CS 492
Senior Design Project

Final Report

Project Name: UThere

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1. Introduction

Video conferencing has emerged as a widely used real-time communication method in the last decade. This technology has numerous applications, including meetings in companies with remote workers or multiple offices, as well as in educational workshops, training, and university lectures, among others. Although online education is not the first preferred form of education, we have been witnessing the education transformation to online, both during the past pandemic and during the extraordinary situations that have been taking place in recent days.

Video conferencing offers many benefits such as reducing travel costs, increasing productivity and time efficiency, and promoting collaboration for individuals and businesses. However, one of its drawbacks is the personal interaction limitation, leading to a decrease in participants' attention spans during online meetings. The purpose of our Senior Design Project is to provide solutions to the drawbacks of video conferencing.

In UThere, we analyze the faces of the participants during the meetings and give real-time feedback to the presenters. Presenters are notified of their audiences' common emotional state. They are notified when the attention span of the participants drops or increases. UThere's machine learning algorithms evaluate participants' attention according to their eye aspect ratio, lip distance, face pose and iris pose.

In conclusion, video conferencing is a powerful tool that has transformed the way people communicate with one another. With UThere, we are aiming to create a more efficient and intelligent meeting experience for both presenters and audiences.

2. Requirements Details

2.1 Functional Requirements

2.1.1 User

- The user can register to the video-conferencing app and create a profile.
- The user can sign in to the system.
- The user can allow the system to use the camera and microphone.
- The user can mute/unmute himself/herself.
- The user can open and close his/her camera.
- The user can view all the participants in the meeting.
- The user can fill out the contact form to get help.
- The user can raise a hand or send emojis.
- The user can edit his/her profile.

- The user can set analysis preferences such as attention rate limit, hiding emotion analysis and hiding attention analysis.
- The user can sign out.
- The user can be the host, presenter or audience in the meeting.

2.1.1.1 Host

- The host can start a meeting and copy the meeting ID to share with others.
- The host can end the meeting.
- The host can set/unset the presenter.
- The host can remove a participant from the meeting.
- The host can share the analysis report formed at the end of the meeting with the participants whom he/she selects.
- The host can access the real-time report indicating the attention level and emotional status of the participants.
- The host can answer the poll created by the presenter.
- At the end of the presentation, a report displaying the overall attention rate and emotional status of the participants is formed and shared with the host.

2.1.1.2 Presenter

- The presenter can join the meeting by using the meeting ID that is provided by the host.
- The presenter can leave the meeting.
- The presenter can share a screen.
- The presenter can access the real-time report indicating the attention level and emotional status of the participants.
- The presenter can send an alert to the selected participants.
- The presenter can create a poll and share it with the participants in order to increase the attention rate.
- The presenter is notified about who left the meeting.
- Before the presentation, the presenter can set an attention limit which the presenter is warned of when the attention rate of the participants goes down below.
- The presenter can see the analysis report that is formed at the end of the meeting if the host of that presentation shares it with him/her.
- The presenter can end the poll.

2.1.1.3 Audience

- The audience can join a meeting by using the meeting ID and token.
- The audience can leave the meeting.
- The audience can answer the poll created by the presenter.

2.2 Nonfunctional Requirements

2.2.1 Usability

- The user interface will be simple and provide quick access to essential features of the application. The design of the website will require minimal explanation to understand how to use it.
- Any user who knows how to use any video-conferencing application will be able to use UThere.
- The user can contact us to get help by filling the online contact form.

2.2.2 Privacy

- The collected personal data from the users such as their camera records will be only used for attention and emotion tracking. These personal data will not be processed for any other purposes which are incompatible with the main purposes of UThere.
- UThere will process the personal data of the user on the condition that users consent to such processing. The provided consent form will be specific, informed and explicit.
- The user's face record or video records will not be kept in the database.

2.2.3 Scalability

- UThere will be scalable in terms of the ability to handle increased workloads such as adding users more than 5 to a meeting if required hardware and software equipment are supplied.

2.2.4 Performance

- UThere will be a real-time system which processes the faces of the users and presents the current attention level to the presenter.
- The system can process at most 5 users' faces within a minimized time lag between the time when data is produced and the time when data is processed.
- The attention level of the presentation should have high accuracy.

2.2.5 Robustness

- The system will not crash under disturbances such as invalid or erroneous input by dealing with these stressful environmental conditions.

2.2.6 Extensibility

- The design and implementation of the system will not hinder future needs and updates of the system.
- The functionality of the project can be expanded in the future such as sleep detection, and specific emotion recognitions such as aggression, excitement, etc.
- The system will be implemented as object-oriented. Therefore, it will be easy to extend the system for future needs and requirements.

3. Final Architecture and Design Details

3.1 Overview

In this section, the proposed software architecture is explained in a detailed way. Software architecture is a fundamental structure that plays an integral role in understanding software systems and providing a road map for their development. This section presents a brief overview of the software architecture's key components including subsystem decomposition, hardware/software mapping, persistent data management, and access control and security.

3.2 Subsystem Decomposition

Subsystem decomposition is a significant aspect of software architecture that divides systems into smaller subsystems to create more manageable components. By dividing the system into smaller subsystems, the process of development becomes more manageable and testable. Then, subsystems are integrated to form the complete system.

The purpose of the view is to demonstrate the main functionalities of the application. Hence, the system is divided into three subsystems and each of them has different responsibilities. In the diagram, the main subsystems and functionalities can be understood.

The client subsystem is responsible for various functions such as setting profile, creating contact form, login, sign up, and video conferencing. On the other hand, the server subsystem handles the management of logic and directs it to appropriate subsystems and modules as illustrated **in Figure 1**. Finally, the database subsystem enables accessing and managing data.

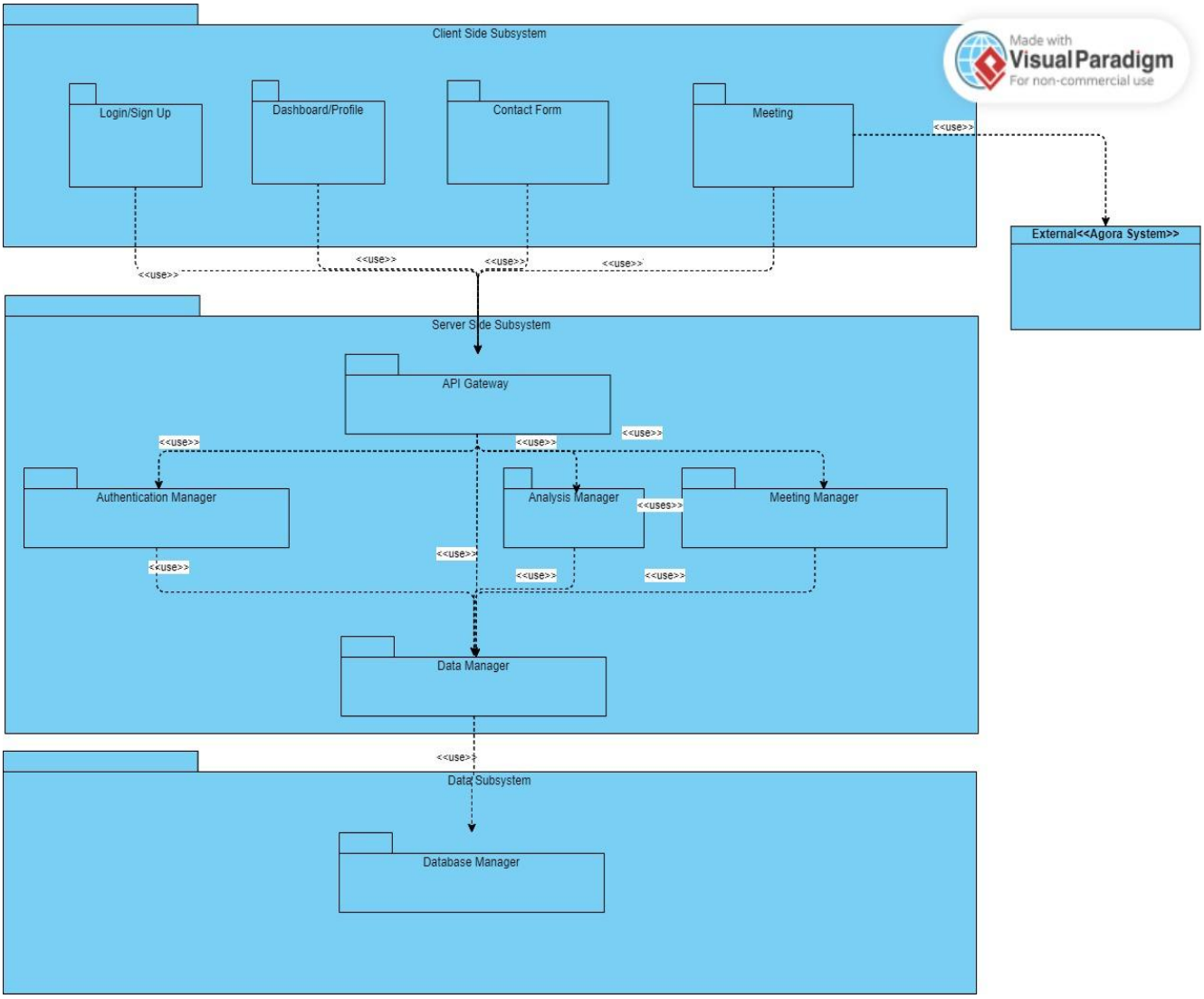


Figure 1

3.3 Hardware/Software Mapping

Hardware/software mapping is an important element of software architecture. Determining software and hardware components enables the execution of software systems effectively.

In **Figure 2**, physical connections between components are demonstrated in a detailed way. The Allocation Style is used to combine software and hardware components and demonstrate the impact of hardware components on software configuration as well as the deployment of software components. The Deployment Style is chosen for this purpose, as it effectively illustrates the connection between hardware and software components. The deployment diagram facilitates a clear understanding of the data transfer and connection between system components.

