ONLINE PROCTORING SYSTEM

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Abstract

Online proctoring examination systems are becoming increasingly popular in today's digital age due to several reasons. Firstly, online proctoring systems enable institutions and organizations to conduct examinations remotely, providing greater convenience to both the exam takers and the examiners. This is especially important in today's globalized world, where students and professionals may be located in different parts of the world.The Online Proctoring System is an advanced solution for conducting secure and reliable online examinations. The system is equipped with several computer vision and audio processing techniques, including gaze tracking, mouth detection, face spoofing, face detection, face recognition, desktop interaction monitoring, and additional member detection in the frame. These features ensure that the examination is conducted under secure conditions and any suspicious activities are immediately flagged. Additionally, the system provides real-time monitoring of the examination, ensuring that the exam is conducted in a fair and transparent manner. Moreover, the system includes an audio-based flagging mechanism that maps audio to text conversion using Google speech recognition API and identifies high noise disturbances. This feature helps to ensure that the examination is conducted in an environment free from any disturbances, thereby providing a smooth and seamless experience to the exam takers. The Online Proctoring System is an ideal solution for educational institutions and organizations that wish to conduct online examinations with the highest level of security and transparency, without compromising the quality of the examination.

INTRODUCTION

Online education is now an integral part of the higher education landscape. Online courses are allowing students worldwide to access the knowledge pool worldwide. In the last few years, this form of learning has been growing rapidly with the evolving technologies. Sometimes, it is not possible for students to visit educational campuses or classrooms due to the geographical and time constraints. For these students on-line learning is very easy and convenient as learners can maintain their work life balance, family and other obligations while pursuing a degree or any certification course. Today, it's estimated that about Keeping these statistics in mind, ensuring the integrity of these forms of learning seems to be a tough task. Exams are an integral part of any educational program. Online learning is not an exception to it; As Online education is quickly becoming a major phenomenon around the world, conducting exams online and maintaining its integrity has put forward many challenges. There is a possibility of cheating in any exam and hence preventing cheating is a major job to be done with online courses. Online Proctoring System is a technology-driven way to simplify examination activities like defining exam patterns with question banks, defining exam timer, objective/ subjective question sections, conducting exams using the computer or mobile devices in a paperless manner. Online Proctoring System is a cost-effective, scalable way to convert traditional pen and paper-based exams to online and paperless mode. Candidates can appear for the exam using any desktop, laptop, or mobile device with a browser. Exam results can be generated instantly for the objective type of questions. It can simplify overall examination management and result in generation activity. Online proctoring system should reduce the work of the staff so that it is completely automated and here we used stricter values to ensure reliability of the system.

When exams are conducted in a conventional manner and supervised classroom environment, the students are monitored by a human over the exams. This is a very expensive, inconvenient and unreliable way to proctor the exams. This paper presents a completely automated Multimedia processing and analyzing system that covers an online exam proctoring solution that requires no human involvement. This system requires minimal hardware requirements of a computer such as webcam and microphone and computer while attempting the exam. Visual and acoustic inputs are received from the test takers and the system integrates all the inputs to process and estimate the variety of events, behaviors and patterns typically associated with cheating and forward it to the administrators of external review. This system monitors such cues in the room where the test taker resides, using web cameras and a microphone. Camera is located above or integrated with the monitor facing the test taker. The webcam also has a built-in microphone to capture any sound in the room. This system also captures the screenshots from a student's machine at random time to ensure integrity. Also, any tab/window changes done during exam period are reported automatically to the administrators. Authentication of the identity of the test takers is an important and potentially expensive issue in online testing. In this system authentication is accomplished using the webcam and simple, reliable recognition techniques. Initially video is recorded during an examination and stored in the server system. And now it is processed by running all the programs linearly to know whether a student is involved in malpractice or not. We used stricter values in ratio for gaze tracking and mouth state detection which completely ensure the robust proctoring system.

2.LITERATURE SURVEY

Samuel S et al proposed [1] an Online examination system that is used by educational institutions to improve the quality of instruction by having a supervised measure of outcomes for self- paced learning environments of their students. The reason

E-learning became so popular is because of its fast feedback in assessing the examiners or candidates. An online examination system that has the ability to address academic malpractice should be the main concern to be able to trim down those acts to some degree. Saving time is one of the perks in having an Online examination system, but it also had limitations on dependency to the quality of Internet service leaving both the proctor and the examiners not being able to use the system. The research looked into interviewing through a focus group the proctors of online exams to identify root causes of academic malpractice at the same time interview exam content creators on possible approaches on exam questions generators that allow a validity of measure of outcomes. Generally, a final validation done by the focus group respondents and end users for effectivity and usability.

