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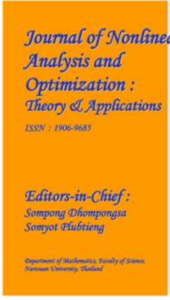

INTELLIGENT WEB-BASED TRACKING SYSTEM EMPOWERED BY ARTIFICIAL INTELLIGENCE

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ABSTRACT:

The fields of teaching and learning have advanced significantly since COVID 19. Universities are becoming digital in order to give their students additional resources. Students now have more options to study and advance their abilities at their own speed thanks to technology. There has been a movement in evaluation methods toward online exams. The biggest obstacle to online mode is probably the lack of a physical invigilator. From this point forward, demand for AI-powered proctoring solutions is rising along with the popularity of online proctoring services. In this project, we outline a method for creating a multi-modal system in order to circumvent a proctor's physical presence throughout the test. With active window capture and a webcam, we recorded video. The test-taker's face is recognized and examined in order to predict his emotional state. His feature points are identified in order to determine his head position. Moreover, elements such as a phone, a book, or the existence of another individual are identified. By combining these models, an intelligent rule-based inference system is produced that can determine whether any malpractice occurred during the examination.

1. INTRODUCTION

Nowadays most educational institutions have been compelled to convert to an online education format, due to the pandemic crisis. Colleges began offering online lessons and assessments for a variety of courses. The COVID-19 Pandemic also had an impact on entrance examinations and the recruitment processes, which uses a written test to select candidates. In this context, academic misconduct is on the rise, whether in the form of plagiarism or cheating during the examination. A proctoring system is required to monitor all students, as there are more methods and possibilities for a student to cheat when tests are conducted online.

Even with numerous checks in place, such as the unique way proposed to electronically invigilate students during tests held in remote places, the possibility of a high incidenc of fraud in online examinations makes monitoring more difficult. As E-Learning courses become popular, so does the likelihood of a student cheating in tests in a number of ways, such as multi-window surfing, asking peers for answers, and even bringing unethical materials into the examination.

There are various proctoring software available to assist instructors in conducting tests online. The usual criteria for taking tests from anywhere is indeed a computer with acamera and an active internet connection. However, they only ensure integrity through the accreditation of professional proctors. But they still continue to bank on the human exam monitoring procedure. As a result, automating the monitoring process while maintaining reliability and low cost is a difficult task that is tackled in this work.

Keeping all this in view, we developed a model that:

• Detects face of the examinee.

• Detects the presence of a cell phone, book or any other person that can be used for malpractice.

• Detects head pose, eye-ball and mouth movement of the examinee.

Apart from that, the speech from the microphone will be recorded, converted to text, and will also be compared to the text of the question paper to report the number of common words spoken by the test-taker.

2. LITERATURE SURVEY

In [1] written by Neelesh Chandra M, Piyush Sharma, Utkarsh Tripathi, Ujwal Kumar, and Dr. G.C. Bhanu Prakash.Several papers are analysed relating to an automated examination system that can identify and flag any fraudulent activity to ensure fair examination concept. The emphasis is on identifying errors by integrating computer audio and visual motions through camera and microphone. Eye ball tracking, Lip movement, Face spoofing, Mobile phone de- tection, Additional member detection in frame, and more characteristics are included in vision-based tracking. In audio- based flagging, mapping of audio to text conversion using Google voice recognition API is provided, coupled with flagging of significant noise disruptions.

W.Wang, K.Xu, H.Niu, and Xiangrong in [2] focuses on the absence of direct, timely,, and efficient communication in online courses. They also put light on studies mentioning a near and stable relationship between a person’s facial expressions and emotions. A method is proposed to use a face recognition (FER: Facial Expression

Recognition) system with online course platforms. The FER algorithm collects face photos from students utilising device cameras, and the facial expressions are evaluated and categorised into eight types of emotions. An online course with 27 students was utilised to evaluate the suggested technique, and the results showed that it functions well in a variety of contexts. This approach is also applicable to other comparable contexts, such as online exams.

The authors, Swathi Prathish, Athi Narayanan, and S. Kamal Bijlani in [3], created a well-rounded inference system capable of assisting the instructor in monitoring the students taking an online test. A system with three primary elements is proposed: active window capture, audio capture and video input processing. At the moment of inspection, active window capture allows for the automatic capture of all running processes in the system. The video input allows you to observe the student's face during the exam. The examinee's communication with someone else present can be detected via audio capture. It can also record variations of sounds in the testing environment.

In [4], focus by Aiman Kiun is on fraud detection in video recordings of examinations using Convolutional Neural Networks (CNN), whereby image classification models were built using Rectified activation units (RAU), which in turn displayed fantastic results for big size data sets. An interface, video processing, and frame categorization were all part of their system. The interface feeds the footage of the students taking the test into a pipeline consisting of a number of algorithms. The enormous recording would be reduced to a small number of minimalistic frames, and several duplicate or similar-looking frames would be removed. The aforemen- tioned frames are then sent into a pipeline, where they are used to train CNNs to recognise objects in the second part of the pipeline.

The work given by N.L Clarke and P. Dowland in [5] proposes a realistic strategy to permit remote and electronic proctoring during student examinations. The technique entails using transparent recognition to provide non-disruptive and permanent identification of the student's identity during the test taking process. A model is built, and an evaluation of the technology of the generated platform demonstrates the method's effectiveness.

