

# A Novel Unsupervised AI/ML based proctored system

MSc Research Project  
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# A Novel Unsupervised AI/ML proctored system

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## Abstract

COVID 19 pandemic has huge impact on all the sectors. But the education sector has been impacted very badly than any other sectors. As all colleges and universities are closed down due to this pandemic, to keep students' academic safe, universities and colleges moved their examination online which was the big challenge in terms of security. To get rid of this issue they started using proctored online examination system but the problem with this system was to maintain and detect the misconducts which they were unable to do. Even these proctored systems need supervisor to be present at the time of examination to monitor the activities of the students. So, to solve this problem A Novel Unsupervised Proctored system is implemented which doesn't need any supervisor to be present at the time of examination as this system is capable of detecting cheating activities or object used for cheating without any human monitoring. This system logs all the misconducts which can be verified by the supervisor post exam.

## 1 Introduction

In the past two years Covid 19 had huge impact on education system. Due to which Colleges and universities has completely moved to the online education delivery mode. Even the examinations are conducted online due to this pandemic. As per the article published by BulbulDhawan[1] in financial express when the first wave ended, all the universities thought that they can conduct exams offline. Although, the second wave worldwide has disrupted these plan, forcing universities and college to conduct exam online. While moving from offline to online classes it has various challenges but it is still manageable. However, when it comes to online exams, there are various new challenges universities and colleges faced. Speaking to financial express Prof Ajay Garg[2] of IIM Lucknow said that the universities and colleges has partnered with various Organizations which provides proctored platform for online examination. This applications allow universities and colleges to proctored students remotely to avoid any misconduct while giving examination. However this proctored systems has various gap which void the integrity of the examination. As per the computer scientist Mathijs Noij[3] of VOX web there various gap in proctored systems which allow students to do cheating. So to fill this gaps in proctored systems which allow students do cheating, implementation of AI/ML based proctored system is done which is completely secured and have the capabilities to detect the misconduct activities.

Research question:

How AI/ML based unsupervised online proctored system can be developed for detecting misconducts during examination?

## 2 Related Work

In this section of the research paper, it contains the similar work done in the past by other researchers. This section highlights and compare the research done by other researchers

Swathi Prathish and all[4] has implemented an intelligent system for online exam monitoring. They have created a system which monitors the students by using webcam and keep track of their face movements and system activities. They have fed all this features in a rule based conjecture system which looks for the occurrence of cheating activities. They had divided there system in three modules i.e. Video processing, Active window capture and audio recording. For detection of face, algorithm by X. Zhu, et. Al is used. In this algorithm each landmark is termed as part. These algorithm uses tree like structure with pool of parts. The main purpose of this algorithm is to find multiple faces. For this execution no public data set is used by the researcher and his team. They have created sample dataset which includes 29 separate videos which contains 13 videos for each subject and 16 misconducts. The outcome of this project was the proctored was able to identify the misconducts. The scope of this project is only limited to single student and the future scope of this project is to develop inference system.

Similar research on online proctored system was conducted by Jiyu Jia and his partner [5]. In this research they have attempted to develop an Intelligent online proctored system to monitor the exams. They have used B/S architecture i.e. Browser Server architecture. In this browser server architecture, the identification data, facial expression, behavior status change of students are stored at server side. At browser side multimodal data of students is collect and analyzed and even the behavior change of the students is transferred to server from browser side. In this research JavaScript is used for real time face recognition and VAD in client web browser. As a study researchers used this system at Peking University. During this study they found that all students has focused on exam without leaving camera or speaking while giving exam. However, sound of some students were not recorded due to not having microphone or intentionally keeping the mic off. It is light weight system which can be integrated with any other education management system such as moodle. However, this system is not much stricter. For testing purpose researcher has integrated this system with Lexue 100. Application was integrated properly and even it was working fine in production environment but due to data regulations researchers has not received an logs neither the report about the IOPS and Lexue 100 execution.

Another research on online examination system was conducted by Ludwig Slusky [6]. He has done research on cyber security for online proctored system. He has investigated existing capabilities of online proctored system and technologies used by them for identifying vulnerabilities and various methods which can be used t secure the online proctored system. He has reviewed implementation security features in almost 20 proctored systems such as Eklavvya, Examity, Examus, Honorlock, Labster simulations, Kryterion, Loyalist Exam Services, Mylab, +ProctorU Auto, Mettl Proctor Plus, OP4RE, onVue, Proctor Exam, ProctorU etc. His study consider various methods and technologies implemented by proctored system such as: AI and machine learning, access controls methods, regulatory compliance, endpoint security, vpn, virtual machines, biometrics, blockchain technologies. His research applies basic principle of cyber security i.e. confidentiality integrity and availability. His research only suggest various security features which should be implemented in proctored system, such as access control and behavior monitoring, administrative, technical, physical controls.

