzing facial features. It has been used in event management, access control, healthcare for patient identification, law enforcement for suspect identification and missing persons, mobile device authentication, retail customer experiences, time and attendance management, and government services. By comparing facial traits and finding similarities between faces, deep learning algorithms like the Siamese network have considerably increased the accuracy and effectiveness of FRT. However, the growing use of FRT has also brought up ethical, legal, and privacy issues, prompting academics and policymakers to be cautious when putting it into practice.

The creation of a Face Recognition Technology (FRT) system served as a demonstration of the importance of computer vision, deep learning, and AI applications in a variety of fields. Face detection, alignment (optional), encoding, and recognition were all part of the workflow. Siamese network-based deep learning techniques offered a potent solution for face comparison and identification. The project increased awareness of the ethical ramifications of AI technologies and emphasized the value of debugging skills in problem-solving. FRT has the potential to alter society, but responsible development and usage are still essential to ensuring its beneficial effects.



Signature of Student **Signature of PS Faculty**

Date: 20/07/2023 **Date**

Acknowledgement

I'd like to thank Dr. Arnab Guha, for all of the help and advice he's given me on my current project, "PROCTORING TECHNIQUES DURING VIRTUAL INTERVIEWS” His knowledge and observations have helped me decide on the direction and method of my study. His steady support and feedback have helped the project move forward in a big way.

I'd also like to thank iQuadra Information Services Pvt. Ltd. from the bottom of my heart for giving me the chance to work on this important project. Their help and participation have been very important in finding new ways to create a facial recognition system required for proctoring. I'm thankful for the trust and tools given to me, which have helped me learn more about this new field and make efforts that matter.

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About iQuadra Information Services Pvt. Ltd.

iQuadra Information Services (www.iQuadra.com) is the world's emerging AI & IP-led (Patents applied) Product as Services Company with its fast tracked Agile paced approach to product development. With its proven IT Services and Software Solution provisioning to many of the companies across the globe spread across all gamut of industries by enabling enterprise wide Agile Transformations, Strategic Consulting and Development for facilitating Digital transformation, Digital Assurance and Enhanced round the clock Support. Headquartered in Atlanta, GA, our team of Technology and Market Strategy professionals are spread across Pune, India providing IT Services and Nellore, India performing Product as Service web and mobile applications.

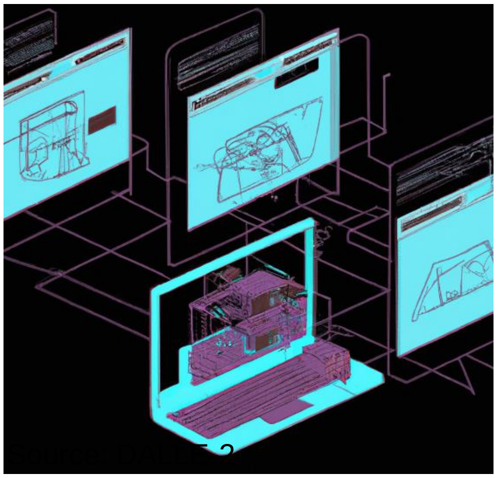
Our offerings include Digital Transformation, Quality Engineering, Strategic Solutioning & Transformation, Artificial Intelligence and Machine Learning, IOT, Data mining, Business Intelligence/Visualization, and Intelligent Automation - RPA.

As a company with over a centuries worth of accumulated experience is successful in implementing some of the largest and most complex projects undertaken in India and United States. With insight, imagination, innovation and integration in our core thought processes, we implement practically what it means to be the leading IT Services and Product development company with utmost professionalism, implementation of quality processes and simplification of complex problems and risk management.

With its flagship patent applied (USPTO) product in the making, www.iQuizUAnswer.com, iQuadra has ventured into PaaS space, and is coming up with AI/ML driven, job seeker centric interviewing portal with its iQ Question Engine being the USP across all job sectors and roles.

Currently, we are working on a product called iQonference which requires the model of an AI Proctoring Software.

Introduction



Source: DALL-E 2

In recent years, virtual interviews have become very popular because they are easy to set up and don't cost much. As more companies use online hiring methods, it's important that candidates are evaluated in a fair and accurate way during virtual interviews. But doing interviews from a distance brings its own challenges, like making sure the grading process is fair and catching people who are trying to cheat.

AI proctoring methods offer new ways to deal with these problems. AI proctoring systems can watch and analyse different parts of a virtual interview, such as facial expressions, speech patterns, body language, and other behavioural cues. They do this by using advanced technologies like computer vision, natural language processing, and machine learning. With these methods, companies can improve the honesty of virtual interviews by spotting possible cheating, confirming the name of candidates, and giving an objective score of how well they did.

AI proctoring methods are important because they can speed up the hiring process, make it easier on human recruiters, and ensure that candidate ratings are fair and unbiased. These methods can find suspicious behaviours that may not be easy for human proctors to spot. They also give recruiters useful information that helps them make smart choices. AI proctoring methods could also help reduce bias in the hiring process by putting more emphasis on objective data and performance measures.