2.1 OBJECTIVE

- To overcome the difficulties of offline examinations using a better proctored system.
- To provide a hassle-free smart exam proctoring system for conducting online examinations.

2.2 PROBLEM DEFINITION

Due to the current covid situation, it is not possible to conduct paper-based examination. Online examination requires a proctoring system to maintain credibility. An alternative to this is to conduct AI based exam proctoring.

III.SYSTEM ANALYSIS

SYSTEM ARCHITECTURE:

EXISTING SYSTEM

- Physical proctoring of the exam involves invigilator being physically present at the examination center.
- For each batch of 50 students one person is needed to monitor the activities of the exam. This is traditional approach followed by many entities while managing examination process.

DISADVANTAGES

- Offline exam required large administrative and operational setup.
- Arrangement of question papers and answer sheet takes heavy cost.
- Chances of cheating or use of unfair means.
- To take offline exam of more candidates more invigilators are required.

PROPOSED SYSTEM

Online exam activity can reduce cost of physical exam up to certain extent. Online Examination Process can eliminate logistical activities related to paper-based exam process significantly.

Throughout the exam, we employed a webcam to obtain video input that was used to identify several factors such as the examinee’s emotions, head pose estimate, multiple person detection, cell phone and book detection. When all of these features are integrated, they are utilized to detect harmful behaviors that may occur during the exam. As a result, the system makes a decision on the users’ actions. Fig.1 depicts the block diagram of the mentioned system.

The remainder of this section elaborates the following topics:

1) Face Detection

2) Person and Phone Detection

3) Facial Landmarks Detection

a) Eye-ball Tracking

b) Mouth Movement Tracking

c) Head Pose Estimation

FUNCTIONALITIES

It includes four vision-based features as well as speech-to-text conversion:

1. Keep a watch on the candidate's eyes and note whether they're gazing left, right, or up.
2. By measuring the space between the candidate's lips at the start, you can see if he expands his mouth.
3. Find and report any mobile phones or other objects.
4. To figure out where the person is looking, estimate their head posture.
5. Create a text file using the user's words.

1. Face Detection

Face detection is a difficult computer vision task that involves detecting and locating people in images. Faces were previously found using Dlib's frontal face HOG detector. However, it did not produce satisfactory outcomes. Face identification models like Haar, dlib, Multi-task Cascaded Convolutional Neural Network (MTCNN), and OpenCV's DNN module were compared. The DNN module in OpenCV gives the best result. Eye tracking, mouth open close detection, and head position estimation all rely on face detections.

For the face detector, an extra quantized model has been added, which may be used by setting the option quantized to True when calling the get face_detector method(). On our machine, the conventional version of the face detector delivered 17.5 frames per second, while the quantized version gave 19.5 frames per second. Because it is uint8 quantized, this would be extremely handy when distributing on edge devices.

2. Person and Phone Detection

To recognize people and mobile phones in the webcam feed, we used the pre-learned weights of YOLOv3 trained on the COCO dataset. Using pre-trained YOLOv3, We counted persons in a webcam. An alarm can be triggered if the count is not equal to one. The COCO dataset's mobile phone index is 67, thus we need to see whether any class indexes are equivalent to that, and then we can report a mobile phone. We can establish a single thread for eye-tracking and mouth detection because they are both based on dlib, and another thread can be used for the YOLOv3 tasks of people counting and mobility detection. YOLOv3 is applied to the webcam stream in the count _people_and_phone() function. The classifications of objects observed are then examined, and if more than one person or a mobile phone is discovered, suitable action is performed.