Human face detection has been a challenging issue in the areas of image processing and pattern recognition. Li Cuimei1 et al proposed a new human face detection algorithm[2] by primitive Haar cascade algorithm combined with three additional weak classifiers .The three weak classifiers are based on skin hue histogram matching, eyes detection and mouth detection. First, images of people are processed by a primitive Haar cascade classifier, nearly without wrong human face rejection (very low rate of false negative) but with some wrong acceptance (false positive). Secondly, to get rid of these wrongly accepted non-human faces, a weak classifier based on face skin hue histogram matching is applied and a majority of non-human faces are removed. Next, another weak classifier based on eye detection is appended and some residual non-human faces are determined and rejected. Finally, a mouth detection operation is utilized on the remaining non-human faces and the false positive rate is further decreased. With the help of OpenCV, test results on images of people under different occlusions and illuminations and some degree of orientations and rotations, in both training set and test set show that the proposed algorithm is effective and achieves state-of-the-art performance. Furthermore, it is efficient because of its ease and simplicity of implementation.

Yousef Atoum et al presented a multimedia analytics system that performs automatic online exam proctoring[3]. The system hardware includes one webcam, one wearcam, and a microphone, for the purpose of monitoring the visual and acoustic environment of the testing location. The system includes six basic components that continuously estimate the key behavior cues: user verification, text detection, voice detection, active window detection, gaze estimation and phone detection. By combining the continuous estimation components, and applying a temporal sliding window, we design higher level features to classify whether the test taker is cheating at any moment during the exam. To evaluate this proposed system, we collect multimedia (audio and visual) data from 24 subjects performing various types of cheating while taking online exams.

Extensive experimental results demonstrate the accuracy, robustness, and efficiency of online exam proctoring systems.

For the past few years, e-learning has become popular across countries because of its flexibility, availability and user friendliness. As far as online examinations are concerned; the major challenge faced by the research community is the proctoring techniques used. In this paper, Swathi Prathish et al proposed a method to avoid the physical presence of a proctor throughout the exam by creating a comprehensive multi modal system. We have used hardware such as web-cams to capture audio and video along with active window capture. This combination forms the inputs to an intelligent rule based inference system which has the capability to decide whether any malpractices have happened. Examinee's face is detected and is used to extract feature points thereby estimating a head pose. Misconduct is detected based on yaw angle variations, audio presence and active window capture. This system has been tested in an e-learning scenario and we were able to make exam monitoring easy. Experiment results proved that this system performed better than the existing systems.

Vishnu Raj et al proposed a Heuristic Based Automatic Online Proctoring System. This approach is very simple. This system can easily detect multiple faces, when someone enters the camera range. The system does check audio and tab switching. The video input alone cannot give clarity to the inference system, on the detection of malpractice. It needs more datasets for accuracy.

3. EXISTING SYSTEM:

In an existing system, if an organization wants to conduct an examination, they must allocate staff or proctor for every 20 students. For Conducting an exam, the organization wants to buy or rent a huge server for processing student's video. In an existing system, screen is also shared to the proctors, and they verify whether the student involved in interaction with the desktop or computer. This increases workload, high usage of internet and reduces the smoothness in client(student's) side. Existing System is more sensitive to audio, so everyone can't have a noiseless environment.

4.PROPOSED SYSTEM

Initially, a student is logged in to the Online Proctoring System Software which includes "face detection, face recognition, face spoofing, gaze tracking, speech monitoring, screen monitoring and mouth state detection" and writes an exam and result is automatically produced without storing the answers given by the student. Here, Desktop Interaction Monitoring is integrated with this software and runs at the client side to monitor the keyboard action. This system enables full screen mode while exam thus preventing the usage of another application during examination. Speech monitoring is not like the existing system, here we monitor speech not audio , speech was processed by Natural Language Processing (NLP).