Similar study related to proctored system was conducted by Susithra V [7] and all. In this research they have studied previous existing proctored system and found out that they are less accurate in detecting anomalous behavior and even they need more computational power. To get rid of this problem they have implemented a framework for image handling activity by using OpenCv programming. In the first stage of framework, it detects the human face and check whether the human face can be distinguished or not. In this process if the face is not distinguished properly then the student giving the exam has to change his position to make is face identical. If it is still not recognized then the framework will capture the picture and send it to the invigilator for security purpose. The face recognition process contains two task i.e. one for creating datasets and other one for testing and validation. The system prototype consist of Python-OpenCV, Anaconda Navigator, Jupyter notebook and matplotlib for plotting. Few additional libraries are used such as NumPy. Similarly they have used interactive python terminal with libraries. This program is integrated with MIME and SMTP protocols for sending anomalous behavior images using mail to the invigilator. After the successful implementation the result was positive with 90 % accuracy. The accuracy was calculated by using ADA boost technique and by probability.

Another study was conducted by Jining Han and all[8] on redesigning remote proctoring for online learning environments. This study follows design base research method (DBR). DBR is always founded in a genuine education research framework and situates research in real-world instructional situations. The main purpose of DBR is to refine education design. It highlights iterative research process. Due to this reason DBR was used to design and implement effective proctoring system at below mentioned university. This study look around to address issue at southwestern university in china. Due to pandemic the entire program of this university was made online. So to create online proctoring system, hardware and equipment's available at university were used. For this study researchers has recruited 10 students as test taker who was not having experience of online testing. Researcher has asked participants to think beyond the system while testing and they have even encouraged the consider the flaws system might have. The exam content was adopted from college English test. This test was conducted remotely and alone as per the instructions given by the remote proctor. Qualitative data collection method was adopted by the study. This qualitative data consist of observation report from proctors and set of interviews with the 10 students. Although the number of students were less, data collected by set of interviews at different time was enough to reach saturation in DBR study. This is how the feedback of the students were collected in this research and based on students feedback the system was redesigned. Based on feedback it was recommended to have authentication before testing in which student's authentication is done via automated authentication system. The second thing recommended was live remote proctoring by using two cameras: one front camera and other was put behind the students diagonally to monitor the surrounding of the student. Third thing recommended was saving the students recording data. The limitation of this study is that it can only handle few students. The future scope of this project is to handle large number of students.

Similar research was done by Yousef Atoum and all[9] on automated online exam proctoring. In this research they have developed a multimedia analysis system to detect cheating activities during an online exam. Their research include two phases i.e. preparation phase and exam phase. In the first phase student has to authenticate himself by using face authentication and password. Calibration steps is also included in this phase to ensure that all sensors are functioning properly. The test phase of this research consist of real time monitoring of students giving exam for cheating detection. Researchers has used three sensors such as webcam, microphone and wearcam to capture audio and visuals of students taking the exam. This collected data is processed by six components such as user verification, text detection, speech detection, active window detection, phone detection and gaze detection. In this implementation the webcam is mounted on the top of monitor then the wearcam is attach to the students head such that it faces to the monitor. During the experiment they have used sony action camera as a wearcam by attaching it to the head by using head band but due to heavy weight of the camera this option was undesirable. Finally the researchers has used wired webcam by attaching it to eyeglasses. These both cameras were synchronized in real time by using custom algorithms designed by researchers. This is how the researchers has designed automated proctoring system. The results of this system was 87% accurate.

During an online test meeting, Asadullah[10] and his colleagues conducted research to develop a media assessment framework for detecting a variety of swindling tactics. The calculation used here is SVM classifier and HSV model to convert the edge over to a paired picture and then assess the screen position, for example, a candidate taking an exam could not leave the room during the test stage, and so on.

In the research conducted by Benmusa[11] and all, they have decided to differentiate duping activities in experiment lobby. To follow locators in the video they used following calculations. They have used locators which are strong. Regardless of the indicators and subsequent calculations, text marking to avoid erroneous order if locators and subsequent calculations fail to follow the countenances. The human movement detection model presented in this research uses just 3-Dimension highlights from an RGB-D camera and a Gaussian Mixture Modal based Hidden Markov Model to interpret human activity.