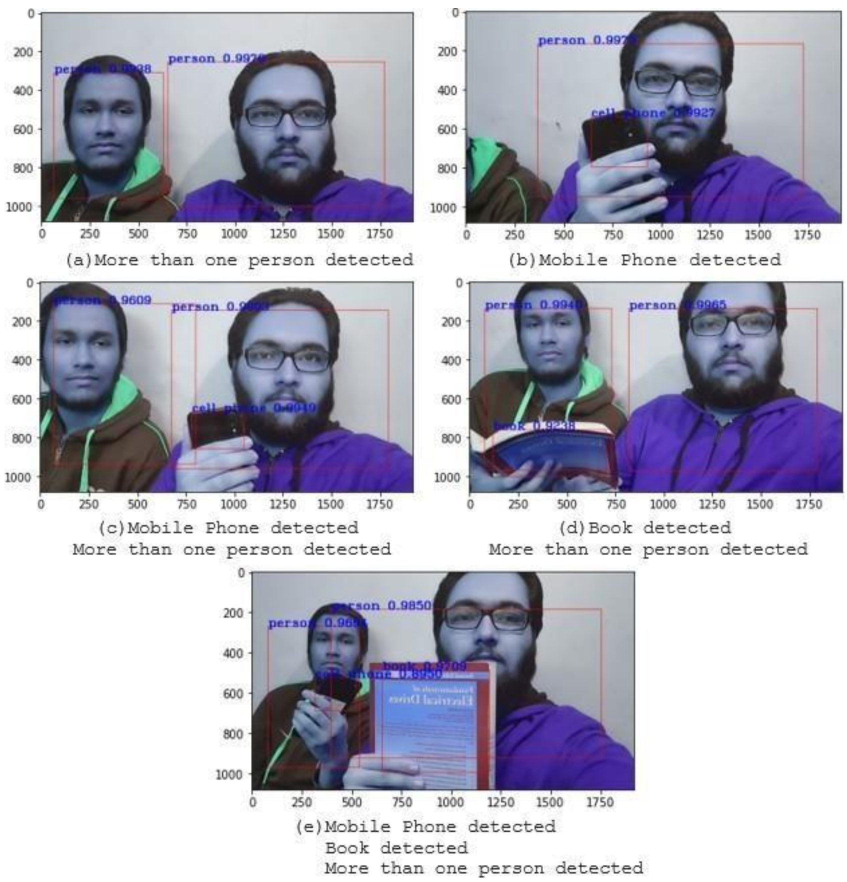


Fig 2.4.1 Output for Cell Phone, Book and Multiple person detection

3. Facial Landmarks Detection

The task of detecting and tracking significant facial landmarks is known as facial landmark detection. Previously, Dlib's model was used, however it does not work well when the face is at an angle. As a result, the proposed model for landmark detection is based on a convolutional neural network developed with tensorflow. It is used for tracking eyes, mouth opening detection, and head pose estimation. Caffe model of OpenCV's DNN module was used for the purpose of face detection. For facial landmark detection, we used a dlib's pre- trained model [7]. It gives 68 facial landmarks.

Six facial Landmark points were used which are: nose tip, chin, extreme left and right points of lips, and the left corner of the left eye and right corner of the right eye. The standard 3D coordinates of these facial landmarks were used and the rotational and translational vectors at the nose tip were estimated. After obtaining the required vectors, those 3D points were protected on a 2D surface that is our image.

a. Eye-ball Tracking

We'll need a face key points detector that can detect eyes in real time for eye tracking. For this, we'll use the dlib library's pre-trained network, which can recognize '68 key spots.' Dlib is utilized because, unlike a Convolutional Neural Network model, it can make predictions in real time.

Before we can continue on to image processing, we must first locate eyes. To find the eyes, we must first locate a face. The facial keypoint detector takes a rectangular object from the dlib module as input, which is just a set of face coordinates. The integrated frontal face detector of dlib is used to find faces.

b. Mouth Movement Tracking

This is used to see if the candidate speaks during the examination. This is analogous to the detection of eyes. This task makes use of Dlib's facial keypoints once more. For 100 frames, the distance between the lips keypoints (5 outer pairs and 3 inner pairs) is recorded. To achieve the final result, this is then averaged. The distance between the points increases as the user opens his or her mouth, and if the increase in distance is greater than a specific amount for at least three other pairs and two inner pairs, the user is flagged.

c. Head Pose Estimation

To determine where the head is facing, head pose estimation is performed. Because of the several steps required to solve it, head position estimation is a challenging problem in computer vision. We must first locate the face in the frame, followed by the numerous facial markers. In today's world, recognizing a person's face appears to be a simple process, and this is especially true when the person is facing the camera. When the face is at an angle, the difficulty occurs. Add to that the fact that some facial landmarks are obscured by head movement. Then, in order to get the inclination, we must convert the points to 3D coordinates. Six points of the face namely nose tip, chin, extreme left and right points of lips, the left corner of the left eye, and the right corner of the right eye are required.

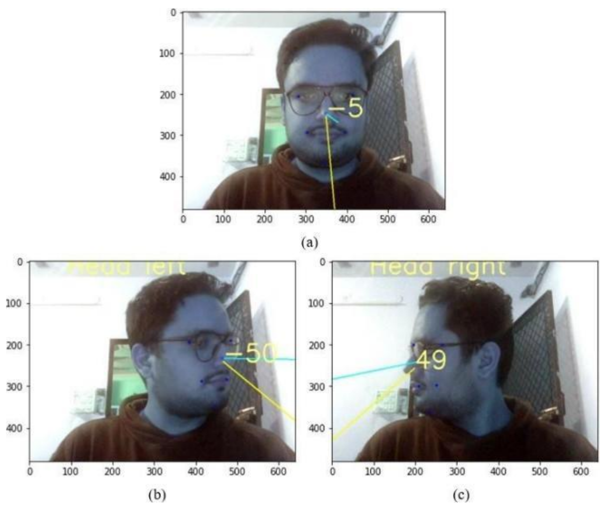


Fig 2.4.2 Output for Head Pose Estimation Model:
(a) Examinee in frontal stable state,
(b) Examinee viewing left,
(c) Examinee viewing right

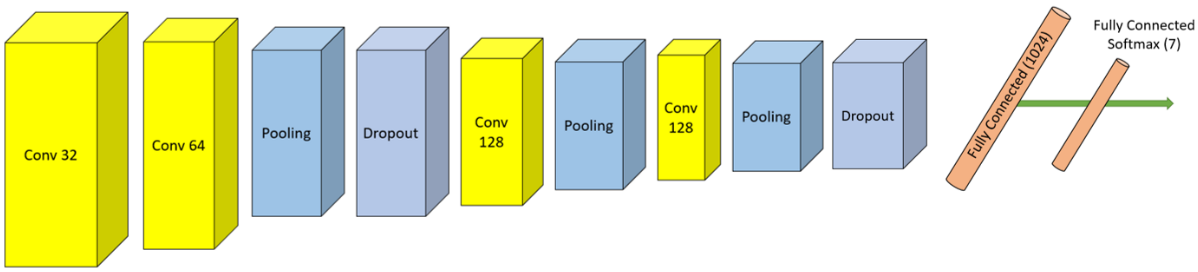


Fig 2.4.3 Architecture of the proposed system

ADVANTAGES

The use of AI-based remote proctoring and invigilation technologies mainly improves the authenticity of the exam conducted in a remote environment. Here are some of the significant advantages that AI-based remote proctoring offers.