Objectives of the project report

To provide a complete comprehension of AI proctoring techniques for virtual interviews: The purpose of this report is to describe the technologies and algorithms used in AI proctoring, including facial recognition, emotion analysis, voice and speech analysis, and behavioural analysis. It will explain how these techniques enhance the credibility and efficacy of virtual interviews.

Evaluate existing AI proctoring techniques for virtual interviews: This report will conduct a literature review to investigate the current state of AI proctoring techniques in the context of virtual interviews. Utilising case studies and research studies, it will assess their efficacy, limitations, and ethical considerations.

To compare and evaluate the performance of selected AI proctoring techniques: The report will present a methodology for assessing the efficacy of particular AI proctoring techniques. It will describe the process of data collection, the selection of evaluation criteria, and the analysis of the results derived from applying the techniques to virtual interview scenarios.

The report will investigate the practical implications of AI proctoring techniques beyond virtual interviews. It will discuss how these techniques can be adapted and implemented in other contexts, including online assessments, distance education, and professional certifications along with in-depth discussion on a facial recognition software.

Overview of virtual interviews and their increasing popularity

Source: DALLE-2

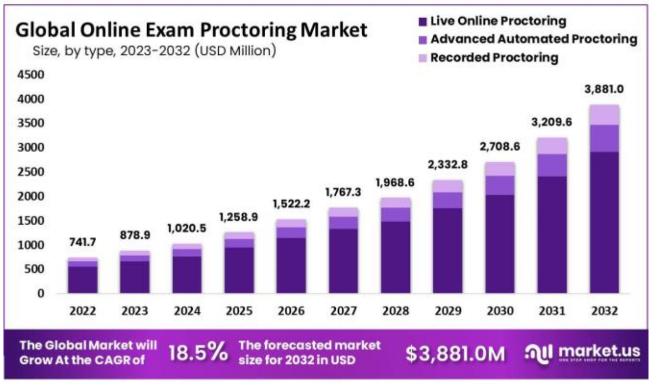
Virtual interviews are conducted using digital platforms, such as video conferencing software or specialised interview platforms. There are two primary categories of these interviews: synchronous and asynchronous. In synchronous virtual interviews, the interviewer and interviewee interact simultaneously in real-time. In contrast, asynchronous virtual interviews enable candidates to record their responses to predetermined questions, which are then reviewed at the hiring team's convenience.

Accessibility is one of the most significant benefits of virtual interviews. By removing geographical barriers, businesses can communicate with candidates from all over the world. This broadens the talent pool and creates opportunities for diverse employment, allowing businesses to access a broader range of skills and experiences.

Virtual interviews offer high cost and labour savings as well. The elimination of travel requirements decreases the costs of transportation, lodging, and venue rental. In addition, it saves candidates and interviewers time by eliminating the need for travel arrangements. The convenience of virtual interviews permits businesses to streamline their hiring procedures and potentially reduce the time required to engage.

Virtual interviews also improve the candidate experience. Candidates are able to participate in interviews from the comfort of their own homes, reducing the tension associated with travel and unfamiliarity. This environment is conducive to a more relaxed and genuine interaction, which may allow candidates to perform at their best. Individuals with disabilities have a more inclusive and accessible experience with virtual interviews, as they can easily adapt the environment to their specific requirements.

Virtual interviews also provide the benefit of flexibility. Virtual interviews, unlike traditional face-to-face interviews, can be conducted at any mutually opportune time. This enables for improved coordination and expedited hiring procedures. In addition, virtual interviews allow multinational corporations to interview candidates across time zones without significant scheduling difficulties.(Nigam et al., 2021)



According to Market.us, the market size for online exam proctoring is expected to surpass USD 3,881.0 million by 2032. From USD 741.7 million in 2022, the market is projected to increase at a CAGR of 18.5% between 2023 and 2032.

Challenges faced in conducting virtual interviews

In today's digital era, virtual interviews are becoming increasingly popular and necessary. Unlike in-person interviews, virtual interviews pose unique challenges despite their convenience and adaptability. Here are some common obstacles encountered when conducting virtual interviews:

Technical issues can disrupt the rhythm of an interview and hinder communication. Common issues that must be addressed include a weak internet connection, video/audio hiccups, and software compatibility issues. Both the interrogator and the interviewee must ensure that they have a stable internet connection and utilise dependable video conferencing platforms to minimise technical difficulties.

In virtual interviews, the absence of nonverbal signals such as body language, facial expressions, and eye contact makes it more difficult to determine a candidate's suitability for a position. Interviewers must pay closer attention to verbal cues and modify their evaluation techniques accordingly.

Virtual interviews occur in various locations, frequently in the candidate's home or office. This can lead to distractions and interruptions, such as background commotion or the entrance of pets or family members. Similarly, interviewers may experience disruptions in their surroundings. To minimise disruptions during the virtual interview, both parties need to locate private, peaceful spaces.