On observing the previous research papers it was identified that all research conducted was implemented successfully. I have observed that most of the researchers has done case study. Most of the researchers has tried to implement multiple security measures which can be further improved in my proposed system. The techniques studied in the above papers will be used and performance of the same techniques will be improved in my proposed system . The detailed approach and methodology to this proposed work will be shown in the next section which will have real time proctoring based on AI/ML and having security features which will prevent cheating activities

## 2.1 Research Niche

Author	Methodology	Limitaions	Future Scope
Swathi Prathish and all	Rule based conjecture system with audio video monitoring	Can detect only single person	To develop inference system
Jiyou Jia and team	Real time face recognition and VAD using browser server architecture	Audio not recorded in some case	Bandwidth, connection speed and microphone permission check
Ludwig Slusky and all	Suggestion on existing security features only in proctored sytem	Supervised proctored features studied only	No future scope given
Susithra V and team	Framework developed using openCV for anamolus activity Detection	It needs invigilator presence	Convert speech to text and send that text to invigilator
Jining Han and team	Used DBR and two cameras for monitoring students	In can only conduct exam for less number of students	To handle more number of students
Yousef Atoum and all	Used three sensor web cam, mic and wear cam	It need us to use glasses to attach wear cam.	To improve system efficiency
Asadullah and team	Silence removal, Time duration estimation, Energy estimation and Spectrum estimation	Not all cheating techniques are identified	Abnormal whispering detection
Ben-Musa and all	Human movement identification models by using 3dimesion highlights	Less accurate and complicated	Detecting Human activities with high certainty

### 3 Research Methodology

The research question requires us to create such platform which is unsupervised examination platform that can be used to conduct exams online remotely with integrity. The first and the most important feature of this product is to identify and authenticate the candidate to maintain the confidentiality of the exam. For this purpose candidate will upload a legitimate ID as an evidence for validating the authenticity. During the start of exam, candidate picture will be capture by using webcam and then it'll be compared with the ID proof given by the candidate at the time of registration. If the image mismatch then the candidate is not allowed to give the exam.

As soon as the exam begins, the browser changes to restricted mode. Using webcam, the applicant is monitored for suspicious actions or behavior in limited mode. We have two options for keeping track of the applicants either by live proctoring or post exam proctoring. During the examination, the applicant is monitored in real time, and if any suspicious behavior is identified, the platform keep the records of that behavior in frames with the object identified. If the candidate try to use another tab while giving the exam then the exam gets end automatically by logging out the candidate from his account.

This Exam monitoring includes –

- Facial expression tracking
- Neck rolling movement tracking
- Identifying multiple people in viewport
- Various object tracking such as mobile phone, smart watch etc.
- Surrounding noise detection
- Browser full screen and tab change restriction

This application keeps the track of cheating activities and save it at the server side. Such as keeping track of how many times a mobile phone is used in a minute. This all strokes are stored in frames. This platform doesn't need instructor to be present at the time of examination as this is an unsupervised platform. Instructor can check the integrity post exam by logging to organization dashboard.

For developing this platform various AI/ML based dependencies are used which made the task of proctoring easy.



## **4 Design Specification**

The implementation is a stand-alone product, which can be further integrated to the company education platform. Other test-taking platforms can be included in this program, and AI-based monitoring can be provided as a service. Users will be able to register, access all tests, view test results, and create their profiles using the system. Organizations may develop new tests and exams, customize proctoring settings to meet their needs, and access all candidate data and records.

### **4.1 Functions of Product:**

#### **4.1.1 User Side Features –**

- New User Registration
- User Login and User Logout
- Tests available for the users
- Student authentication at the start of exam
- Test given by the user
- View result and test submission
- User Details
- User Update

#### **4.1.2 Organization Features –**

- New Organization Registration
- Organization Login and Logout
- New test Creation
- Test settings configuration
- Test management
- Test invites via mail
- View Exam logs

#### **4.1.3 Security Functions –**

- Security authentication based on webcam
- AI/ML proctoring for integrity
- Noise detection
- Dashboard for checking integrity and user cheating activities

