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Automated Recruitment System

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Abstract

Every year, thousands of applicants submit their resumes to major tech companies. However, manually reviewing each resume one by one is an impractical task. Consequently, numerous resumes go unread by interviewers, resulting in a significant loss of potential talent for the company. To address this issue, our project aims to develop an automated platform for resume shortlisting and initial screening tests. Our web-based application empowers administrators to create job postings with specific requirements. Utilizing advanced algorithms, our system extracts relevant information from candidates' resumes and shortlists them based on predetermined criteria for each job. Additionally, the platform conducts screening tests for the selected candidates, and the final selection is based on both the test scores and the initial shortlisting. By automating this process, we streamline and optimize the hiring process for tech companies, ensuring that the most qualified candidates are identified and considered for further evaluation.

Executive Summary

Most successful IT companies owe their success to having the right people working for them. This is primarily because competent recruiting may have a significant impact on a startup's success story. A fantastic team is formed through the journey its members take together. It is a challenge in and of itself to find the company's best employees. This is because major IT companies receive a lot of applications each year, making it hard to look at each resume individually. This ultimately results in a significant loss of talent for the company because the interviewer doesn't even look at many resumes.

To address this, an automated system will be developed that not only provides a shortlist of candidates based on their skills and experiences, but also provides a wide range of additional features, such as the scheduling of tests and interviews, the use of online screening tests, the selection of candidates for interviews based on their test scores, and a feature that displays the highest probability of cheating in online tests.

This process can be automated by developing a software system based on Artificial Intelligence (AI) algorithms and machine learning. The automated system will shortlist the applicants based on the skills provided on their CVs and then these abilities will be tested by various tests. Different candidates will be scheduled to give tests on different dates according to the number of active users that can be entertained by our server. The faculty member would be asked about the dates of their availability for the interviews so that the interview would be scheduled accordingly. Also, the app will help to detect cheating of candidates in online tests. This will help both the applicants and the companies because hiring of genuine employees will no longer be a headache.

After completing our research, we can state that shortlisting has been used in a few machines learning-based projects. In addition to machine learning, natural language processing has also been utilized in several projects to implement shortlisting features. Furthermore, it has come to our knowledge that TestGorilla is a website that is implemented to conduct online screening tests. Its objective is to provide a stress-free and enjoyable screening without bias for the hiring committee and their candidates. It does this by employing a multilayered, deeply scientific strategy that always guarantees the fairness, dependability, and validity of our screening tests. Not only TestGorilla but Corra group is also a website that allows screening tests. It has experience in corporate research, competitive intelligence, pre-employment screening, and real-world answers to your most pressing questions. It can highlight or highlight parts of a background check that might make it hard to hire a certain job candidate.

In conclusion, we may say that the system would be dealing with the recruitment of instructors in academic institutions. Candidates who would be interested in applying for the position would be required to provide all of the necessary information to the system first. The system would use forms to collect this information. The merit criteria established by the institute would then be used by the system to narrow the list of candidates. The administrator would then set a time and date for the candidates' test once the candidates have been shortlisted. The system would then put the shortlisted candidates' abilities and knowledge to the test with a variety of tests. These tests would include short- and long-answer questions from a variety of subjects related to the field for which the position or seat is being offered, as well as objective questions like multiple choice questions (MCQs). After the objective test, the candidate would go through a trial that tests the nominee's coding skills. After the applicant had completed the code, the system would give them several test cases to look at to see how well they could code. If the program produces the required output in accordance with the provided test cases, the candidate will have a good chance of being selected for interview.

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Chapter 1: Introduction

Successful IT companies usually attribute their success to having the appropriate staff. This is mostly because of the significant influence that competent recruiting may have on a startup's success narrative. However, the problem starts right after one decides to hire staff for the company. Hiring appropriate people for the company is itself a task. This is because major IT companies receive many applications each year and it gets difficult to individually review each resume. Since many resumes are not even examined by the interviewer, this ultimately proves to be a significant talent loss for the business.

Observing this problem every now and then, this process is decided to be automated, so that it becomes easier for the educational institutes to hire skilled employees i.e., lab instructors without skimming through each applicant's resume in a hurry. Furthermore, this process plays a beneficial role for the applicants as well since they get a chance to show the ability and skills they precisely possess. This process can be automated by developing a software system based on Artificial Intelligence (AI) algorithms and machine learning. The automated system will shortlist the applicants based on the skills provided on their CVs and then these abilities will be tested by various tests. Different candidates will be scheduled to give tests on different dates according to the number of active users that can be entertained by our server. The faculty member would be asked about the dates of their availability for the interviews so that the interview would be scheduled accordingly. Also, the app will have the feature that would help to detect cheating of candidates in online tests. This will help both the applicants and the companies because hiring of genuine employees will no longer be a headache.

In conclusion, we will be developing an automated recruitment system that will permit employees to upload resumes and enter their personal information. Candidates' entries will be reviewed, and their positions will be assigned based on their experience, grade point average, and university. The shortlist of candidates will be made, and the tests and interviews will be scheduled in accordance with that. As a result, it will no longer be difficult for businesses to hire genuine employees, which will be beneficial to both applicants and employers.

1.1 Purpose of this Document

The purpose of this document is to explain the functional and non-functional requirement and different use cases of the automated recruitment system. We will develop an application that makes it easier for the educational institutes to hire skilled and knowledgeable lab instructors through an automated system. The application not only saves the time of the hiring committee but also lessens their efforts by shortlisting the candidates based on their achievements and institute’s requirements. This process of shortlisting is done by scanning through the CVs of applicants and taking required information from them through forms.

The purpose of this project is not just about making a shortlist of candidates; it also aims to make it easier for the hiring committee and institutes to test the shortlisted candidates' coding skills and knowledge by giving them several tests related to their domain and area of expertise. This helps the institutes in hiring genuine and deserving lab instructors.

Therefore, the main objective and purpose of this project lies in hiring lab instructors through automated tools that help narrow down candidates and testing their abilities.

1.2 Intended Audience

The Hiring Committee of educational institutions, which must devote a significant amount of time and effort to find the ideal candidate for the position of lab instructors, is the intended audience for this project. But not only is it intended to facilitate the hiring committee, but it also helps candidates. Each year, educational institutions receive a lot of applications, making it difficult to review each resume individually. This ultimately results in a significant loss of talent for the company because the interviewer does not even look at many resumes properly. Therefore, this application is also intended for those candidates who's CVs do not get evaluated thoroughly.

1.3 Definitions, Acronyms, and Abbreviations

Abbreviations used in Document

OOP: Object oriented programming

PF: Programming fundamentals

EEOC: Equal Employment Opportunity Commission

DIF: Differential Item Functioning

SDG: Sustainable Development Goal

1.4 Conclusion

In conclusion, educational institutions and successful IT businesses give regard to their staff for all the success and the issue arises immediately following the decision to hire employees for the business. It is a challenge in and of itself to find the company's best employees. This is because major IT companies receive a lot of applications each year, making it hard to look at each resume individually. This ultimately results in a significant loss of talent for the company because the interviewer doesn't even look at many resumes.

We are developing an automated recruitment system that will allow employees to upload resumes and enter personal information in order to address this issue. The applications of candidates will be evaluated, and positions will be assigned based on their experience, university, and GPA. Tests and interviews will be scheduled in accordance with the shortlist of candidates that will be made. Businesses will no longer have a hard time finding genuine employees, which is good news for both job seekers and employers.

Chapter 2: Project Vision

It is challenging to conduct interviews for instructors in educational establishments due to the ever-increasing demand. When it comes to finding genuine employees, institutions face several challenges. This project aims to implement a platform that makes it possible to evaluate shortlisted candidates using a simple online questionnaire and coding-based test to simplify the process of shortlisting candidates. In addition, our project will provide a list of candidates who have been chosen based on the evaluation criteria. The entire procedure will be beneficial to both candidates and hiring committees.

We will highlight the area of our work, our objectives, and the challenges we must overcome, in this section. The purpose of this section is to provide a thorough analysis of the problem as well as the project's constraints and scope.

2.1 Problem Domain Overview

The problem that our system would be dealing with is with the recruitment of instructors in academic institutions. This is because it is almost impossible to manually go through each resume one at a time. Since many resumes are not even read by the interviewer, this results in a significant talent loss for the institute. Through an automated system, application makes it simpler for educational institutions to hire skilled and knowledgeable lab instructors.

The system is designed to first take all the required information from the candidates that are interested in applying for the job. This information is gathered by the system using forms.

The system then narrows down the list of candidates based on the merit criteria set by the institute. Once the candidates are shortlisted then the admin must schedule time and date for the test that is to be conducted for candidates. Afterwards, the system tests the skills and learning of the shortlisted candidates through various tests. These tests include some objective questions i.e., some MCQs and short answer questions from different subjects related to the field for which the position/seat is offered. The candidate goes through a trial that tests the nominee's coding skills after the objective test. The system assigns the applicant several test cases to evaluate their coding abilities after the applicant has completed the code. The candidate has a good chance of being chosen for interviews if, in accordance with the provided test cases, the program produces the required output.

2.2 Problem Statement

The problem that we are dealing with is that every year, thousands of people apply for jobs at institutions. Manually going through each resume one at a time is almost impossible. The company loses a lot of talent as a result of the interviewer's inability to even read many resumes. Therefore, an automated recruitment system will be designed that will solve this problem. This system will appoint deserving and skillful employees for the seat while lessen the efforts and time of the interviewers.

2.3 Problem Elaboration

The entire process of finding, sourcing, screening, shortlisting, and interviewing candidates for jobs within an organization is known as recruitment. Recruiters and hiring managers encounter many challenges when searching for new talent at their companies/institutes. Several steps in the hiring process may necessitate the use of critical thinking and problem-solving skills. The most critical step is the screening and selecting candidates from a list of applicants. This step involves the complete process of:

1. Skimming through the CVs of applicants
2. Testing knowledge and skills of applicants
3. Conducting interviews
4. Selection of candidates

Our system is going to target the following issues of recruitment:

2.3.1 Shortlisting of candidates

Every company/institute gets a lot of applications at the time of job opening. Different people pursuing education and knowledge in different fields present their CVs to the hiring committee to get themselves hired. All these applicants deserve at least one proper sight towards their resumes. However, due to the huge number of applicants, it gets difficult for the recruiters to go through each resume thoroughly one by one for the selection of candidates for the testing. This requires a lot of time and effort and is nearly impossible. This problem leads to another problem i.e., talent loss.

Not reviewing all resumes properly leads to talent loss which ultimately is a negative factor for the company/institute. The system we'll design will cater to this problem of reviewing resumes thoroughly and then shortlisting candidates according to provided and required criteria. As soon as the resume is submitted the system will immediately tell if the candidate is shortlisted or not. This arises another problem i.e., is scheduling. Scheduling and notifying candidates about the schedule are also a task.

2.3.2 Scheduling

First the admin needs to set up a start and end day for resumes submission of candidates into the system. This is because the system will immediately announce if the CV is shortlisted or not as soon as it receives one. For this purpose, scheduling is done. The admin will set up a time limit i.e., for how many days a company would entertain applicants to apply and send their CVs. In this time span system wouldn't return the list of shortlisted people and will show it on the day it is scheduled by the admin. This scheduling feature is not only for the shortlisting part but also the admin would be able to schedule shortlisted applicants' tests and interviews. The tests and interviews need scheduling too. This is because we need to consider free time slots of our faculty member i.e., if they are available to conduct interviews or not.

2.3.3 Notifying

After Scheduling is done the next problem, we face is to let our nominees know if they are shortlisted and have a test schedule ahead. For this problem we need to add a feature that notifies the candidates about the upcoming updates regarding tests and its day/date/time. This can be done by sending an email to the applicants with schedule tests details.

2.3.4 Testing of skills

Taking tests online is a very major task. Providing different test questions to each candidate according to their domain raises the need of hundreds of test questions and material. MCQs/short answers-based test and coding question related to guessing output will be different for candidates so that the chances of cheating are less. However, this problem can still not be dealt with properly.

2.3.4.1 Cheating in online tests

Cheating in online tests remains a constant problem that can be controlled through some conditions and restrictions by the system. This can be dealt with by putting time constraints on different sections having questions of different domains i.e., networks, OOP, data structures etc. Each section is to be solved in the given time. This will limit the focus of candidates towards cheating rather the candidates would rush to fill in the answers to the test questions before the time ends. Another functionality that can be added to keep a track of an applicant's cheating is to add the feature that doesn't allow the applicant to change the tab of the laptop/pc once the test has been started. Along with this facial recognition will be used to recognize candidate before test starts. This will also create difficulty for candidates for cheating.

2.3.5 Selection criteria for interview

Selecting candidates for interviews defines another problem. The selection criteria are based on the score achieved in the tests. This raises the need for implementation of fuzzy logic. We cannot define a specific boundary value that declares the result of the test i.e., pass/fail and if the candidate is selected or not. We need to consider values that are near to the boundary and make those candidates eligible for an interview. This selection for interviews considers many factors such as test score, experience, skills etc.

2.4 Goals and Objectives

Interviewing in educational institutes for instructors is not an easy task due to ever growing demand. To make this process easier we will implement a platform with the following objectives:

- Automatic Shortlisting based on the provided criteria
- Assessment of shortlisted candidates based on basic online questionnaire and coding-based test.
- Providing a list of candidates who have been selected based on the assessment criteria.

2.5 Project Scope

For the shortlisting phase machine learning algorithms will be used to correctly identify potential candidates for the next phase. These algorithms will be implemented in Python and will be deployed on a different server with which we will fetch information using API calls. The second server will contain the code to handle the administrative tasks of the website i.e. authentication, running test cases and handling questionnaires. These servers will be created differently to handle the use of two different programming languages i.e., Python for machine learning and JavaScript for backend in Node.

2.6 Sustainable Development Goal (SDG)

The SDG our project is going to target is industry, innovation and infrastructure as it will innovate the process of shortlisting and interviewing. It will basically introduce a new way to interview candidates and may be adopted by many industries related to software.

Figure 1: Industry, Innovation and Infrastructure
The target SDG is SDG 9 industry, innovation and infrastructure

2.7 Constraints

Following are some constraints related to our project:

Time: Project must be completed within a year i.e., each module/task must be completed within the required timeframe.

Work Resources: 3 members will work on this project in order to complete it.

Scope: The scope of the project should be achievable in the limited time of 1 year.

Quality: The project should meet the requirements of software companies as well as the other end users like applicants etc. It should also be reliable and robust in its working.