The diagram in Figure 2 aims to demonstrate the link between hardware and software components in the physical layer. To access the web application, users require a machine equipped with a web browser and a camera. The web application is linked to application programming interfaces (APIs) which facilitate communication between two software components. The connection between the web server and API is established using the HTTP protocol. UThere uses Google Cloud to deploy its database, and main services in the server-side subsystem. Additionally, the web server is connected to the user's machine via TCP/IP. Vercel, hosting provider of the frontend part of the application, is connected with the web browser by using the HTTP protocol.

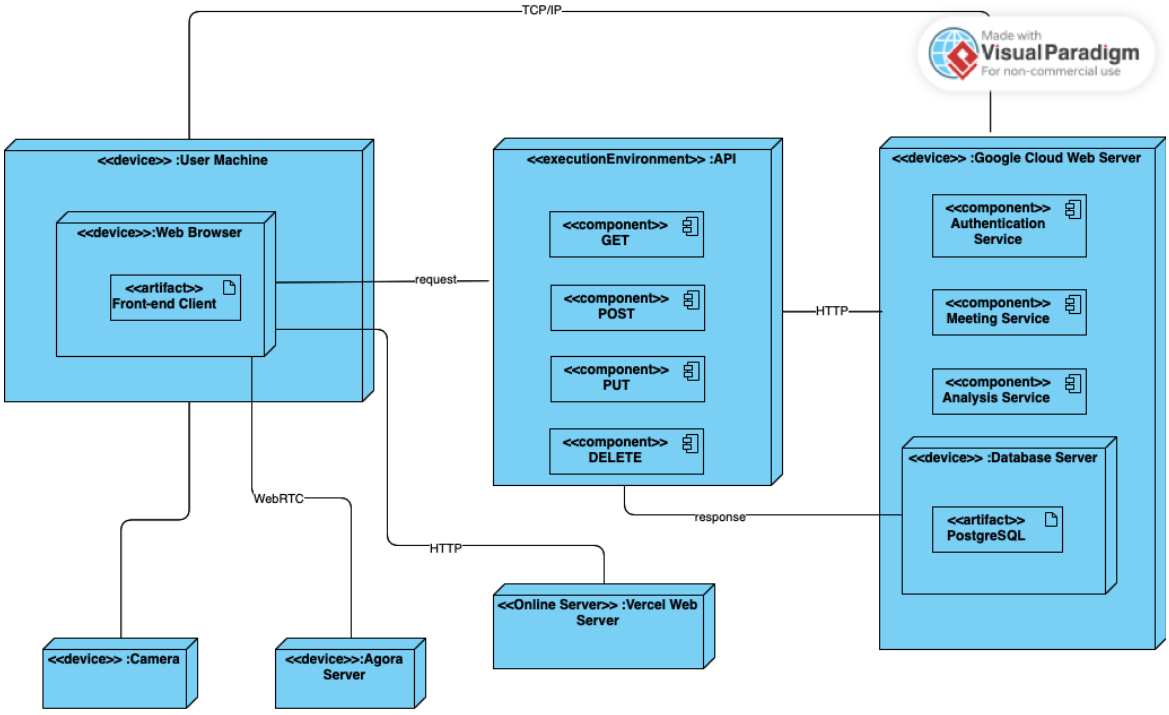


Figure 2

3.4 Persistent Data Management

Persistent data management has vital importance in the lifecycle of any application since it affects the storage of large amounts of data, retrieval of the data by enabling both consistency and security, and scalability of the application. In the UThere system, to provide persistent data management, in the project development lifecycle, we made some design decisions.

Firstly, we identified the data types to be stored in our application. For example, we decided not to store the videos of the participants because of two reasons: the privacy of the users and the performance problems related to the high volume of video data management. Instead of this, we decided to store the data which is collected after processing the video data.

Secondly, we chose a database system that can handle the high volume of data that UThere needs. We chose PostgreSQL as a database management system since PostgreSQL is known for its reliability that can manage significant data volumes and heavy traffic [1]. This capability is essential for a video conference application that has to run smoothly and continuously.

Thirdly, in our architecture, we have a data manager layer as in **Figure 1.** This layer provides an abstraction of the database system by handling reading and writing operations. This layer isolates the application logic from processes involving data and increases the modularity of data handling.

Finally, we decided to use Google Cloud's PostgreSQL data engine to implement backups and as a database server. Regularly backing up data to Google Cloud prevents data losses and enables persistent data management.

3.5 Access Control and Security

Protecting the confidentiality, integrity, and availability of data requires the implementation of access control and security mechanisms. In the UThere system, we use authentication.

As an authentication system, we use Django's built-in authentication functionality. Some key features of this built-in functionality shaped the access control of the UThere application. For example, Django comes with middleware that may be used to enforce user authentication. Unauthenticated users can be redirected by this middleware to the login page or other authentication views [2]. Besides, a permission system, provided by Django, will be used to specify what tasks users are permitted to carry out [3].

3.6 Subsystem Services

UThere uses a 3-tier architectural pattern that implements the client-server model. There are three computing tiers in this architectural pattern: Presentation Tier, Application Tier, and Data Tier [4]. The presentation tier is the user interface tier. Its goal is to handle client requests and provide information to clients[4]. The application tier is the logic tier of the application that gets the data that comes from the client, processes and stores it by communicating with the data tier, and sends it back to the presentation tier [4]. The data tier stores the data and consists of the database servers [4].

In the UThere system, the presentation layer serves as the client and requests resources or services from the application layer, which serves as the server in client-server relations. In other words, the UThere system has three main subsystems as mentioned in **Figure 1.**

3.6.1 Client-side Subsystem

It is the presentation tier in a 3-tier architectural pattern and the client side interacts with the user of the UThere system. It requests data from the application tier to show the information to the client and sends data to the application layer to process and store. As in **Figure 3,** the client-side subsystem has 4 subsystems.

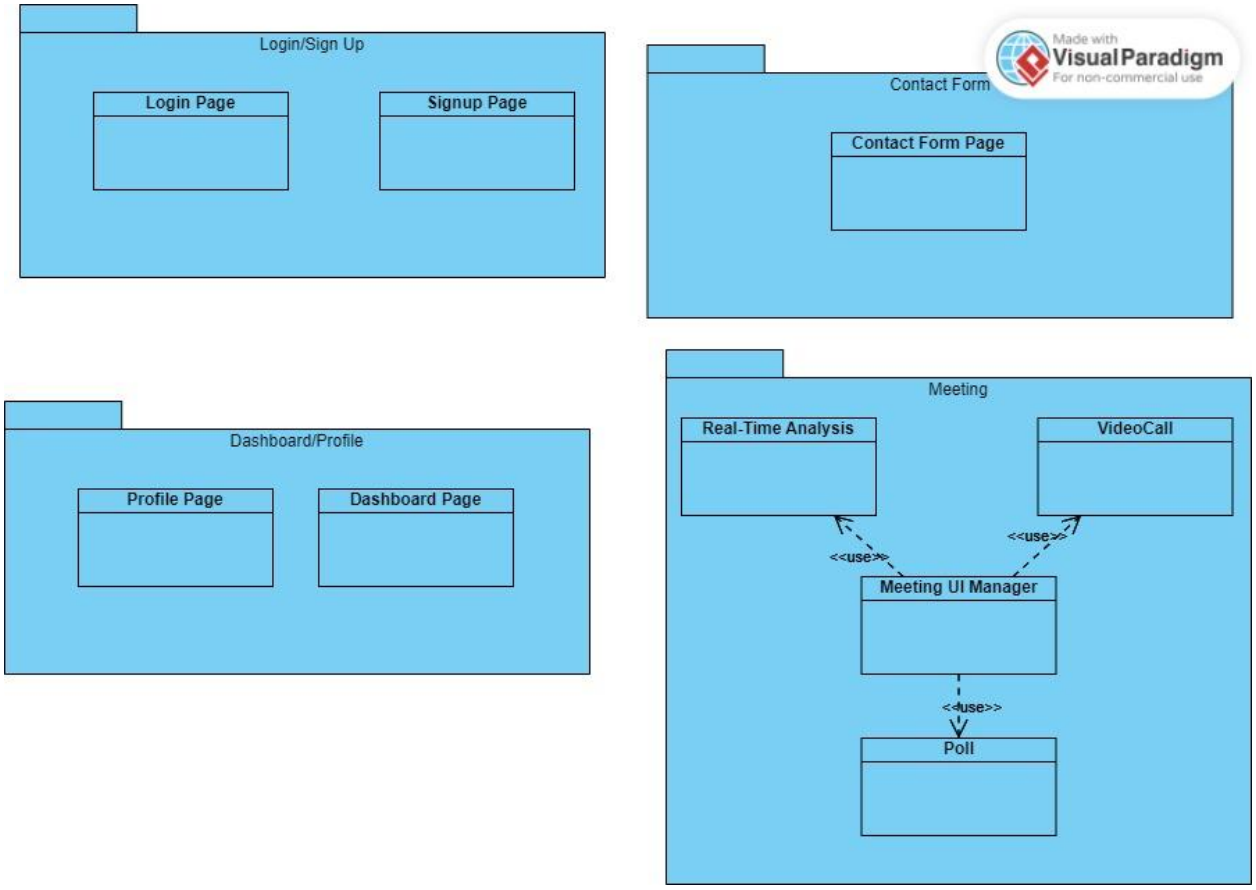


Figure 3

3.6.1.1 Login/Sign Up

When the user enters the site, he/she will be directed to the "Sign Up" page. If the user has an account and clicks the "Have an account? Sign in" under the signup form, he/she will be directed to the "Login Page". All of the interactions of the user on both of these pages are obtained by these pages and most of them are sent to the application tier.

3.6.1.2 Contact Form

When the user is in the dashboard, if he/she clicks the contact form button, he/she will be directed to the "Contact Form Page". All of the interactions of the user on this page are listened to by this page. If the user sends the form, these interactions will be sent to the Application tier.

