i C u - Automated Proctoring System

PROJECT REPORT

Submitted by

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to

The APJ Abdul Kalam Technological University

in partial fulfillment of the requirements for the award of the Degree

of

Bachelor of Technology (Hons)

in

Computer Science and Engineering

Department of Computer Science and Engineering

College of Engineering Trivandrum

Kerala

July 11, 2023

DECLARATION

We undersigned hereby declare that the project report **i C u - Automated Proctoring System**, submitted for partial fulfillment of the requirements for the award of honours degree of Bachelor of Technology of the APJ Abdul Kalam Technological University, Kerala is a bonafide work done by us under supervision of **Prof. Lubi E**. This submission represents our ideas in our own words and where ideas or words of others have been included, we have adequately and accurately cited and referenced the original sources. We also declare that we have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in our submission. We understand that any violation of the above will be a cause for disciplinary action by the institute and/or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously formed the basis for the award of any degree, diploma or similar title of any other University.

Place: Thiruvananthapuram

Date: July 11, 2023

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CERTIFICATE

This is to certify that the report entitled **"i C u - Automated Proctoring System",** submitted by **Allen Y**, **Divina Josy**, **Elsa Maria Joseph** to the **APJ Abdul Kalam Technological University** in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology (Hons) in Computer Science and Engineering is a bonafide record of the project work carried out by them under our guidance and supervision. This report in any form has not been submitted to any other University or Institute for any purpose.

Lubi E	**Thara R J**	**Dr. Sumesh Divakaran**
Assistant Professor	Assistant Professor	Professor
Department of CSE	Department of CSE	Department of CSE
(Guide)	(Coordinator)	(Head of Department)

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ABSTRACT

Since the emergence of COVID-19, remote learning has become increasingly popular. With schools and universities closed, many have turned to platforms like Microsoft Teams to complete their academic years. However, the issue of remote testing has yet to be solved. Some have opted for assignment-based assessments, which can be easily copied and pasted from the internet, while others have simply cancelled exams altogether. If remote learning is to become the new norm, a solution is needed. As a result, there has been a significant increase in the use of online proctoring systems for remote exams. These systems employ a variety of methods, such as video monitoring, audio recording, and screen sharing, to prevent cheating during online exams. However, manually monitoring a large number of students can be a challenging task, which has led to the emergence of automated proctoring systems. ETS, which conducts TOEFL and GRE among other exams, is allowing students to take exams from home while being monitored by a proctor. However, implementing this scheme on a large scale may not be feasible due to the required workforce.

An innovative solution to the issue of remote exam proctoring is the development of AI-based monitoring systems that utilize machine learning algorithms. These systems have the ability to automatically identify and flag potential cheating behaviors, such as irregular eye movements, head gestures, and keyboard activity, and alert the proctor in real-time. To this end, we plan to create an AI monitoring system using Python that can monitor students via their laptop's webcam and microphone, enabling teachers to observe multiple students simultaneously. The AI monitoring system will incorporate four vision-based capabilities - gaze tracking, mouth open or close detection, person counting, and mobile phone detection - that are integrated using multi-threading to operate cohesively.

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Chapter 1

Introduction

In recent years, the field of education has undergone a significant transformation with the advent of online classes. Online learning has opened up new possibilities for students to access education remotely, providing flexibility and convenience. However, with this shift to virtual classrooms, new challenges have emerged, particularly in ensuring academic integrity and preventing cheating during online exams and assessments.

Online classes offer numerous advantages, allowing students to learn from anywhere, at any time, and at their own pace. They eliminate the need for physical classrooms, enabling individuals to pursue education while juggling other responsibilities such as work or family commitments. Moreover, online classes often provide interactive multimedia content, discussion forums, and collaboration tools, creating engaging learning environments.

Despite these benefits, maintaining academic integrity in online education has become a critical concern. Without proper monitoring and supervision, students may be tempted to engage in dishonest behaviors, compromising the credibility and fairness of assessments. To address this challenge, online class proctoring systems have emerged as a valuable tool.

Online class proctoring systems utilize advanced technologies and techniques to monitor and supervise students during online exams or classes. These systems employ a range of methods, such as identity verification, live or automated monitoring, browser restrictions, keystroke monitoring, and environment monitoring. By implementing these measures, online class proctoring systems aim to detect and prevent cheating attempts, ensuring that the assessments accurately reflect students' knowledge and abilities.

However, the adoption of online class proctoring systems also raises concerns regarding privacy and accessibility. It is essential for educational institutions to implement these systems with transparency, ensuring that students' rights and privacy are respected. Additionally, accommodations should be made for students with disabilities or limited access to technology, to ensure equitable access to online education.

In this report, we will look into one possible implementation of such a monitoring system, focusing mainly on features that can be extracted from video display.