2.8 Business Opportunity

As software companies are the primary user of this software so it is designed keeping such companies in mind. This product will not only save the time of employees (which is required to skim through the resumes and test results) but will also end up saving money for the company as they will not be required to hire new talent acquisition employees. Moreover, this can also be proved even more beneficial for the company as existing employees can continue working on the projects and their respective tasks without being allotted a task which is not related to them i.e., interviewing.

2.9 Stakeholders Description/ User Characteristics

The users of this system will be the applicants, admins, interviewers and FAST-NUCES.

2.9.1 Stakeholders Summary

The system's target is primarily FAST-NUCES as it will be designed keeping in mind the hiring of lab instructors at FAST. This will allow online interviewing of applicants and will prove to be cost and time efficient for the institution. A higher turnover is also expected using this system.

Other stakeholders include system include applicants and interviewers/ Admins who are basically the end users and the actors. This system is designed to provide ease to both type of end users. Applicants can clear first 2 rounds of the interview right from the comfort of their home and interviewers do not have to arrange seating for the thousands of applicants in the first round. Later in the process the applicants can be assessed onsite when a few applicants are shortlisted.

2.9.2 Key High-Level Goals and Problems of Stakeholders

2.9.2.1 Time Saving

This system will be able to save a good chunk of time for the company using it. It takes weeks and months for the talent acquisition department to skim through thousands of resumes. This system will be capable to effectively grade the resumes within a fraction of time required in grading resumes manually.

2.9.2.2 Capital required

Software companies will also be able to save huge sums of money that is required for HR teams or outsourcing interview process by adopting this system.

2.9.2.3 Automatic operation

Minimal human interaction is required as the process is mostly automated. Admins only need to adjust variables like application due date, test date, availability of faculty etc. Other tasks which do not require human interaction will be automated.

2.9.2.4 Accommodate larger number of applicants

Many applicants are not willing to visit other cities for a single interview. This system will also cater that by taking initial test online. All in all, a higher turnover is expected with the use of this system

2.9.2.5 Unbiased and consistent result

As this system will use prebuilt constraints so unlike human resume grading the grading will be consistent and will be unbiased as there will be no reference-based resume scanning i.e., all resumes will be scanned.

2.10 Conclusion

In conclusion, the scope of our work, our objectives, and the difficulties that will be encountered in the project have been highlighted in this section. It provides a deep examination of the constraints and area of our project. The project will be designed to address all of the aforementioned issues, including candidate shortlisting, testing and interview scheduling, online screening tests, and candidate selection.

Chapter 3: Literature Review / Related Work

This section contains a comprehensive summary of previous research on our topic i.e., the literature review. The previous research is enumerated, summarized, evaluated objectively, and clarified in this section. Our research's primary objective is to make it clear to everyone what existing knowledge, concepts, and ideas on our subject have, as well as their strengths and weaknesses. The following sections describe the detailed literature survey of previous research.

3.1 Definitions, Acronyms, and Abbreviations

The important definitions, acronyms and abbreviations used in this chapter are listed below:

RF: Random Forest

NB: Naive Bayes

LG: Logistic Regression

SVM: Support Vector Classifier

KNN: K-nearest neighbors

CV: Curriculum vitae

NLP: Natural language processing

TF-IDF: Term frequency-inverse document frequency

JSON: JavaScript Object Notation

3.2 Candidates Shortlisting

This section includes a comprehensive study of related work done on shortlisting of candidates by using different approaches.

3.2.1 A Machine Learning approach for automation of Resume Recommendation system:

The proposed system in [1] uses machine learning based solutions. Proposed system mainly works in 2 steps: first is Prepare and second is Deploy and interface. Dataset used was downloaded from Kaggle which is in Excel format. Data contains the information about the category of resume and resume description. Data is modified by using techniques of Stop words removal, Stemming and Lemmatization. Classification of data is done by using 4 different models Random Forest (RF), Multinomial Naive Bayes (NB), Logistic Regression (LG), and Linear Support Vector Classifier (Linear SVM). Firstly, an RF classifier was used on the modified data. RF classifier provides accuracy of 38.9%. Due to an unsatisfactory result of RF, an NB classifier was used on the data. NB provides accuracy of 44.39%. Similarly, LG and Linear SVM classifiers are used on the data which yield 62.4% and 78.53% accuracy. Based on the accuracy of different models used, Linear SVM classifier was used for processing. A recommendation model is designed which takes job description and CVs and provides a list of CVs which are like the job description. Two approaches were used: first was content based recommendation using Cosine Similarity. This model takes job description and cleans resume data and computes the cosine similarity between both. And based on similarity between the two it outputs top n resumes. Second approach uses K-Nearest Neighbors technique which identifies nearest match CVs to job description. A library genism was used to get job

description and resume to the same scale, then KNN technique was used to identify the nearest match of resumes to job description.

Table 1. Classifier Comparisons

Comparison of different classifier used in above approach

No.	Classifier	Accuracy
1.	Random Forest	38.99%
2.	Multinomial Naive Bayes	44.39%
3.	Logistic Regression	62.40%
4.	Linear Support Vector Machine Classifier	78.53%

3.2.2 An automated resume screening system using natural language processing and similarity

The system in [2] uses the technique of Natural Language Processing. It works in 2 phases: First phase is information extraction and second is content-based recommendation system. Objective of the first phase is to remove any kind of noise, chunks and irrelevant data from provided data to use for further processing. This phase consists of a different process: Tokenization which divides long text of data into small useful tokens. Tokenization was performed using Natural Language Toolkit and spaCY libraries. Further, the process of Stemming and lemmatization, Parts of speech tagging, chunking and Named entity recognition was performed on the data. The resulting data after the whole set of operation then of each resume is saved in JSON format which can be easily used for the next phase of the recommendation system. Second phase of the system uses extracted data from the first phase to recommend resumes according to job description. This phase uses the concept of Vectorization, weightage assigning techniques like TF-IDF and similarity measures like cosine distance to measure the similarity among the resume and job description. Vectorization was used to convert string format data into numerical vectors. Because most of the models require input data to be in the form of numerical vectors. Then TF-IDF Transformer python module used in order to check the text frequency and inverse text frequency in job description and job resumes and result store in matrix form. Then the Cosine similarity measure is used to check how similar is the job description to the resume of the candidate and rank the resume with respect to similarity index with job description.

3.2.3 An automated resume screening system using natural language processing and similarity

Method discussed in [3] proposed a Natural Language Processing (a Machine Learning approach) for resume screening. This system works in two phases: First, all the resumes are converted to PDF format. In the second phase, an NLP approach is used to scan this text and compare it with different skills stored in the skills dataset. Skills dataset is a CSV file which contains different skills to which resumes must be matched. Upon successful execution, a CSV file generated containing a match of a resume with particular skills set.

Above mentioned are few approaches for the purpose of short listing of candidates, all the related work involves shortlisting of candidates on the base of comparison of candidate resume with job description. In our system, candidates' resumes are shortlisted by having a comparison of job description with candidate resume/ discerption and also resume will be short listing on by keeping certain attributes like education criteria, experience, GPA requirements etc.

3.3 Online Screening tests

A component of the hiring or recruitment process is an online employment screening test, also known as a pre-employment test or online screening interview. It is a type of employment testing that typically takes place prior to a phone interview or formal job interview and either precedes or follows a job application.

Most employment screening tests are forms or questionnaires with questions resembling those in tests or interviews. Multiple-choice, yes/no, rank-order, or open-ended questions are all options. Before conducting a phone screening or in-person interview, the questions are used to gauge job applicants' knowledge, skills, attitudes, and/or personalities.

3.3.1 TestGorilla

As explained earlier, screening tests are a major component in the hiring process. TestGorilla is an online screening test platform that is designed to identify the best candidates and make hiring decisions faster, easier and bias-free.

The goal is to give the hiring committee and their candidates a stress-free and enjoyable screening experience without biasness. It accomplishes this by employing a multi-layered, deeply scientific strategy that guarantees the validity, dependability, and fairness of our screening tests always.

Key indicators that constantly verify and enhance our tests are analyzed by our advanced statistical algorithms. To keep track of and confirm the internal consistency of a test's questions, we use metrics like Cronbach's alpha.

To eliminate unconscious bias from the hiring process, it has based our platform and tests on the Equal Employment Opportunity Commission [4] (EEOC) standards.

In conclusion, the best candidates will be ranked highest regardless of age, gender, race, or ethnicity. Differential item functioning (DIF) studies on candidate data are also utilized on occasion. As a result, it can continuously eliminate any potential negative effects from the hiring process.

3.3.2 Corra Group

You can't rely on guesswork when your company's future is at stake. If you want to know if a job candidate will be an asset or a liability to your company, you must conduct a thorough background check. Before making a hire, you need to know the truth about your candidate's past. Before you run the risk of incurring costly liability or waste time and money on re-hiring and firing employees.

Corra Group [5], a Los Angeles-based employment screening company, was established in 2005 with the intention of assisting employers nationwide in better screening job candidates. It offers a wide range of background screening services to its customers and educates them on employment screening laws in both the states and the federal government. It has developed cutting-edge technology to simplify the ordering process and safeguard your private information.

In conclusion, it has experience in corporate research, competitive intelligence, pre-employment screening, and real-world answers to your most pressing questions. It can highlight or highlight parts of a background check that might make it hard to hire a certain job candidate.

3.3.3 E-exam cheating Detection system

Method discussed in [6] describes a method to detect cheating in an online exam. There are two types of authentications will be used throughout the exam. Static authentication which takes place at the beginning of examination. And another authentication is continuous which will verify whether the current user is the same as the user who starts the exam. Continuous authentication consists of two-part, fingerprint and eye tracking. For the process of fingerprint recognition system scan and store all the images of enrolled candidates in the database. During exam system capture fingerprint and extract minutiae and compare fingerprint with stored fingerprints to authenticate user. Fingerprint verification phase involves 5 stages. It involves Fingerprint image Acquisition, Image Processing, Locating Distinctive Characteristics, Template Creation and Template Matching.

Second process involves eye tracking that include calculating eye gaze point of a user. Eye gaze coordinates are calculated with respect to a screen position and calculated in the form of x-y coordinates. For eye tracking purpose system need to distinguish between different scenarios. Scenario one in which examinee looking toward the screen. Second scenario can be in which examinee is looking down. In third scenario examinee moved away from the screen. Based on the recording made system calculates average number of times examinee view out of screens and can be distinguish between non-cheating and cheating.

3.3.4 An Automatic Method for Cheating Detection in Online Exams by Processing the Student`s Webcam Images

Solution for cheating detection discussed in online exam discussed in [7] include image processing. For this purpose, different images of student are captured during the test and saved in database. For the first step they captured 50 normal images of student and captured 5 pictures of student doing cheating. For the comparison of images to deduct cheating there are 2 different approaches are used and then result are compared. In first method MATLAB is used for the purpose of image processing and comparison. The method was selected for image comparison is detection of difference between two images by calculating subtraction between the pixels of two images. A threshold will be selected and if value of distance between the images is more than threshold then image is in cheating state. For the second method clustering technique is used. A cluster is made using k-mean cluster of 50 images of student in different states. After clustering of reference images, we compare images of students during exam with center of cluster. If value of distance is less than threshold, images is considered as normal state images, otherwise considered as cheating state image.

3.4 Conclusion

To conclude this section, we might say that online screening tests and shortlisting have been the subject of a lot of research, and these features are being seriously considered for use in the future. The research that was done for the literature review has helped us learn a lot more about the mechanisms and methods that are currently being studied and used to solve these kinds of problems. The primary goal of our study was to make it clear to everyone what knowledge, concepts, and ideas already existed about our topic, as well as their strengths and weaknesses.

Chapter 4: Software Requirement Specifications

This chapter highlights important features of the projects. It also includes functional and non-functional requirement of the project, defines database design and risk analysis involves in the project.

4.1 List of Features

Our system will be able to do these important features:

- Allows admin to post a job.
- Allows applicants to apply to that job.
- Short-List resumes/applicants based on the job description.
- Schedule initial screening interview of applicant.
- Notify applicant for their interview.
- Perform a screening test and show the result to the recruiter.
- Allow admin to select a candidate for job/ further interviews.

4.2 Functional Requirements

4.2.1 Functional requirements for interviewee:

System will allow interviewee to:

- Create a new account
- Login to the portal
- Fill the resume form
- View jobs posted by FAST-NU
- Apply for jobs posted
- View application details
- Take initial screening test
- Take a secondary mcqs and coding test

4.2.2 Functional requirements for interviewer/admin:

System will allow interviewer/admin to:

- Pick a new admin
- View screening test results of candidates
- Set a cutoff score of selection for secondary test
- Create a test schedule for the selected candidates
- Add mcqs/coding questions to the pool of questions
- Select/reject a candidate manually

- Send email notifications

4.2.3 Functional requirements of the system:

System will:

- Shortlist resumes
- Create schedule automatically
- Create personalized test

4.3 Non-Functional Requirements

4.3.1 Performance

User will be able to access the site within 5-10 seconds. The system will be efficient enough to handle a realistic number of users at a time

4.3.2 Reliability

The application will ensure measures for maximum possible uptime. Our goal is at least 99% of uptime

4.3.3 Usability

The system will provide a user-friendly interface that allows the user to use the application in a few minutes and it will be self-explanatory

4.3.4 Reusability

Code reusability: The code should be divided into modules based on the functionality so that it favors code reusability

4.4 Assumptions

The following assumption have been made for this system:

- End users have browser installed in their desktop which is JavaScript compatible.
- As web application will be deployed for the users so internet connection is a must.
- User can understand the basics of the website i.e., Navigation, buttons etc.

4.5 Hardware and Software Requirements

Hardware and Software requirements of the project are:

4.5.1 Hardware Requirements

Following is some hardware requirement of the project.

- Desktop PC/Laptop
- Internet is required.

4.5.2 Software Requirements

Following are some software requirement of the project.