## 4.2 Activity diagram

### 4.2.1 Organization Activity

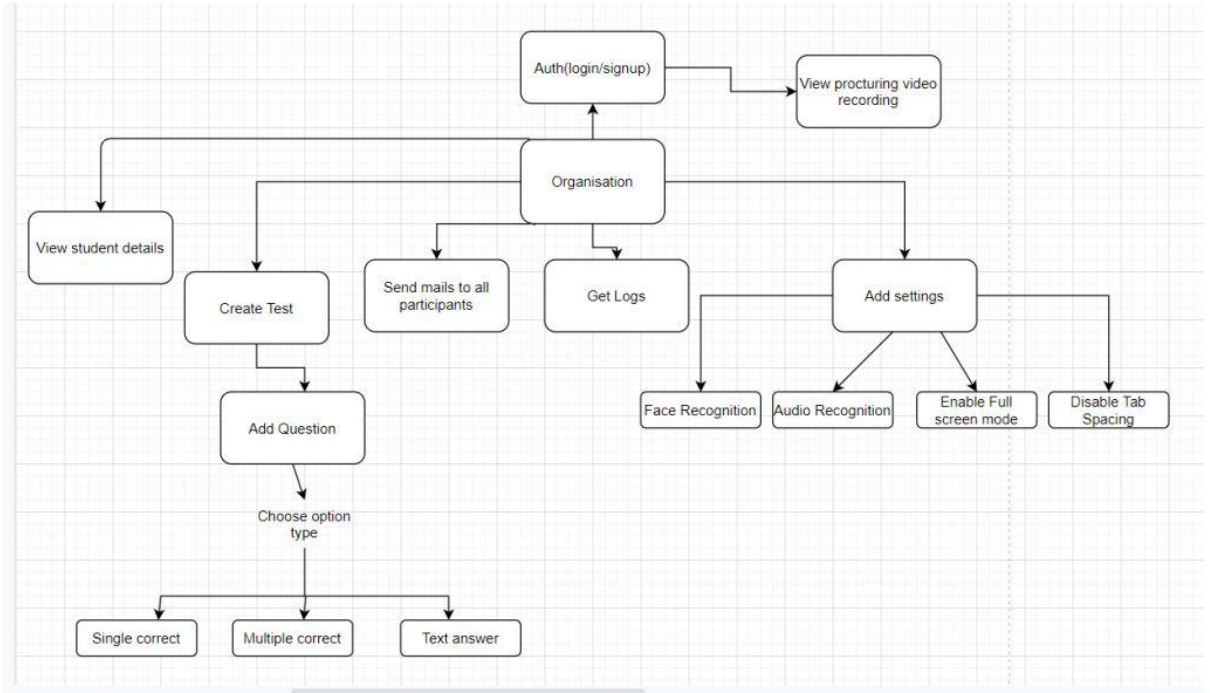


Figure 1: Organization Activity Diagram

### 4.2.2 User Activity

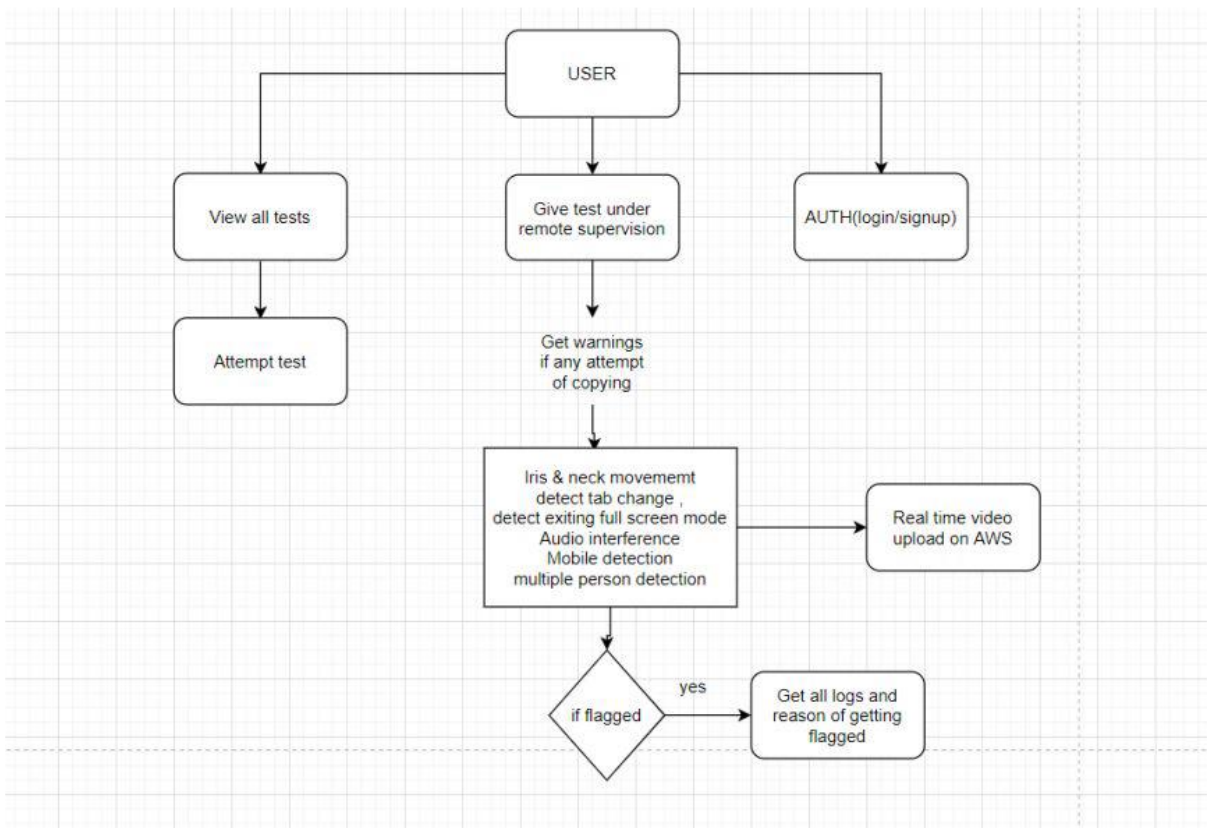


Figure 2: User Activity Diagram

### **4.3 Assumptions Dependencies and Constraints**

This system allows candidates to attend exam remotely. Security is the most important feature of this system. This system has extreme intolerance in terms of cheating activities. This system warn candidate before terminate exam for performing cheating activities. This system provides logs for misconducts did by students during the examination.

For the proper working of the implementation following dependencies are there –

- High speed internet
- Google chrome or firefox web browser
- Permission to webcam and microphone
- User will allow control of webcam and microphone

### **4.4 Different Interface Requirements**

#### **4.4.1 User and Organization Interfaces**

This system will provide an UI Interfacing with browser software is part of the software interface. The program also communicates with a cloud-based web server. This server connects to a cloud-based storage and database provider to store for both user and organization through which is accessible through internet.

#### **4.4.2 Hardware interfaces**

This interface include permission for webcam and mic which is given through web browser such as chrome and firefox.

#### **4.4.3 Software Interfaces**

This includes the web server, web browser and database interaction which is hosted on cloud

### **4.5 Functional Requirements**

#### **4.5.1 User Functions**

##### **4.5.1.1 User Sign Up**

The candidate must first register in order to access any other features. Candidate information such as complete name, email, phone number, residence, educational background, and so on must be supplied during registration. For authentication, the candidate must then upload a genuine government ID verification document. The candidate's image will be captured by the Webcam for additional verification. All of the information will be saved in a MongoDB Atlas.

##### **4.5.1.2 User Login and Logout**

To login to user account candidate must be first registered then and then only he can login to the account. To login registered candidate can use email id and password which is verified