3.6.1.3 Dashboard/Profile

If the user login to the system, he/she will be directed to the “Dashboard Page”. From this point, the user stays on this page until he/she presses one of the buttons on the page. If the user presses the profile button in the “Dashboard Page”, he/she will be directed to the “Profile Page”. This page requests information related to the profile of the user from the application tier. The user can also edit his/her profile information. In this scenario, this page sends a request to the application tier to update the information. If the user changes tabs to see or update the settings, the profile page again requests information from the application tier and sends information to the application tier.

3.6.1.4 Meeting

The Meeting subsystem has “Meeting UI Manager” which uses real-time analysis, polls, and video call modules. If the user creates a meeting or joins a meeting from the “Dashboard Page”, he/she will be directed to the “Meeting Page” which is controlled by the “Meeting UI Manager”. The “Videocall” module in this subsystem uses the external “Agora system” to publish and receive the real-time video of the participants.

3.6.2 Server-side Subsystem

It is the application tier in a 3-tier architectural pattern, and the server side interacts both with the presentation and data tiers. It can request data from the data tier to provide the information to the presentation tier and it can get requests from the presentation tier and send data to the data tier store. As in **Figure 4,** the client-side subsystem has 5 subsystems.

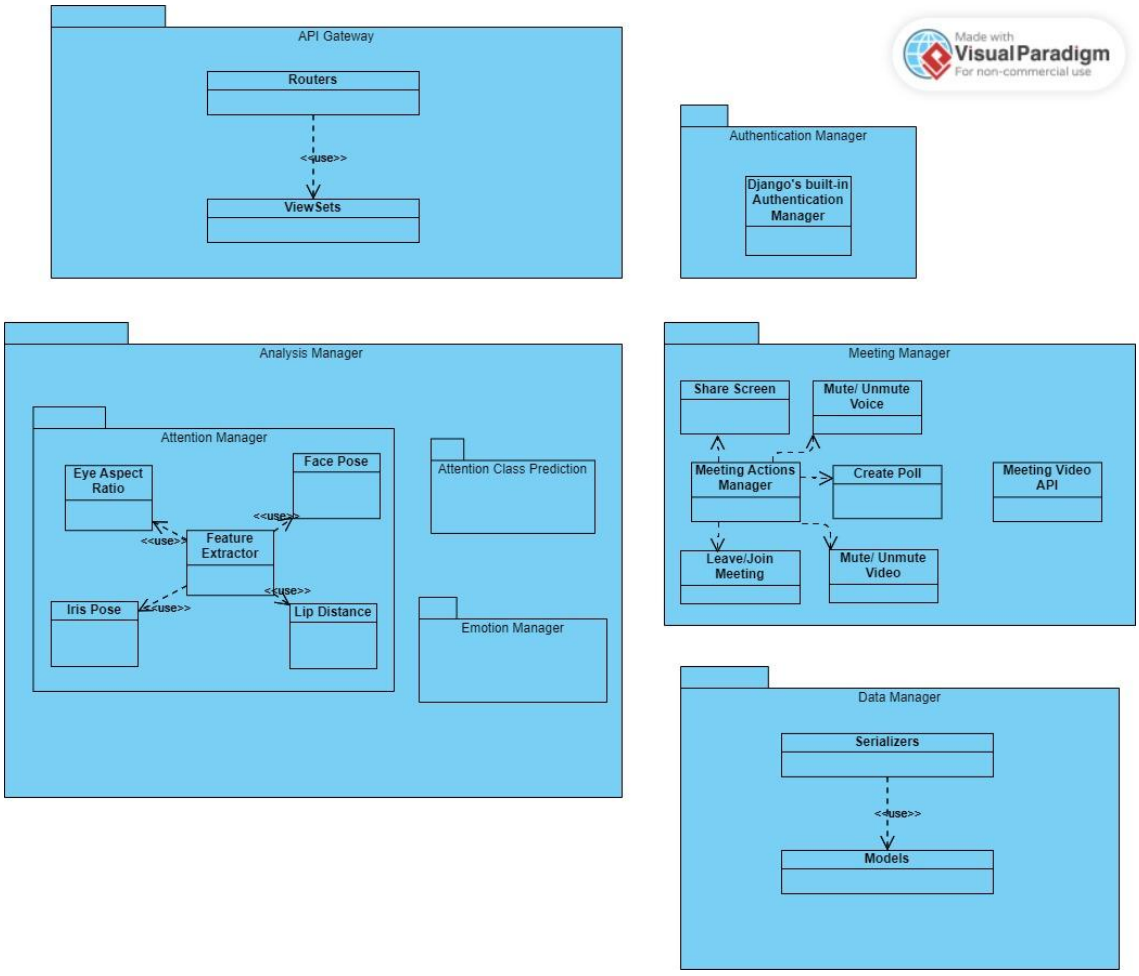


Figure 4

3.6.2.1 API Gateway

API Gateway takes the requests from the client side subsystem and directs them to one of the four managers. Django uses routers to control URL routing for web APIs [5]. The UThere system uses them to control how various "Viewsets" respond to requests for a certain URL.

3.6.2.2 Authentication Manager

UThere system uses Django's built-in authentication system [6].

3.6.2.3 Analysis Manager

The analysis manager has three subsystems: the "Attention Manager" subsystem, "Prediction" and the "Emotion Manager" subsystem. The "Attention Manager" has the "Feature Extractor" system that extracts the required features for predictions. These features are eye aspect ratio, face pose, iris pose and lip distance of the user. The "Attention Class Prediction" subsystem predicts the attention level of the user by using the model that is saved in Attention Manager. The "Emotion Manager" subsystem classifies the emotional status of the participants.

3.6.2.4 Data Manager

The data manager is the submodule in the application tier that provides communication between the other manager modules in addition to the API Gateway and the data tier. “Serializers” are used in Django to transform complicated data types, such as query sets and model instances, into more readily transferred content formats like JSON and XML [7]. “Models” contains the source of information about the data [8]. Each model in Django correspondence to a single database table[8].

3.6.2.5 Meeting Manager

The meeting manager subsystem is responsible for managing storing information about the meeting into the database.When the new meeting is created, the meeting actions manager adds a new entry to the database. When a user joins or leaves the meeting, the database table for participants is updated accordingly. Furthermore, the Meeting Video API submodule serves as an endpoint which receives image data from the meeting participants in order to perform promised analysis.

4. Development/Implementation Details

4.1 Frontend

For Frontend, we have used React which is a JavaScript library that follows a component-based approach, allowing developers to create reusable UI components and manage their state independently. To implement a video conferencing features, we have used Agora WebRTC SDK for React. We designed the user interface with React components for video display, participant list, screen share and controls. We implemented video conferencing functionalities (joining/leaving a meeting, sharing/muting video or voice, sharing screen etc.) by receiving the user input from components and passing it to Agora SDK’s functions.

To perform attention and emotion analysis, we acquired user video using React's MediaDevices interface. We also utilized the MediaRecorder component in React to record the video. We sent these recorded video chunks to the backend every 5 seconds in blob format.

4.2 Backend

For Backend, we have used Django. Django is a popular Python web framework that simplifies the process of building web applications. It provides tools and libraries for tasks like handling databases, URL routing, form handling, authentication, and more. With Django views, we are handling incoming web requests from frontend and return HTTP responses accordingly. Django views encapsulate the logic of the application and define how the application responds to different URLs and HTTP methods (GET, POST, etc.). With Django’s routing, we handled how

incoming requests are matched to specific views or functions that handle those requests. We also used models of Django. Models are Python classes that represent the data structure of the application. We have defined the tables and fields of the database and encapsulated the business logic related to data manipulation with models. Models provide a high-level abstraction for performing database operations, such as creating, reading, updating, and deleting records. We also benefited Django's authorization managements which helps to ensure that only authorized users can access and perform actions within the application, enhancing security and data integrity.

To handle attention and emotion analysis request, we have also implemented FastAPI endpoint connected to our Django backend. FastAPI is a modern, high-performance web framework for building APIs with Python. It leverages the asynchronous capabilities of Python through the use of the ASGI (Asynchronous Server Gateway Interface) specification, making it highly efficient and scalable. But while deploying the backend, we realized that running apps on two different port is not possible on Google Cloud Run Service. That's why, we re-implemented the functionality of this endpoint in Django views.

4.3 Database

We used PostgreSQL as our relational database management system. The general database structure is in Figure 5. It consists of two types of tables. The first type belongs to Django and stores information regarding backend session, management, migration history, and authorization details. The second type are tables that store data associated with various components and functionalities, including Meeting, Attention Emotion Score, Presenter, and Profile etc. Bigger version of the figure can be displayed here.

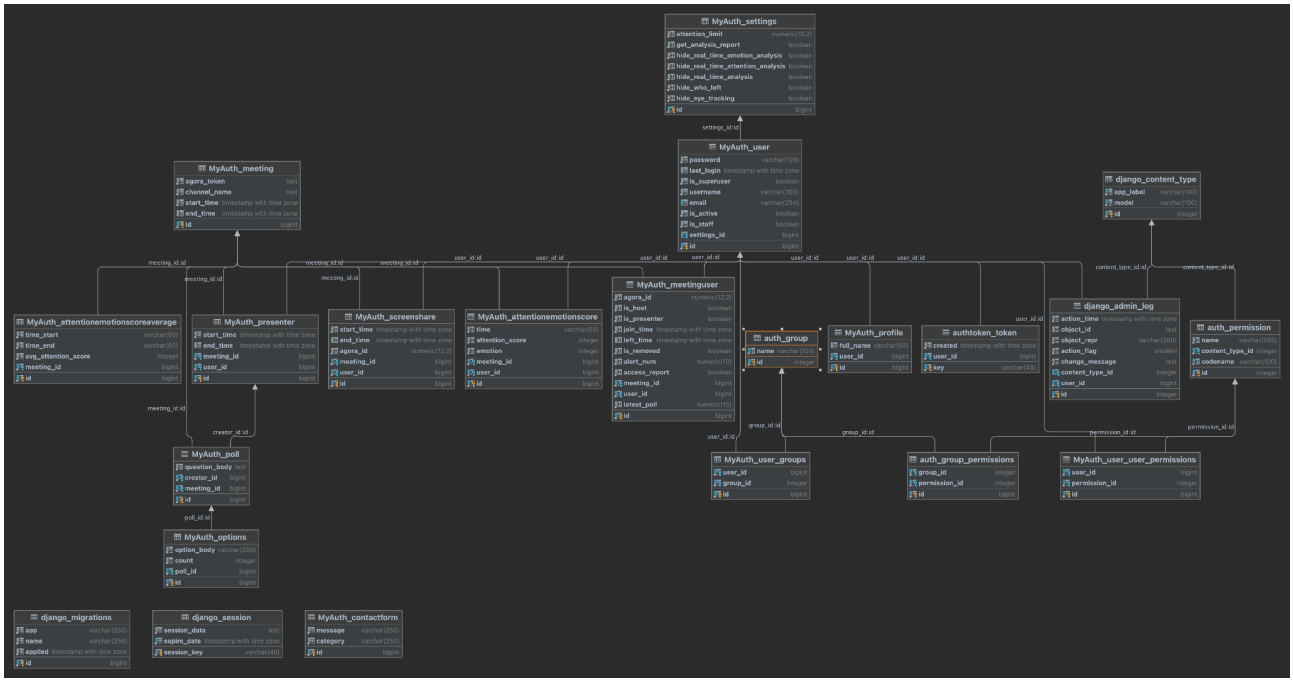


Figure 5

4.3.1 Attention Emotion Score

Attention and emotion predictions are saved in this table for every 5 seconds for every non presenter user in the meeting.