- Vs Code
- React
- MongoDB
- React JS
- Node JS
- Python

4.6 Use Cases

4.6.1 Login

Name	Login
Actors	Admin/interviewer, interviewee
Summary	The user shall provide their email and password on the login form and after successful verification, redirect the user to the home page.
Pre-Conditions	The user must be in the database records either added by any of the authorized users or added manually by a developer. The user must not already be logged in.
Post-Conditions	The user's session is successfully established and shall be redirected to the home page.
Special Requirements	None

Basic Flow			
Actor Action		**System Response**	
1	The user opens the login page.	2	The login page is displayed asking for email and password.
3	The user enters valid email and password.	4	The system verifies the email and password, establishes a session for the user and redirects the user to the home page.
Alternative Flow			
3	The user enters invalid email or password.	4-A	The system responds with an error message: *Incorrect email or password entered.*

4.6.2 Logout

Name	Logout
Actors	Admin/interviewer, interviewee
Summary	The user clicks on the sign out button and will be redirected to the login page.
Pre-Conditions	Users must be logged into the system.
Post-Conditions	Users must be logged out of the system and redirected to the home

	page.		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	Users click on the logout button.	2	System will logout the user from and redirect him to the login page.
No Alternative Flow			

4.6.3 Create a new account

Name	Create a new account		
Actors	interviewee		
Summary	The user shall provide all the required information like email, phone number, degree, university, GPA after which user can login to the system		
Pre-Conditions	The user must not already be present in the database record.		
Post-Conditions	The user's session is successfully established and shall be redirected to the home page and all the details are saved to the database		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	The user opens the sign-up page.	2	The sign-up page is displayed asking for email, password, phone number, university, degree and other details.
3	The user enters valid email, password and the required information.	4	The system adds the email, password, and other information to the database and establishes a session for the user and redirects the user to the home page.
Alternative Flow			
3	The user enters invalid email, password or the information is not in the required format.	4-A	The system prompts the user to reenter the invalid information.

4.6.4 Create a new job post

Name	Create a new job post
Actors	Admin/interviewer
Summary	Create a new job with instructions required to post the job.
Pre-Conditions	The user must be logged into the system.
Post-Conditions	A new job post will be created with the requirements of the job. Where candidates can apply.

Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	The user clicks on the button to create a job post.	2	A new page will be opened on which information will be provided about the job.
3	The user will fill out all the required information required for the job.	4	Job form will show the information filled by the user.
5	The user clicks on the submit button.	6	A new job post will be created successfully.
Alternative Flow			
5	The user leaves required fields blank or does not fill in the required format.	6-A	The system prompts users to fill the affected fields.

4.6.5 View jobs posted

Name	View jobs posted		
Actors	Interviewee		
Summary	View the various available jobs, the required skill set, experience, GPA etc.		
Pre-Conditions	The user is logged in.		
Post-Conditions	The web page containing the available jobs is displayed.		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	The user clicks on ‘view jobs’ button	2	The system fetches all the available jobs from the database and displays it.
No Alternative Flow			

4.6.6 Apply for jobs

Name	Apply for jobs
Actors	Interviewee
Summary	Interviewee can apply for the job in area of interest if the qualifications match.
Pre-Conditions	The applicant is logged in
Post-Conditions	The applicant’s application is saved and will be proceeded further.
Special Requirements	None
Basic Flow	

Actor Action		System Response	
1	The applicant clicks on the 'apply' button under the job of interest	2	The system saves the user in applicants list for that particular job and the application is ready for further processing
No Alternative Flow			

4.6.7 View application details

Name	View application details
Actors	Interviewee
Summary	View application status, i.e., how far has the application been processed e.g., Pending, Reviewed, Interview pending etc.
Pre-Conditions	The user is logged in and has applied for at least one job.
Post-Conditions	The system displays the application status and estimated time for the next phase.
Special Requirements	None

Basic Flow

Actor Action		System Response	
1	The interviewee clicks on View Application Status on the Header.	2	The system displays the application details about all the applicant on selected job.
No Alternative Flow			

4.6.8 Add Question in system used for assessments

Name	Add Question in system used for assessments
Actors	Interviewer/ Admin
Summary	Add question to the system with relevant tag, options and correct answers. This will later be used for taking assessments.
Pre-Conditions	The user is logged in the system.
Post-Conditions	The question will be added into the list of questions.
Special Requirements	None

Basic Flow

Actor Action		System Response	
1	The admin clicks on Create Question option available.	2	The system displays the form to provide information related to question.
3	Users fill the form and press submit key.	4	Operation successfully message will be displayed, and a new question added into question list.

Alternative Flow			
3	User missed a required option to add into the form.	4-A	System displayed an error msg to provide all the required information.

4.6.9 Take screening test

Name	Take screening test		
Actors	interviewee		
Summary	Allows interviewee to take the initial screening test which may consist of MCQs.		
Pre-Conditions	The user has applied for the job and resume has been shortlisted.		
Post-Conditions	The test finishes within the due time and displays a Thank you message.		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	The interviewee clicks start test button.	2	The systems start to display all the question with a countdown timer for the test
3	The user clicks finish test button or test time is finished.	4	The system displays ‘Thank you, your application is being processed’ message.
No Alternative Flow			

4.6.10 Fill the resume form

Name	Fill the resume form		
Actors	interviewee		
Summary	Fill the form created by the interviewers for assessing the applicant and shortlist the applicants for the next phase.		
Pre-Conditions	The user is logged in.		
Post-Conditions	The details are saved to database and are prepared for the shortlisting.		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	The user clicks ‘Fill resume’ button	2	The system displays a blank form with fields like experience, personal details, projects etc.
3	The user fills the form	4	The data is saved to the database and a Thank you page is displayed
Alternative Flow			

3	The user leaves required fields blank or does not fill in the required format.	4-A	The system prompts user to fill the affected fields.

4.6.11 Create a new admin

Name	Create a new admin		
Actors	Admin/interviewer		
Summary	Add a new admin for administrative tasks		
Pre-Conditions	User must be admin and be logged in		
Post-Conditions	A new admin is added to list of admins		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	Admin clicks on "Create a new admin" button.	2	System redirect to form to add information for new admin.
3	Admin add required information to the form and click submit.	4	The system creates a new account for the system.
Alternative Flow			
3	Admin leaves required fields blank or does not fill in the required format.	4-A	The system prompts user to fill the affected fields.

4.6.12 Shortlist Resumes

Name	Shortlist Resumes		
Actors	System, Admin		
Summary	As resume submission deadline is reached the system starts shortlisting resumes.		
Pre-Conditions	Resume submission deadline is reached.		
Post-Conditions	Resumes are successfully graded, and top n will be selected.		
Special Requirements	None		
Basic Flow			
Trigger		**System Response**	
1	Resume submission deadline is reached. Or Admin can click on shortlist applicant on the view applicant details page.	2	Resumes are successfully graded, and top resumes are selected.
No Alternative Flow			

4.6.13 Select Final Candidates

Name	Schedule Interviews		
Actors	System		
Summary	Send an email to Admins and selected candidate about their clearance of second phase.		
Pre-Conditions	Screening test is completed.		
Post-Conditions	Schedule is generated.		
Special Requirements	None		
Basic Flow			
Trigger		**System Response**	
1	Screening test is completed.	2	An email will be send to both admin and candidate about the final status of application.
No Alternative Flow			

4.6.14 Create Personalized Test

Name	Create personalized test		
Actors	System		
Summary	Create different test for every candidate by selecting questions randomly from the pool of questions.		
Pre-Conditions	Test has been started.		
Post-Conditions	A random test is generated.		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	“Start test” button has been clicked	2	System generates a test based on given ratio of easy, medium and hard questions
No Alternative Flow			

4.6.15 View test score

Name	View test score
Actors	Interviewer/ Admin
Summary	Show the score of all the candidates appear into the test.
Pre-Conditions	The user must be admin and logged in the system.
Post-Conditions	The system will display list of all the candidates along with their test score.

Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	The admin clicks on view application status option on home page.	2	The system will list all the jobs.
3	The admin will select a job for which he wants to check the score.	4	The system will display score of all the candidates.
No Alternative Flow			

4.7 Graphical User Interface

This is sample GUI of system.

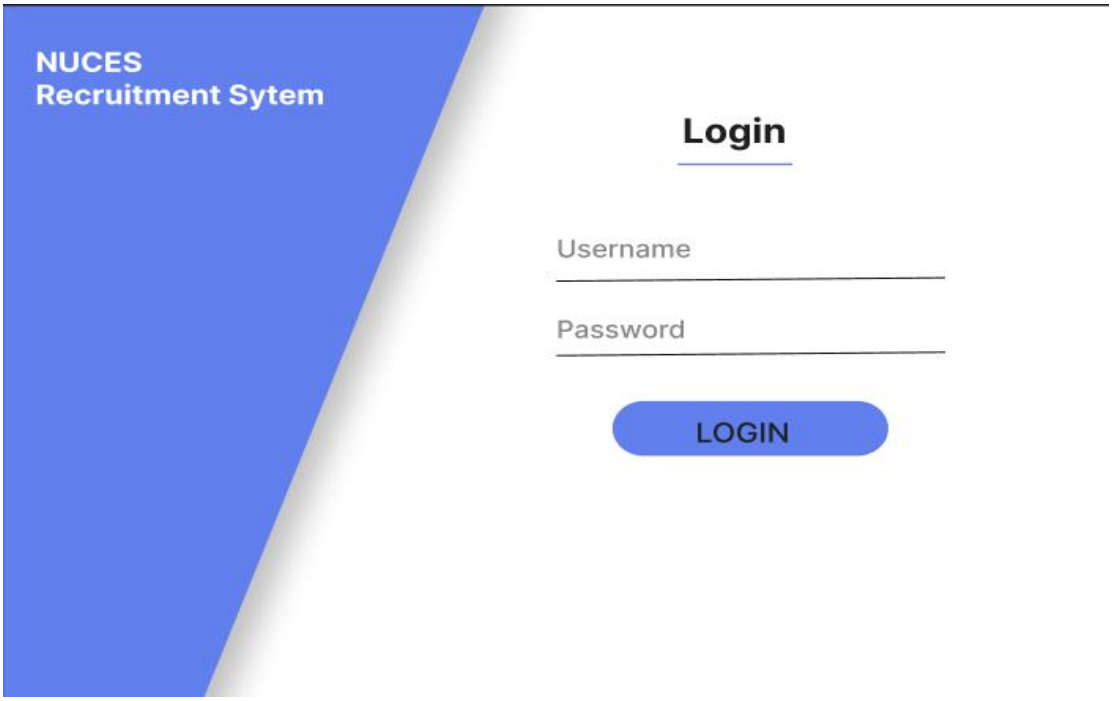

Figure 2: Login

This figure shows the login page.

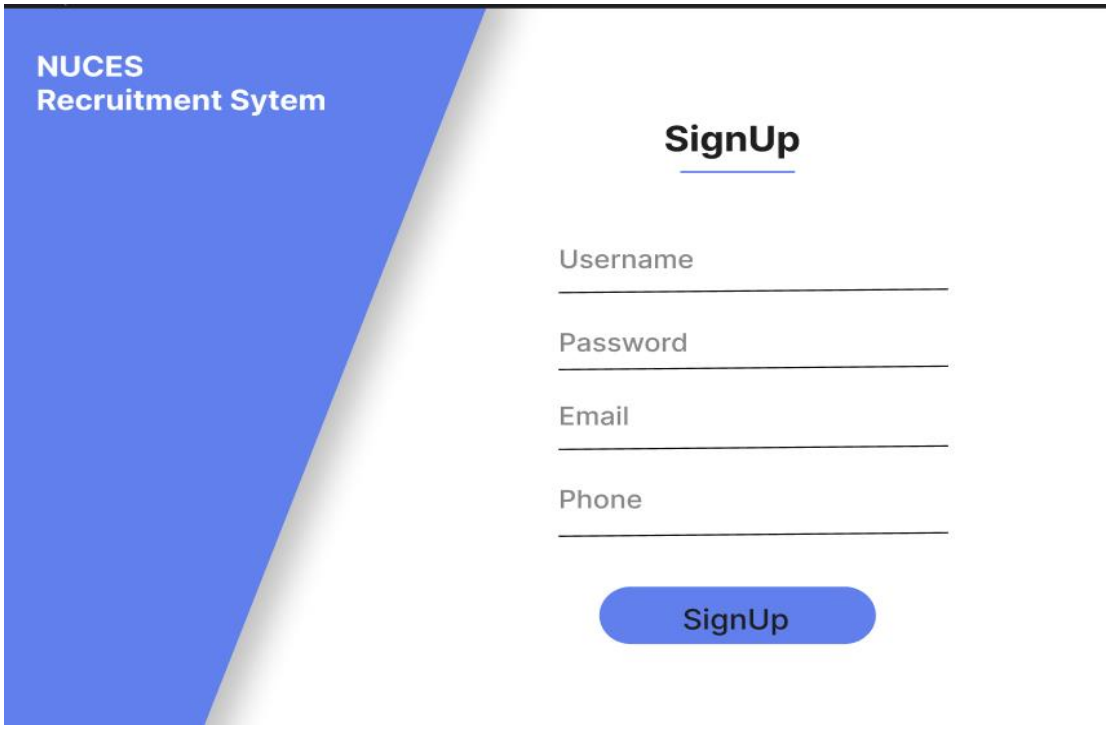

Figure 3: Signup
This figure shows the Signup page.

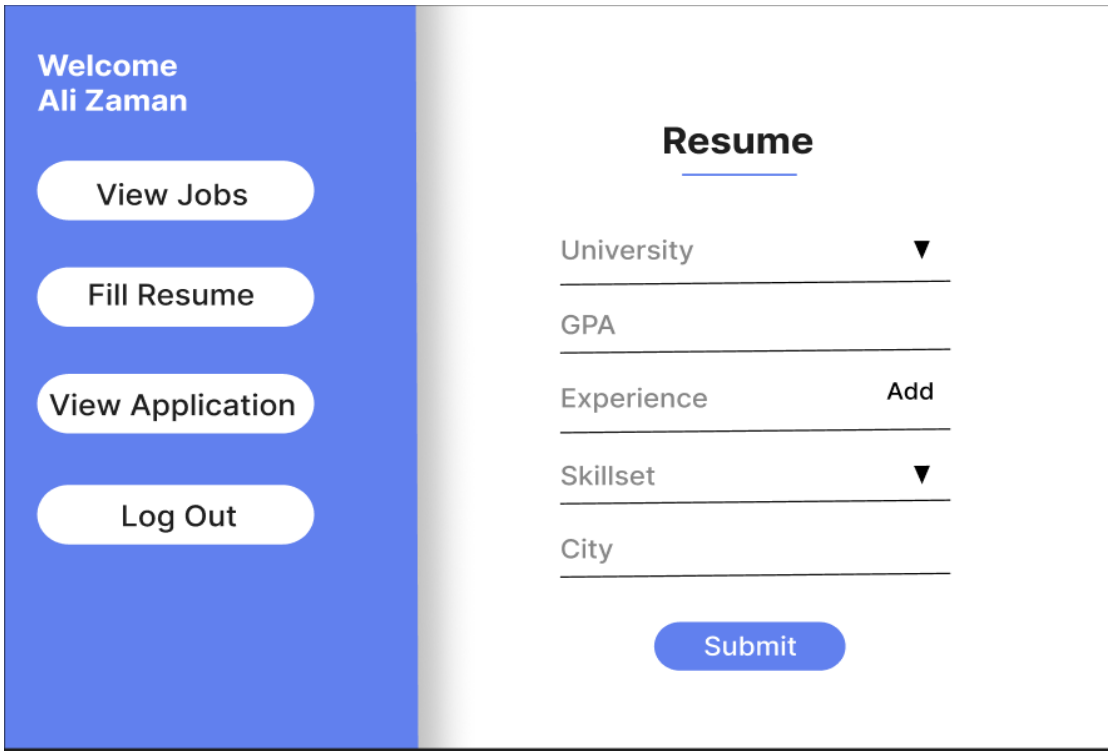

Figure 4: Resume Form
This figure shows the Resume form page.