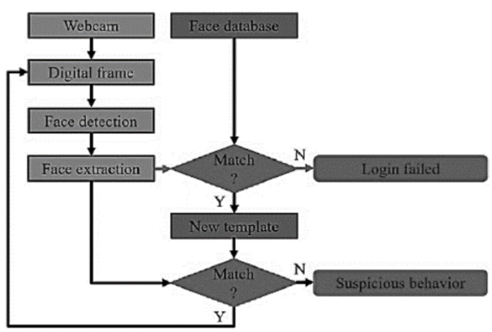
Face-to-face interviews are typically more effective for establishing a rapport with a candidate. Interviews conducted online may feel impersonal and lack rapport. The absence of physical proximity can make it difficult to establish a trusting and familiar environment, which may negatively impact the candidate's performance. By engaging in small talk, active listening, and expressing genuine interest in the candidate's background, interviewers should strive to establish a welcoming environment.

Certain positions require candidates to demonstrate practical skills or complete duties in order to evaluate their abilities. In virtual interviews, it can be more difficult to replicate hands-on assessments and provide practical scenarios. It may be necessary for interviewers to find alternatives, such as sharing displays, utilising virtual whiteboards, or requesting that candidates submit samples of their work in advance.

Interview scheduling across multiple time zones can be a logistical challenge. It can be difficult to coordinate interview times that facilitate both the interviewer's and the candidate's availability, especially when there is a significant time difference. Flexibility and effective communication are essential to overcoming this obstacle.(Sah et al., 2020)

Existing AI proctoring techniques for virtual interviews

Existing AI proctoring methods for virtual examinations include the following:



Source: (Zhang et al., 2016)

1. Automated facial recognition and emotion analysis: This technique analyses a candidate's facial expressions during a virtual interview using computer vision algorithms. The AI system identifies key facial landmarks, such as the position of the eyes, nose, and jaw, and monitors the evolution of these landmarks over time. The system can infer the candidate's emotional state by comparing these alterations to a database of known facial expressions.

The operation of this method entails training machine learning models on large facial expression datasets. These datasets contain photographs or recordings of individuals displaying a variety of emotions. The models acquire the patterns and characteristics associated with various emotions. During a virtual interview, the AI system continuously analyses a candidate's facial expressions and applies them to previously learned emotional patterns, thereby estimating their emotional state.

2. Voice and speech analysis: Voice and speech analysis techniques analyse the candidate's utterances during a virtual interview using natural language processing (NLP) algorithms. The AI system receives the candidate's audio input and analyses it to extract various characteristics, including pitch, tone, speech rate, and pauses. After analysing these characteristics, inferences are made regarding the candidate's demeanour, fluency, and potential indicators of deception or nervousness.

The operation of this method entails training NLP models on large labelled speech sample datasets. These datasets include recordings of individuals speaking in various contexts, emotions, and languages. The models learn linguistic patterns and signals associated with various speech characteristics.

3. Behavioral and body language analysis: This method employs computer vision algorithms to analyse the candidate's behavioural signals and body language during a virtual interview. Using video analysis techniques, the AI system monitors the candidate's movements, gestures, posture, and eye contact. The system then analyses these signals to determine the candidate's level of engagement, confidence, and attentiveness during the interview.

This method functions by training computer vision models on datasets of labelled body movements and gestures. These datasets include videos of individuals exhibiting various behaviours and body language indicators. These indicators are recognised and interpreted by the models. During a virtual interview, the AI system continuously analyses the video feed, monitoring the candidate's movements and inferring their behavioural patterns and body language cues using the learned models.

Limitations of current AI proctoring techniques

Now, let's examine the limitations of the three proctoring methods mentioned previously.

1. facial recognition and emotion analysis through automation
Limited accuracy: Complex emotions may not always be correctly interpreted by facial recognition and emotion analysis algorithms. Individuals' facial expressions can vary significantly, and cultural differences can impact how emotions are interpreted. The inability of the algorithms to distinguish between subtle emotional nuances may lead to inaccuracies in determining the candidate's genuine emotional state.

Face recognition alone cannot provide a comprehensive comprehension of a candidate's emotions due to a lack of context. It disregards the interview's broader context, such as the conversation's topic or external factors that may influence the candidate's expressions. To accurately interpret emotions, it is essential to comprehend their context.

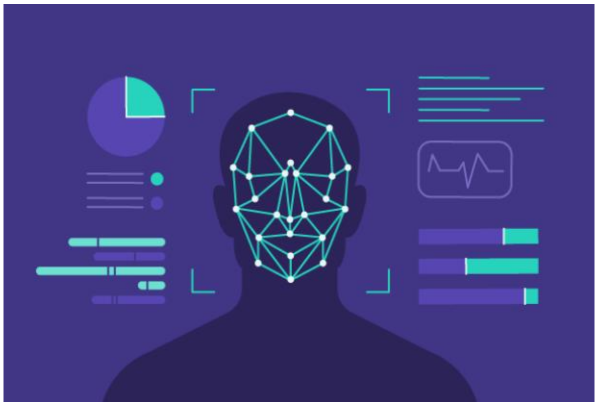
2. Voice and speech analysis
Challenges in interpretation Although voice and speech analysis can provide insight into a candidate's communication skills, fluency, and potential indications of nervousness or deception, accurately interpreting these cues is difficult. Individuals' speech patterns can vary greatly based on cultural background, speech impediments, and language proficiency. It is essential to avoid making biassed judgements or incorrect interpretations solely based on speech analysis.

Absence of nonverbal signals: Voice and speech analysis techniques concentrate primarily on the audio component, ignoring nonverbal signals such as facial expressions and body language. These non-verbal signals frequently play a crucial role in comprehending the entire message and assessing a candidate's suitability for a position.