with the login credentials present in the database. For authenticating the user JWT is used i.e. JSON web token which has data and unique signature for the user.

#### **4.5.1.3 Checking eligible tests**

This feature allows candidate to view eligible test with the details such as test name, duration and marks etc.

#### **4.5.1.4 Result summary**

By using this feature candidate can view their previous results and the summary of the results which also include candidate integrity score.

#### **4.5.1.5 Profile Update**

This feature is implemented to allow candidate to update their details post registration.

### **4.5.2 Organization Functions**

#### **4.5.2.1 Organization Sign Up**

To conduct any exam the organization first has to register their account with the details such as organization name, organization mail id, contact number address etc.

#### **4.5.2.2 Organization Login and Logout**

To login or log out the organization must be first registered. The login activity is carried out securely by using JWT technology to verify the organization credentials with the credentials present in the database. Even the password is stored in hash format for security purpose.

#### **4.5.2.3 Profile Update**

Same like user profile update, organization profile update works. It basically allow organization to update the details post registration

#### **4.5.2.4 New Test**

For creating or modifying the test, organization has to login first. After logging organization is provide with a test creation dashboard where they can setup the proctoring severity and related things. After this organization has to give a test name, duration and total marks. The time duration for this proctored system is in minutes. Then the organization is redirected to the question creation tab where organization adds the question and its answer. This implementation has various features such as single correct answer, multiple correct answer and subjective answers. And even the organization has to assign the marks for per question. After all this organization can upload a file having students email id to whom they want to invite for the examination. Invitation to the candidate is sent by email.