- Better Accuracy
- Improved Security
- Better Scalability
- Cost-effective
- Smarter and Intelligent

FEASIBILITY STUDY

Preliminary investigation examines the project feasibility, the likelihood that the system will be useful to the organization. The main objective of the feasibility study is to test the Technical, Operational and Economic feasibility for adding new modules and debugging old running system. All system is feasible if they are unlimited resources and infinite time. There are aspects in the feasibility study portion of the preliminary investigation:

- Technical Feasibility
- Operational Feasibility
- Economic Feasibility

ECONOMIC FEASIBILITY

A system can be developed technically and that will be used if installed must still be a good investment for the organization. In the economic feasibility, the development cost in creating the system is evaluated against the ultimate benefit derived from the new systems. Financial benefits must equal or exceed the costs.

The system is economically feasible. It does not require any additional hardware or software. Since the interface for this system is developed using the existing resources and technologies available at NIC, there is nominal expenditure and economic feasibility for certain.

OPERATIONAL FEASIBILITY

Proposed projects are beneficial only if they can be turned out into information systems that will meet the organization's operating requirements. Operational feasibility aspects of the project are to be taken as an important part of the project implementation. Some of the important issues raised to test the operational feasibility of a project include the following: -

- Is there sufficient support for the management from the users?
- Will the system be used and work properly if it is being developed and implemented?
- Will there be any resistance from the user that will undermine the possible application benefits?

This system is targeted to be in accordance with the above-mentioned issues. Beforehand, the management issues and user requirements have been taken into consideration.

The well-planned design would ensure the optimal utilization of the computer resources and would help in the improvement of performance status.

TECHNICAL FEASIBILITY

The technical issues usually raised during the feasibility stage of the investigation include the following:

- Does the necessary technology exist to do what is suggested?
- Does the proposed equipment have the technical capacity to hold the data required to use the new system?
- Can the system be upgraded if developed?
- Are there technical guarantees of accuracy, reliability, ease of access and data security?

The model is generated using OpenCV and Dlib library of Python. Face detection is performed using the Histogram of Oriented Gradients based face detector, and the landmarks calculation are estimated using the 68-point landmark estimation algorithm. For any (most) given related input weights, configuration and names file, it predicts the name of the person. The software and hardware requirements for the development of this project are not many and are already available in-house at NIC or are available as free as open source. The work for the project is done with the current equipment and existing software technology.

IV.IMPLEMENTATION

4.1 MODULES DESCRIPTION

1. Real Time Video Input:

Real time video input is taken from the user with the use of Python's OpenCV library. VideoCapture() function is used take the input from either the integrated camera or web camera.

2. Face Detection:

The real time video input must be preprocessed before moving on to the next step in the algorithm pipeline. Face detection can then be performed on the preprocessed input.

<u>Image pre-processing:</u> The input needs to be pre-processed, i.e., flipped, resized and converted to greyscale. As the frame received from the web camera is automatically flipped, we need to re-flip it using OpenCV flip() function. Resizing is done using

imutils's resize() function. We convert the input to greyscale using OpenCV cvtColor(), as the complexity of dealing with greyscale pixels is lesser than compared to the coloured ones.

<u>Face Detection:</u> Dlib's Histogram of Oriented Gradients (HOG) algorithm based face detector is used for detecting faces in the pre-processed video input. In this algorithm, the gradient direction of an image in localized regions is used to build histograms. HOG is preferred as it is more accurate compared to Haar cascades, and the false positive ratio is smaller. It also allows motion of the user to be overlooked and hence is more practical. A call to the get_frontal_face_detector() function is enough to activate the face detector.

3. Facial Landmark Estimation:

Dlib library's 68 point facial landmark algorithm based predictor is used. This algorithm locates 68 distinct landmarks around the face. We make use of the shape_predictor () function in order to initialize it.

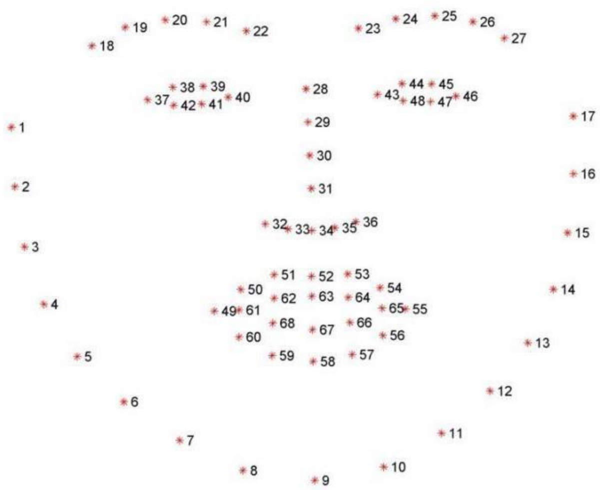


Fig 4.1.1 68 Facial landmarks mapped on the face

The 68 distinct landmarks estimated by dlib's 68 point landmark estimation algorithm are shown in Fig 4.1.1. Out of these, we are interested in the landmarks around the eyes mouth, and the nose.