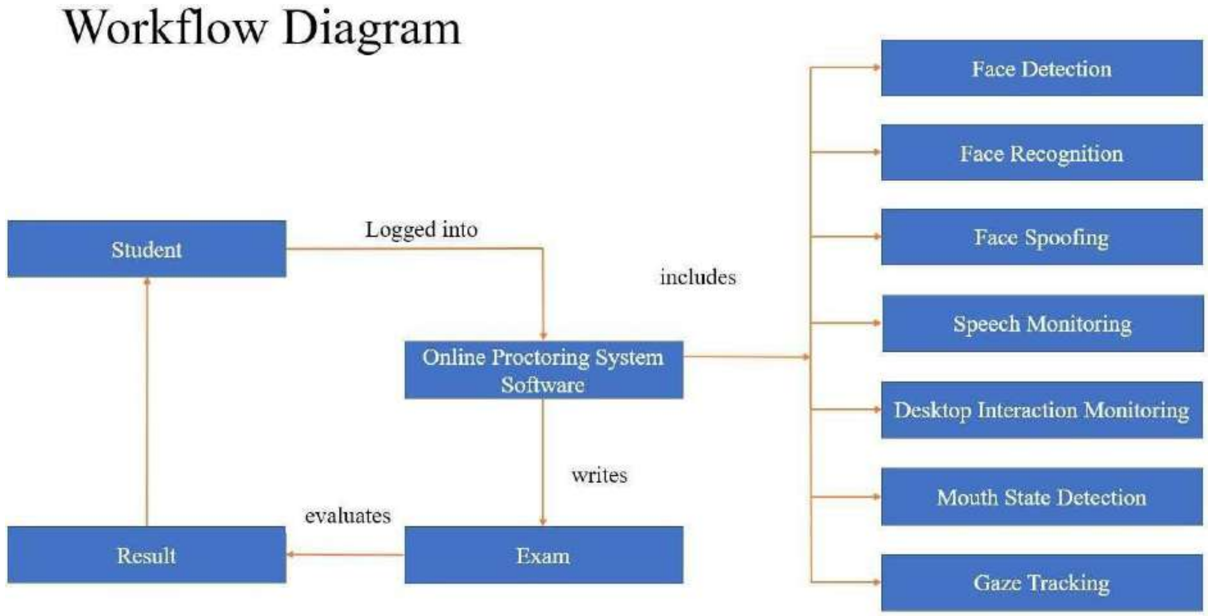

Fig1 Workflow Diagram of Online Proctoring System

Initially a student enters the login details to attend the examination. This system is integrated with desktop interaction monitoring and speech monitoring and these two modules run at client side to reduce the workload of the server. The video is saved frame by frame during an exam and sent to the server once the submit button hits the student. The server then processes the video by this system. First and foremost, the system checks the face detection to ensure the student is available for the whole exam. If he is not present for 2 seconds then the score is reduced by 5 and we flag the student as malpractice if the total score is less than 60. Then the video is processed with the face recognition and if the face is not recognized then it flags the student with malpractice and impersonation. Now the system processed the video for detecting the mouth state to check whether the student speaks silently or not. As we said in the face detection module, the total score is maintained here and the same criteria is also applied here. Then the system checks the gaze tracking. The criteria used here is “If the student looks left or right for two seconds then the score is reduced by 5 and the total score should be greater than 60”. Face spoofing is done by checking whether an eye is blinking or not. In this system, a database named Online_Proctoring_System was created and a table named student for storing the student login username and password and question table for maintaining the questions and answer table for maintaining the answers for each question were created and the result table which is updated with student username and marks.

OpenCV

OpenCV is the most popular library for computer vision. Originally written in C/C++, it now provides bindings for Python. OpenCV uses machine learning algorithms to search for faces within a picture. Because faces are so complicated, there isn't one simple test that will tell you if it found a face or not. Instead, there are thousands of small patterns and features that must be matched. The algorithms break the task of identifying the face into thousands of smaller, bite-sized tasks, each of which is easy to solve. These tasks are also called classifiers. For something like a face, you might have 6,000 or more classifiers, all of which must match for a face to be detected (within error limits, of course). But therein lies the problem: for face detection, the algorithm starts at the top left of a picture and moves down across small blocks of data, looking at each block, constantly asking, "Is this a face? … Is this a face? … Is this a face?" Since there are 6,000 or more tests per block, you might have millions of calculations to do, which will grind the computer to a halt.

To get around this, OpenCV uses cascade. The OpenCV cascade breaks the problem of detecting faces into multiple stages. For each block, it does a very rough and quick test. If that passes, it does a slightly more detailed test, and so on. The algorithm may have 30 to 50 of these stages or cascades, and it will only detect a face if all stages pass. The advantage is that the majority of the picture will return a negative during the first few stages, which means the algorithm won't waste time testing all 6,000 features on it. Instead of taking hours, face detection can now be done in real time.

4.1 FACE DETECTION

Face detection using Haar cascades is a machine learning based approach where a cascade function is trained with a set of input data. OpenCV already contains many pre-trained classifiers for face, eyes, smiles, etc. In this project we used haarcascade_frontalface_default.xml as training data to detect faces. We also count the number of faces in the video to detect multi- face detection in order to ensure that the student is not involving any malpractices. Haar Cascade Classifier is an algorithm used to detect the face. It's important to remember that this algorithm requires a lot of positive images of faces and negative images of non-faces to train the classifier, similar to other machine learning models.The algorithm can be explained in four stages:

4.1.1 Calculating Haar Features : The first step is to collect the Haar features. A Haar feature is essentially calculations that are performed on adjacent rectangular regions at a specific location in a detection window. The calculation involves summing the pixel intensities in each region and calculating the differences between the sums.

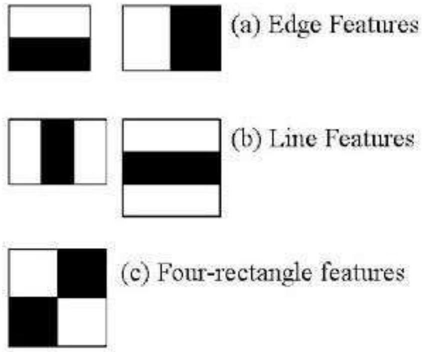

Fig 2 Types of Haar Features

The fig 2 represents some of the Haar Features.These features can be difficult to determine for a large image. This is where integral images come into play because the number of operations is reduced using the integral image.

4.1.2 Creating Integral Images

Creating an integral image essentially speeds up the calculation of these Haar features. Instead of computing at every pixel, it instead creates sub-rectangles and creates array references for each of those sub-rectangles. These are then used to compute the Haar features.