#### **4.5.2.5 Logs and Reports**

For each of the candidates and tests, the organization may access the reports and logs of the various monitoring procedures. Webcam tracking data, facial landmark data, object detection data, and voice recognition data, as well as the timestamps of the occurrences, will be included in these logs. The organization will have access to all exam and test recordings for evaluation.

### **4.5.3 Platform functions**

#### **4.5.3.1 Inviting Candidates**

The platform allows organization to upload a CSV file with the email addresses to whom the tests should be sent. Only the students who have been chosen will receive the email with the invitation link.

#### **4.5.3.2 Automatic termination and warnings**

Multiple warnings are provided when suspicious behavior is discovered on the applicants' end. The organization that is conducting the test should be allowed to customize these warnings. If the behavior exceeds the defined threshold, the system should go into lockdown mode and the inspection should be ended.

#### **4.5.3.3 logs for the examination conducted**

During the examination, all the information of the candidate and his/her behavior during the exam is recorded and logs are generated.

## **4.6 Non-Functional Requirements**

### **4.6.1 Performance**

The system should have latest processor and minimum 4GB ram for high performance

### **4.6.2 Security**

The organization should assign only few employees the permission to manage the exam to maintain the integrity of the exam

### **4.6.3 Availability**

The system must have required storage space available, and data must be easily accessible to the authorized user

## **4.7 Framework**

Vue.js –

Vue.js is an open-source framework developed in JavaScript. It is mainly used to build user interface and single page application. We have Vue.js in this implementation for designing user interface for both organization and user.

Vue.js allows for extending HTML with HTML attributes called directives. The directives offer functionality to HTML applications and come as either built-in or user defined directives [12].

## **5 Implementation**

### **5.1 Models**

For implementation this project has been divided into three different models given below:

#### **5.1.1 Organization Model –**

This model is implemented to handle all the organization function such as creating test, Viewing the test result, Examining the misconducts and checking the integrity score etc.

#### **5.1.2 User Model –**

This model is implemented for providing the ease of accessing the test available an activity related to the test such as checking result.

#### **5.1.3 Test Model –**

This Model is implemented with the purpose of creating and handling the test with various function such adding questions, setting test duration, adding answers to the questions etc. This model is further integrated with both user and organization model.

### **5.2 Modules or Dependencies**

There are various modules used in this implementation, out of which only main module is described below:

#### **5.2.1 Face recognition Module**

This is the most important and main module of this implementation which is responsible for detecting cheating activities. This module name is tensorflow.

tensorflow.js is implemented for face recognition and face detection. Tensor flow give us a face mesh coordinates which are tracked and have certain threshold set to it. When the distance increases the threshold then we mark the candidate as flagged [13].

#### **5.2.2 Object Detection Module –**

For object detection cocossd module is implemented. This module is implemented to detect various objects which might be used to cheat in the examination. It detects various object such as Mobile phone, smart watch etc. Whenever any object is detected, it warns the student giving exam with the message that mobile phone is not allowed. Even the object type is logged in the system logs with objects used in frames in a minute [14].

### 5.3 Database –

In this research project, NoSQL database is implemented on MogoDB atlas. This has been done by creating cluster and a database which is been accessed by certain credentials. These credentials are given inside .env file i.e. environment file.