We Extract the left and right eye coordinates, mouth coordinates and the nose pointer, then draw contours around eyes and mouth using OpenCV's drawContours() function. Using the extracted landmarks, the Eye Aspect Ratio (EAR) and Mouth Aspect Ratio (MAR) values are calculated.

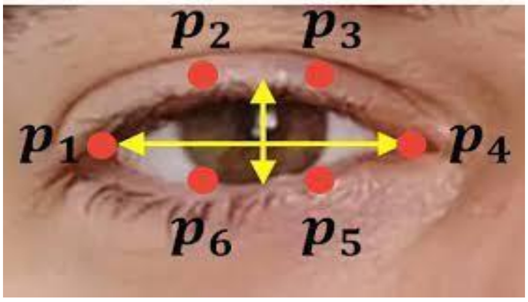


Fig 4.1.2 Landmarks around the eye

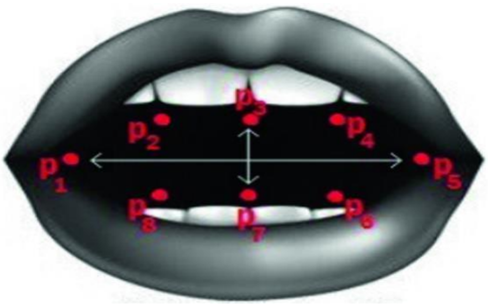


Fig 4.1.3 Landmarks around the mouth

4. Real-time eye tracking:

The first step is to download the required packages. Installation via pip Other than this we will need a facial keypoints detector that can detect eyes in real-time. For this will use a pre-trained network in the dlib library which can detect '68 key points'. Dlib is used because it can give predictions in real-time, unlike a CNN model which was very important for making an AI for online proctoring.

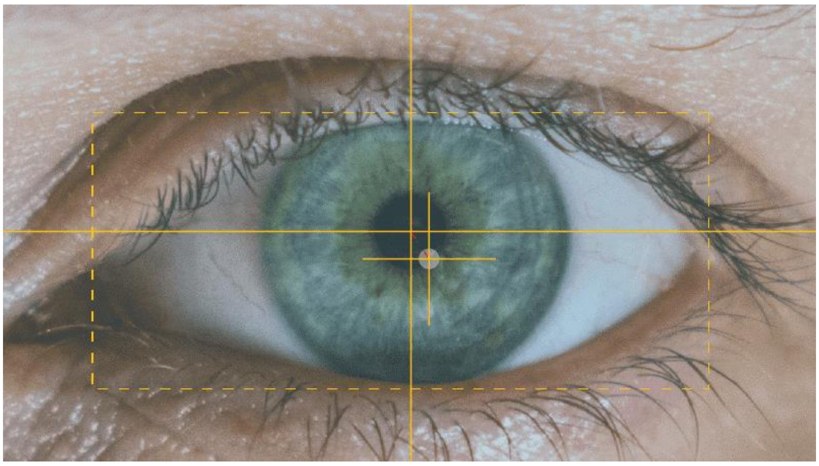


Fig 4.1.4 Eye-ball Tracking

5. Real-time Head Pose Detection:

Head pose estimation is a challenging problem in computer vision because of the various steps required to solve it. Firstly, we need to locate the face in the frame and then the various facial landmarks. Now, recognizing the face seems a trivial task in this day and that is true with faces facing the camera. The problem arises when the face is at an angle. Add to that some facial landmarks are not visible due to the movement of the head. After this, we need to convert the points to 3D coordinates to find the inclination. Sounds like a lot of work? Don’t worry we will go step by step and refer two great resources that will make our work a lot easier.

We need six points of the face i.e. is nose tip, chin, extreme left and right points of lips, and the left corner of the left eye and right corner of the right eye. We take standard 3D coordinates of these facial landmarks and try to estimate the rational and translational vectors at the nose tip. Now, for an accurate estimate, we need to intrinsic parameters of the camera like focal length, optical center, and radial distortion parameters. We can estimate the former two and assume the last one is not present to make our work easier. After obtaining the required vectors we can project those 3D points on a 2D surface that is our image.

6. Person and Phone Detection:

YOLOv3 pre-trained model can be used to classify 80 objects and is super-fast and nearly as accurate as SSD. It has 53 convolutional layers with each of them followed by a batch normalization layer and a leaky RELU activation. To downsample, instead of using pooling they have used a stride of 2 in convolutional layers. The input format for it is that the images should be in RGB (so if using OpenCV remember to convert), having an input type of float32, and can have dimensions 320x320 or 416x416 or 608x608.

Use yolo to get the predictions on the image. Load the class names files containing all the object names for which the model was trained.

Now to count persons or anything present in the classes.txt we need to know its index in it. The index of person is 0 so we need to check if the class predicted is zero then we increment a counter.