3. Behavioural and body language analysis
Cultural and individual variations Behavioural and body language signals can vary substantially between cultures and individuals. What one culture interprets as confident or attentive may be interpreted differently in another. AI systems may find it difficult to account for these variations and may mislabel certain behaviours as positive or negative due to their limited cultural perspective.
Behavioural and body language analysis techniques provide post-interview analysis as opposed to real-time feedback. This restricts the interviewer's ability to adapt or respond to the candidate's behaviour during the interview, thereby jeopardising meaningful interaction or clarification opportunities.

Now, we will delve into the facial recognition system, a crucial component for proctoring, discussing its significance in detail.

Facial Recognition Technology



Source: DALLE-2

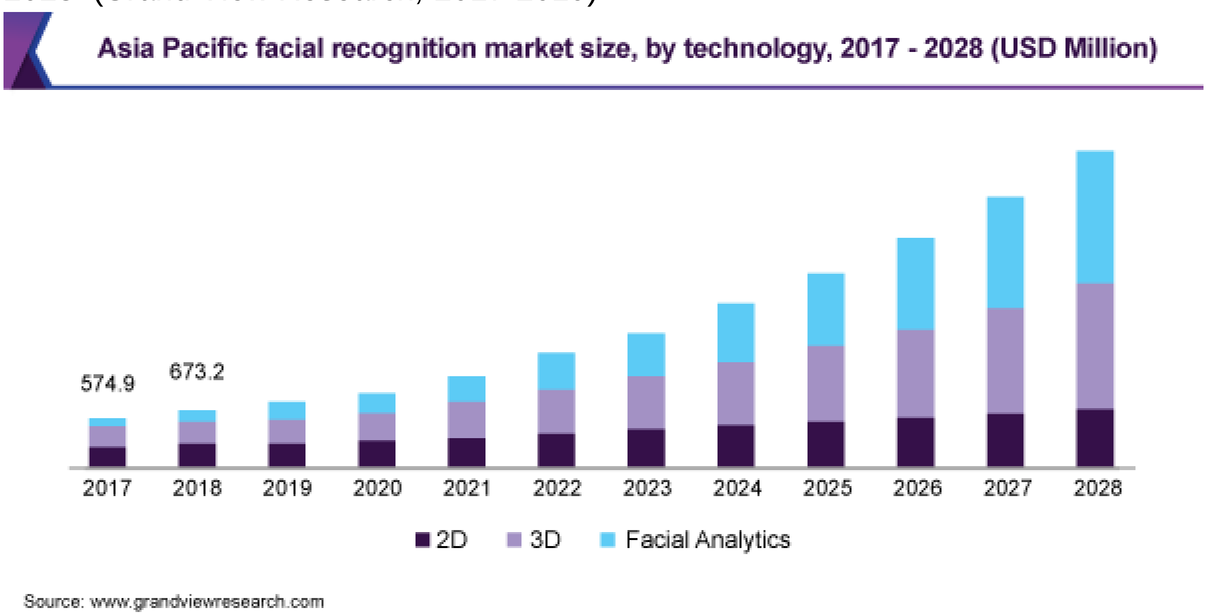
In the domains of computer vision and artificial intelligence, Facial Recognition Technology (FRT) has emerged as a revolutionary and rapidly evolving field. It is a sophisticated system capable of identifying and verifying individuals through the analysis of distinctive facial characteristics extracted from digital images or video frames. FRT has found widespread use in numerous industries, including security, law enforcement, user authentication, retail, and more, by leveraging the power of advanced algorithms and machine learning techniques.

The human face possesses a high degree of individuality, as evidenced by its distinct eye shape, nose structure, and facial contours. FRT capitalizes on this inherent distinction by converting facial biometrics into digital data that can be efficiently processed and compared. Improved hardware capabilities, access to large-scale datasets, and breakthroughs in deep learning methodologies have propelled tremendous advancements in this technology over the past few years.

FRT has already demonstrated its potential to revolutionize various aspects of modern life in this dynamic environment. It is utilized by law enforcement agencies to identify suspects and locate missing persons, thereby enhancing their investigative capacities. Businesses and organizations incorporate FRT into their access control systems, thereby streamlining authentication procedures and bolstering security. The technology has also made its way into consumer electronics, enabling facial unlock features on smartphones and other devices.

As FRT continues to make progress, its adoption has sparked discussions regarding its ethical, legal, and societal implications. Privacy concerns, potential biases, and the responsible use of data are at the forefront of these discussions, compelling researchers and policymakers to navigate the ethical terrain of this transformative technology with caution.

In 2020, the global market for facial recognition was valued at USD 3.86 billion and is projected to expand at a compound annual growth rate (CAGR) of 15.4% from 2021 to 2028. (*Grand View Research,* 2017-2019)



Use Cases of Facial Recogniton

Due to its extensive range of applications, Facial Recognition Technology (FRT) has become an indispensable tool in a variety of industries and fields. One of its primary applications is in access control and security, where FRT is integrated into systems to verify the identity of authorised personnel based on facial biometrics and grant them access to restricted areas.