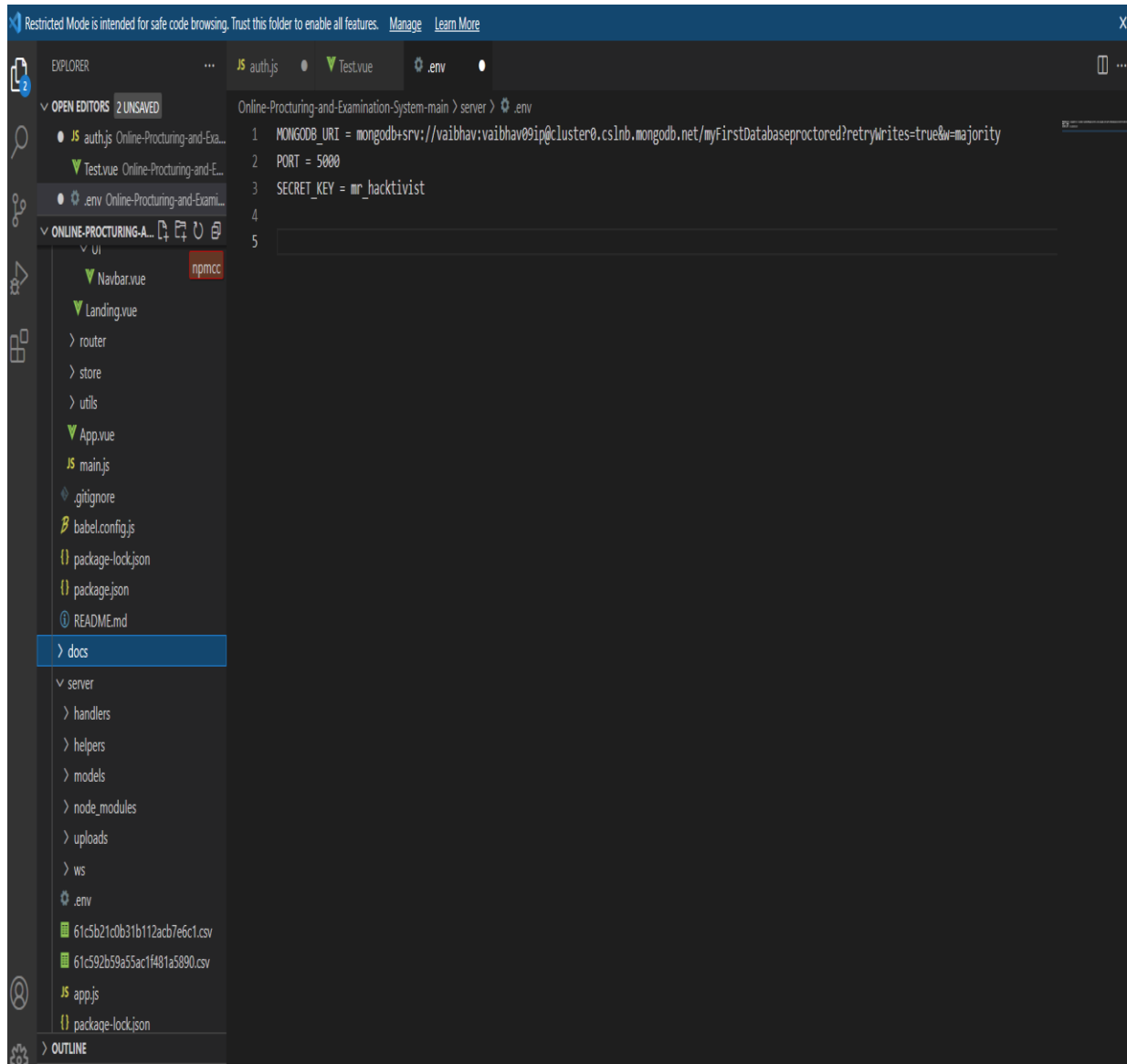
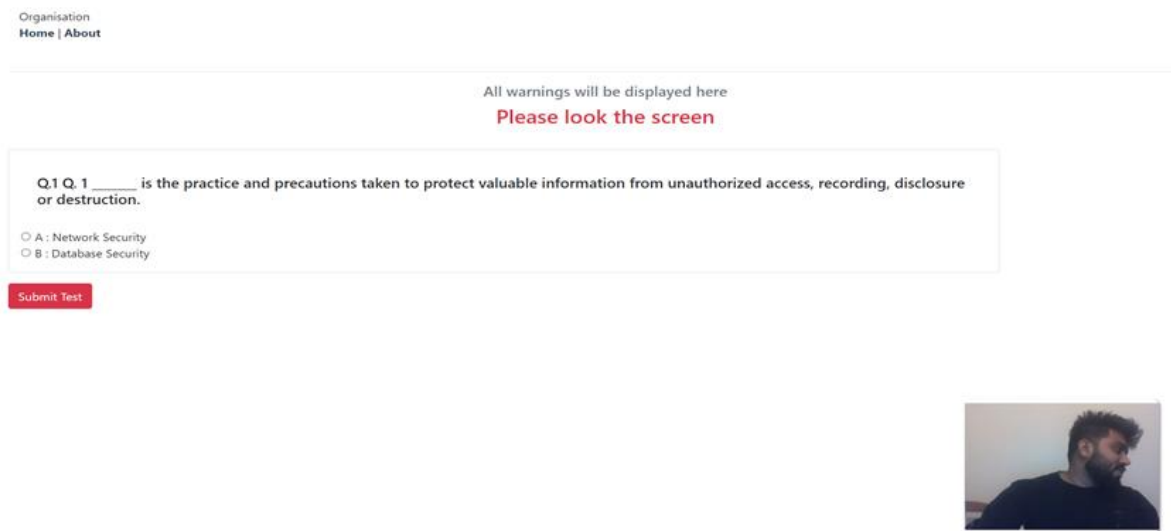