Over the course of this paper, the methodology, implementation setups and the analysis of the proctoring method are being discussed in detail. The analysis of the results obtained and the future scope of this project is also described towards the end of the report.

Chapter 2

Existing Methods

AI proctoring is an effective tool for monitoring classroom activities and ensuring a productive learning environment. It helps teachers identify disengaged students, detect potential cheating, and maintain discipline, thereby enhancing the overall effectiveness of class monitoring. Here we discussed existing monitoring methods in these literature reviews

2.1 SMART CLASS ROOM MONITORING SYSTEM [1]

- The Smart Classroom Monitoring System aims to enhance traditional classrooms by incorporating modern technology for monitoring and managing classroom activities.
- The proposed smart classroom system in Figure 2.1 includes an Arduino microcontroller connected to IR sensor, sound sensor, LCD, and cloud, enabling efficient monitoring and management of classroom activities.
- The system incorporates features such as automatic student attendance management, real-time student density monitoring using IR sensors, and automated lecture playback based on scheduled class timetables stored in the cloud.

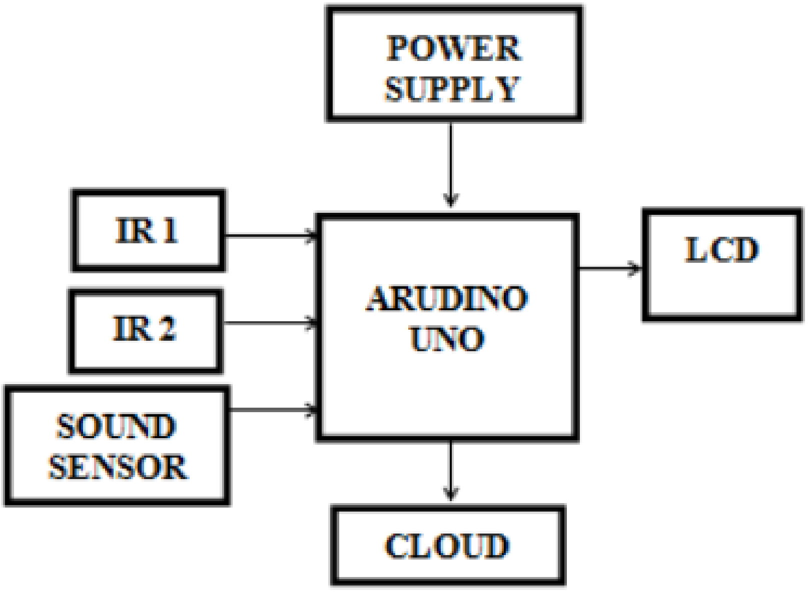

Figure 2.1: Block Diagram

- The system monitors student density using IR sensors, and if the density falls below the threshold value, the video lecture stops playing and displays a message indicating low-class strength.

- Sound sensors connected to the Arduino Micro-Controller are used to detect the noise level in the classroom. If the noise level exceeds the threshold value, the screen displays a message indicating high noise, and this information is transmitted to higher authorities through the cloud. Additionally, an LCD screen provides real-time information on student count and the current subject being taught.

- The simulation layout in Figure 2.2 of the proposed smart classroom includes the use of an IR sensor to monitor student density. The sensor works based on the principle that light emitted by an LED is reflected back by a white surface, while it is absorbed by a black surface. The emitted light reaches a photodiode, and the output voltage of the photodiode, connected to the microcontroller, is proportional to the light intensity falling on the junction. The microcontroller's comparator compares the voltages and outputs a high signal if more light is detected, indicating the presence of a student.

- When students enter the classroom, they block the light from the LED, causing the comparator output to be low, and the student count is increased accordingly. This allows for real-time monitoring and tracking of student density in the smart classroom.