V. RESULTS

5.1 OUTPUT SCREENS

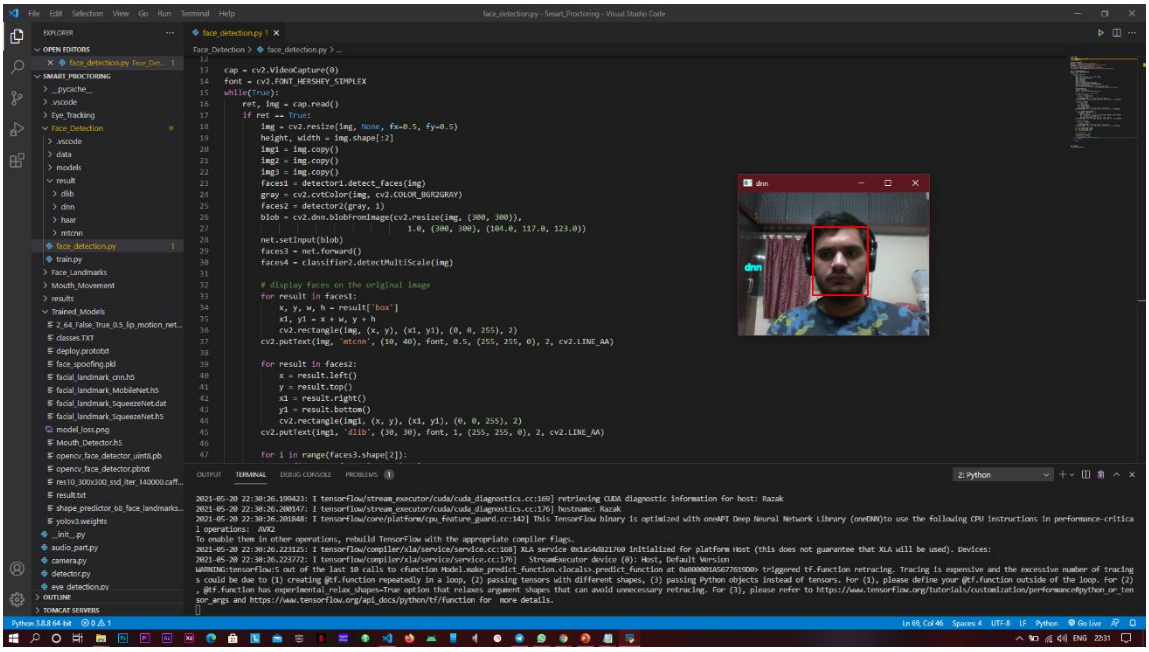


Fig 8.1.1 Detecting Face

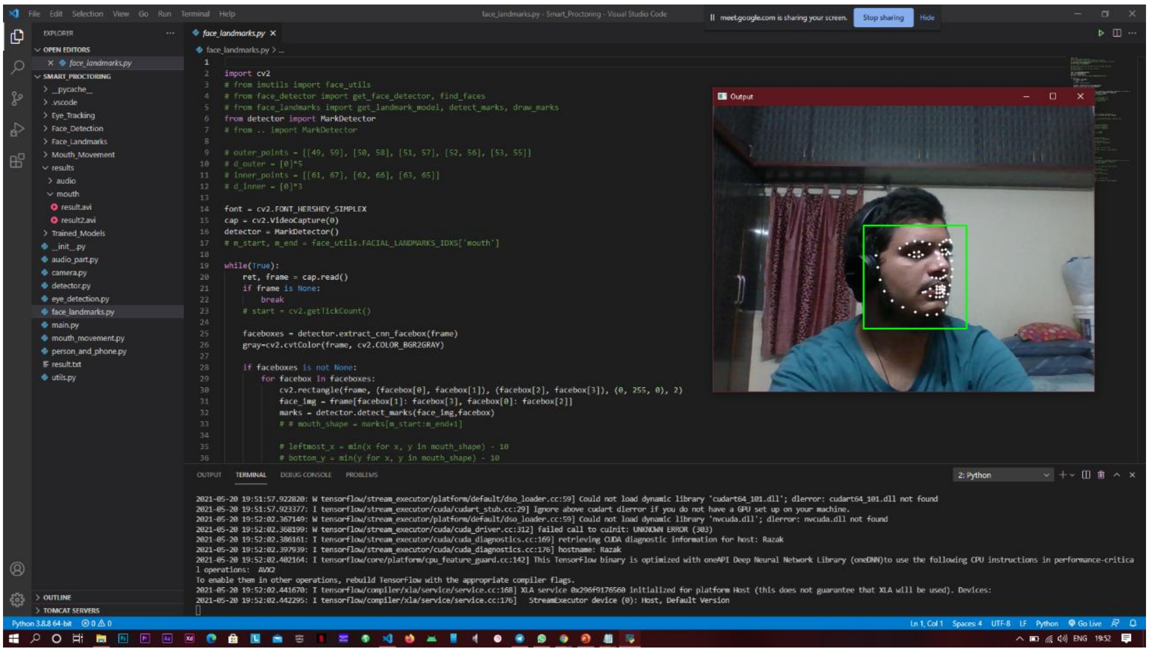


Fig 8.1.2 Detecting Face Landmarks