id	time	attention_score	emotion	meeting_id	user_id
1	2023-05-17 16:03:08.904000	3	3	4	4
2	2023-05-17 16:03:18.902000	3	0	4	4
3	2023-05-17 16:03:28.905000	3	0	4	4

Figure 6

4.3.2 Attention Score Average

Attention score averages are saved in this table. Average of the attention scores of all non presenter users in the meeting saved every 5 seconds.

id	time_start	time_end	avg_attention_score	meeting_id
1	2023-05-17 16:…	2023-05-17 16…	3	4
2	2023-05-17 16:…	2023-05-17 16…	3	4

Figure 7

4.3.3 Contact Form

Contact form messages are saved in this table together with the category of message.

id	message	category
11	poll design	Error Reporting
12	poll design	Error Reporting

Figure 8

4.3.4 Meeting

Meeting information such as agora token, channel name, start and end time stored in this table.

id	agora_token	channel_name	start_time	end_time 1
1	006c3154f9b5b96…	e03dI4	2023-05-17 15:58:04.757505 +00:00	<null>
2	006c3154f9b5b96…	fvRPCa	2023-05-17 15:59:07.264051 +00:00	<null>
3	006c3154f9b5b96…	T6Jbe7	2023-05-17 16:02:12.518740 +00:00	<null>

Figure 9

4.3.5 Meeting User

Meeting User information for each user in the meeting are held in this table. This table is one of the main tables that are checked regularly and according to the information acquired user interface changes for host/presenter/regular user.

id	agora_id	is_host	is_presenter	join_time	left_time 1	is_removed
2	2815721061.00	false	• true	2023-05-17 16…	2023-05-17 16:…	• true
1	2565250393.00	• true	false	2023-05-17 15…	2023-05-17 16:…	• true
5	1923649571.00	false	• true	2023-05-17 16…	2023-05-17 16:…	false

Figure 10

alert_num	access_report	meeting_id	user_id	latest_poll
1	false	2	3	-1
0	• true	2	1	-1
0	false	5	6	-1

Figure 11

4.3.6 Presenter

Presenter informations are saved in this table.

id	start_time	end_time 1	meeting_id	user_id
3	2023-05-17 16:15:22…	2023-05-17 16:20:16.48909…	12	3
6	2023-05-17 16:24:42…	2023-05-17 16:25:42.86057…	17	1
7	2023-05-17 16:26:48…	2023-05-17 16:27:07.82758…	19	5

Figure 12

4.3.7 Screen Share

Screen share information is held in this table.

id	start_time	end_time	agora_id	meeting_id	user_id
41	2023-05-18 14:5…	2023-05-18 17:…	4193639079.00	98	4
42	2023-05-18 14:5…	2023-05-18 17:…	1921295891.00	99	8
43	2023-05-18 15:0…	2023-05-18 18:…	852551754.00	99	8

Figure 13

4.3.8 Settings

User settings takes place in this table. By checking this table, user interface is adjusted for each user.

id	attention_limit	get_analysis_report	hide_real_time_emotion_analysis
38	50.00	• true	false
37	50.00	• true	false

Figure 14

hide_real_time_analysis	hide_who_left	hide_eye_tracking
false	false	false
false	false	false

Figure 15

4.3.9 Poll

When presenters create poll question body is saved, together with meeting and user information, in this table.

id	question_body	creator_id	meeting_id
1	quest	5	127
2	quest	5	127

Figure 16

4.3.10 Options

Options of the poll saved in this table.

id	option_body	count	poll_id
75	Both	0	46
74	No	1	46

Figure 17

4.4 Analysis Model

4.4.1 Dataset Preparation

In order to train a neural network for attention classification, an initial requirement was a labeled dataset. Initially, we decided to make predictions for video chunks that were 10 seconds in duration. Consequently, we implemented two Python scripts. The first script, create_video.py, was used by all group members to record their videos using their webcams while attending online meetings. The frames per second (FPS) of these videos were standardized to 20. No specific resolution was set for the videos, as the resolution of the video chunks received from users during prediction varied based on their PC's camera capabilities and browser preferences.

After saving the video files, we utilized a second script that we had implemented for the labeling process. In labeling.py, the selected video was divided into 10-second-long chunks, and each chunk was displayed on the screen individually. Group members used the keyboard to assign labels to these video chunks, categorizing them into three classes: Low, Middle, and High. The assigned labels were then stored in a CSV file. Each group member was responsible for labeling a video duration of 2.5 hours. Ultimately, we obtained a labeled video dataset that is 45,720 seconds (12.7 hours) long. The head of labels.csv can be seen in Figure 18. Chunk index indicates the order of the video chunk in recorded video, label indicates the attention: 1 for low, 2 for middle, 3 for high attention.

video_name	chunk_index	label
bil_1	0	1
bil_1	1	2
bil_1	2	2
bil_1	3	1
bil_1	4	2

Figure 18

We have designed a two-step approach for the attention prediction module: firstly, the extraction of features from video chunks, followed by the utilization of these extracted features as inputs to our RNN model. Consequently, the dataset used for training the model requires the inclusion of the features extracted from the video chunks, rather than the videos themselves. To do that, we have implemented an additional Python script responsible for extracting the desired features from the video chunks and storing them in a CSV file. The head of features.csv can be seen in Figure 19. During the feature extraction process, various features such as the eye aspect ratio (EAR), lip distance, face pose, and iris pose were computed for each frame and subsequently saved. Each frame was associated with the corresponding video name, indicating the video from which it was extracted. Additionally, the chunk index was recorded to indicate the specific video

chunk to which the frame belongs. Furthermore, the order of the frames was preserved and saved for reference. The meaning of the values is explained in the next section.

video_name	chunk_index	frame	ear	lip_distance	face_pose	iris_pose
mel_1	0	0	0.322427335	0	1	1
mel_1	0	1	0.3444305603	0	1	1
mel_1	0	2	0.3398471992	0	1	1
mel_1	0	3	0.3401763664	0	1	1
mel_1	0	4	0.3323135263	0	1	1

Figure 19

4.4.2 Attention Analysis

4.4.2.1 Feature Extraction

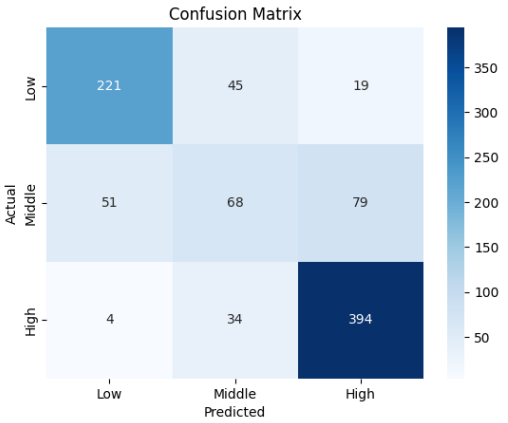
In the extractor.py, we are extracting various facial features from a sequence of frames, such as Eye Aspect Ratio (EAR), Lip Distance, Face Pose, and Iris Direction. We do this by finding the facial landmark coordinates by using the Mediapipe FaceMesh model [9].

We calculated the eye aspect ratio from the eye landmarks and used it directly for predictions. The lip distance is calculated using landmarks on the upper and lower lips. A threshold is set, and if the lip distance is greater than the threshold, the result is saved as 1 (open); otherwise, it is saved as 0 (closed). OpenCV is used to solve the perspective-n-point (PnP) problem and estimate the face pose. Once again, a threshold is set to determine if the user's face is facing the screen or not. Based on this threshold, the result is saved as 1 (facing the screen) or 0 (not facing the screen). For the iris pose, we are using iris landmarks of FaceMesh and again there is a threshold. If irises are looking on the screen result is saved as 1 (on screen), else 0 (out screen).

4.4.2.2 Attention Model for 10 Seconds Long Video Chunk

After preparing the dataset for 4572 samples from 45,720 seconds long videos, it is then split into training and testing sets with a test size of 20%. Prediction model is built with two LSTM layers with 64 and 32 units. Dropout layers with a rate of 0.1 are inserted after each LSTM layer to decrease overfitting. The final layer is a dense layer with 3 units representing the three classes: Low, Middle, and High. The softmax activation function is applied to the output layer.