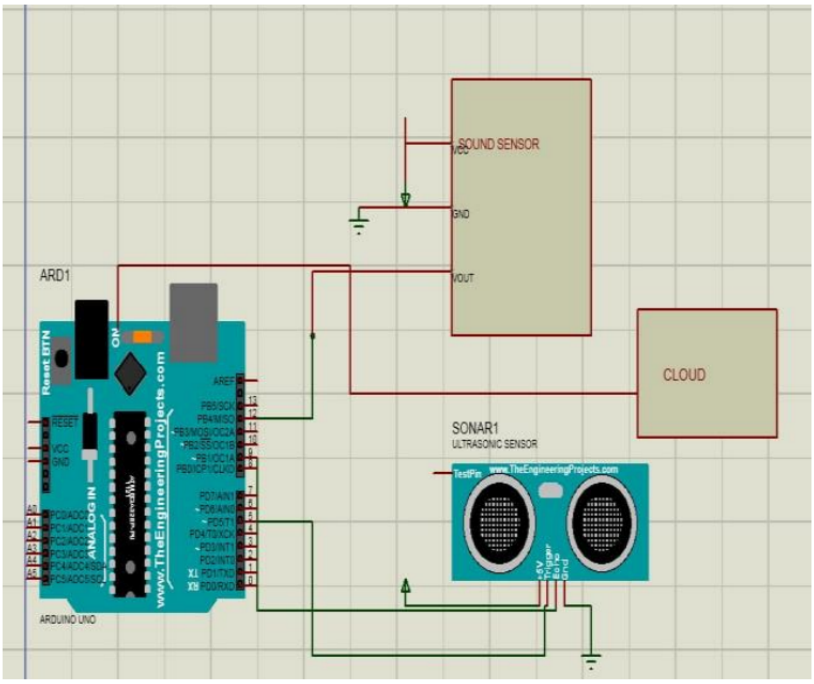

Figure 2.2: Block Diagram

- The system incorporates numerous features and functionalities to facilitate classroom management. It provides automatic attendance management, eliminating the need for manual attendance taking. Additionally, teachers can assess individual student progress and identify areas for improvement through student performance analysis. Furthermore, the system can generate alerts in the event of abnormal circumstances, ensuring a safe and secure learning environment.

- The implementation process focuses on creating a user-friendly system that can be easily deployed in educational institutions without requiring extensive technical expertise.

- The paper discusses the challenges and considerations faced during the implementation phase, such as ensuring data privacy and security, optimizing system performance, and addressing any technical limitations.

- It highlights the importance of conducting thorough testing and validation to ensure the reliability and effectiveness of the implemented system.

- The implementation details also include information on any customizations or adaptations made to the system to suit the specific needs and requirements of the educational institutions involved in the study.

- The article highlights the potential of the Smart Classroom Monitoring System to transform traditional teaching methods. It underscores the importance of leveraging technology in education to enhance classroom management and student outcomes. The study sets the stage for further research and development in the field of smart classroom technologies.

2.2 Classroom Management in Virtual Learning: A Perceptions Study with School Teachers in Qatar [2]

- The paper focuses on studying the perceptions of school teachers in Qatar regarding classroom management in virtual learning environments.

- The research aims to explore the challenges faced by teachers in managing virtual classrooms and understand their perceptions of effective classroom management strategies. Data was collected through surveys and interviews with school teachers in Qatar.

- The study's findings underscore the challenges faced by teachers in maintaining student engagement and participation in virtual classrooms, emphasizing the importance of effective communication and clear instructions for successful classroom management.

- Building positive relationships with students, providing individual support, and investing in professional development and training programs are essential components for effective virtual classroom management.

- The study included 110 teachers from secondary and preparatory schools in Qatar who were teaching in virtual mode. A descriptive and analytical research methodology was used, analyzing data through SPSS using a Likert-scale questionnaire to measure perceptions, beliefs, and attitudes towards virtual classroom management and discipline. The questionnaire also assessed the challenges and effectiveness of the app platform in promoting synchronous and asynchronous student interaction.

- The data for the study was collected from 110 teachers using a Google Forms-based questionnaire distributed through WhatsApp. The collected data was analyzed using the SPSS 22.00 program, and the findings were presented in tables and figures to facilitate interpretation as shown in Figure 2.3 and Figure 2.4

Descriptive Statistics

Teachers' Challenges	N	Minimum	Maximum	Mean	Std. Deviation
1. Teachers have difficulty to manage the classroom virtually.	110	1.00	4.00	2.2909	.89181
2. Teachers are unable to put away distractions made by students.	110	1.00	4.00	2.3636	.82091
3. The most challenging to manage the	110	1.00	3.00	1.8909	.68195