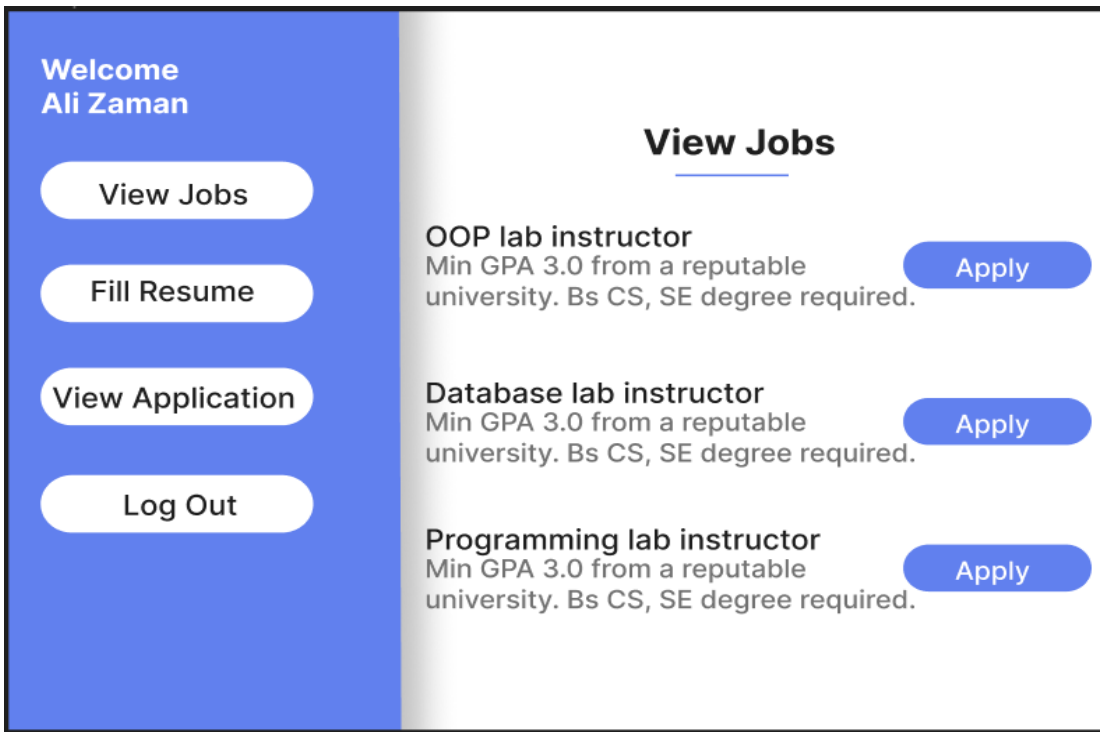

Figure 5: Jobs Page
This figure shows the available jobs page.

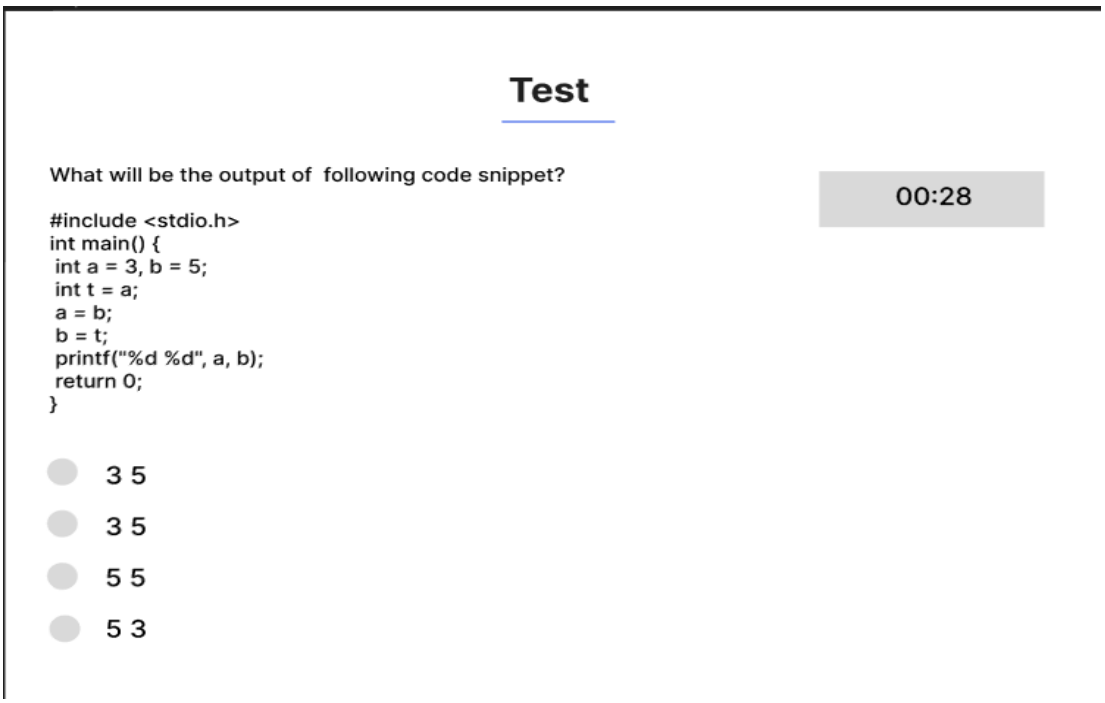

Figure 6: Test Page
This figure shows the test page with timer running.

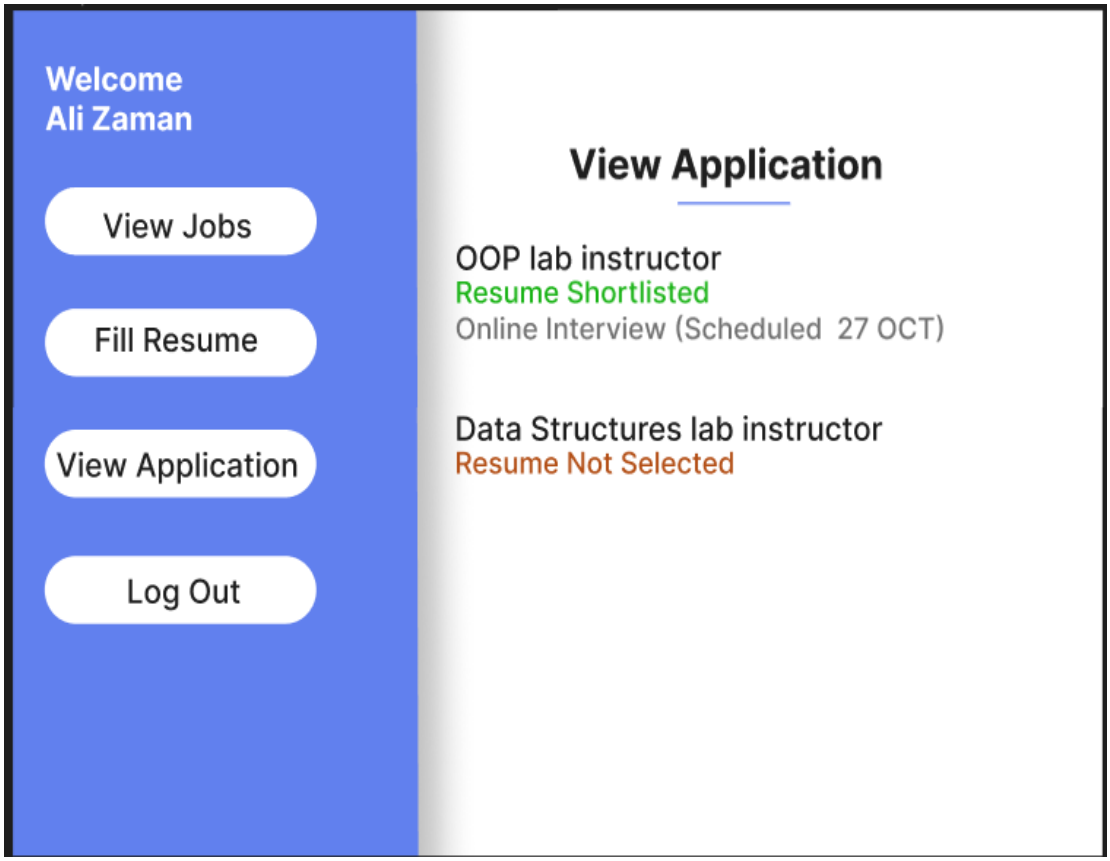

Figure 7: Application Status
This figure shows the application status page.

4.8 Database Design

4.8.1 ER Diagram

The ER diagram shows relationship of all the table stored in the database.

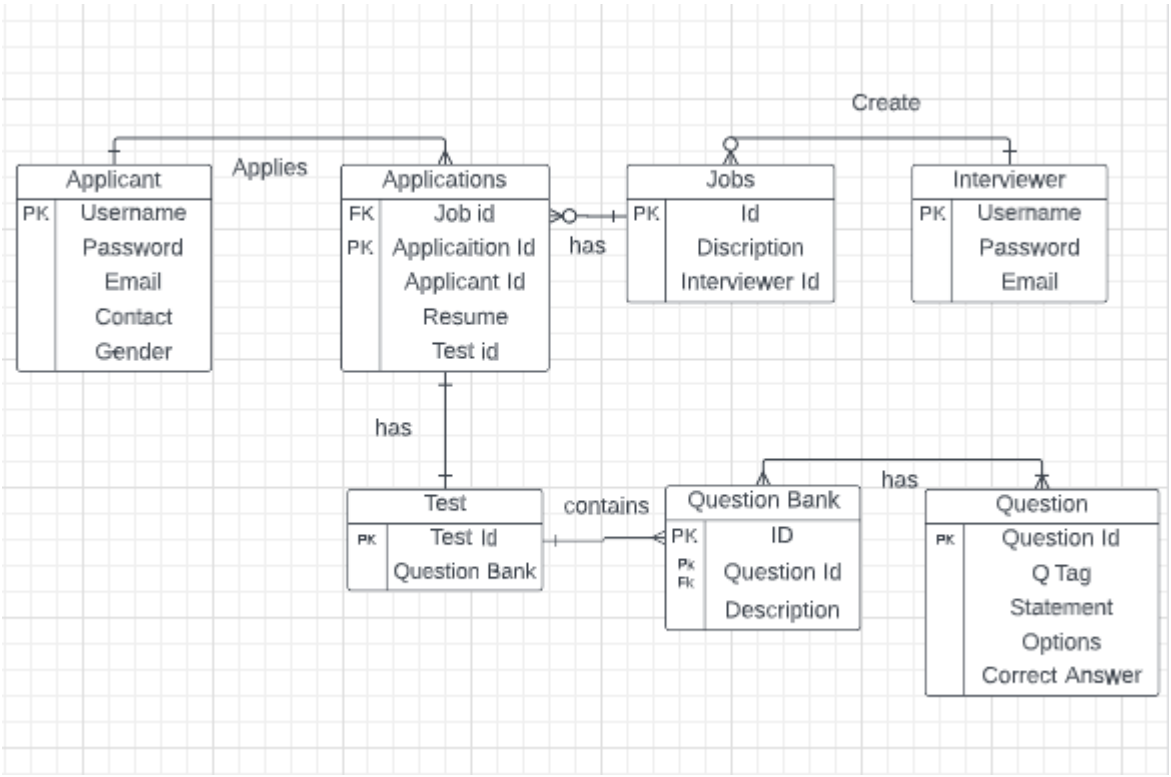

Figure 8: ER Diagram
This figure describes the database design

4.8.2 Data Dictionary

All the entities along with attributes are listed in table below.

Table 2: Data dictionary
The table shows the attributes and their data types of different entities

Entity	Attributes	Data Type	Relation To	Nullable	Description
Applicant	Username	String		No	Username of user (PK)
	Password	String		No	Password of user
	Email	String		No	Email of user
	Contact	String		No	Contact of user
	Gender	String		No	Gender of user
Interviewer	Username	String		No	Username of user (PK)
	Password	String		No	Password of user
	Email	String		No	Email of user
Jobs	Id	Int		No	Id of job created (PK)
	Description	String		No	Description of job
	Interviewer username	String	Interviewer	No	Interviewer username who has created this job (FK).
Applications	Job id	Int	Jobs	No	Id of job (FK)
	Application Id	Int		No	Id of Application (PK)
	Applicant Id	Int	Applicant	No	Id of Applicant (FK)
	Resume	String		No	Resume of Applicant

	Test Id	Int	Test	Yes	Test ID against this applicant (FK)
Test	Test Id	Int		No	Id of test
	Question Bank	Int	Question Bank	No	Id of Question Bank used for test (FK)
Question Bank	Id	Int		No	Id of Question Bank (PK)
	Question Id	Int	Question	No	Question Id used in Question Bank (PK)(FK)
	Description	Int		Yes	Description about Question Bank
Questions	Question Id	Int		No	Id of Question (PK)
	Q Tag	String		No	Question Tag/ Topic
	Statement	String		No	Statement of Question
	Options	String		No	Possible option of Question
	Correct Answers	String		No	Answer to Question

4.9 Risk Analysis

Following are the risk involves in the project:

4.9.1 Time constraint

Short listing, scheduling an initial screening test, and further short listing of candidates based on the test are some of the phases of this project. For all of this, a lot of work is required. Therefore, a team of three people working on this project may experience a time constraint.