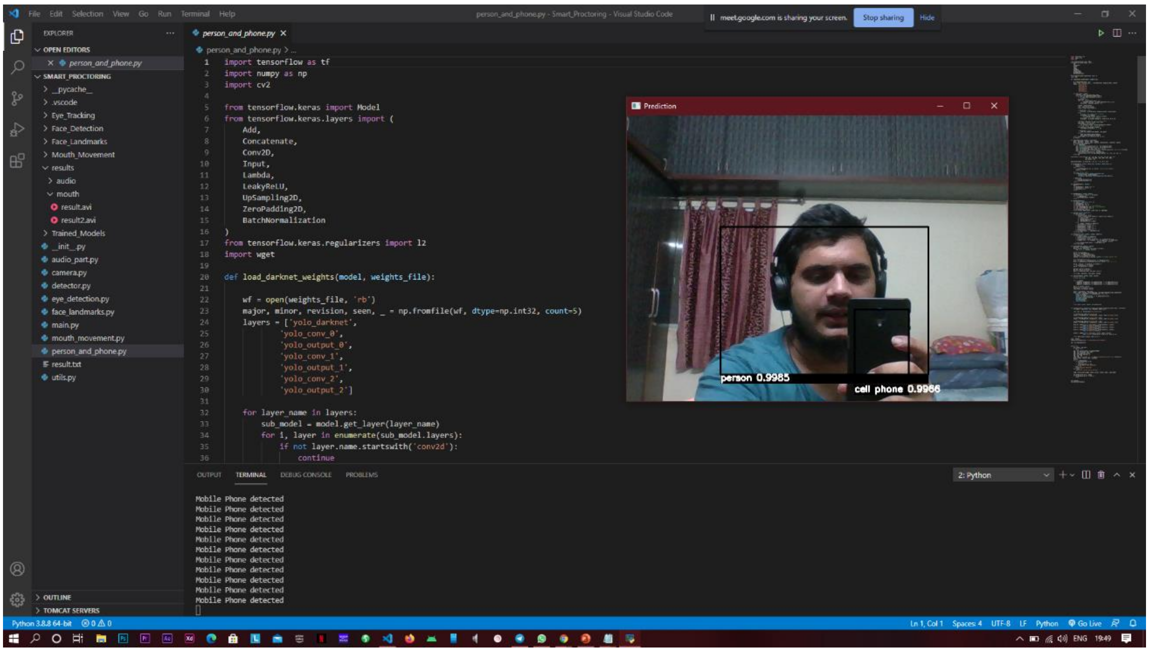


Fig 8.1.3 Detecting phone

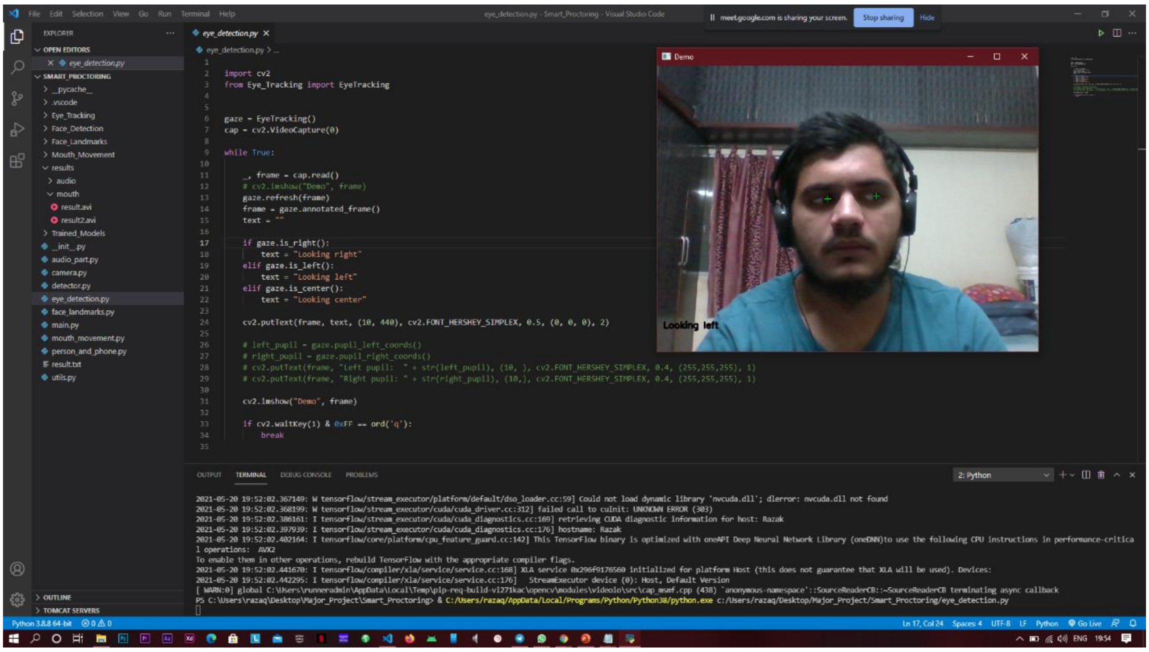
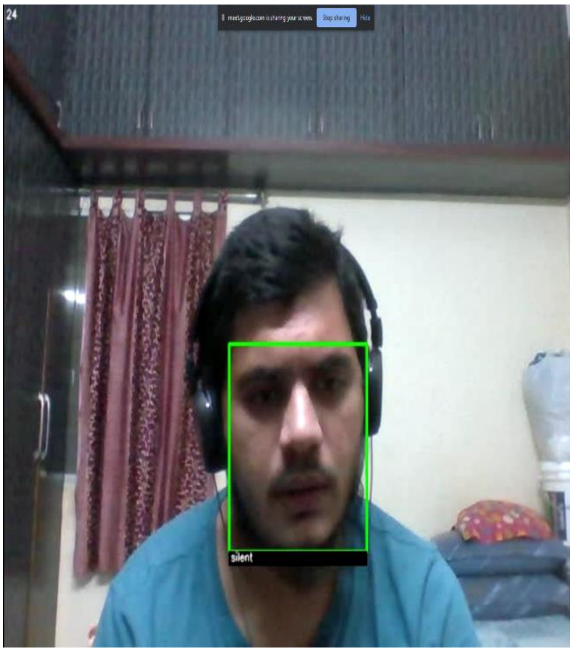