The model is compiled with the AdamW optimizer, using a learning rate of 0.0001. The loss function is specified as sparse categorical cross-entropy which is the most suitable loss function for multi-class classification. To prevent overfitting an early stopping callback is implemented with a patience of 20 epochs. The model is trained with the training data, validation split of 15%. Number of epochs is set to 400 and batch size is set to 64. After training, the model is evaluated using the test data. Resulting test loss and accuracy, confusion matrix of the model are as follows:



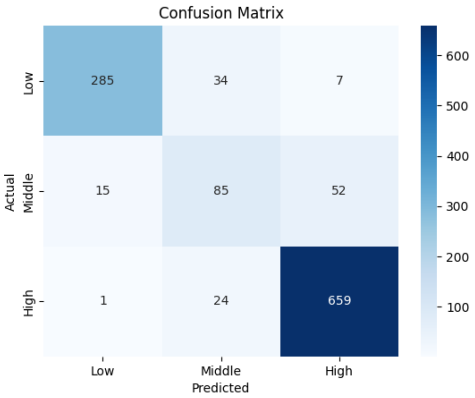
Test loss: 58.10%
Test accuracy: 74.64%

Figure 20

4.4.2.3 Attention Model for 5 Seconds Long Video Chunk

Although the initial model performed adequately, the test loss did not fall within the desired range. To enhance the model's performance, a decision was made to re-label video chunks. The quality of our prediction model will improve in proportion to the dataset's accuracy in representing the problem. To ensure objectivity in the labeling process, it was decided that a single person would perform all the labeling. Another modification was made regarding the length of the video chunks. During testing the real-time analysis results in our application, it became apparent that more frequent updates were necessary to accurately reflect the current situation. So, the duration of the video chunks was reduced from 10 seconds to 5 seconds.

Following these two adjustments, a new dataset was prepared. 5806 video chunks, each with a duration of 5 seconds, labeled by one of us. The same set of features as the previous model was employed. Model structure, compiler, and hyperparameters were not changed. The only change made with the input size of the first layer. Then, the model was trained and evaluated using the test data. The resulting test loss, accuracy, and confusion matrix of the model are below:



Test loss: 31.96%
Test accuracy: 88.55%

Figure 21

4.4.3 Emotion Analysis

To perform emotion classification, our initial approach involved utilizing the emonet model, which is a pretrained model derived from the official implementation of the paper titled "Estimation of continuous valence and arousal levels from faces in naturalistic conditions." [10].We have choosed the emonet model due to its ability to not only classify emotions but also predict valence and arousal levels. These valence and arousal predictions were intended to be utilized as features for our attention model. However, after implementing and integrating this model into our analysis module, we observed that the runtime of the predictions did not meet our desired speed requirements. Given that our analysis is performed in real-time, extended delays would conflict with our performance criteria. As a result, we made the decision to replace this model with another that makes faster predictions.

After conducting some research, we have found Deepface. Deepface is a lightweight face recognition and facial attribute analysis (age, gender, emotion and race) library for Python [11]. We adopt this library and and utilized it for making predictions by selecting 10 frames from each video chunk with a length of 100 frames. The most frequent emotion was determined by obtaining the mode of these 10 predictions.

5. Test Cases and Results

5.1 Functional Test Cases

Test ID: TC_F_01	**Test Category:** Functional
Test Title: Attempting to change the email address to an already existing email address	
Test Summary: The user can't change his/her email address to an already existing email address. In other words, the email address must be unique.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Navigate to the Profile page. ● On the first tab of the page, click on the edit icon next to the email address data. ● On the opening pop-up, enter an already existing email address. ● Click on the edit button.	
Expected Result: In such an attempt to change the email address to an already existing email address, an appropriate error message stating that the email address must be unique is displayed.	
Test Priority: Medium	

Date Tested: 18.05.2023	**Pass/Fail:** Pass
Test Result: An error message stating “Email already exists. Please try again!” was displayed.	

Test ID: TC_F_02	**Test Category:** Functional
Test Title: Verifying the email address of the user	
Test Summary: To enable the user to contact the system administrators, the email address of the user should be verified.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Navigate to Profile page ● On the first tab of the page, click on the “Verify my email address” button next to the email address data. ● Check your email inbox. ● Click the link provided in the response email sent by the UThere organization.	
Expected Result: When the user registers to the application and reviews the profile information for the first time, he/she is required to verify his/her email address. A notification stating that you are required to verify your email address is displayed. A button named “Verify my email address” is shown beside his/her email address information. After clicking the button and following the steps expressed in the auto-generated email, the user verifies his/her email address and the button named “Verify my email address” will not show again until the user demands to change his/her email address.	
Test Priority: Medium	
Date Tested: 19.05.2023	**Pass/Fail:** Fail
Test Result: Our application does not support email verification yet. However, users still can submit forms to contact us because when the form is submitted, the email is sent from and to the UThere organization email address. The email includes the message and the information of the user who submits the form even if the email address of the user is invalid.	

Test ID: TC_F_03	**Test Category:** Functional
Test Title: Verifying whether the email is sent properly	
Test Summary: It should be controlled whether the email is sent properly when the user sends his/her message to system administrators.	

Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Navigate to Contact Us page. ● Select an option from the dropdown menu and enter a message. ● Click on the send button. ● Check your email inbox for the auto-generated email message sent by UThere organization stating that your message is successfully delivered.
Expected Result: An auto-generated email message is sent in response to the email sent by the user.
Test Priority: Medium
Date Tested: 19.05.2023 | **Pass/Fail:** Pass
Test Result: When the user submitted the form to contact us, an email was successfully sent from and to the UThere organization email address. However, an auto-generated email message cannot be sent to the user since the verification of the email address of the user cannot be checked for now.

Test ID: TC_F_04	**Test Category:** Functional
Test Title: Visibility of calibration dots	
Test Summary: All of the 8 points that should be clicked for calibration purposes before the user is directed to the meeting page should be visible for different window sizes to prevent any inconvenience.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Navigate to the Profile page. ● On the third tab of the page, check your meeting analysis preferences. ● Toggle off the “Hide Eye Tracking” item if not toggled off. ● Redirect to the dashboard by clicking on the UThere logo. ● Click on either the “New Meeting” or “Join Meeting” buttons. ● Check whether 8 calibration buttons are visible.	
Expected Result: All of the points should be visible in the calibration page without any extra effort.	
Test Priority: Low	
Date Tested: 19.05.2023	**Pass/Fail:** Pass

Test Result: No matter the screen size, all calibration buttons were visible.

Test ID: TC_F_05	**Test Category:** Functional
Test Title: Verifying the password to change the password	
Test Summary: The user should verify his/her existing password in order to edit the password.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Navigate to the Profile page. ● On the first tab of the page, click on the edit icon next to the password data. ● On the opening pop-up, enter your old password and the new password. ● Click on the edit button.	
Expected Result: The user is prompted to enter the already existing password before creating a new password.	
Test Priority: Medium	
Date Tested: 18.05.2023	**Pass/Fail:** Pass
Test Result: A popup that prompted the user to enter the current password, and the new password was displayed.	

Test ID: TC_F_06	**Test Category:** Functional
Test Title: Verifying the new email address	
Test Summary: The user should verify the new email address by clicking the link in the email sent to his/her new email address. Otherwise, the user can't edit the email address.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Navigate to the Profile page. ● On the first tab of the page, click on the edit icon next to the email address data. ● On the opening pop-up, enter your new email address. ● Click on the edit button. ● Check your new email inbox and click the verification link on the auto-generated response email sent by the UThere organization.	

Expected Result: When the user submits the new email address, a verification email is sent to his/her new email address. If the user can verify the email address by clicking the link sent to his/her new email address, he/she can change the email address. Otherwise, the request is denied, and a notification pop-up is shown.	
Test Priority: Medium	
Date Tested: 19.05.2023	**Pass/Fail:** Fail
Test Result: Our application does not support email verification yet.	

Test ID: TC_F_07	**Test Category:** Functional
Test Title: Reminding the user of his/her meeting analysis preferences before entering a meeting	
Test Summary: Before the user enters a meeting, he/she should be notified about his/her meeting preferences set in the profile page.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Click on either the "New Meeting" or "Join Meeting" buttons. ● Before entering the meeting, your meeting analysis preferences are documented on the page. ● You can edit any option about the meeting analysis preferences.	
Expected Result: When the user attempts to enter a meeting, his/her meeting analysis preferences are shown on the page. The user is allowed to edit his/her preferences on the pre-meeting page without being directed to the profile page.	
Test Priority: High	
Date Tested: 18.05.2023	**Pass/Fail:** Pass
Test Result: When the user attempted to enter a meeting, he/she was reminded that he/she was about to join/create the meeting and kindly asked whether he/she wanted to review the meeting analysis preferences first. Instead of documenting the meeting analysis preferences on a pre-meeting page without being directed to the profile page, as stated in the Expected Result section, navigating the user to the profile page was preferred.	

Test ID: TC_F_08	**Test Category:** Functional
Test Title: Selecting a dropdown menu option for contact message	

Test Summary: To send a system-related/help message, the user should select the most appropriate option of the dropdown menu.
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Click on the Contact Us button. ● Enter a message and do not select any option from the dropdown menu. ● Click the send button.
Expected Result: The user is prompted to select the most appropriate option out of 3 suggested subject options. If the user attempts to submit his/her message without selecting any option, a notification pop-up encouraging the user to select an option is shown.
Test Priority: Low

Date Tested: 18.05.2023	**Pass/Fail:** Pass
Test Result: When the user attempted to submit his/her message without selecting any option, an error message stating "You should select a category to be able to contact us. Please try again!" was displayed.	

Test ID: TC_F_09	**Test Category:** Functional
Test Title: Pressing logo while in a meeting	
Test Summary: The user should not be directed to the dashboard when he/she is in a meeting and clicks the "UThere" logo.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Click on either the "New Meeting" or "Join Meeting" buttons and attend a meeting. ● Complete the calibration if required. ● In the meeting, try clicking on the UThere logo located on the top left corner of the page.	
Expected Result: The "UThere" logo located on the top left corner of the page is disabled and not clickable.	
Test Priority: High	
Date Tested: 18.05.2023	**Pass/Fail:** Pass
Test Result: The "UThere" logo located on the top left corner of the page was not clickable on the meeting page.	