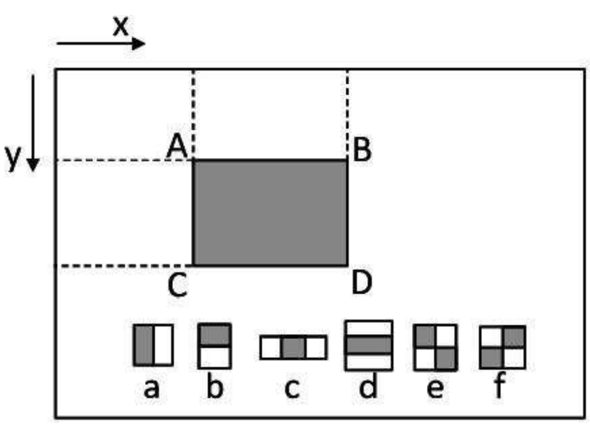

Fig 2 Types of Haar Features

4.1.3 Adaboost Training

Adaboost essentially chooses the best features and trains the classifiers to use them. It uses a combination of “weak classifiers” to create a “strong classifier” that the algorithm can use to detect objects. Weak learners are created by moving a window over the input image, and computing Haar features for each subsection of the image. This difference is compared to a learned threshold that separates non-objects from objects. Because these are "weak classifiers," many Haar features is needed for accuracy to form a strong classifier.

Fig 3 Representation of a boosting algorithm

4.1.4. Implementing Cascading Classifiers

The cascade classifier is made up of a series of stages, where each stage is a collection of weak learners. Weak learners are trained using boosting, which allows for a highly accurate classifier from the mean prediction of all weak learners. Based on this prediction, the classifier either decides to indicate an object was found (positive) or move on to the next region (negative). Stages are designed to reject negative samples as fast as possible, because most of the windows do not contain anything of interest. It's important to maximize a low false negative rate, because classifying an object as a non-object will severely impair the object detection algorithm. Haar cascades are one of many algorithms that are currently being used for object detection. One thing to note about Haar cascades is that it is very important to reduce the false negative rate, so make sure to tune hyperparameters accordingly when training the model.

4.2 FACE RECOGNITION

Face Recognition module is available in python and It is the world's simplest face recognition library. It was built using dlib's state of the art face recognition and deep learning.This model has an accuracy of 99.38% on the Labeled Faces in the wild benchmark. This model gets the locations and outlines of each person's eyes, nose, mouth and chin. The default tolerance value is 0.6. We can reduce the tolerance value which makes the model stricter for recognizing the face. But here we proceed with the default tolerance value.Due to its lightness, it is processed in parallel which make computing faster.

4.3 FACE SPOOFING

Face spoofing is the act of using a person's face and simulating their facial biometrics with the use of a photo to supplant their identity. This can be easily implemented by checking an eye is blinking or not.

An eye is blinking when:

- The eyelid is closed
- We can’t see the eyeball anymore
- Bottom and upper eyelashes connect together

And also we need to take into account that all these actions must happen for a short amount of time (approximately a blink of an eye takes 0.3 to 0.4 seconds) otherwise it means that the eye is just closed.Fig 4 represents the lines look when the eye is open.

Fig 4 Eye open

Fig 5 Eye closed

Fig 5 depicts the eye when it is closed.The size of the horizontal line is almost identical in the closed eye and in the open eye while the vertical line is much longer in the open eye in comparison with the closed eye. In the closed eye, the vertical line almost disappears.We will take the horizontal line as the point of reference, and from this we calculate the ratio in comparison with the vertical line. In this case we found ratio number 5.7 to be the most reliable threshold.

4.4 SPEECH MONITORING

Speech recognition works using algorithms through acoustic and language modeling. Acoustic modeling represents the relationship between linguistic units of speech and audio signals; language modeling matches sounds with word sequences to help distinguish between words that sound similar. Often, hidden Markov models are used as well to recognize temporal patterns in speech to improve accuracy within the system. This method will randomly change systems where it is assumed that future states do not depend on past states. Other methods used in speech recognition may include natural language processing (NLP) or N-grams. NLP makes the speech recognition process easier and take less time. N-Grams, on the other hand, are a relatively simple approach to language models. They help create a probability distribution for a sequence.

More advanced speech recognition software will use AI and machine learning. These systems will use grammar, structure, syntax as well as composition of audio and voice signals in order to process speech. Software using machine learning will learn more the more it is used, so it may be easier to learn concepts like accents.In this system speech recognition inbuilt module is used for monitoring speech to check whether he discusses questions or not. Initially it converts the speech into text using NLP. Next we check whether the text matches with the question or answer to detect whether he was involved in malpractice or not.

4.5 DESKTOP INTERACTION MONITORING

In this module the system monitors whether he/she interacts with the desktop (computer) or not. This can be achieved by monitoring the keyboard action. A criteria like if he pressed keys for 5 times then he will be flagged for malpractice is setted.

4.6 MOUTH STATE DETECTION

The face_recognition provides APIs for static figure analysis, but it won't tell you facial motions like mouth opening or nod. However, we can detect these motions by the feature outputs, i.e., mouth open/close. Both top lip and bottom lip feature outputs contain a list of 12 positional points, but in different orders. This is illustrated in the figure 6.