4.9.2 Performance issue

The screening test system might not be able to handle multiple candidates. The speed of the system might be impacted by the simultaneous inclusion of multiple candidates.

Chapter 5: Proposed Approach and Methodology

This chapter includes the proposed approach and methodology for the development of the discussed system. It contains discussion about the generation of formula for the shortlisting of candidates. Lastly there would be a discussion on model used for the facial recognition and pre-processing of image for it.

5.1 Feature extraction:

To extract plain text from resumes of candidates we will be using PDFMiner. PDFMiner convert pdf document to text. The university name, GPA, highest education level, email and phone number is extracted using regular expressions from this text. This data will be stored in database which will be used for further processing by next module.

5.2 Formula Generation:

Candidates will be shortlisted on the base of a formula. This formula will be consisting of 4 attributes. These attributes include GPA, Educational institutes, Experience, and highest education level (e.g., Masters) of the candidates. Each attribute will be given a certain weightage, and a score will be generated against every resume for a particular job. Technique of Cosine similarity will be used to compare skills of candidates with skills required for job. Furthermore, a fuzzy logic method will be applied on the above formula to incorporate IF-THEN rules to avoid a candidate to discard from the selection for not having experience or having low GPA. For example, if a candidate a new graduate, then its GPA and education will be deciding factor towards calculating full score for the shortlisting phase. All the rules are listed in fuzzy logic knowledge base module. Based on final score calculated a list of shortlisted candidates will be saved in database.

5.3 Facial Recognition:

To perform facial recognition, system will compare the live images of candidates with stored images in the database. JavaScript API face-api.js will be sued to recognize face of candidates. This API compare live webcam image of user with images store in database. It is based on pretrained face recognition model.

Chapter 6: High-Level and Low-Level Design

6.1 System Overview

The application that is to be developed makes the hiring process feasible and easy for the company's hiring committee and the applicants. Our system software has the following modules:

6.1.1 Shortlisting of resume:

In this phase the software shows multiple jobs that can be pursued by people of different interests. After the applicants apply for the job, their resumes are collected and filtered according to the specific criteria set by the organization.

6.1.2 Notifying about the test

This phase deals with setting test schedules and notifying selected participants. Once the CVs are filtered out through the pool of resumes, the next step is to schedule posts on different dates for different candidates and notify them through email. The admin sets up the date/time for the test that is to be conducted and pushes a notification to let applicants know about their test date and timing.

6.1.3 Test Conduction

Now moving forward, this phase is related to test conduction. The tests are conducted online while each participant gets different test questions. The test questions are generated randomly but according to the subject chosen by the participant. The tests contain both multiple choice and coding questions. Furthermore, the test score is calculated as soon as one is done with the test.

6.1.4 Cheating Detection

This phase consists of face recognition and face movement of candidate during exam. At the start of test system will recognize face of candidate and compare it with stored picture available in database. Further activity of candidate is monitored by movement of candidate from the test website window.

6.1.5 Final Selection

This phase deals with the test score generated by the previous module. If the test score lies within or at the boundaries of the organization's set criteria, then the applicant and recruiter is notified about selection. Else, the candidate is rejected.

6.2 Design Considerations

For our application to be successful, we need to cater to every problem and dependency, so our end user does not face any problem while using the application. This section describes many of the issues that needs to be addressed or resolved before attempting to device a complete design solution

6.2.1 Assumptions and Dependencies

Following are the assumptions and dependencies associated with our web application that needs to be addressed.

6.2.1.1 Operating system

The users must have the stable version of Google Chrome/Internet Explorer/Mozilla Firefox or Safari installed in their machines (Laptop, Pc, Mobile etc.) to access the web application.

6.2.1.2 End-User Characteristics

- End user will have a reliable Internet connection.
- End user will have latest device with stale version of browsers.
- End user will have basic knowledge of using the application.
- End user must have installed a webcam on their machine that produce clear image.

6.2.2 General Constraints

This project aims to provide an easy-to-use platform for candidates to get their resumes perfectly examined by the companies and get their dream jobs. However, there are certain limitations or constraints that will have a significant impact on the design of the system's software. Such constraints may be imposed by any of the following and must be kept in mind:

6.2.2.1 Hardware and software environment

- Internet not connected
- Website is overflowed with traffic and may not run for certain users
- Browser version not supported
- Website is hacked by third party software and has to be shut down until it regains full control back

6.2.2.2 End-User environment

- User does not have basic understanding of Internet
- User does not have basic understanding of using a web application

6.2.2.3 Availability or volatility of resources

- Poor Internet Connection
- Poor Machine
- Insufficient speed to load complete website
- Webcam of user producing unclear image

6.2.2.4 Interoperability requirements

- Smooth connection between the connected user ad the database

6.2.2.5 Interface/protocol environments

- User friendly interface to navigate easily through the system

6.2.2.6 Data repository and Distribution requirements

- The user information must be kept secure and avoid breach of data
- The database must be kept secure to avoid data leakage

6.2.2.7 Performance Requirement

- The system must be able to handle large amount of user load simultaneously
- The system must be accurate in sending mails to candidates about test scheduling and interview date/time
- The system database must be up and running causing no problem

6.2.3 Development Methods

For the development of project, Scrum methodology will be used. Scrum is an agile development approach used to improve software that is dependent on repeatable and iterative cycles. Work will be divided into several sprints, each of which will have a deadline. This period will not exceed one week. A 15-to-20-minute meeting will be held following the completion of each sprint to review progress and adjust the overall schedule as necessary. Scrum is adaptable, making it simpler to change projects or add new functionalities, so it makes sense to use this development methodology.

6.3 System Architecture

The Project provides interviewers and interviewees an easy platform to carry out the recruitment process. The process begins by an admin creating a job post followed by a candidate or applicant applying to a particular job of interest. System will save resume of candidates into a database from which the system can process and shortlist candidates for further process.

The detailed diagram is shown below:

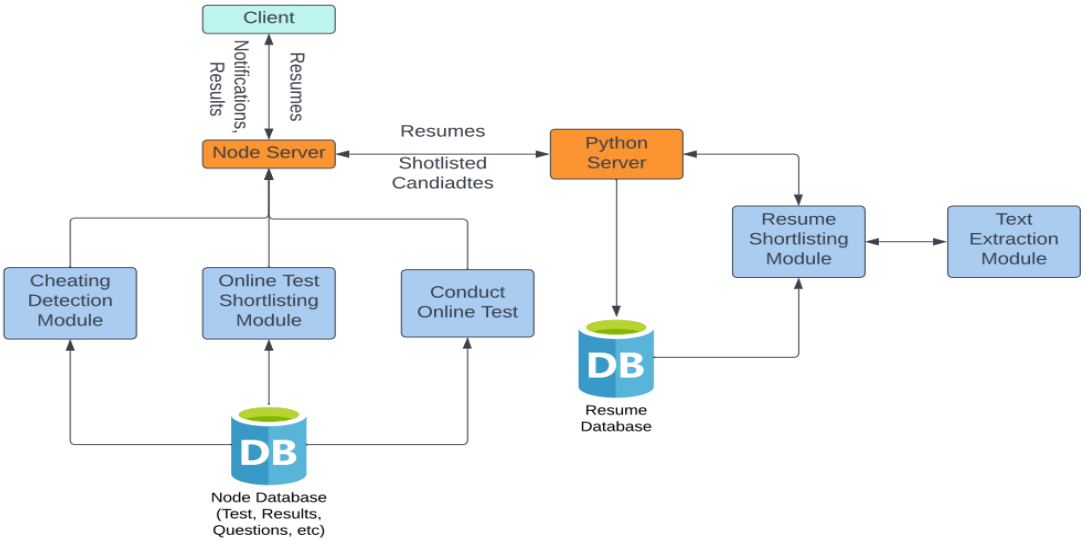

Figure 9: System Architecture Diagram
Shows the overview of the system's architecture

6.3.1 Resume Shortlisting Module

This module will be coded in Python for the ease of use of pre-built libraries like pyresparser, NLTK etc. It will extract the required data from resumes in PDF or docx format and preprocess it. After that grading algorithms will be applied to the data to grade the resumes effectively.

6.3.1.1 Text Extraction Module

This module will be coded in Python for the ease of use of pre-built libraries like pdfminer and docx2pdf. It will basically convert resumes in PDF or docx format to plain text from which the required data can be easily extracted.

6.3.2 Shortlisting module

This module will be used after the test is over. It will extract the score of each candidate and calculate a weighted sum based on the difficulty level of the question. Top n candidates will be selected after this procedure.

6.3.3 Cheating Detection Module:

This module will extract saved pictures of candidates that were captured during the test and detect cheating using eye movements and hand usage of the candidate. If caught cheating the candidate will be warned and the admin will be notified. The admin will receive a list of all candidates captured cheating. The admin may disqualify such students after further examination of the pictures.

6.3.4 Conduct Online Test:

This module will enable the system to conduct online test by sending random questions from the pool of questions to the client, accept answers check correctness and then save to the database.

6.3.5 Server

The Node server will control all the procedures in a timely fashion based on the input of candidates and admin and perform the required operations by using the above-mentioned modules. It will also forward resume to the python server which will extract data, process it and send list of shortlisted candidates back to the node server.

6.4 Architectural Strategies

Following architectural strategies are decided for the project.

6.4.1 Programming Language

Python and JavaScript programming language will be used in this project. Use of python is due to its libraries related to data handling and extensive use in machine learning based model. In order to develop our product with a clean and easy to use user interface that is capable of providing high level and quick user interactions, we prefer using JavaScript, its library React is used to create front-end architecture and Node will be used at backend of website. The decision to use JavaScript stack is based on the fact that JavaScript provides powerful frameworks and libraries along with a component-based design structure which serves a far better purpose than other means of developing a web application.

6.4.2 Product Enhancement and Extensibility

Website can be extended to add more functionalities for user interaction like rating Jobs etc.

6.4.3 Concurrency and Synchronization

Following strategies can be adopted:

- Async operations will be used on frontend, so user is able to interact with website while the system is working on any time-consuming operations like web API requests.
- Parallel processing will be used on the backend application so that the application is able to handle multiple users simultaneously.