FRT is extensively utilised by law enforcement agencies for public safety and crime prevention. Comparing facial images captured by surveillance cameras to databases of known criminals aids in identifying and locating suspects. Additionally, it aids in locating and reuniting missing persons with their families.

FRT plays a significant role in the authentication of mobile devices in the realm of technology and personal devices. Numerous smartphones and tablets use facial recognition as a secure and convenient method for unlocking devices and gaining access to sensitive data, ensuring that only authorised users have access.

Moreover, FRT is utilised across industries for user authentication and identity verification. In banking and financial services, where FRT ensures secure online transactions and access to sensitive accounts and services, this is especially evident.

Facial recognition is used to enhance customer experiences in the retail industry. By analysing facial expressions and demographic information, FRT enables businesses to comprehend customer preferences, personalise advertisements, and enhance customer service.

FRT is also utilised for time and attendance management outside of the commercial sector. Using facial recognition, employees can clock in and out, reducing manual errors and streamlining attendance tracking processes.

FRT is utilised in healthcare for patient identification and safety. This technology is utilised by medical facilities to prevent medical identity theft and accurately match patients with their medical records, ensuring patients' safety and confidentiality.

In addition, FRT has applications in event management and security, where it assists in identifying potential threats or individuals on watchlists, thereby ensuring the safety of large gatherings and events.

FRT also benefits the public sector, as government agencies utilise it to streamline processes, verify the identities of citizens requesting various services, and increase overall efficiency.

Additionally, the marketing and advertising industries have embraced FRT. The technology can analyse customer demographics and emotions in real-time, enabling businesses to optimise the effectiveness of their marketing campaigns and advertisements.

Facial Recognition Pipeline

Face recognition pipeline consists of four essential steps for identifying individuals accurately:

Face Detection: The initial step entails locating all faces within an image. Various methods, including Haar cascades, Histogram of Oriented Gradients (HOG), and deep learning-based face detectors, can be used for this purpose.

Face Alignment (optional): In the optional next step, facial landmarks are used to align or normalise the detected faces. This optional step aims to improve the face recognition system's overall accuracy.

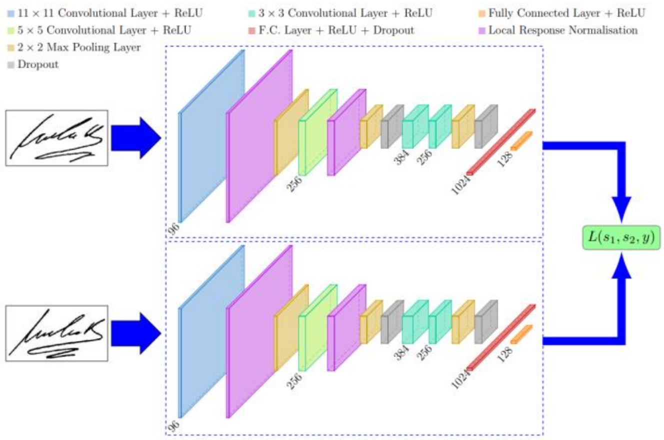
Face Encoding: During this phase, the face image is passed through a model that extracts essential facial features, thereby creating a unique facial representation, or face encoding.

Face Recognition: The final step involves comparing the extracted facial features to a database of known face representations in order to identify a possible match. Various algorithms, including K-Nearest Neighbours (KNN), Support Vector Machine (SVM), and Random Forest, are utilised to conduct this comparison. The algorithm attempts to determine the individual's identity based on the best database match.

Deep Learning-based Face Recognition Algorithms and How They Operate?

In recent years, deep learning algorithms for face recognition have made significant progress, and one of the most important architectures is the Convolutional Neural Network (CNN). Due to their ability to automatically discover hierarchical features from the input data, CNNs are ideally suited for image-related tasks.

Among the CNN architectures, the Siamese network is a notable face recognition technique. The Siamese network is a type of neural network composed of two or more identical sub-networks, also known as "twins" or "arms." These subnetworks share the same set of parameters and weights. The term "Siamese" is derived from Thailand's conjoined twins because the network's structure visually resembles their shared characteristics.



Source: SigNet(1707.02131)

A Siamese network's primary objective is to compare and quantify the similarity between two or more input images. Instead of focusing on direct classification, as is the case with conventional CNNs, the primary objective of the Siamese network is to identify similarities and differences between image pairs.

How the Siamese network operates:

Multiple images are fed into the Siamese network as inputs. These images may depict two distinct faces or the same face in various lighting, angles, or facial expressions.

Shared Sub-Networks: Each input image is processed by identical sub-networks (twins) that share the same architecture and weights. These sub-networks are responsible for feature extraction from input images.

Extraction of Features: The shared sub-networks extract pertinent features from each input image. These characteristics represent high-level image characteristics, such as edges, textures, and facial landmarks.

The extracted features from the two images are then compared, frequently using a distance metric or a measure of similarity. Common distance metrics include the Euclidean and cosine distances.

On the basis of the comparison, the Siamese network is able to determine whether the images belong to the same person (similar) or to different people (dissimilar).