Test ID: TC_F_10	**Test Category:** Functional
Test Title: Pressing submit button twice in a quick manner	
Test Summary: The user should not be able to submit a form twice by pressing the submit button in quick succession.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● For instance, click on the Contact Us button and fill out the form by selecting an option from the dropdown menu and entering a message. ● Click the send button more than once in a quick manner. ● Check your email to control whether more than one email is sent or not.	
Expected Result: When the user clicks a submit button twice in quick succession, the data is recorded in the database only once.	
Test Priority: Low	
Date Tested: 19.05.2023	**Pass/Fail:** Pass
Test Result: The test steps were followed. Contact form was filled and submitted by clicking the submit button more than once in quick succession. Only one email is sent.	

Test ID: TC_F_11	**Test Category:** Functional
Test Title: Attempting to enter a meeting without credentials	
Test Summary: The user should not be able to attend the meeting without signing in. For instance, the user should not enter a meeting by navigating to a URL provided by someone in the meeting.	
Test Steps: ● Request the URL of the meeting from a participant of the meeting. ● Go to the URL provided.	
Expected Result: When the user attempts to enter a meeting without signing in, he/she should be directed to the login page.	
Test Priority: Medium	
Date Tested: 18.05.2023	**Pass/Fail:** Pass

Test Result: When a user attempted to enter a meeting without signing in through the provided meeting link, he/she could not enter the meeting.

Test ID: TC_F_12	**Test Category:** Functional
Test Title: Limiting the number of participants	
Test Summary: The maximum number of allowed participants for a meeting should not be exceeded, and it shouldn't be possible for a user to join the meeting after the maximum number of participants is reached.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Click on the "Join Meeting" button and try to attend a meeting that has the maximum number of allowed participants already.	
Expected Result: When the number of participants in a meeting is equal to the maximum number of allowed participants in a meeting, the user should be notified via a pop-up stating that the maximum allowed number of participants has been reached.	
Test Priority: High	
Date Tested: 19.05.2023	**Pass/Fail:** Pass
Test Result: When the user attempted to join a meeting which already had the maximum number of participants a meeting could have, the user was not admitted into the meeting and a warning message was displayed.	

Test ID: TC_F_13	**Test Category:** Functional
Test Title: Automatic sign-out on session expiration	
Test Summary: In case of a timeout, the user should be automatically signed out.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Stay signed in for more than the session expiration time in the application.	
Expected Result: When the maximum amount of time allowed for a user's session to be active has been reached, the user should be automatically directed to the login page.	

Test Priority: Low	
Date Tested: 19.05.2023	**Pass/Fail:** Fail
Test Result: Automatic sign-out on session expiration is not supported in our application yet.	

Test ID: TC_F_14	**Test Category:** Functional
Test Title: Identity of screen shared and seen	
Test Summary: It should be controlled whether the shared screen and the screen seen by other participants align with each other.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Click on either the "New Meeting" or "Join Meeting" buttons and attend a meeting. ● Complete the calibration if required. ● If you have joined a meeting, request being a presenter from the host because only the host and presenters are allowed to share the screen in our application. ● Share your screen. ● Check another participant's screen to control whether the screen you are sharing is the same as what the other participant sees.	
Expected Result: The screen shared by the presenter and the screen seen by the other participants are the same.	
Test Priority: Low	
Date Tested: 18.05.2023	**Pass/Fail:** Pass
Test Result: The screen shared by the presenter and the screen seen by other participants were identical.	

Test ID: TC_F_15	**Test Category:** Functional
Test Title: Setting participants as presenter	
Test Summary: Only the host can set which participants will be titled as presenters.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered).	

• Click on “New Meeting” and create a meeting. • Complete the calibration if required. • Click on the Participants button located on the below bar of the meeting page. • Try setting a participant as the presenter. • End the meeting. • Click on the “Join Meeting” button and attend a meeting. • Complete the calibration if required. • Click on the Participants button located on the below bar of the meeting page. • Try setting a participant as the presenter.
Expected Result: At the meeting, only the host who starts the meeting is able to give permission to participants to be presenters. The host can set the title via the buttons appearing on the participants list. Participants other than the host only see the participants list without any buttons.
Test Priority: Medium
Date Tested: 18.05.2023 | **Pass/Fail:** Pass
Test Result: Only the host who created the meeting could set a participant as the presenter.

Test ID: TC_F_16	**Test Category:** Functional
Test Title: Notifying users about successfully completing the contact form	
Test Summary: The user should be notified via a response email about successfully filling out the contact form.	
Test Steps: • Open the UThere web page. • Enter the credentials to sign in to the application (register if not registered). • Click on the Contact Us button. • Enter a message and select an option from the dropdown menu. • Click the send button. • Check your email inbox to see whether an auto-generated response email stating that the contact message is successfully delivered is sent.	
Expected Result: When the user submits the contact form, an auto-generated email message is sent to indicate that the submission is successful.	
Test Priority: Low	
Date Tested: 19.05.2023	**Pass/Fail:** Fail
Test Result: Notifying users via an auto-generated email message about successfully	

completing the contact form is not available in our application yet since our application does not support email verification yet.

Test ID: TC_F_17	**Test Category:** Functional
Test Title: Checking input text length	
Test Summary: Input lengths should be checked to prevent any inconsistency with the database.	
Test Steps: ● Open the UThere web page. ● Navigate to the registration page. ● For instance, enter a full name composed of more than 30 characters. ● Fill out other input areas validly. ● Accept terms and conditions. ● Click on the sign-up button.	
Expected Result: Users cannot input more characters than the allowed limit, and data is successfully recorded into the database.	
Test Priority: Low	
Date Tested: 19.05.2023	**Pass/Fail:** Pass
Test Result: The input length was checked and limited by Django's built-in mechanism.	

Test ID: TC_F_18	**Test Category:** Functional
Test Title: Checking input data type	
Test Summary: Input data types should be checked to prevent any inconsistency with the database.	
Test Steps: ● Open the UThere web page. ● Navigate to the registration page. ● For instance, enter a full name, including special characters such as $, €, or +. ● Fill out other input areas validly. ● Accept terms and conditions. ● Click on the sign-up button.	
Expected Result: Users cannot input any data whose type is not compatible with the system’s	

requirements. In such a case, the user is warned via a text written in red on top of the input area.	
Test Priority: Low	
Date Tested: 19.05.2023	**Pass/Fail:** Fail
Test Result: In our application, input characters are not checked yet. However, for instance, the validity of the email address is controlled.	

Test ID: TC_F_19	**Test Category:** Functional
Test Title: Inputting a message for contact request	
Test Summary: To send a system-related/help message, the user should not leave the message area blank.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Click on the Contact Us button. ● Select an option from the dropdown menu and leave the message area blank. ● Click the send button.	
Expected Result: The user is prompted to enter a message for the contact form. If the user attempts to submit his/her form without writing any message, a notification pop-up encouraging the user to input a message is shown.	
Test Priority: Low	
Date Tested: 18.05.2023	**Pass/Fail:** Pass
Test Result: When the user attempted to submit his/her form without writing any message, an error message stating “You should enter some message to be able to contact us. Please try again!” was displayed.	

Test ID: TC_F_20	**Test Category:** Functional
Test Title: Pressing the back button of the browser while in a meeting	
Test Summary: The user should not be directed to the previous page when he/she is in a meeting and clicks the back button of the browser.	
Test Steps:	

● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Click on either the “New Meeting” or “Join Meeting” buttons and attend a meeting. ● Complete the calibration if required. ● In the meeting, try clicking on the back button of the browser located on the top left corner of the screen.
Expected Result: When the back button of the browser located on the top left corner of the screen is clicked, the user is asked whether he/she wants to leave the meeting.
Test Priority: High
Date Tested: 19.05.2023 | **Pass/Fail:** Fail
Test Result: When the back button of the browser was clicked in a meeting, the user was removed from the meeting but the user remained in the meeting page without displaying control panel or meeting-related component.

Test ID: TC_F_21	**Test Category:** Functional
Test Title: Leaving the meeting	
Test Summary: The user should not be allowed to leave the meeting before being asked whether the user is sure.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Click on either the “New Meeting” or “Join Meeting” buttons and attend a meeting. ● Complete the calibration if required. ● On the meeting page, click on the leave meeting button.	
Expected Result: When the user clicks the leave meeting button, a pop-up asking the user whether he/she is sure to leave the meeting is displayed.	
Test Priority: High	
Date Tested: 18.05.2023	**Pass/Fail:** Pass
Test Result: When the host clicked the leave meeting button, a pop-up asking the host whether he/she was sure to leave the meeting was displayed. The host could either end the meeting for all participants or give up leaving the meeting. When a participant other than the host clicked the leave meeting button, a pop-up asking the participant whether he/she was sure to leave the meeting was displayed. The participant could either leave the meeting or give up leaving the meeting.	

Test ID: TC_F_22	**Test Category:** Functional
Test Title: Verifying the email address of the user before submitting a contact form	
Test Summary: To enable the user to submit a contact form, the email address of the user should be verified.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Make sure you have not verified your email address yet. ● Navigate to “Contact Us” page ● Select an option from the dropdown menu and enter a message. ● Click the send button.	
Expected Result: When the user attempts to submit a contact form without verifying his/her email address, a notification pop-up reminding the user to verify his/her email address to be able to submit the contact form is displayed.	
Test Priority: Medium	
Date Tested: 19.05.2023	**Pass/Fail:** Fail
Test Result: Our application does not support email verification yet. However, users still can submit forms to contact us because when the form is submitted, the email is sent from and to the UThere organization email address. The email includes the message and the information of the user who submits the form even if the email address of the user is invalid.	

Test ID: TC_F_23	**Test Category:** Functional
Test Title: Matching password and password verification fields	
Test Summary: On the registration page, the inputs entered into the password and password verification fields should match	
Test Steps: ● Open the UThere web page. ● Navigate to the Registration page. ● Enter different inputs for password and password verification.	
Expected Result: When the user enters unmatching inputs into the password and password verification fields, an error message of “Passwords do not match” is shown on top of the input	

area.	
Test Priority: Low	
Date Tested: 18.05.2023	**Pass/Fail:** Pass
Test Result: When the user entered unmatching inputs into the password and password verification fields, an error message of “Passwords do not match!” was shown on top of the input area.	