6.5 Domain Model/Class Diagram

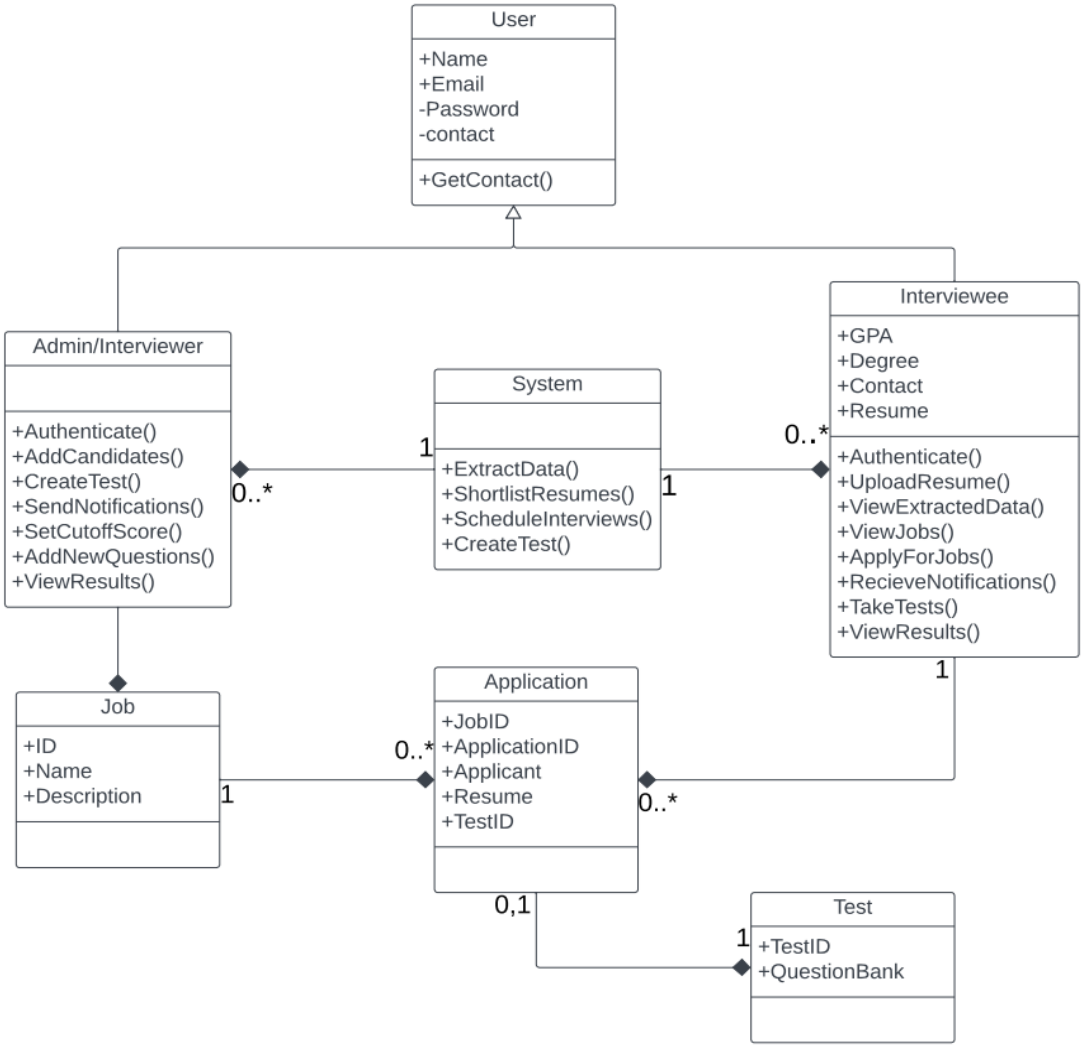

Figure 10: Class Diagram

Figure shows classes and their relations

6.6 Sequence Diagrams

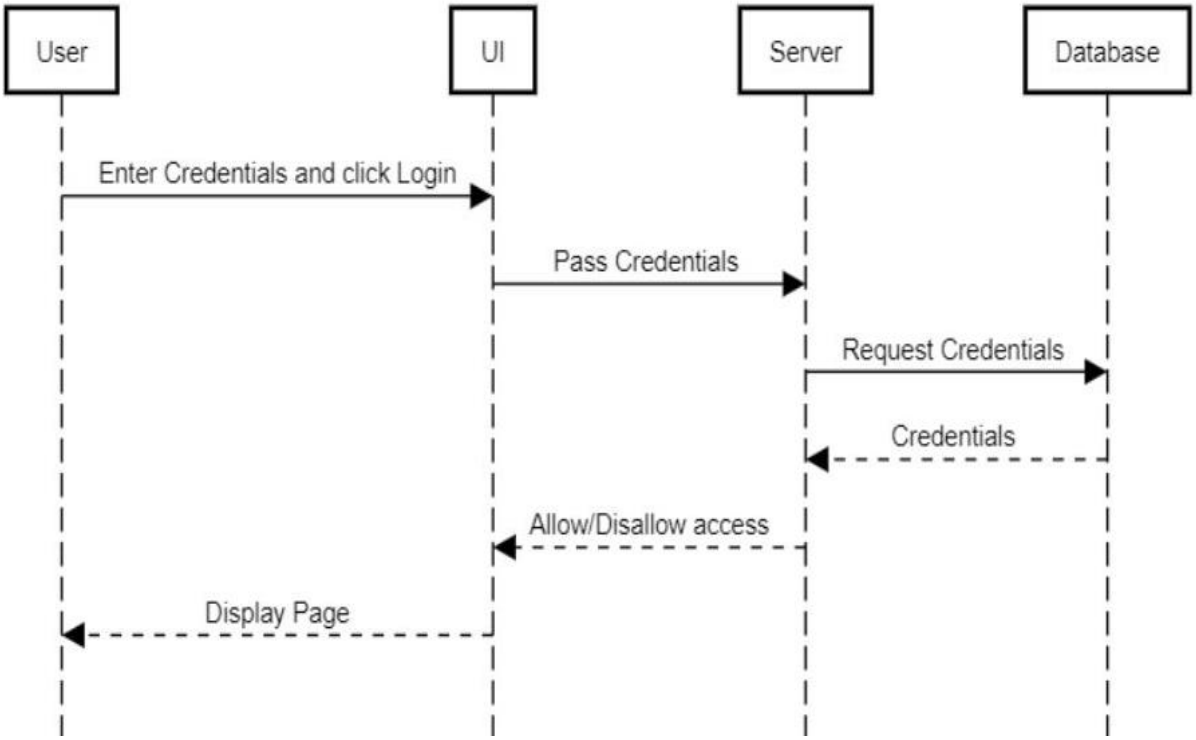

Figure 11: Login Sequence Diagram
Get and Process Login Credentials with appropriate response

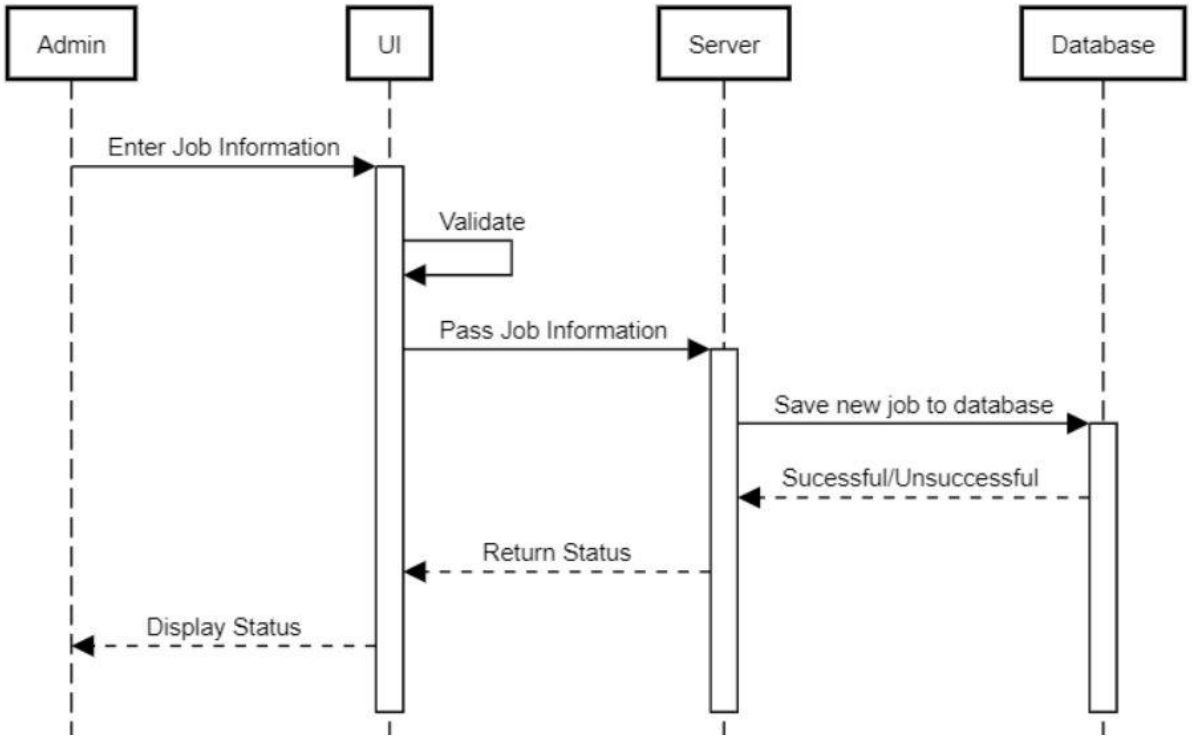

Figure 12:Create Job Post Diagram
Get job information from admin to create a new job and save it to database

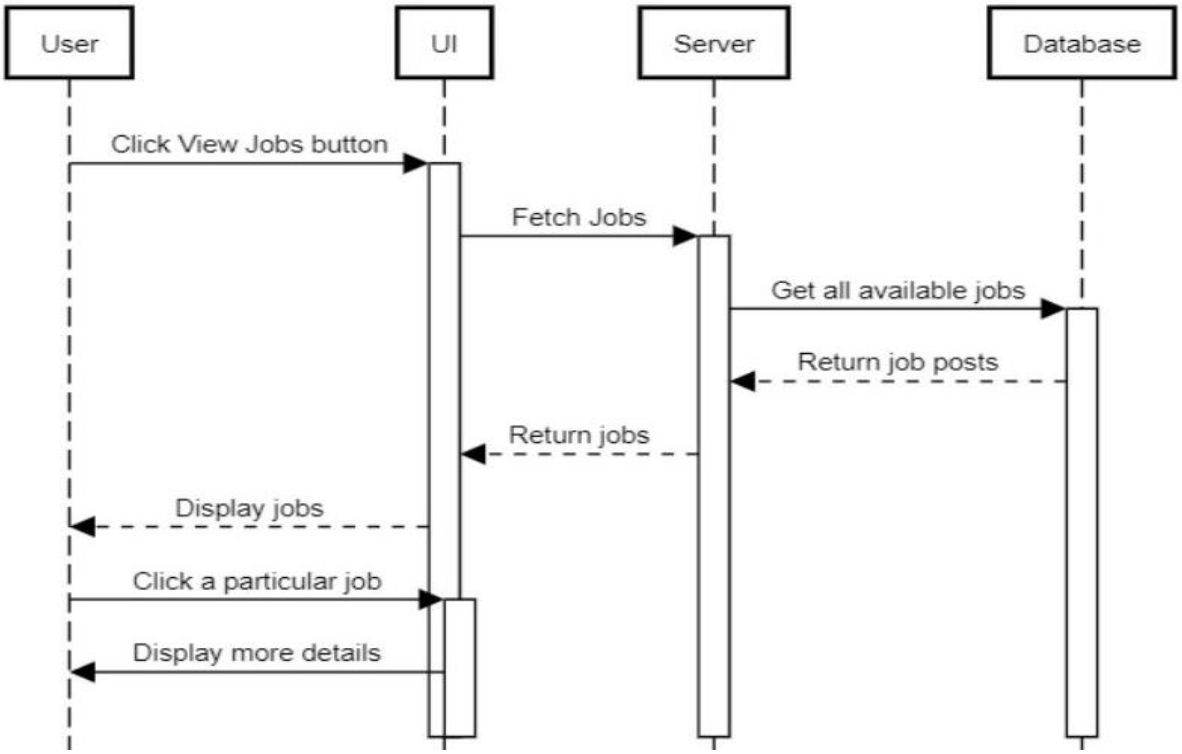

Figure 13:View Job Post Diagram

For admin and candidate to view already created jobs and view more details of some particular job

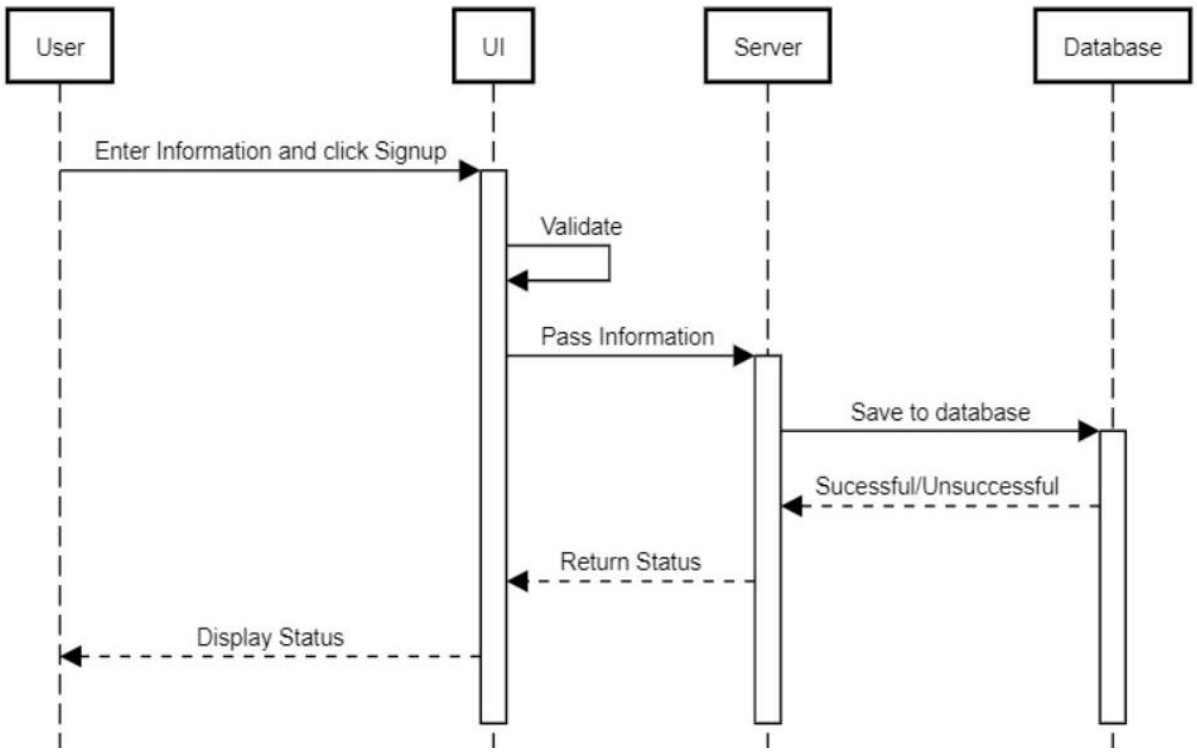

Figure 14:Signup Diagram

Get required information from a new user and create an account

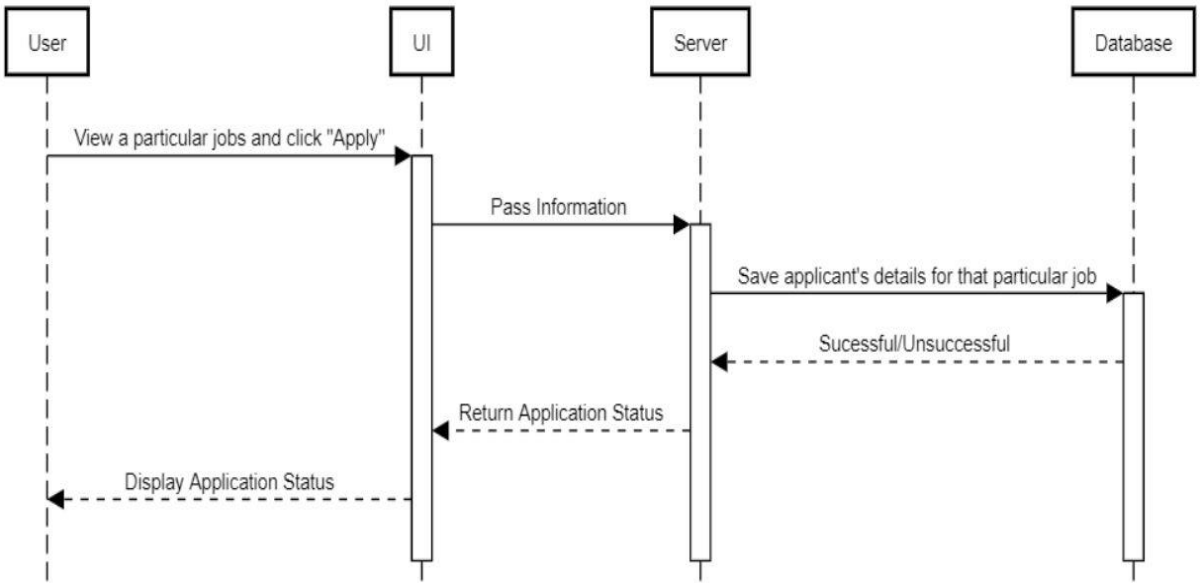

Figure 15:Apply for jobs Diagram

For Candidate to apply for job of interest. System will save applicant id and job of interest in database