The ability of the Siamese network to compare and measure similarities between input images makes it particularly effective for tasks such as face recognition, in which locating similar features between different facial images is essential for accurate identification. By sharing weights and parameters between the sub-networks, the Siamese network can effectively learn and represent features that are invariant to lighting, pose, and expression variations, enabling robust face recognition performance.

Detailed Approach on Face Recognition System

Libraries Used

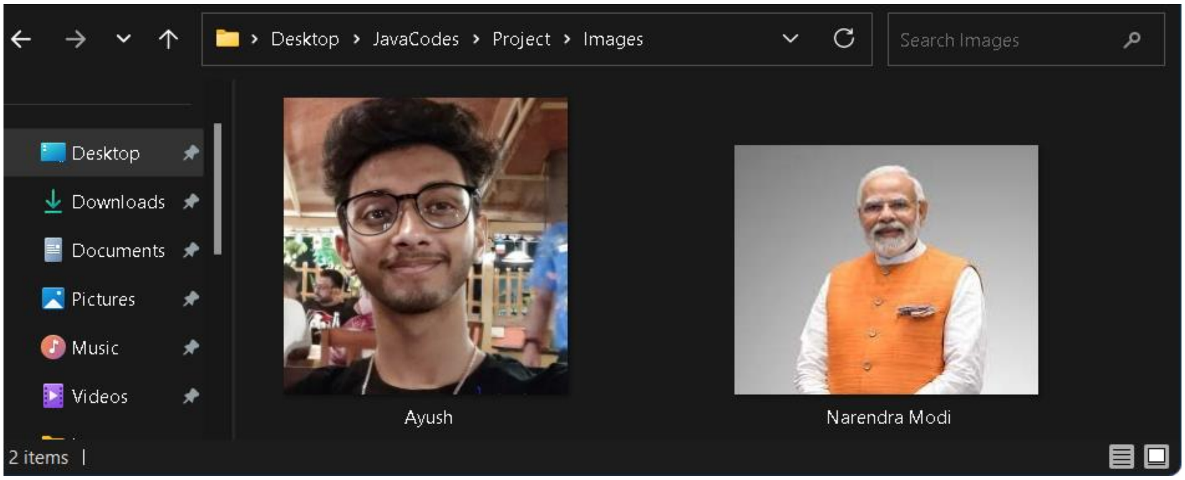
1. OpenCV (cv2): OpenCV (Open Source Computer Vision) is a powerful image processing and computer vision library. The fact that it is written in C++ and has a Python interface makes it suitable for a variety of applications. OpenCV provides an extensive set of functions for image and video processing, feature detection, and object recognition, among other tasks. OpenCV is used for tasks such as reading and displaying images and video streams, resizing images, converting colour spaces, and drawing bounding boxes around detected faces in this face recognition system.

2. face_recognition: Popular Python library face_recognition is built on top of dlib and OpenCV. It is specifically designed for face recognition, making it simple to detect and identify faces in images and video streams. The library employs cutting-edge deep learning techniques to encode faces as numerical vectors (encodings) and compare them to determine similarities and differences. face_recognition facilitates face recognition by offering high-level functions for face detection, face encoding, and face comparison.

3. NumPy: NumPy is an essential Python library for numerical computation. It offers support for large, multidimensional arrays and matrices, as well as a vast collection of mathematical functions for efficiently operating on these arrays. NumPy is used to manage arrays of face encodings, perform mathematical operations for face distance calculation, and manipulate image pixel data in the face recognition system.

4. os: The os library is an integral Python module used for operating system interaction. It provides functions for working with file paths, directories, and operations related to the system. In this face recognition system, the os module is utilised to navigate the file system and retrieve images from a specific directory.

Image Information and Encoding



The system utilises a collection of images stored in the above shown directory. The programme initially reads the images from the specified directory and stores them in the 'images' list. It additionally extracts the individual names from the filenames and stores them in the 'classNames' list.

Using the 'face_recognition' library, the function 'encoding(images)' is responsible for encoding the face information from each image. It converts the image's colour space from BGR to RGB and extracts each image's facial encodings. These encodings are stored in the 'encodeList' list.

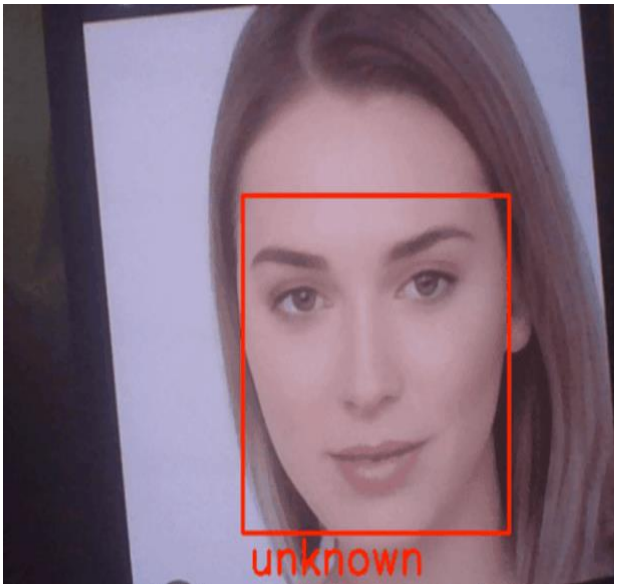
Live Face Recognition

The 'captureFunction(knownEncode)' function implements the core functionality of the system. Using a camera feed, this function performs face recognition in real time. It creates a video capture object from the camera device (assuming it is the default camera with index 0).