Figure 2.3: Descriptive Statistics of Teachers Challenges

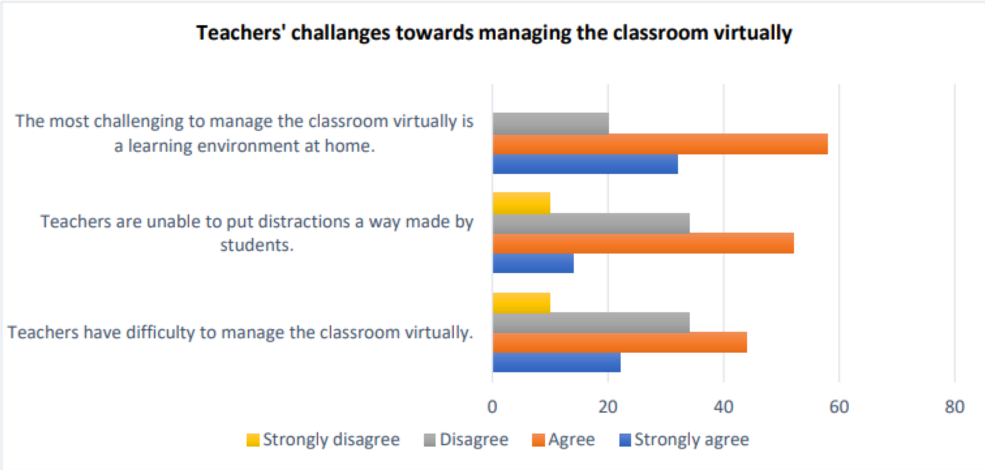

Figure 2.4: (Teachers' Challenges) frequencies

- According to the questionnaire responses, a significant proportion of teachers (65%) agreed that managing the virtual classroom is difficult, while 60% agreed that they struggle to control distractions made by students. Additionally, 52.7% reported that a challenging aspect of virtual classroom management is the learning environment at home.
- The study suggests that a comprehensive approach to virtual classroom management, including the use of technology, pedagogical strategies, and teacher-student interaction, is essential for successful virtual learning experiences.
- The findings provide insights and recommendations for policymakers, school administrators, and teachers to improve classroom management practices in virtual learning environments.

2.3 Students Live Behaviour Monitoring in Online Class using Artificial Intelligence [3]

- The proposed system leverages practical wisdom to predict student behavior in online classes by analyzing data from student characteristics and movements such as eye, oral, and head movements. Images are used to demonstrate student performance in different class activities.

- The system provides benefits by facilitating a better understanding of students' interest in respective classes, empowering teachers to make informed decisions to improve the effectiveness of their teaching approaches.
- The System Design Document encompasses system conditions, operating terrain, the armature of system and subsystems, database design, input formats, interface layouts, detailed design, recycling logic, and external interfaces.
- The system comprises three modules. The Client module runs on the student's device, capturing and displaying their video. Frames are analyzed using a trained model, and results are presented graphically. The Server Module tracks student details and facilitates data exchange between the Client and Face Processing modules. The Face Processing Module analyzes each frame using a shape predictor model to extract facial features and sends the results to the Server Module for further processing.
- A system armature, also known as a systems architecture, is an abstract model that describes the structure, geste, and additional views of a system as shown in Figure 2.1. A formal description and depiction of a system is an armature description. Organized in a way that provides logic about the system's architecture and activities.

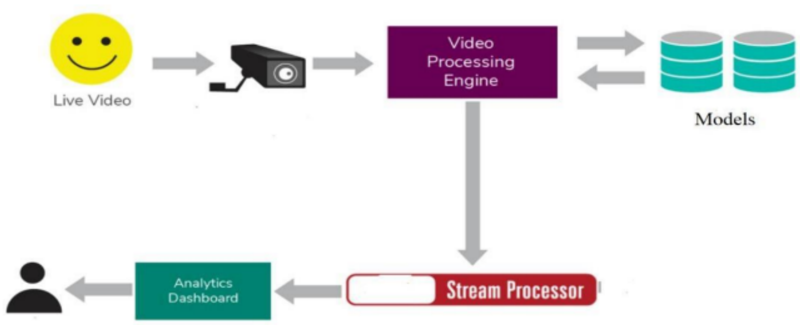

Figure 2.5: Survey system architecture

- Activity diagrams shown in Figure 2.2 are graphical representations of the workflow of activities and actions, providing support for selection, repetition, and consistency. Integrated Model Language task diagrams can be used to illustrate the business and step-by-step operation of system components. The task diagram represents the overall control flow.

- This project is implemented using Anaconda prompt and flask framework. It also uses Face Detection, Shape predictor model, Modules-Client, Server, Face processing module.

- A comprehensive system is implemented to enable student behavior recording, mathematical continuity, and demonstration of the completed structure. The system supports student behavior recording and data continuity. It is important to note that our first constraint is the lack of awareness regarding other relevant information, such as emotions.