Test ID: TC_F_24	**Test Category:** Functional
Test Title: Downloading PDF files	
Test Summary: The user should be able to successfully download PDF files generated after a meeting.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Navigate to the Profile page. ● On the third tab of the page, make sure the “Get Analysis Report” item is toggled on. ● Click on the UThere logo to go back to the dashboard. ● Click on either the “New Meeting” or “Join Meeting” buttons and attend a meeting. ● Complete the calibration if required. ● If you have joined a meeting, request being a presenter from the host because only the host and presenters are allowed to access meeting analysis reports in our application. ● When the meeting ends, navigate back to the Profile page. ● On the second tab of the page, click on one of the PDF files generated so far.	
Expected Result: When the user clicks on the PDF file icon, the file is automatically downloaded.	
Test Priority: Medium	
Date Tested: 19.05.2023	**Pass/Fail:** Pass
Test Result: PDF file was automatically downloaded when the file icon or the name of the file was clicked.	

Test ID: TC_F_25	**Test Category:** Functional
Test Title: Notifying the presenter about the decrease below the rating limit	

Test Summary: When the attention rate decreases below the limit set by the presenter, he/she should be notified about the status.
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Navigate to the Profile page. ● On the third tab of the page, set the attention rating limit. ● Click on the UThere logo to go back to the dashboard. ● Click on either the “New Meeting” or “Join Meeting” buttons and attend a meeting. ● Complete the calibration if required. ● If you have joined a meeting, request being a presenter from the host because only the host and presenters are allowed to get real-time analysis feedback. ● Check the attention analysis feedback periodically.
Expected Result: When the real-time attention analysis feedback drops below the limit set by the presenter, the presenter is notified via a pop-up stating that the attention rate of participants has decreased below the specified limit.
Test Priority: Medium

Date Tested: 18.05.2023	**Pass/Fail:** Pass

Test Result: When the real-time attention analysis feedback dropped below the limit set by the presenter, the presenter was notified via a pop-up stating “The attention level of participants tends to decrease. You may consider creating a poll or alert users to attract their attention.”.

Test ID: TC_F_26	**Test Category:** Functional

Test Title: Joining a meeting
Test Summary: The user should be able to join a meeting successfully by entering the Meeting ID.
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Click on the “Join Meeting” button. ● Enter the Meeting ID into the input area displayed on a pop-up. ● Click on the join button. ● Complete the calibration if required.
Expected Result: When the user enters the correct Meeting ID, he/she joins the meeting.

Test Priority: High	
Date Tested: 18.05.2023	**Pass/Fail:** Pass
Test Result: When the user clicked the Join Meeting button, a pop-up that prompted the user to enter the channel name, and the token was displayed. If the channel name and the token was correct, the user was reminded that he/she might want to review his/her meeting analysis preferences. If the user clicked the Join Anyway button, he/she successfully joined the meeting.	

Test ID: TC_F_27	**Test Category:** Functional
Test Title: Password length validity	
Test Summary: The password should include at least eight characters.	
Test Steps: ● Open the UThere web page. ● Navigate to the Registration page. ● Enter a password with less than eight characters. ● Enter the same input into the password verification field. ● Enter valid data into full name and email address fields. ● Accept terms and conditions ● Click on the Sign-Up button.	
Expected Result: When the user attempts to register with a password including less than eight characters, an error message of “Password shorter than eight characters! Registration unsuccessful!” is shown.	
Test Priority: Low	
Date Tested: 18.05.2023	**Pass/Fail:** Pass
Test Result: When the user attempted to register with a password including less than eight characters, an error message stating “Password shorter than eight characters! Registration unsuccessful!” was displayed.	

Test ID: TC_F_28	**Test Category:** Functional
Test Title: Email address validity	
Test Summary: The email address should be valid to register successfully.	
Test Steps:	

• Open the UThere web page. • Navigate to the Registration page. • Enter an invalid email address, such as an email address without a '@' sign. • Enter valid data into full name and password fields. • Accept terms and conditions • Click on the Sign-Up button.
Expected Result: When the user attempts to register with an invalid email address, an error message of "Invalid email address! Registration unsuccessful!" is shown.
Test Priority: Low

Date Tested: 18.05.2023	**Pass/Fail:** Pass
Test Result: When the user attempted to register with an invalid email address, an error message stating "Invalid email address! Registration unsuccessful!" was displayed.	

Test ID: TC_F_29	**Test Category:** Functional
Test Title: Forgetting the password	
Test Summary: The user should renew his/her password securely in case of forgetting the password.	
Test Steps: • Open the UThere web page. • Navigate to the Login page. • Click on "Forgot Password?" option. • Enter your email address on the opening pop-up screen and click on the send button. • Check your email inbox and click on the link provided in the auto-generated email sent by the UThere organization. • Enter your new password in the newly opened window. • Open the UThere web page and navigate to the Login page again. • Sign in to the application by using your new password.	
Expected Result: When the user forgets his/her password, he/she renews the password and signs in to the application.	
Test Priority: Medium	
Date Tested: 19.05.2023	**Pass/Fail:** Fail
Test Result: "Forgot your password" feature is not available in our application yet since our application does not support email verification yet.	

Test ID: TC_F_30	**Test Category:** Functional
Test Title: Sharing analysis report at the end of the meeting	
Test Summary: In the application, only the host is allowed to share the attention and emotion analysis report and choose who to share it with.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Click on the “New Meeting” button and create a meeting. ● Complete the calibration if required. ● Set some participants as presenters. ● End the meeting. ● Share the analysis report with presenters.	
Expected Result: At the end of the meeting, a new screen listing all participants is shown. The names of only the participants who have presented have a share button next to them.	
Test Priority: Medium	
Date Tested: 19.05.2023	**Pass/Fail:** Pass
Test Result: The user who was the host in the meeting could share the analysis report with the presenters.	

5.2 Non Functional Test Cases

Test ID: TC_NF_01	**Test Category:** Security
Test Title: Accessing application pages without logging in after logging out	
Test Summary: When the user logs out of the application, the system should not let the user access to application pages without logging in. For instance, the user should be required to enter the credentials when he/she presses the back button of the browser after logging out.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Click on the sign out button located on the top right corner of the page. ● Click on the back button of the browser.	
Expected Result: The user is directed to the login page to enter his/her credentials.	

Test Priority: High	
Date Tested: 18.05.2023	**Pass/Fail:** Pass
Test Result: When the user logged out of the application, he/she was directed to the login page to enter his/her credentials if he/she clicked on the back button of the browser or tried to navigate to an application page through manipulating the URL path.	

Test ID: TC_NF_02	**Test Category:** Security
Test Title: Encryption of HTTP cookies	
Test Summary: If there is a cookie stored in the browser, it should be encrypted such that it does not reveal any sensitive information.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Right click on the screen and select "Inspect" on the opening pop-up. ● From the opening window, select the "Application" tab. ● Select the "Cookies" section from the left side. ● Check the values of the cookies.	
Expected Result: The cookies accessed do not reveal any sensitive information. They are perceived as meaningless.	
Test Priority: High	
Date Tested: 19.05.2023	**Pass/Fail:** Fail
Test Result: Cookies are not encrypted in our application yet. However, cookies do not reveal any sensitive information.	

Test ID: TC_NF_03	**Test Category:** Security
Test Title: Storing video recordings of participants	
Test Summary: The meeting participants' video recordings should not be stored for any purpose.	
Test Steps: ● Check the database whether there is any table storing users' video recordings.	
Expected Result: The video recordings of participants are not present in the database. Instead,	

the required processing is done directly on the upcoming data without keeping them permanently.	
Test Priority: Medium	
Date Tested: 18.05.2023	**Pass/Fail:** Pass
Test Result: The video recordings of participants were not stored in the database. The videos of participants were analyzed and the required data such as attention score or emotion status was recorded into the database.	

Test ID: TC_NF_04	**Test Category:** Performance
Test Title: Delay of the real-time attention and emotion analysis	
Test Summary: Real-time attention and emotion analysis feedback should be given within an acceptable time range.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Navigate to the Profile page. ● On the third tab of the page, check your meeting analysis preferences. ● Make sure “Hide Real-Time Emotion Analysis”, “Hide Real-Time Attention Analysis”, and “Hide Real-Time Analysis” items are toggled off. ● Click on the “Join Meeting” button and attend a meeting. ● Complete the calibration if required. ● Request being a presenter from the host because only the host and presenters are allowed to see the real-time analysis feedback. ● Start your presentation and check when the feedback starts to be given after you start the presentation.	
Expected Result: Real-time attention and emotion analysis feedback is given without much delay so that the presenter is not misled.	
Test Priority: High	
Date Tested: 19.05.2023	**Pass/Fail:** Pass
Test Result: For a time period at the beginning of the meeting, no attention rate or emotion status can be shown since the transmission of the videos and analyzing them in terms of attention and emotion status take some time. However, it does not affect the meeting performance. After the attention rate and emotion status start to be shown on the screen, they are updated with current values.	

Test ID: TC_NF_05	**Test Category:** Performance
Test Title: Screen sharing limitation	
Test Summary: Only one user should be allowed to share the screen at a time.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Click on either the “New Meeting” or “Join Meeting” buttons and attend a meeting. ● Complete the calibration if required. ● If you have joined a meeting, request being a presenter from the host because only the host and presenters are allowed to share screen in our application. ● Share your screen. ● Ask a participant to try to share his/her screen too.	
Expected Result: Only one user can share his/her screen at a time. Other participants are not allowed and the share screen button is disabled.	
Test Priority: Medium	
Date Tested: 19.05.2023	**Pass/Fail:** Fail
Test Result: Screen sharing limitation is not checked in our application yet.	