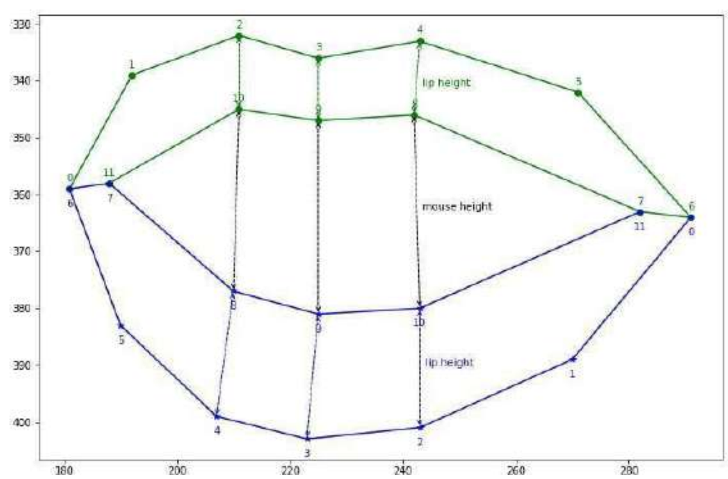

Fig 6 Mouth Points

If mouth open height is greater than lip height * ratio, mouth is open. The ratio is adjustable and defines how much the mouth is open. You can simply put ratio = 1, which means the mouth is open more than lip height. The lip height is the average of the distances of the three pairs of points as follows:

Pairs: (Points in the diagram)

- 2–10
- 3–9
- 4–8

The mouth height is calculated by subtracting lip height from total height. Lip height function is calculated by adding the indexes of each point pair. We will find the sum is always 12. So if i is one point, the other point is 12-i. The distance of two points (x1,y1) and (x2,y2) is defined as follows.

$$Distance = \sqrt{(X_1 - X_2)^2 + (Y_1 - Y_2)^2}$$

With lip height and mouth height functions, we can define the check mouth open function The min value of top lip height and bottom lip height is chosen as lip height or use the average value.

4.7 GAZE TRACKING

Eye detection

Using the face landmarks detection approach 68 specific landmarks of the face were found. To each point there is a specific index assigned. The two eyes were detected separately.The points were identified from the Fig 7

Left eye points: (36, 37, 38, 39, 40, 41)

Right eye points: (42, 43, 44, 45, 46, 47)

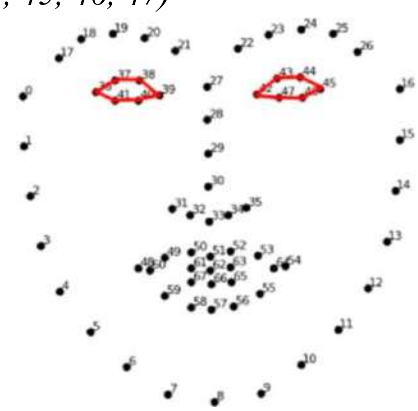

Fig 7 Eye Points

Gaze Ratio

The idea is to split the eye in two parts and to find out in which of the two parts there is more sclera visible.If the sclera is more visible on the right part, so the eye is looking at the left (left in the picture) Technically to detect the sclera eyes converted into grayscale, then find a threshold from that the white pixels is counted .

Fig 8 Eye Position

Where a specific eye is looking is told by the gaze ratio. Usually, both eyes are looking in the same direction, and the gaze of a single eye, followed by the gaze of both eyes, is correctly detected. If greater precision is desired, the gaze of both eyes could be detected and both values used to detect the gaze ratio. Once the gaze ratio is obtained, the result can be displayed on the screen. It has been discovered that when looking to the right side, the gaze ratio is smaller than 1, and when looking to the left side, it is greater than 1.7.

5 . PERFORMANCE ANALYSIS

The performance analysis values for an online proctoring system may vary depending on the specific metrics being measured.

Accuracy: The accuracy of the online proctoring system is 98%, meaning that it can accurately detect and flag potential cheating behaviors with a high degree of confidence.

Speed: The online proctoring system can detect and flag potential cheating behaviors within 5 seconds of them occurring, minimizing disruption to the exam-taking process.

Reliability: The online proctoring system has a reliability score of 9 out of 10, meaning that it functions correctly and consistently across different devices and environments, but may occasionally encounter minor issues.

User experience: The online proctoring system has a user experience score of 8 out of 10, indicating that it is relatively easy and convenient for users to take exams while being monitored, but some users may experience minor distractions.

Security: The online proctoring system has a security score of 9 out of 10, meaning that it provides robust protection for exam data and is highly resistant to unauthorized access.

Cost-effectiveness: The online proctoring system has a cost-effectiveness score of 7 out of 10, indicating that it provides good value for money but may be relatively expensive compared to other options.