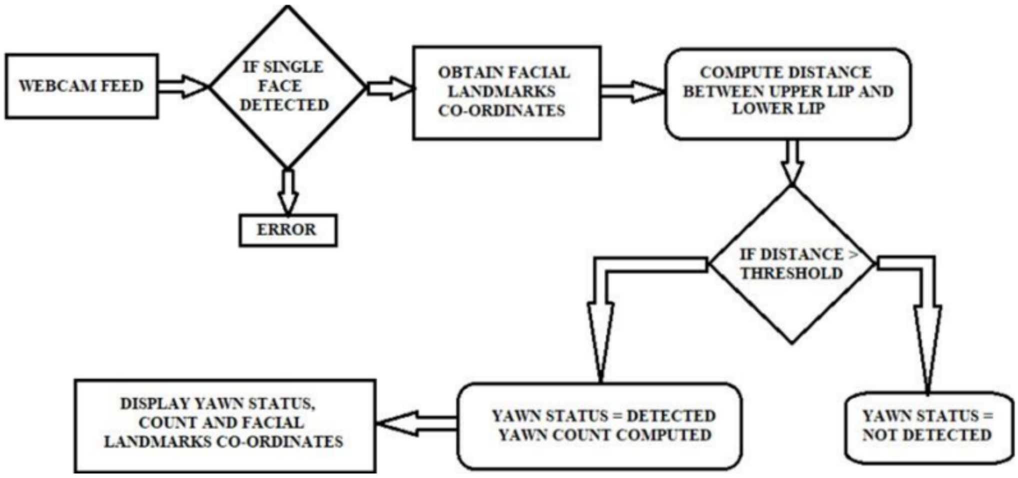

Figure 2.6: Activity Diagram

2.4 Smart Classroom Monitoring Using Novel Real-Time Facial Expression Recognition System [4]

- This article examines the impact of facial emotions on classroom learning by integrating novel facial features into a proposed deep learning-based automatic emotion identification system.
- The most important components of human emotions are incorporated into machines to enable automatic recognition of emotions conveyed by humans through their facial features.
- Happy, sad, satisfied, concentrated, unsatisfied, and frightened facial expressions were selected, and innovative facial feature movements were developed to accurately identify each facial expression.
- The study involved 100 students from three institutions (SBKWU, BUITEMS, and UOB) and four departments (CS, CE, Education, and IT) to investigate the impact of facial expressions on various variables, including department, lecture time, gender, subject difficulty, and sitting position.
- As shown in Figure 2.3, students' facial expressions varied throughout the presentation, indicating a direct relationship between facial emotions and classroom learning

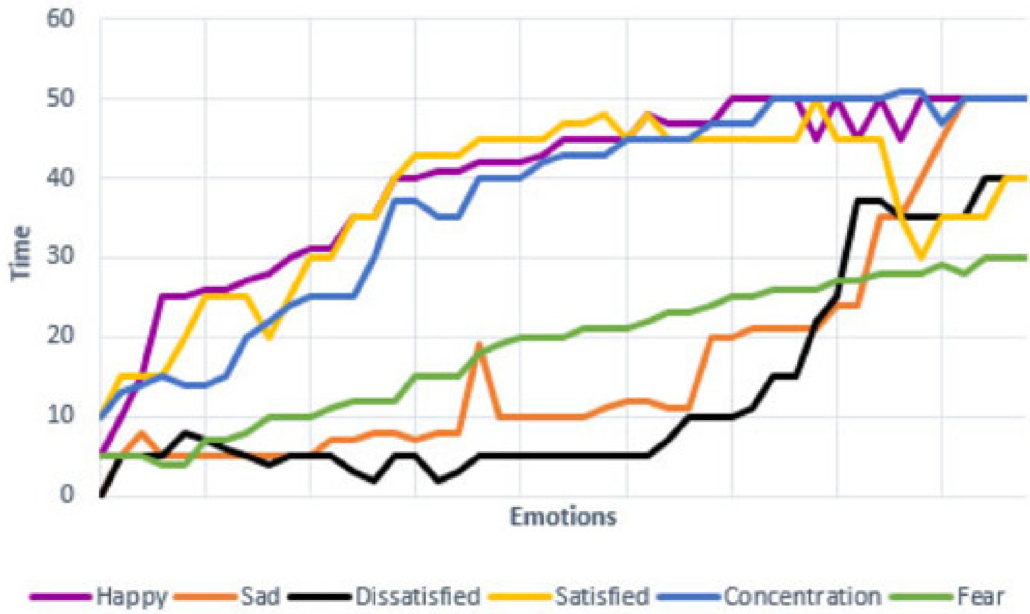

Figure 2.7: Changes in facial expression with respect to time

- The study examined the impact of variables such as department and seating position on students' facial expressions during classroom learning. The results showed that department had no significant effect, but seating position did. Students in the front row expressed higher satisfaction compared to those in the middle and last rows.

- The variable "difficulty of subject" significantly affected students' facial expressions, with more difficult subjects leading to unfavorable expressions during studying. The proposed emotion recognition system was compared with several existing commercial FERs, such as Face ++, Face Reader, Emotient, Affectiva, MorphCast, and Azure, to evaluate its accuracy.

- Furthermore, the findings of the study were analyzed by a senior psychologist who provided valuable insights. He recommended implementing interactive teaching techniques for subjects with higher difficulty levels to enhance learning, suggesting the importance of shorter lectures or breaks during long sessions to refresh students' minds, and emphasizing the need to improve seating positions for better learning outcomes.

2.5 MOTIVATION

After studying the aforementioned papers the following gaps were identified:

1. Majority of the proposed methods are applied to real-time classrooms and could translate better in a virtual setting

2. Some of the methods are very general monitoring methods and do not focus on individual student mannerisms

3. In [2], teachers are given suggestions for improvement while not acknowledging added difficulties of virtual classroom environments as compared to traditional one

4. Each methods addresses only one aspect of proctoring

Our motivation for this project is to built a robust proctoring system that can be implemented in online classroom for monitoring students which subsequently will improve the quality of online education.