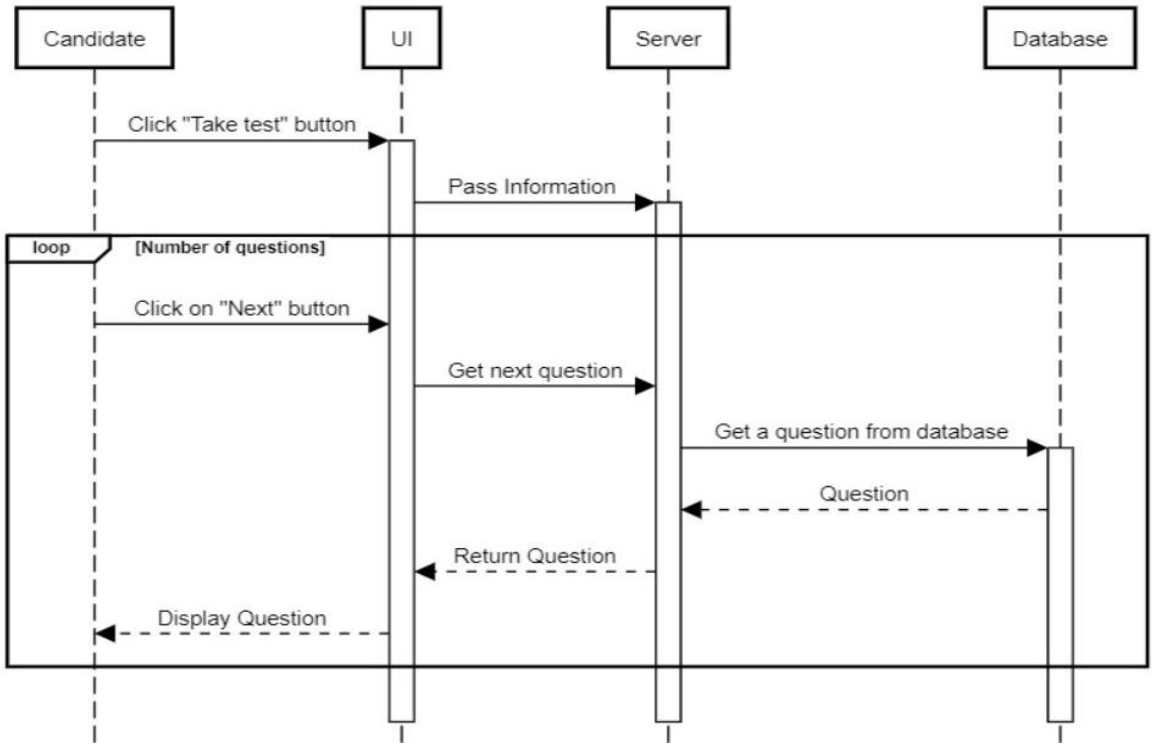

Figure 16:Take test Diagram

For candidate to take a test. The system will provide questions one by one till the time runs out or total number of questions have been solved

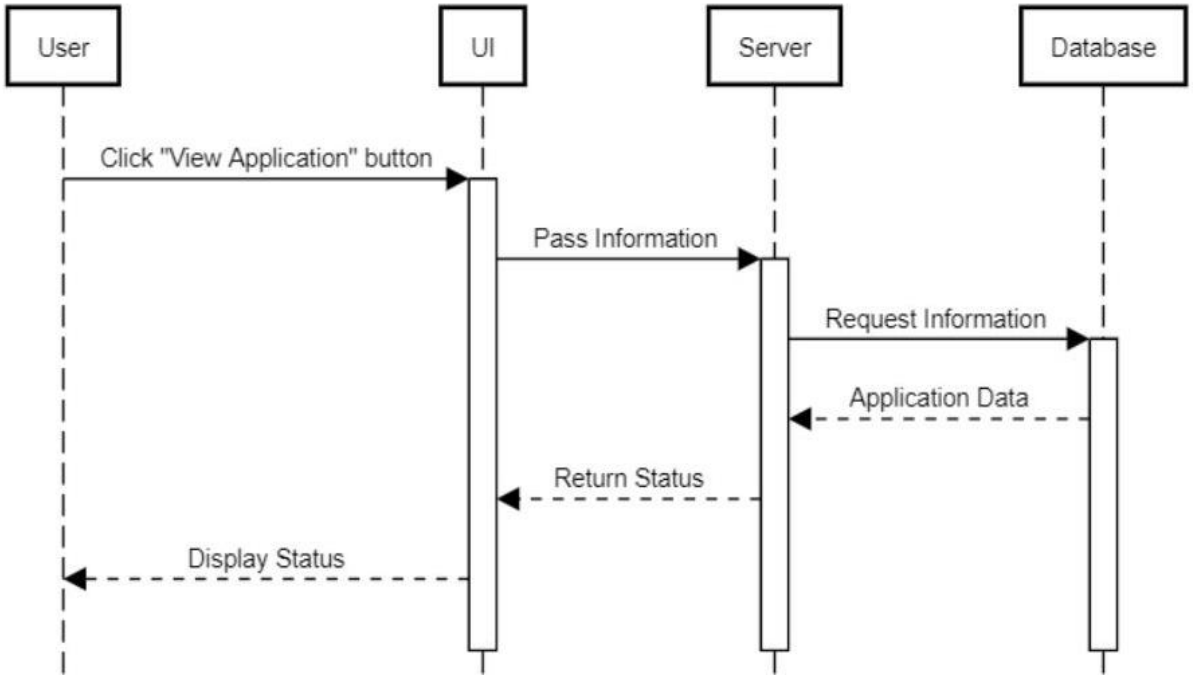

Figure 17:View Application Status Diagram

Candidate can view the upcoming interview process by getting required information from the server.

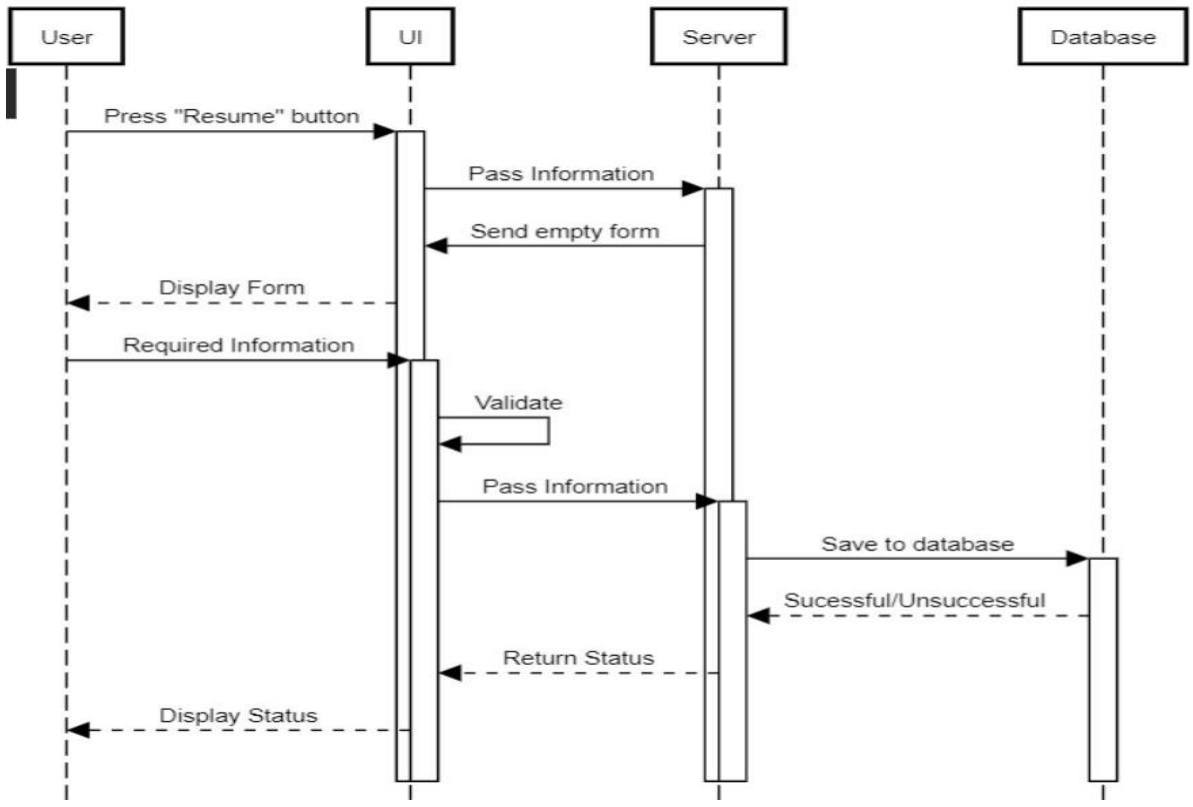

Figure 18:Fill Resume Form Diagram

Candidate will request a resume form. After it has been filled and submitted the system will save it into database for further processing

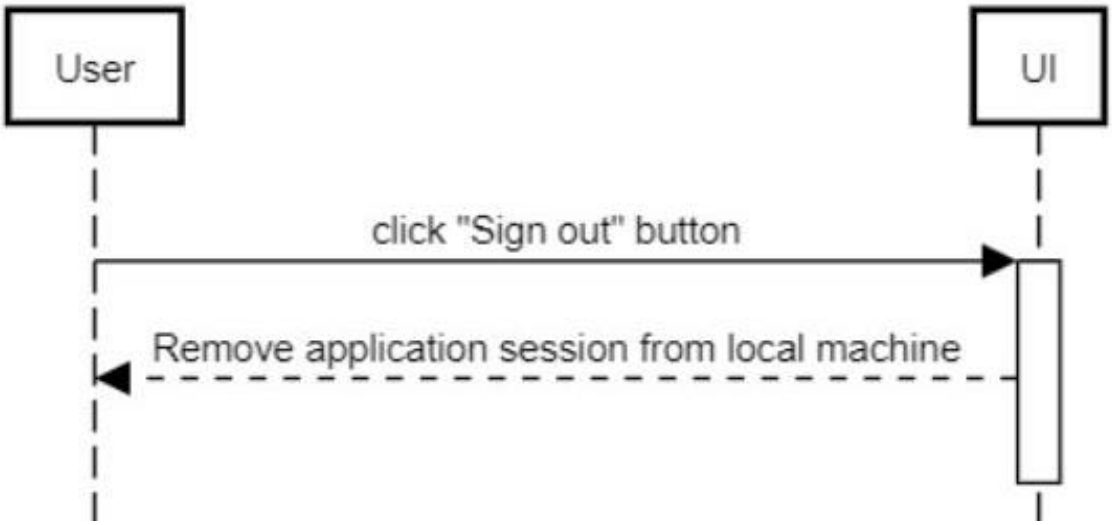

Figure 19:Take test Diagram
The application will sign out by removing the session key from the local machine

6.7 Policies and Tactics

The following are the considerations for the policies that would be followed in the project:

6.7.1 Tools to be used

Many API's, tools and external libraries will be used. The major one's are discussed below:

- Pdfminer (Library to extract text from pdf)
- NLTK (Python library for natural language processing)
- Pyresparser (Python library for extraction of particular sections from resume)
- face-api.js (JavaScript library for detection if two pictures are of a same person)

6.7.2 Coding guidelines and conventions

JavaScript and Python will be used as the programming language. Standard set and programming rules will be strictly followed.

6.7.3 User interface

The application will be simple yet modern and easy to use UI. It will ensure that an appealing color scheme is used that is relevant and right.

6.7.4 Extensibility

The system's extensibility will be kept in mind. We may add new features in the future and scale up our user base. Therefore, we will design our system accordingly. For this we will use the modular approach and create micro services for every small part of the project. This will drastically improve the integration ability of the project.

6.7.5 Policies for system testing

Both white box and black box testing will be used to test our system. Before deploying the application, we will test every aspect of the application.

6.7.6 Software maintenance

The work doesn't end with the completion of the development of the product. Once it is developed the feature expansion of the product as well as the maintenance of the product would depend on the availability of our advisor and time. Upgrade features would be implemented once we finish our current scope.

6.7.7 Algorithms

Data collected form resumes will be cleaned through machine learning algorithms. The face matching will be done by python and JavaScript package "Face recognition" which has many deep learning modules already implemented.

Chapter 7: Implementation and Test Cases

This chapter contains the information about implementation of prototype of Automated Recruitment System.

7.1 Resume Text Extraction

Python libraries py2pdf and docxtotxt are used to extract plain text from pdf and word document format. The text extracted is used in the process of shortlisting.

7.2 Resume Shortlisting

Next step is to shortlist resume based on the information collected from resumes in previous step. Shortlisting is done by allotting scores to different aspects of the resume. For example, to universities (with different scores for high, medium, and low-level universities), experience, GPA etc. After this has been done weighted sum will be calculated for each resume and top N candidates will be shortlisted for further examination.

7.3 Backend

The resume of a candidate is compared to job description provided by the recruiter using cosine similarity and count vectorizer and a similarity score is given to the resume. The above-mentioned implementation has been integrated in the python FAST-API server. This server is responsible for processing and shortlisting resumes. The other server is based on Nodejs. This server is responsible for the administrative task of website like authentication, passing and getting resumes and results from python server, etc.

7.4 Testing and Shortlisting Website

A recruiter can select weightage for a certain job while creating a job on the website. And shortlisting website is also in progress in which questionnaire has been made from which test will be conducted for the users.

7.5 Test case Design and description

All of the test cases which are mentioned here require Safari/Chrome/Edge or any latest browser capable of running JavaScript.