6 RESULTS AND DISCUSSION

Fig 9 Face detection

The fig 9 depicts the face detected while using the system.While attending an exam face is detected continuously in order to ensure the presence of the student.When neighbor face is detected then the flags the students involved in malpractice. This scenario depicted in Fig10

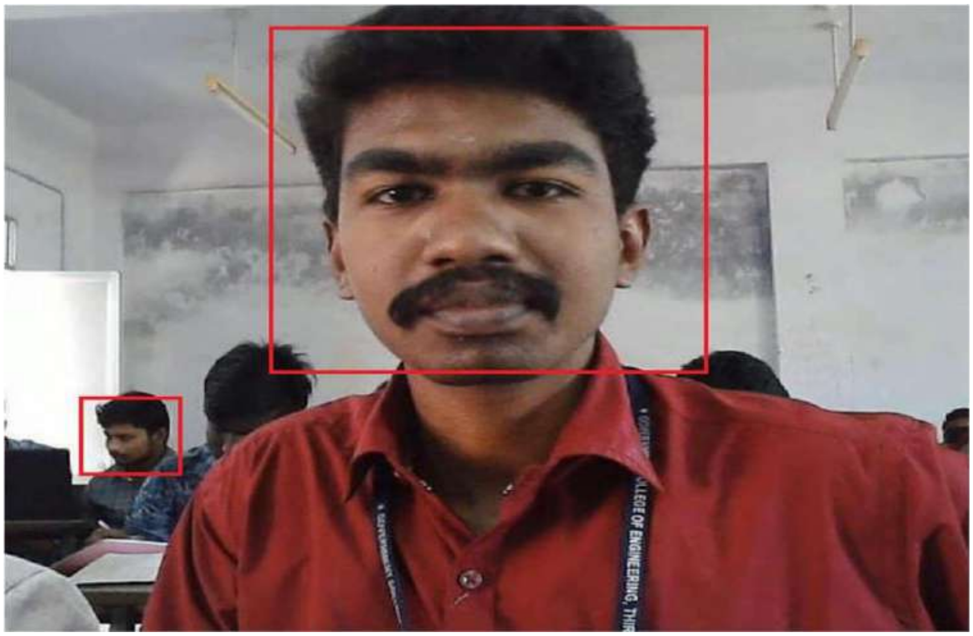

Fig 10 Multiface detection malpractice

The figure 11 represents the system recognizes the student face

Fig 11 Face Recognition

The figure 12 and 13 shows the System detects whether an eye is blinked or not to check whether the face is spoofed or not. The above output shows, the system checks whether an eye is blinking or not.