Chapter 3

Problem Statement and Objectives

3.1 Problem Statement

The problem statement of our project :

Create an online class monitoring AI system that can help teachers identify disengaged or struggling students, and detect potential cheating or misconduct in real-time, improving the overall quality and effectiveness of online education.

3.2 Objectives

In this project, the objective is to provide a proctoring AI system that enhances the online education experience by ensuring academic honesty and monitoring student activity. It supports educators in identifying students who may be disengaged or experiencing difficulties, as well as detecting any potential instances of cheating or misconduct in real time. The key discussion points include:

1. Track eyeballs and report if the candidate is looking left, right, or up.
2. Find if the candidate opens his mouth by recording the distance between lips at the start.
3. Instance segmentation to count the number of people and report if no one or more than one person is detected.
4. Find and report any instances of mobile phones.

5. Head pose estimation to find where the person is looking.

Over the course of this chapter, we have formulated the problem statement for this project and the five key objectives that it wishes to fulfil has been described. In the next chapter, the design and implementation of the system is being described.

Chapter 4

Design and Implementation

In this chapter we will go over the different features that were implemented in the proposed system individually and see how they were realized. We use Python for creating the necessary code.

4.1 Gaze Tracking and Mouth Detection

For this task we make use of the Python libraries, Open CV and Dlib. OpenCV is an open-source library for the computer vision, machine learning, and image processing and it plays a major role in real-time operations. Dlib is one of the most powerful open-source library consisting of machine learning library/algorithms and various tools for creating software. It is mainly used for face recognition purposes. The Dlib library allows us to detect the key points of the face (see figure 4.1).

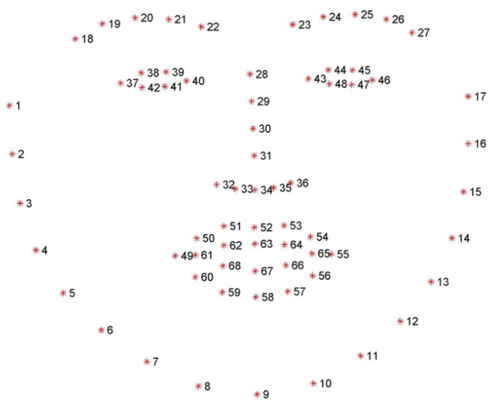

Figure 4.1: Dlib facial keypoints

First the rectangular face coordinates are found and this is passed to a pre-trained model from Dlib library to detect the keypoints. After key point detection, using functions available in OpenCV, the eyeballs are detected by making use of a black mask and detecting the eye areas then whitening all but the iris of the eyes. This is then utilized to detect eye gaze. This looks like in figure 4.2.

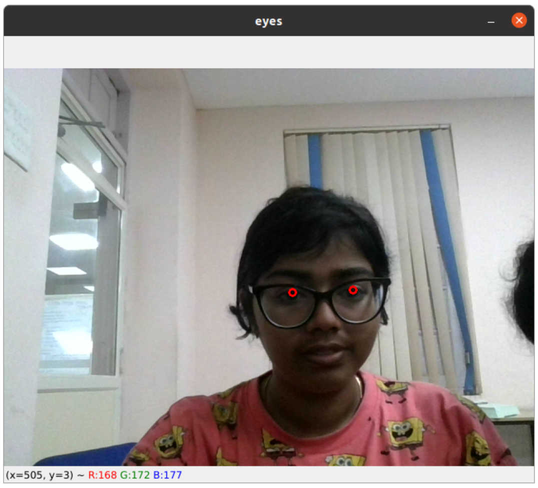

Figure 4.2: Eye gaze tracking

Similar to eye detection, for mouth detection, Dlib's face keypoints are used once more and the separation between the keypoints for the lips—5 outside pairs and 3 inner pairs is employed (figure 4.3).

Figure 4.3: Mouth tracking

4.2 Person Counting and Mobile Phone Detection

Here we employ the Python libraries OpenCV and TensorFlow. OpenCV is used for its many image processing functions. TensorFlow is a free and open-source software library for machine learning and artificial intelligence and is the library from where we import the pre-trained model YOLOv3 which we are to use for the person counting and mobile detection.

YOLOv3 is a real-time object detection model that is widely used due to its high speed and competitive accuracy. Its architecture is shown in figure 4.4.