Figure 3: Environment File

## 6 Evaluation

### 6.1 Experiment / Case Study 1

In the first case as you can see below we have achieved the desired outcome in which, while giving an exam we have tried to look into a different direction than looking into the screen and we got a warning that please look at the screen. This has been achieved by using a face recognition module.



**Figure 4: Candidate looking in right direction**



All warnings will be displayed here

Please look the screen

Q.1 Q. 1 \_\_\_\_\_ is the practice and precautions taken to protect valuable information from unauthorized access, recording, disclosure or destruction.

- A : Network Security
- B : Database Security

Submit Test



**Figure 5: Candidate looking in left direction**

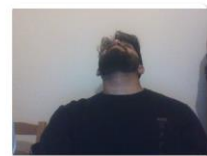
All warnings will be displayed here

Please look the screen More than 1 people

Q.1 Q. 1 \_\_\_\_\_ is the practice and precautions taken to protect valuable information from unauthorized access, recording, disclosure or destruction.

- A : Network Security
- B : Database Security

Submit Test



**Figure 6: Candidate looking up**

...

## 6.2 Experiment / Case Study 2

In the second case we have tried to include more than 1 people in the live examination to check whether the implementation is able to detect more than one person and as you can see implementation throws the warning i.e. more than 1 people

All warnings will be displayed here

**More than 1 people**

Q.1 Q. 1 \_\_\_\_\_ is the practice and precautions taken to protect valuable information from unauthorized access, recording, disclosure or destruction.

- A : Network Security
- B : Database Security

Submit Test



**Figure 7: More than one person**

### 6.3 Experiment / Case Study 3

In the third case of this implementation, we have tried to use mobile device and smart watch to check whether the implementation is able to detect the mobile phone and smart watch which has been used for cheating purpose and as you can see the we got warning that using mobile phone is not allowed.

All warnings will be displayed here

**Using Mobile is not Allowed**

Q.1 Q. 1 \_\_\_\_\_ is the practice and precautions taken to protect valuable information from unauthorized access, recording, disclosure or destruction.

- A : Network Security
- B : Database Security

Submit Test



**Figure 8: Candidate using Mobile**

...

All warnings will be displayed here

Using Mobile is not Allowed

Q.1 Q. 1 \_\_\_\_\_ is the practice and precautions taken to protect valuable information from unauthorized access, recording, disclosure or destruction.

- A : Network Security  
 B : Database Security

Submit Test



**Figure 9: Candidate Using Smart Watch**

## 6.4 Discussion

This Implementation has various security features which was not there in the systems implemented previously. The best part about this implementation is that it is an unsupervised proctored system which doesn't need any supervisor or examiner to be present at the time of examination to monitor the student. This proctored system is capable of detecting all types of neck movement which move the candidate direction from monitor to somewhere else and keep track of this. Even this system is capable of detecting 72+ objects which might be used for cheating purpose. The only problem with the object detection at the movement is every object is flagged as the mobile device because to differentiate the object we have to write condition for all the different objects which is not possible at the movement. Even this system has overcome the issue which was there in the previously developed systems which allow to change the tab at the time of examination but if you try to do the same with this system then your examination will end without any warning. Mainly all the expected results has been achieved and the research question has been satisfied by implementing this system. This system has not that good interface, which can further improve. At the first start this system takes a time to run smoothly which can be improved in the future.

## 7 Conclusion and Future Work

I conclude that the research question on developing secured unsupervised proctored system has been achieved in which we are able to detect various misconducts such as multiple person in the single frame giving the exam, Objects use for the cheating in the exam and tab change restriction for the user which terminates the exam upon tab change. All this module are working with high accuracy. The only limitation is to detect multiple face from long distance and distinguishing the object category.

Future scope of this implementation includes developing a better user interface and easy to use interface, Alarm system for misconducts, implementing SSL and TLS for secure encryption and developing a plugin which can used to provide proctoring as service.

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