7.5.1 Login

Login			
Test Case ID:	*1*	**QA Test Engineer:**	*Iman Jawad*
Test case Version:	*1*	**Reviewed By:**	*Ali Zaman*
Test Date:	*27-04-2023*	**Use Case Reference(s):**	*4.6.1 Login*
Revision History:	*None*		
Objective	*To check if user is able to successfully login to the app*		
Product/Ver/Module:	*Website login module*		
Environment:	*Website is running on any web browser and internet is connected.*		
Assumptions:	-		
Pre-Requisite:	*The user is already stored in the database and registered as a valid user*		

Step No.	**Execution description**	**Procedure result**
1.	*User enters their credentials, i.e., their username and password, and clicks login.*	*System takes the user to the home screen.*

Comments: The test case is passed. Our system is working according to our need.
☑ *Passed* ☐ *Failed* ☐ *Not Executed*

7.5.2 Logout

Logout			
Test Case ID:	*2*	**QA Test Engineer:**	*Iman Jawad*
Test case Version:	*1*	**Reviewed By:**	*Ali Zaman*
Test Date:	*27-04-2023*	**Use Case Reference(s):**	*4.6.2 Logout*
Revision History:	*None*		
Objective	*To logout user from the system*		
Product/Ver/Module:	*Website login module*		
Environment:	*Website is running on any web browser and internet is connected.*		
Assumptions:	*Assumptions that might affect the testing process.*		
Pre-Requisite:	*The user is already stored in the database and registered as a valid user*		

Step No.	**Execution description**	**Procedure result**
1.	*Users click on the logout button.*	*System takes the user to the login page.*

Comments: The test case is passed. Our system is working according to our need.
☑ *Passed* ☐ *Failed* ☐ *Not Executed*

7.5.3 Create a new account

Create a new account			
Test Case ID:	*3*	**QA Test Engineer:**	*Iman Jawad*
Test case Version:	*1*	**Reviewed By:**	*Ali Zaman*
Test Date:	*27-04-2023*	**Use Case Reference(s):**	*4.6.3 Create a new account*
Revision History:	*None*		
Objective	*The user shall provide all the required information like email, phone number GPA after which user can login to the system.*		
Product/Ver/Module:	*Website login module*		
Environment:	*Website is running on any web browser and internet is connected.*		
Assumptions:	*Assumptions that might affect the testing process.*		
Pre-Requisite:	*The user is already stored in the database and registered as a valid user*		

Step No.	**Execution description**	**Procedure result**

1.	*The user enters valid email, password and the required information on the sign-up page.*	*The system adds the email, password, and other information to the database and redirects the user to the home page.*
Comments: The test case is passed. Our system is working according to our need.		
☑ *Passed* ☐ *Failed* ☐ *Not Executed*		

7.5.4 Create a new job post

Create a new job post			
Test Case ID:	*4*	**QA Test Engineer:**	*Iman Jawad*
Test case Version:	*1*	**Reviewed By:**	*Ali Zaman*
Test Date:	*27-04-2023*	**Use Case Reference(s):**	*4.6.4 Create a new job post*
Revision History:	*None*		
Objective	*Create a new job with instructions required to post the job.*		
Product/Ver/Module:	*Website login module*		
Environment:	*Website is running on any web browser and internet is connected.*		
Assumptions:	*Assumptions that might affect the testing process.*		
Pre-Requisite:	*The user is already stored in the database and registered as a valid Admin*		
Step No.	**Execution description**	**Procedure result**	
1.	*The user will fill out all the required information required for the job.*	*A new job post will be created successfully.*	
Comments: The test case is passed. Our system is working according to our need.			
☑ *Passed* ☐ *Failed* ☐ *Not Executed*			

7.5.5 View jobs posted by FAST-NU

View jobs posted by FAST-NU			
Test Case ID:	*5*	**QA Test Engineer:**	*Iman Jawad*
Test case Version:	*1*	**Reviewed By:**	*Ali Zaman*
Test Date:	*27-04-2023*	**Use Case Reference(s):**	*4.6.5 View jobs posted by FAST-NU*
Revision History:	*None*		
Objective	*View the various available jobs, the required skill set, experience, GPA etc.*		
Product/Ver/Module:	*Website login module*		
Environment:	*Website is running on any web browser and internet is connected.*		
Assumptions:	*Assumptions that might affect the testing process.*		
Pre-Requisite:	*The user is already stored in the database and registered as a valid user*		
Step No.	**Execution description**	**Procedure result**	

1.	*The user clicks on 'view jobs' button*	*The system fetches all the available jobs from the database and displays it.*
Comments: The test case is passed. Our system is working according to our need.		
☑ *Passed* ☐ *Failed* ☐ *Not Executed*		

7.5.6 Apply for jobs

Apply for jobs			
Test Case ID:	*6*	**QA Test Engineer:**	*Iman Jawad*
Test case Version:	*1*	**Reviewed By:**	*Ali Zaman*
Test Date:	*27-04-2023*	**Use Case Reference(s):**	*4.6.6 Apply for jobs*
Objective	*Interviewee can apply for the job in area of interest if the qualifications match.*		
Product/Ver/Module:	*Website login module*		
Environment:	*Website is running on any web browser and internet is connected.*		
Assumptions:	*Assumptions that might affect the testing process.*		
Pre-Requisite:	*The user is already stored in the database and registered as a valid user*		
Step No.	**Execution description**	**Procedure result**	
1.	*The applicant clicks on the 'apply' button under the job of interest*	*The system saves the user in applicants list for that particular job and the application is ready for further processing*	
Comments: The test case is passed. Our system is working according to our need.			
☑ *Passed* ☐ *Failed* ☐ *Not Executed*			

7.5.7 Add Question in system used for assessments

Add Question in system used for assessments			
Test Case ID:	*7*	**QA Test Engineer:**	*Iman Jawad*
Test case Version:	*1*	**Reviewed By:**	*Ali Zaman*
Test Date:	*27-04-2023*	**Use Case Reference(s):**	*4.6.8 Add Question in system used for assessments*
Objective	*Add question to the system with relevant tag, options and correct answers. This will later be used for taking assessments.*		
Product/Ver/Module:	*Website login module*		
Environment:	*Website is running on any web browser and internet is connected.*		
Assumptions:	*Assumptions that might affect the testing process.*		
Pre-Requisite:	*The user is already stored in the database and registered as a valid admin.*		
Step No.	**Execution description**	**Procedure result**	

1.	*Admin fills the question form and press submit key.*	*Operation successfully message will be displayed, and a new question added into question list.*
Comments: The test case is passed. Our system is working according to our need.		
☑ *Passed* ☐ *Failed* ☐ *Not Executed*		

7.5.8 Take screening test

Take screening test			
Test Case ID:	*8*	**QA Test Engineer:**	*Iman Jawad*
Test case Version:	*1*	**Reviewed By:**	*Ali Zaman*
Test Date:	*27-04-2023*	**Use Case Reference(s):**	*4.6.9 Take screening test*
Revision History:	*None*		
Objective	*Allows interviewee to take the initial screening test which may consist of MCQs.*		
Product/Ver/Module:	*Website login module*		
Environment:	*Website is running on any web browser and internet is connected.*		
Assumptions:	*Assumptions that might affect the testing process.*		
Pre-Requisite:	*The user is already stored in the database and registered as a valid user*		
Step No.	**Execution description**	**Procedure result**	
1.	*The user starts the test and fill in the mcqs and submits the test.*	*The system displays 'Thank you, your application is being processed' message.*	
Comments: The test case is passed. Our system is working according to our need.			
☑ *Passed* ☐ *Failed* ☐ *Not Executed*			

7.5.9 Fill the resume form

Fill the resume form			
Test Case ID:	*9*	**QA Test Engineer:**	*Iman Jawad*
Test case Version:	*1*	**Reviewed By:**	*Ali Zaman*
Test Date:	*27-04-2023*	**Use Case Reference(s):**	*4.6.10 Fill the resume form*
Revision History:	*None*		
Objective	*Fill the form created by the interviewers for assessing the applicant and shortlist the applicants for the next phase.*		
Product/Ver/Module:	*Website login module*		
Environment:	*Website is running on any web browser and internet is connected.*		

Assumptions:	*Assumptions that might affect the testing process.*	
Pre-Requisite:	*The user is already stored in the database and registered as a valid user*	
Step No.	**Execution description**	**Procedure result**
1.	*The user fills the resume form.*	*The data is saved to the database and a Thank you page is displayed.*
Comments: The test case is passed. Our system is working according to our need.		
☑ *Passed* ☐ *Failed* ☐ *Not Executed*		

7.5.10 Create a new admin

Create a new admin			
Test Case ID:	*10*	**QA Test Engineer:**	*Iman Jawad*
Test case Version:	*1*	**Reviewed By:**	*Ali Zaman*
Test Date:	*27-04-2023*	**Use Case Reference(s):**	*4.6.11 Create a new admin*
Objective	*Add a new admin for administrative tasks*		
Product/Ver/Module:	*Website login module*		
Environment:	*Website is running on any web browser and internet is connected.*		
Assumptions:	*Assumptions that might affect the testing process.*		
Pre-Requisite:	*The user is already stored in the database and registered as a valid Admin*		
Step No.	**Execution description**	**Procedure result**	
1.	*An existing admin fills the form for new admin.*	*The system creates a new account for the admin.*	
Comments: The test case is passed. Our system is working according to our need.			
☑ *Passed* ☐ *Failed* ☐ *Not Executed*			

7.5.11 Set minimum candidate for test

Set minimum candidate for test			
Test Case ID:	*11*	**QA Test Engineer:**	*Iman Jawad*
Test case Version:	*1*	**Reviewed By:**	*Ali Zaman*
Test Date:	*27-04-2023*	**Use Case Reference(s):**	*4.6.12 Set minimum candidate for test*
Objective	*Admin can set minimum required candidate for the mcqs and coding test to pass the test and qualify for the next round*		
Product/Ver/Module:	*Website login module*		
Environment:	*Website is running on any web browser and internet is connected.*		
Assumptions:	*Assumptions that might affect the testing process.*		
Pre-Requisite:	*The user is already stored in the database and registered as a valid user*		

Step No.	Execution description	Procedure result
1.	*Admin sets minimum candidate required for any job.*	*The minimum candidate for the selected jobs is saved.*
Comments: The test case is passed. Our system is working according to our need.		
☑ *Passed* ☐ *Failed* ☐ *Not Executed*		

7.5.12 Shortlist Resumes

Shortlist Resumes			
Test Case ID:	*12*	**QA Test Engineer:**	*Iman Jawad*
Test case Version:	*1*	**Reviewed By:**	*Ali Zaman*
Test Date:	*27-04-2023*	**Use Case Reference(s):**	*4.6.13 Shortlist Resumes*
Objective	*As resume submission deadline is reached the system starts shortlisting resumes.*		
Product/Ver/Module:	*Website login module*		
Environment:	*Website is running on any web browser and internet is connected.*		
Assumptions:	*Assumptions that might affect the testing process.*		
Pre-Requisite:	*The submission deadline is reached*		
Step No.	**Execution description**	**Procedure result**	
1.	*Resume submission deadline is reached.*	*Resumes are successfully graded, and top resumes are selected.*	
Comments: The test case is passed. Our system is working according to our need.			
☑ *Passed* ☐ *Failed* ☐ *Not Executed*			

7.6 Test Metrics

Following are some test cases matrices.

7.6.1 Functional Tests

Metric	**Purpose**
Number of Test Cases	12
Number of Test Cases Passed	12
Number of Test Cases Failed	0
Test Cases Defect Density	0
Test Cases Effectiveness	0
Traceability Matrix	File is enclosed separately.

Chapter 8: User Manual

8.1 Admin

Few guidelines for Admin to getting started with the website are listed below:

8.1.1 Getting Started

To get started with the Automated Recruitment System, follow these steps:

- Go to the website's homepage.
- Login with your email and password on the login page.

8.1.2 Create new Job

To create new job on the Automated Recruitment System, follow these steps:

- Log in to your account.
- Go to create new job page.
- Fill out the required fields carefully.
- Submit form to create new job.

8.1.3 Check application status

To check about the application status of jobs, follow these steps:

- Log in to your account.
- Go to application status page.
- All the applications of candidate along with these information will be listed by clicking on the drop down menu of certain job.

8.2 For Candidate

Few guidelines for Admin to getting started with the website are listed below:

8.2.1 Getting Started

To get started with the Automated Recruitment System, follow these steps:

- Go to the website's homepage.
- Register for an account by providing your email address and creating a password.
- Once you have registered, you will be taken to the home page, where you can view your profile and any job applications you have submitted.

8.2.2 Applying for Jobs

To apply for a job on the Automated Recruitment System, follow these steps:

- Log in to your account.
- Browse through the job listings to find a position you are interested in.
- Click on the "Apply" button next to the job listing.
- Fill out the application form by a copy of your resume.
- Submit the application.

8.2.3 Shortlisting Candidates

The Automated Recruitment System uses machine learning algorithms to shortlist candidates based on their resumes. Once the system has shortlisted candidates, they will be notified by email that they have been selected for the next stage of the recruitment process.

8.2.4 Taking the MCQ Based Test

Shortlisted candidates will be required to take an MCQ based test. The test will be administered online, and candidates will be given a set amount of time to complete it.
To take the MCQ based test, follow these steps:

- Log in to your account.
- Navigate to the "Tests" section of your dashboard.
- Click on the test you have been selected to take.
- Read the instructions carefully before starting the test.
- Answer the questions to the best of your ability within the given time limit.
- Submit your answers once you have completed the test.

Chapter 9: Experimental Results and Discussion

This chapter includes experiments that have been carried till now for this project along with their results.

9.1 Candidate Shortlisting:

An analysis has been performed on the module build for the shortlisting of candidates. System is tested with the resume of the applicant for the position of Lab Attendant for FAST Lahore campuses. We got 90 resumes from the department for the applicant for the lab assistance spring 2023. And a list of 17 selected candidates for the test. We pass all the resume to our shortlisting module and select top 17 resume based on score assign by out shortlisted modules. Result we got by comparing selected resume by department and out system is as follow:

9.1.1 Overlapping resumes:

There were 8 resumes that were shortlisted by our module and department. These overlapping resumes contains all the information about GPA, Educational history, and teaching experience if any were properly written.

9.1.2 Disjoint Resumes:

There were 9 resume that were disjoint in both selections. Few of the resumes were very poorly written selected by the department which were not able to get good score in our system. Other than this major reason behind disjoint resumes because of unavailability of GPA, Educational history on most of resumes that were selected by department and our system give more priority to experience and skill if no GPA is present and reduce weightage for GPA. Most of resume does not have any introduction or any explanation of their teaching experience were selected by department and out system compare experience and skill score based on it.

Table 3 System Result

Comparison of result by Department and Shortlisting module

Comparison	**No. of Candidate**
Total Candidates	85
Selected Candidates	17
Common Selected Candidates	8
Disjoints Candidates	9

9.2 Conclusion

Till now our system produce good result for the resume have complete information in it. In cases resume does not have complete information with are necessary for hiring instructor for university like educational history and GPA, results may accept to be different.

Chapter 10: Conclusion and Future Work

There has been good amount of work has been done to automated basic recruitment system every work has its pros and cons based on its scope. A thorough analysis of earlier efforts to automate the hiring process and online testing has been done. Different relevant technique on the process of deducting cheating in an online exam has been viewed.

The software requirements for the system are also documented along with the important features of the project and other hardware and software requirements. This document includes low level and high-level design and er-diagram of system.

The development work include portal for admin to handle jobs and applicants and portal for candidate to apply on those job and a short screening test. These portals handle different operation of the project like create jobs and apply to jobs. It also includes feature to check status of application for both recruiter and candidates.

Along with this a Job module which includes text extraction to score calculation and then selecting candidates based on the score. This server is based on python flask and returns JSON which includes name, email and various scores for each resume. And has an ability for candidate to apply to open job post. Recruiters can also manually adjust the weightage of every parameter like GPA, university and experience.

The functionalities related to the cheating detection in screening test module can be extended in the future by groups that might be interested in this idea.

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