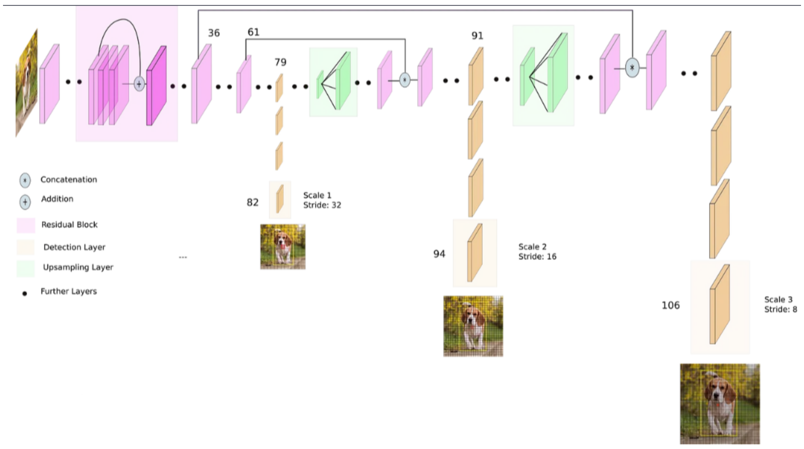

Figure 4.4: YOLOv3 architecture

In order to define YOLOv3 convolutional layers, our YOLO model's output, draw the outputs, create bounding boxes from predictions, and define a function for non-maximal suppression, we must now create the necessary functions. We also need to define our anchor boxes. Finally, we need to develop a function that combines everything to produce our model. Now input can be taken via webcam and person and mobile phone detection can be carried out (figure 4.5).

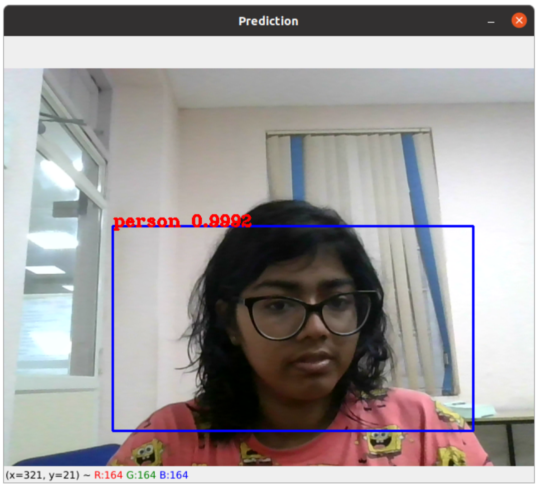

Figure 4.5: Person and mobile detection in video

4.3 Head Pose Estimation

For this we use OpenCV and Tensorflow libraries. To detect face for getting facial landmarks, we use a Caffe model of OpenCV's DNN module. After that, we detect annotation box around the head to get the angles of the head in 3-dimensional space. We make use of a Tensorflow CNN trained by Yin Guobing for this purpose. From this we get the tilt of the head along the x-axis and the y-axis.(figure 4.6).

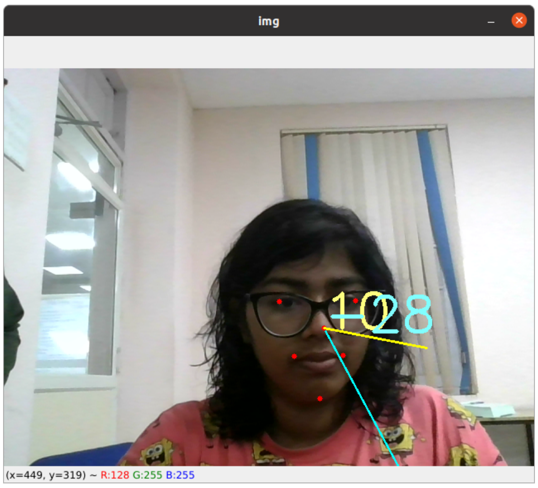

Figure 4.6: Head pose in video

Over the course of this chapter we get insight into how this proctoring system is implemented using many different pre-trained models. In the following chapter we will look at how the outputs for each of these modules will be.

Chapter 5

Results and Discussion

In this chapter we see how the outputs for the features mentioned in the previous chapter are obtained and what they look like. Following this, we see the results of the cumulative program, that is, the desired output for our proctoring system.

5.1 Gaze Tracking

We aim to track the eyeballs of the test-taker and report if he is looking to the left, right, or up which he might do to have a glance at a notebook or signal to someone. The output is as follows in figure 5.1:

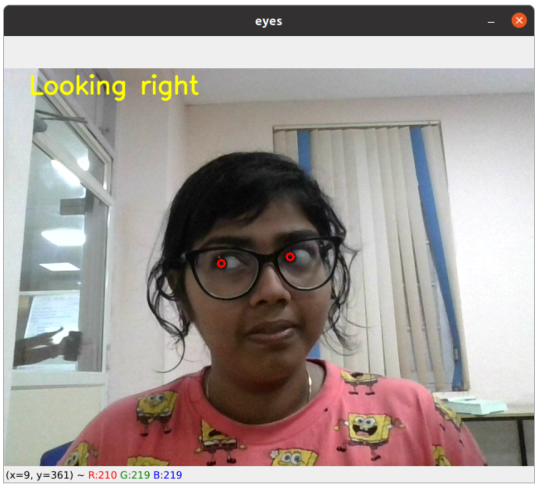

Figure 5.1: Gaze tracking sample output

5.2 Mouth Detection

The distance between the keypoint of the mouth is measured for 100 frames and averaged at the very start of the program.