The function then enters an infinite loop to capture images from the camera feed continuously. Within each iteration, the captured frame is resized to optimise performance and converted to the RGB colour space.

The system employs 'face_recognition' to identify face locations and encodings within the captured frame. If no face is detected, a count of consecutive frames without a detected face is maintained.

If a face is detected, the 'compare_faces()' function compares the detected face's encoding with the stored encodings. It calculates the face distance using the 'face_distance()' function to find the closest match, taking into account a similarity threshold.



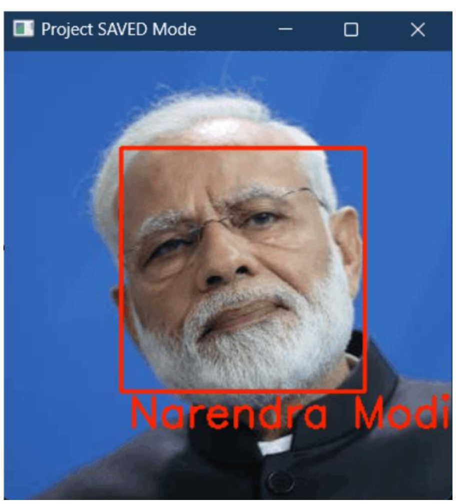
If a match is found (i.e., the face belongs to an encoded person), the system retrieves the person's name from the 'classNames' list and draws a rectangle containing the person's name around the detected face.

If no match is found, the system labels the face 'unknown'.

If consecutive frames lack faces, the 'count' variable is incremented to indicate the absence of faces.

The user can press the 's' key to terminate live face recognition. The system will then release the camera and end the loop.

Face Recognition Using a Saved Image



Additionally, the system provides the capability to compare a saved image to the stored face encodings. This is accomplished via the function: 'savedComparison(knownEncode)'.

This function reads a single image from the specified file path and resizes it prior to processing. Using 'face_recognition', the system then finds face locations and encodings in the image. In the same manner as in the live recognition procedure, the encoding is compared to the stored encodings.

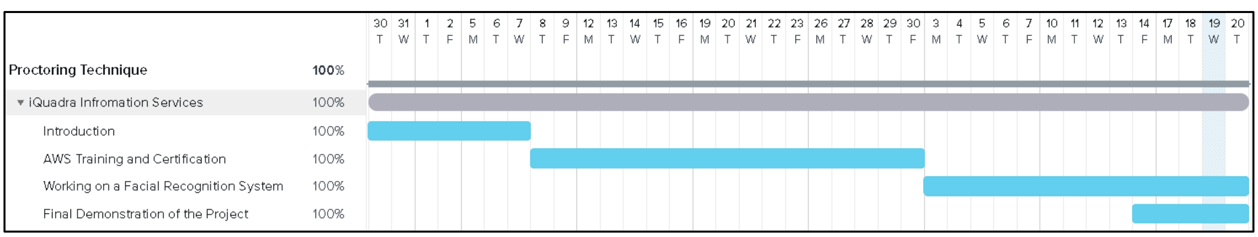
If a match is found, the system retrieves the individual's name from the 'classNames' list and annotates the image with a rectangle and the individual's name. If no match is detected, the system labels the face 'unknown'.

Conclusion

The process of developing a Face Recognition Technology (FRT) system has been enlightening, broadening my understanding of computer vision, deep learning, and AI applications. I have acquired a comprehensive comprehension of face detection, facial encodings, and face comparison techniques. Utilizing the OpenCV and face_recognition libraries enabled me to process images, manage video feeds, and encode faces for comparison in an efficient manner. Implementing live face recognition and single-image face comparison challenges refined my real-time computer vision skills and raised my awareness of the ethical issues associated with AI technologies. This experience has inspired me to continue investigating AI innovations responsibly and to contribute to the advancement of computer vision technologies in a variety of practical applications.

In this project, I learned the significance of debugging skills in problem-solving. Understanding the potential impact of face recognition systems in areas such as security and surveillance provided valuable insight into the broader societal implications of AI-driven technologies. As I continue to pursue additional challenges and advancements in AI, I am enthusiastic about the opportunities for ongoing learning and development that lay ahead. The Face Recognition Technology initiative has sparked my interest in artificial intelligence and inspired me to make positive contributions to this dynamic field.

The following gantt chart represents my overall work



Appendix

The following code was implemented for the completion of the project.