Fig 8.1.4 Tracking Eye-ball



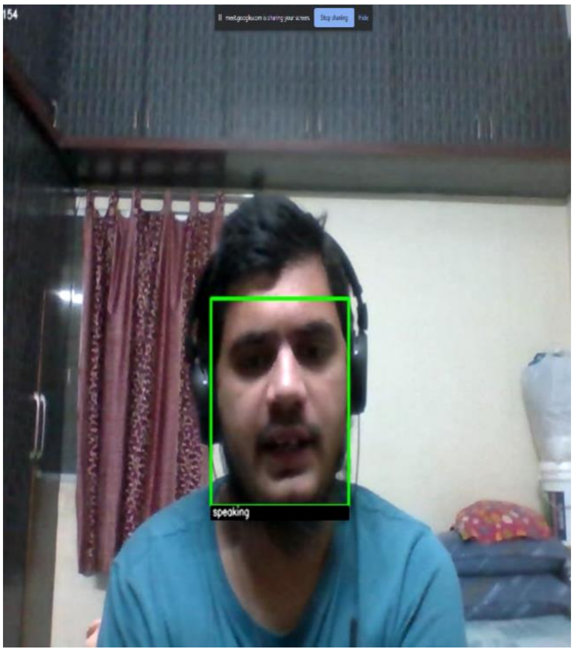


Fig 8.1.5 Detecting Mouth Movement

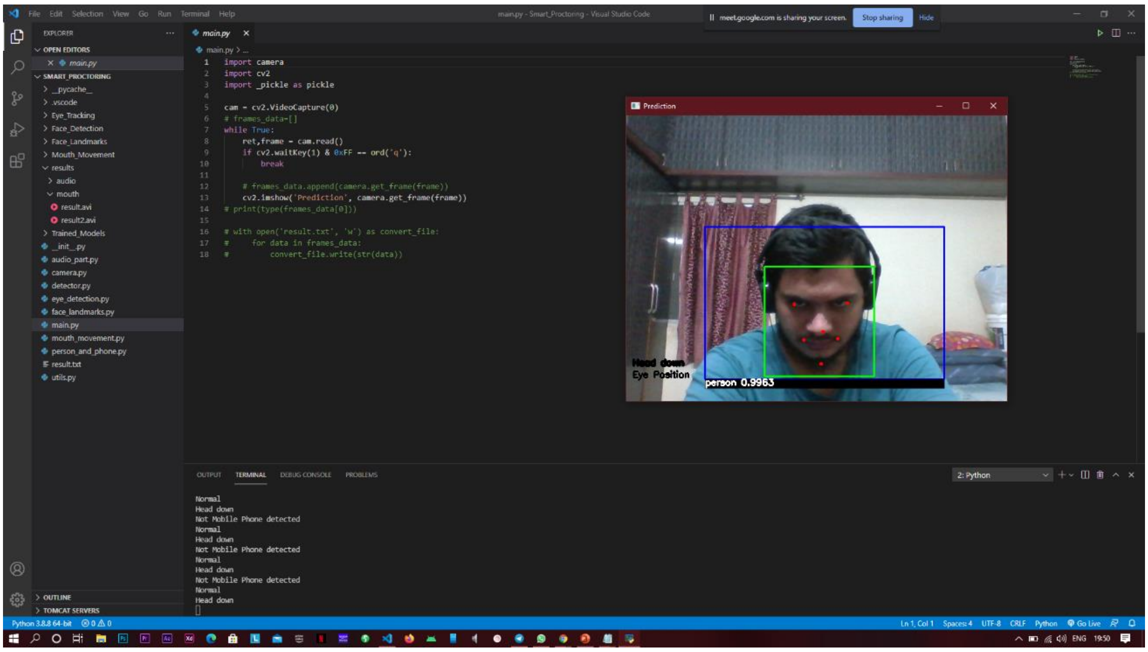


Fig 8.1.6 Detecting Head pose

VI. CONCLUSION

To provide a platform for proctoring online exams, the "Smart Exam Proctoring Using Artificial Intelligence" system is a sound and useful solution. In summary, we have developed a proctoring system that is accurate, practical, and efficient and that solves the issues with the previous solutions. The goal of this project is to replace traditional offline examination methods with one that encourages operational independence.

A visual representation of a proctoring system has been created by us in order to stop dangerous activity during online exams. Among the features of the system are:

• Emotion detection: One of the most crucial aspects of figuring out whether or not an examinee is cheating is recognizing his or her emotions during the exam. The candidate's expression of fear can be a sign that they are engaging in illegal activity.

• Estimation of Head Movement: In this case, the examinee's head movement may be a sign that they are lying or manipulating information.

• Multiple person detection (Malicious object detection), cell phone, and book detection: Finding the aforementioned objects in the examinee's exam environment might also reveal information on cheating strategies.

To stop exam cheating, this approach can be used in combination with a secure exam browser. However, human involvement may be necessary in certain situations as the system will not be able to totally eradicate all forms of cheating.Future research may focus on improving model efficiency to provide a more effective proctoring system. To further expand its scope of use, speech recognition technology can be added to this system. In the future, the suggested technology might potentially be very important for virtual reality and security applications.

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