The distances between the points increase when the user opens his or her mouth, and infringement is considered to have occurred if the distance increase exceeds a predetermined value for at least three outside pairs and two inner pairs. The output can be seen in figure 5.2.

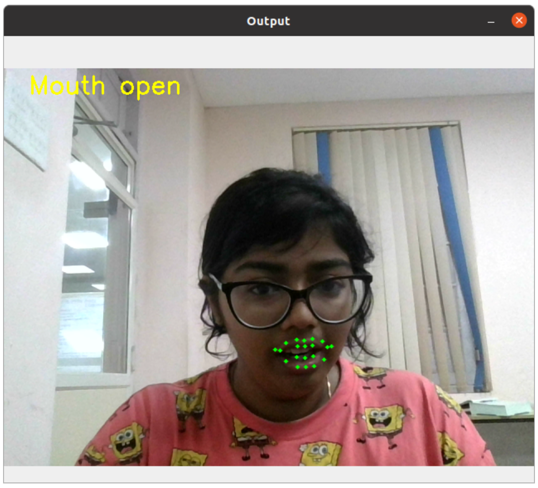

Figure 5.2: Mouth detection sample output

5.3 Person Counting and Mobile Phone Detection

We have the pre-trained YOLOv3 model with its defined weights that is ready for us in detecting persons and mobile phones. What we want is to show a message if there is no one in the frame, if there is more than one person in the frame and if there is a mobile phone in the frame. In this model, the prediction index of "person" for object detection is 0 and that for "cell phone" is 67. If count of person is 0 or greater than 1 and/or count of mobile phone is greater than 0, violation is reported. (see figure 5.3).

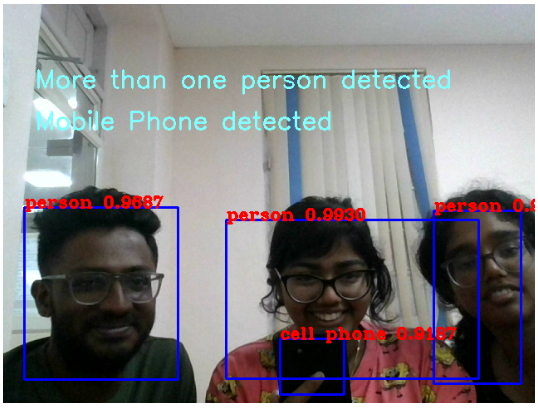

Figure 5.3: Person count and mobile phone detection sample output

5.4 Head Pose Estimation

The angle of the head is detected initially along x-axis and y-axis. Head is said to tilt left, right, up or down if the angle changes past a certain threshold (48 degrees left, right, up and down). The result is as shown in figure 5.4.

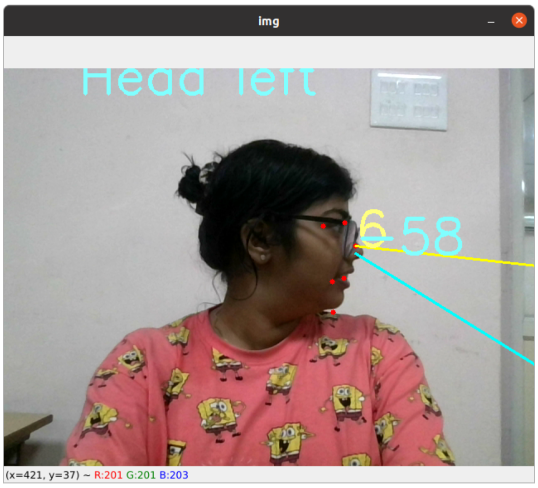

Figure 5.4: Head pose estimation sample output

All of the aforementioned features are combined and run in a switch case so as to have the choice of deciding what aspect is to be monitored. The output will show a video with the infringement variable, in the video and/or in the terminal.

Chapter 6

Conclusion and Future Scope

This project analyzes what the important features of an online proctoring system might be and also showcases a possible methods for their implementation. We see use cases for gaze tracking to know if student is distracted by something visually, mouth detection to check if the student is talking, person detector to see if student is present and also to know if more than one person is around, mobile phone detection to find out if the student is using their phone, and finally, head pose detection to see if student is nodding off.

The project can be a starting point for some further expansion in the future with some improvements and some refinement to the models and some additional features. Such features could include multiple open tabs, face recognition to ensure that the student itself is attending class, true face detection to make sure student doesn't leave an image of himself in the screen instead of actually being present. Attendance management could also be implemented. Audio features can also be implemented. For example, during examinations, audio can be converted to text and can be cross-referenced with the answers for questions in the examination papers. These elements will definitely improve the proctoring system and hence enhance the online class experience and be a great help to teachers.

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