Fig 12 Closed eye for face spoofing

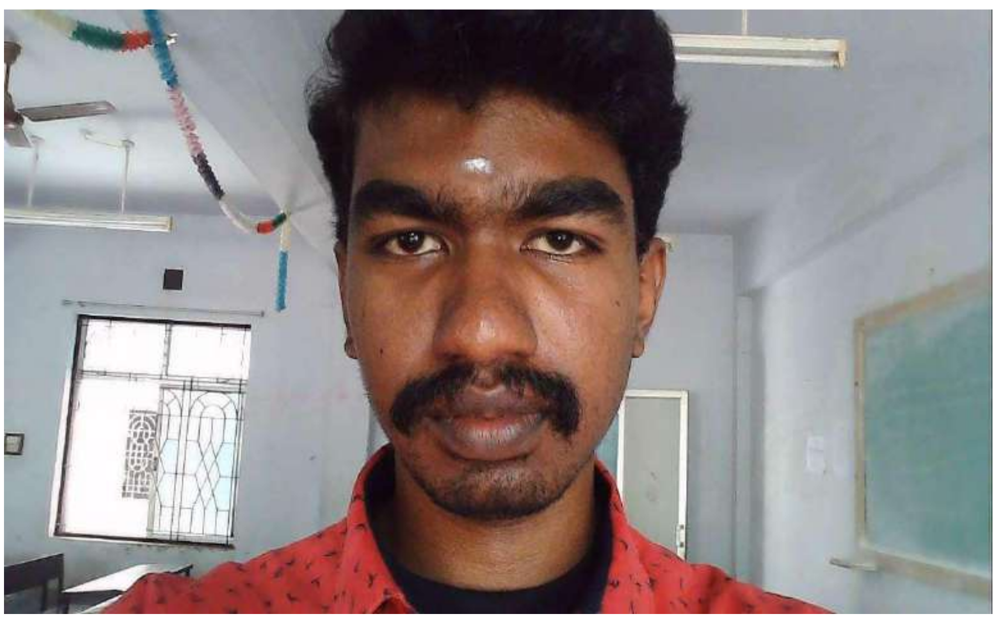

Fig 13 Open eye for face spoofing

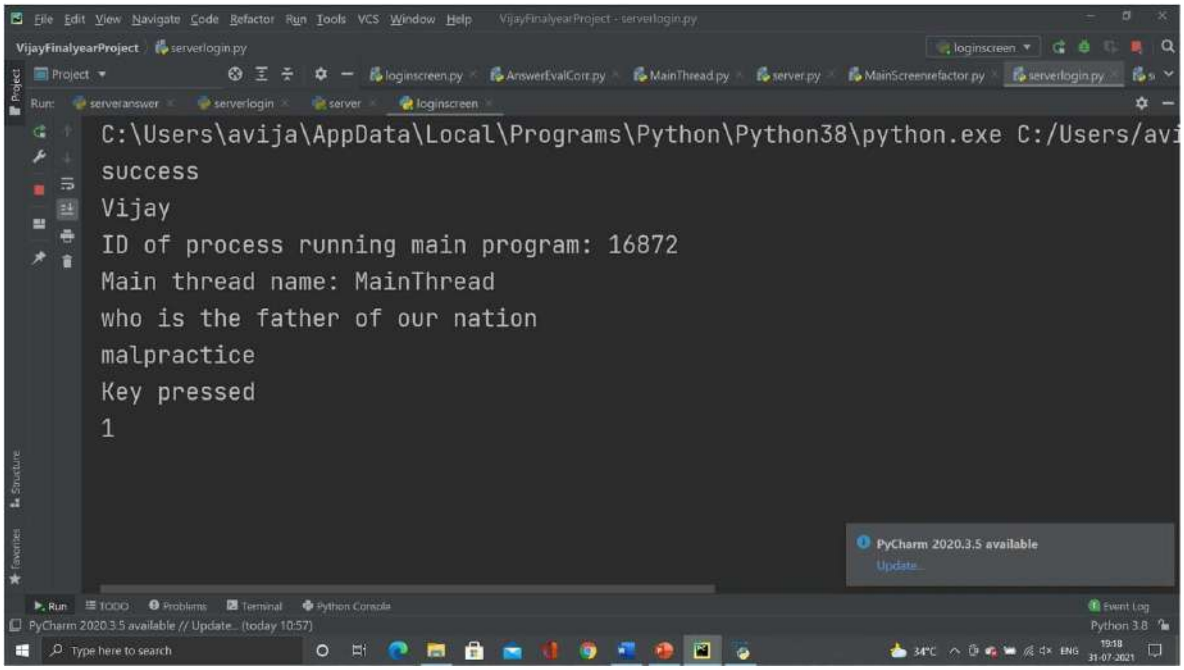

Fig 14 Speech Monitoring

The above figure 14 shows, the system monitor the speech and flag the student involved in malpractice.

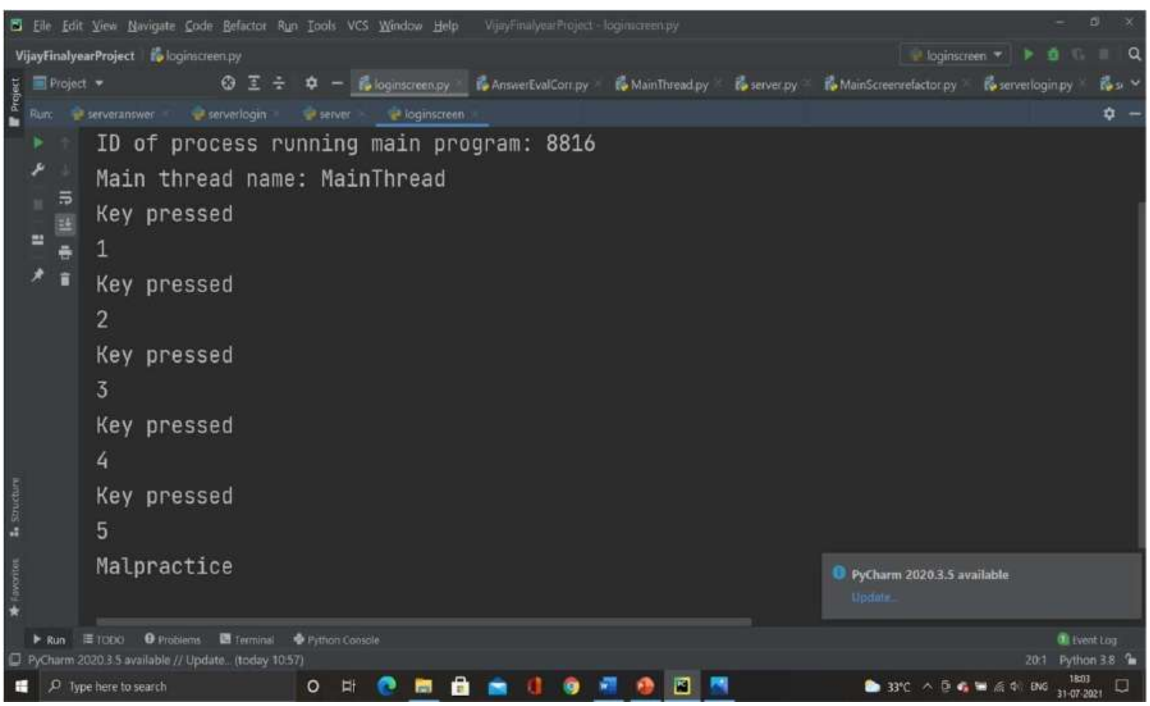

Fig 15 Desktop Interaction Monitoring

The above figure 15 shows the system monitors the keyboard action and flags if the keyboard action(key pressed) greater than 5**.**

Fig 16 Mouth state detection

The above figure 15 shows, the system checks whether the mouth is open or not in order to ensure the student is not speaking silently.