#Importing Libraries

```
import cv2 as cv
import face_recognition as fr
import numpy as np
import os
```

#Image Information and Encoding

```
path=r'C:\Users\ayush\Desktop\JavaCodes\Project\Images'
images=[]
classNames=[]
myList=os.listdir(path)

for cl in myList:
    path_img = os.path.join(path,cl)
    curImg= cv.imread(path_img)
    images.append(curImg)
    classNames.append(os.path.splitext(cl)[0])

def encoding(images):

    encodeList=[]
    for img in images:
        img = cv.cvtColor(img,cv.COLOR_BGR2RGB)
        encode = fr.face_encodings(img)[0]
        encodeList.append(encode)

    return encodeList

knownEncode=encoding(images)

print ('-------Stored Image Encoded------')
```

#Live Face Recognition Function

```
def captureFunction(knownEncode):
```

```
count =0;
prev_faces=[]

capture = cv.VideoCapture(0)
while True:
    isTrue,cap = capture.read()


    imgResized = cv.resize(cap,(0,0),None,0.25,0.25)
    imgRGB = cv.cvtColor(imgResized,cv.COLOR_BGR2RGB)


    if cv.waitKey(20)== ord('s'):
        break;

    faceLocList = fr.face_locations(imgRGB)
    encodeList2 = fr.face_encodings(imgRGB)

    if encodeList2==[]:
        if prev_faces == []:
            count = count
        else:
            count+=1
        prev_faces = []
    else:
        # Faces detected
        prev_faces = encodeList2

    print(count)

    for faceLoc,faceEncode in zip(faceLocList,encodeList2):
        matches = fr.compare_faces(knownEncode,faceEncode)
        faceDis = fr.face_distance(knownEncode,faceEncode)

        matchIndex = np.argmin(faceDis)

        if matches[matchIndex]:
            name=classNames[matchIndex]

        else:
            name='unknown'
```

```
            y1,x2,y2,x1=faceLoc

            y1,y2,x1,x2=y1*4,y2*4,x1*4,x2*4
            cv.rectangle(cap,(x1,y1),(x2,y2),(0,34,255),thickness=2)
            cv.putText(cap,name,(x1+5,y2+25),cv.FONT_ITALIC,1,(0,34,255),th
ickness=2)
            cv.imshow('Project Camera',cap)
    print(count)
    capture.release()
    cv.destroyAllWindows()

captureFunction(knownEncode)
```

#Face Recognition using saved image Function

```
def savedComparison(knownEncode):

img=cv.imread(r'C:\Users\ayush\Desktop\JavaCodes\Project\Sample\aaaa.jpg')
    imgResized = cv.resize(img,(0,0),None,0.25,0.25)
    imgRGB = cv.cvtColor(imgResized,cv.COLOR_BGR2RGB)



    faceLocList = fr.face_locations(imgRGB)
    encodeList2 = fr.face_encodings(imgRGB)

    for faceLoc,faceEncode in zip(faceLocList,encodeList2):
        matches = fr.compare_faces(knownEncode,faceEncode)
        faceDis = fr.face_distance(knownEncode,faceEncode)

        matchIndex = np.argmin(faceDis)

        if matches[matchIndex]:
            name=classNames[matchIndex]

        else:
            name='unknown'


        y1,x2,y2,x1=faceLoc
```

```
        y1,y2,x1,x2=y1*4,y2*4,x1*4,x2*4
        cv.rectangle(img,(x1,y1),(x2,y2),(0,34,255),thickness=2)
        cv.putText(img,name,(x1+5,y2+25),cv.FONT_ITALIC,1,(0,34,255),thickn
ess=2)
        imgResized = cv.resize(img,(0,0),None,0.5,0.5)
        cv.imshow('Project SAVED Mode',img)

        cv.waitKey(0)

savedComparison(knownEncode)
```

References

Nigam, A., Pasricha, R., Singh, T., & Churi, P. (2021). A Systematic Review on AI-based Proctoring Systems: Past, Present and Future. *Education and Information Technologies*, *26*. https://doi.org/10.1007/s10639-021-10597-x

Sah, L. K., Singh, D. R., & Sah, R. K. (2020). Conducting qualitative interviews using virtual communication tools amid COVID-19 pandemic: A learning opportunity for future research. *Journal of the Nepal Medical Association*, *58*(232), 1103–1106. https://doi.org/10.31729/jnma.5738

Zhang, Z., Zhang, M., Chang, Y., Esche, S., & Chassapis, C. (2016). A Virtual Laboratory System with Biometric Authentication and Remote Proctoring Based on Facial Recognition. *Computers in Education Journal*, *7*, 74–84.

Dey, S., Dutta, A., Toledo, J. I., Ghosh, S. K., Llados, J., & Pal, U. (2017). SigNet: Convolutional Siamese Network for Writer Independent Offline Signature Verification. ArXiv. /abs/1707.02131. (n.d.).

Face Recognition with Python, Dlib, and Deep Learning | *Don't Repeat Yourself*. (2022, October 10). Don't repeat yourself. Retrieved July 17, 2023, from https://dontrepeatyourself.org/post/face-recognition-with-python-dlib-and-deep-learning/#face-recognition-pipeline

Grand View Research. (n.d.). Facial Recognition Market Size, Share & Trends Analysis Report: Methodology. (2017-2019). https://www.grandviewresearch.com/industry-analysis/facial-recognition-market/methodology#

Rovai, M. (n.d.). *Real-Time Face Recognition: An End-To-End Project*. Towards Data Science. Retrieved July 17, 2023, from https://towardsdatascience.com/real-time-face-recognition-an-end-to-end-project-b738bb0f7348

Glossary

AI	Artificial Intelligence
ML	Machine Learning
OpenCV	Open Source Computer Vision Library
FRT	Facial Recognition Technology