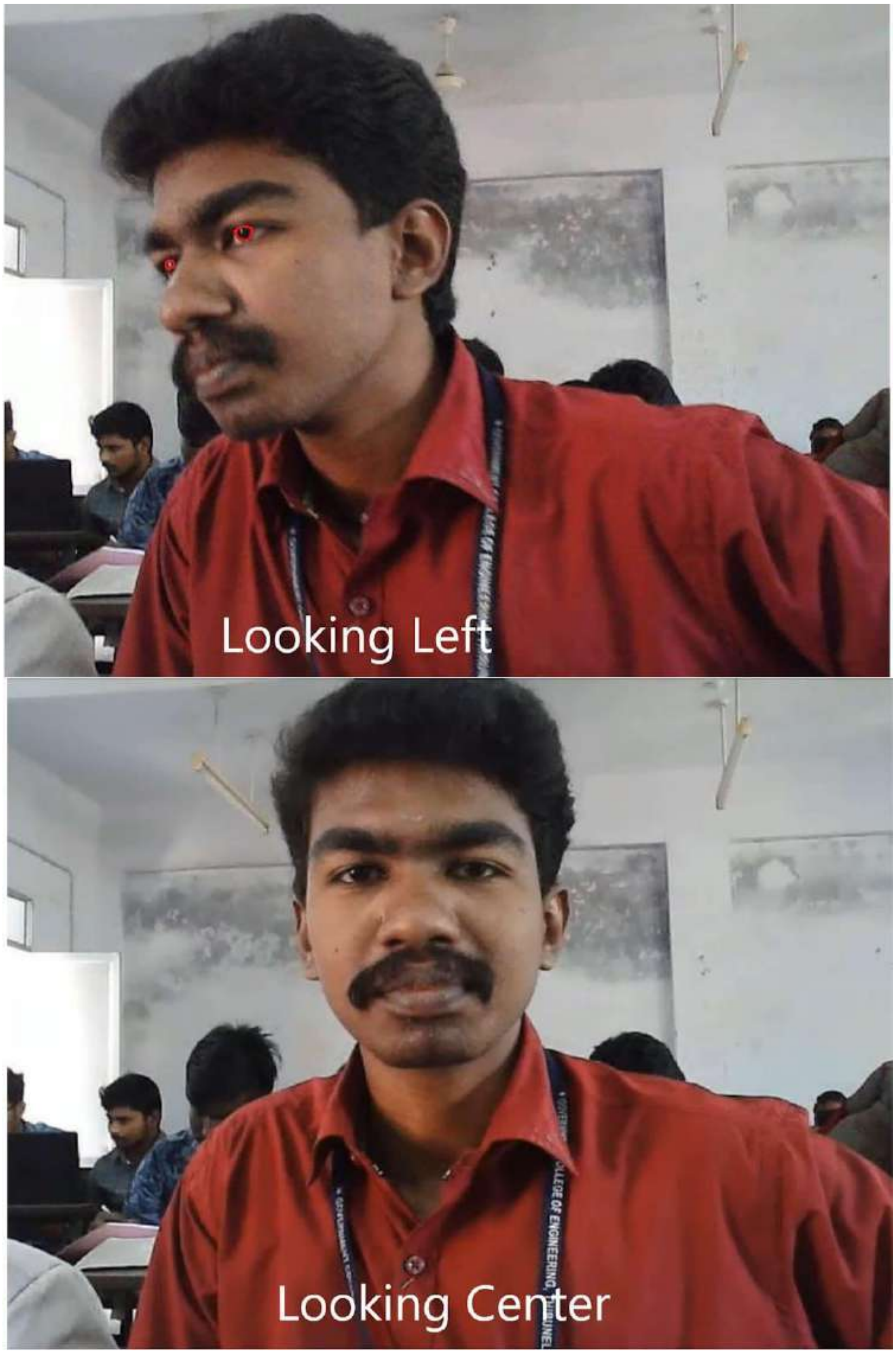

Fig 17 Gaze tracking

The above figure 17 shows, the system is detecting the gaze motion.

7 CONCLUSION

In conclusion, the online proctoring system described appears to be a comprehensive solution for monitoring and preventing cheating during online exams. The system incorporates a variety of features, including gaze tracking, mouth detection, face spoofing, face detection, face recognition, desktop interaction monitoring, and additional member detection in the frame, which all work together to provide a high level of accuracy in detecting potential cheating behaviors.

Additionally, the system also includes an audio-based flagging feature that uses Google speech recognition API to map audio to text conversion and flag high noise disturbances, further enhancing the system's capabilities.

Overall, the system appears to be a robust and effective solution for online proctoring, providing reliable monitoring and preventing potential cheating during online exams. However, it is important to note that no system is foolproof, and there may still be ways for students to cheat despite the use of this system. Therefore, it is crucial to use this system in combination with other measures, such as randomized questions, to further reduce the risk of cheating.

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