Test ID: TC_NF_06	**Test Category:** Security
Test Title: Asking for permission to share the screen	
Test Summary: The user who wants to share a screen should be asked whether he/she is sure to share the screen and which page he/she wants to share.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Click on either the “New Meeting” or “Join Meeting” buttons and attend a meeting. ● Complete the calibration if required. ● If you have joined a meeting, request being a presenter from the host because only the host and presenters are allowed to share screen in our application. ● Click on the “Share Screen” button located on the below bar of the meeting page.	
Expected Result: When the user clicks the share screen button, a pop-up is displayed, which asks the user which screen or tab he/she wants to share with other participants.	

Test Priority: Medium	
Date Tested: 18.05.2023	**Pass/Fail:** Pass
Test Result: When the user clicked the share screen button, a pop-up asking the user which window he/she wanted to share was displayed.	

Test ID: TC_NF_07	**Test Category:** Usability
Test Title: Accuracy of the attention and emotion analysis algorithms	
Test Summary: The accuracy rate of the attention and emotion analysis algorithms should be within the acceptable range.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Navigate to the Profile page. ● On the third tab of the page, check your meeting analysis preferences. ● Make sure “Hide Real-Time Emotion Analysis”, “Hide Real-Time Attention Analysis”, and “Hide Real-Time Analysis” items are toggled off. ● Click on the “Join Meeting” button and attend a meeting. ● Complete the calibration if required. ● Request being a presenter from the host because only the host and presenters are allowed to see the real-time analysis feedback. ● Check whether the participants’ attention and emotion status corresponds with the provided feedback.	
Expected Result: When the user is in a meeting, and his/her attention and emotional status are analyzed, the attention and emotional status rated by the algorithms should correspond with the actual status of the user.	
Test Priority: High	
Date Tested: 19.05.2023	**Pass/Fail:** Pass
Test Result: The accuracy rate of the attention and emotion analysis is about 89%, which is within the acceptable range.	

Test ID: TC_NF_08	**Test Category:** Usability
Test Title: Instructing the user about completing calibration	
Test Summary: The calibration page should instruct the user on how to complete the	

calibration for eye-tracking purposes.
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Navigate to the Profile page. ● On the third tab of the page, check your meeting analysis preferences. ● Toggle off the “Hide Eye Tracking” item if not toggled off. ● Redirect to the dashboard by clicking on the UThere logo. ● Click on either the “New Meeting” or “Join Meeting” buttons.
Expected Result: When the user is directed to the calibration page, an informative text clarifying the steps needed to follow to complete calibration should be displayed.
Test Priority: Medium
Date Tested: 18.05.2023 | **Pass/Fail:** Pass
Test Result: When the user was directed to the calibration page, a pop-up informing the user by stating “Please replace your face in the rectangle and click all buttons until they all become black.” was displayed.

Test ID: TC_NF_09	**Test Category:** Usability
Test Title: Setting session timeout	
Test Summary: The session timeouts should be set properly in accordance with the required time for being logged in the application.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Do things that UThere mainly offers such as joining a video conference meeting. ● Check whether you are automatically signed off after a certain period of time.	
Expected Result: The session timeout should have been set properly such that when the user stays signed in for a long time in the application, he/she should automatically be signed out and directed back to the login page. In case of staying signed in for a short period of time in the application, the user should not be signed out automatically.	
Test Priority: Medium	
Date Tested: 19.05.2023	**Pass/Fail:** Fail
Test Result: Session expiration is not supported in our application yet.	

Test ID: TC_NF_10	**Test Category:** Compatibility
Test Title: Operating system compatibility	
Test Summary: The application should work without any problem in the most popular operating systems such as Windows, Linux and Mac.	
Test Steps: ● From different computers using Windows, Linux and Mac operating systems, open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Do things that UThere mainly offers and check if there is a difference between different operating systems.	
Expected Result: The application should run without any problem in Windows, Linux and Mac in the same way.	
Test Priority: Low	
Date Tested: 19.05.2023	**Pass/Fail:** Pass
Test Result: Our application works in Windows and Mac without any problem. Also, since we make use of containerization through Docker, our application works in Linux without any problem as stated in [12] that the Docker platform runs natively on Linux.	

Test ID: TC_NF_11	**Test Category:** Security
Test Title: Storing passwords encrypted in the database	
Test Summary: All passwords should be stored encrypted in the database as a prevention against potential data leakage.	
Test Steps: ● Check the table where the passwords are stored.	
Expected Result: The passwords accessed in the database do not reveal the actual values. They seem like encrypted and meaningless data.	
Test Priority: Medium	
Date Tested: 18.05.2023	**Pass/Fail:** Pass
Test Result: The passwords are stored encrypted in the database. Django's built-in encryption mechanism is used for this purpose. The encryption mechanism is specifically PBKDF2 which is a simple cryptographic key derivation function and resistant to some well-known attack	

types [13].

Test ID: TC_NF_12	**Test Category:** Security
Test Title: Selecting proper request method for form submission	
Test Summary: Form submissions should be done using post methods instead of get methods [14].	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● For instance, click on the Contact Us button and fill out the form by selecting an option from the dropdown menu and entering a message. ● Right click on the screen and select “Inspect” on the opening pop-up. ● From the opening window, select the “Network” tab. ● Submit the form data by clicking on the send button while keeping the inspect page open. ● Keep track of the request sent when clicked on the send button and check the type of the method.	
Expected Result: HTTP POST method is used instead of HTTP GET method to send requests for form submission.	
Test Priority: Low	
Date Tested: 18.05.2023	**Pass/Fail:** Pass
Test Result: For all form submissions, HTTP POST method was used.	

Test ID: TC_NF_13	**Test Category:** Compatibility
Test Title: Cross-browser compatibility	
Test Summary: The application should work without any problem in the most widely used browsers such as Google Chrome and Safari.	
Test Steps: ● From different browsers such as Google Chrome or Safari, open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Do things that UThere mainly offers and check if there is a difference between different browsers.	

Expected Result: The application should run without any problem in Google Chrome and Safari in the same way.	
Test Priority: Low	
Date Tested: 19.05.2023	**Pass/Fail:** Pass
Test Result: Our application runs without any problem in Google Chrome, Microsoft Edge and Safari.	

Test ID: TC_NF_14	**Test Category:** Performance
Test Title: Displaying profile information in a fast response time	
Test Summary: Profile information, such as full name, email and meeting analysis preferences, should be displayed within an acceptable response time.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Navigate to the Profile page. ● Check how fast the profile information is loaded.	
Expected Result: Profile information is displayed as soon as the profile page is accessed. In case of any delay, a loading spinner is shown to inform the user.	
Test Priority: Medium	
Date Tested: 18.05.2023	**Pass/Fail:** Pass
Test Result: Profile information was displayed with a delay of less than a second. While the data was being retrieved from the database, a loading spinner was shown to inform the user.	

Test ID: TC_NF_15	**Test Category:** Security
Test Title: Hiding entered password	
Test Summary: In the registration and login page of the application, the password entered into the input area should be shown with an asterisk.	
Test Steps: ● Open the UThere web page. ● Navigate to either the registration or login page. ● Fill out the password input area.	

Expected Result: The password entered by the user to the corresponding input area should be shown with an asterisk.	
Test Priority: Low	
Date Tested: 18.05.2023	**Pass/Fail:** Pass
Test Result: In the registration page, login page and the pop-up used to change the existing password in the profile page, the password entered into the input area was shown with a set of asterisks.	

Test ID: TC_NF_16	**Test Category:** Security
Test Title: Asking for permission to access camera and microphone	
Test Summary: When the user attends a meeting, the application should ask the user whether he/she allows the system to access the camera and microphone.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Click on either the “New Meeting” or “Join Meeting” buttons.	
Expected Result: When the user attends a meeting, a notification pop-up appears and asks for permission to access camera and microphone.	
Test Priority: Medium	
Date Tested: 18.05.2023	**Pass/Fail:** Pass
Test Result: When the user attended a meeting, a notification pop-up appeared and asked for permission to access camera and microphone.	

Test ID: TC_NF_17	**Test Category:** Security
Test Title: Attending a meeting with the camera and microphone turned off	
Test Summary: When the user attends a meeting, his/her camera and microphone should be turned off by default.	
Test Steps: ● Open the UThere web page.	

● Enter the credentials to sign in to the application (register if not registered). ● Click on either the “New Meeting” or “Join Meeting” buttons. ● Check whether the camera and microphone are turned off.
Expected Result: When the user attends a meeting, by default, he/she is muted, and his/her camera is turned off.
Test Priority: Medium
Date Tested: 19.05.2023 | **Pass/Fail:** Fail
Test Result: When the user attended a meeting, he/she was not muted and his/her camera was turned on. We decided to set camera and microphone to be turned on by default since our application’s main feature is about analyzing the videos of the participants.

Test ID: TC_NF_18	**Test Category:** Performance
Test Title: Bandwidth usage	
Test Summary: It should be verified that the application does not consume excessive bandwidth during a meeting, causing lag or poor video and audio quality.	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Click on either the “New Meeting” or “Join Meeting” buttons. ● Turn on your camera and unmute yourself. ● Check other participants’ audio and video quality. ● Request feedback about your audio and video quality from other participants.	
Expected Result: When the user attends a meeting, the audio and video quality do not decrease and lags do not arise.	
Test Priority: Medium	
Date Tested: 19.05.2023	**Pass/Fail:** Fail
Test Result: This test case is partly satisfied. Video quality is not much high and at some times, lags might arise. However, in general, it does not affect the application performance and usability.	

Test ID: TC_NF_19	**Test Category:** Documentation

Test Title: Comprehensive coverage of “Terms & Conditions” text	
Test Summary: It should be checked that the “Terms & Conditions” document covers all relevant topics and issues, such as user rights, data privacy and protection policies.	
Test Steps: ● Open the UThere web page. ● Navigate to the Registration page. ● Click “Terms & Conditions”.	
Expected Result: The document is comprehensive, which states data privacy and protection policies, and user rights clearly.	
Test Priority: Low	
Date Tested: 18.05.2023	**Pass/Fail:** Pass
Test Result: In the registration page of the application, the user was required to accept the terms and conditions in order to register to the application. The terms and conditions text included sections of application use, privacy and data security, user responsibilities, intellectual property, limitation of liability, modifications and termination, governing law, and contact us.	

Test ID: TC_NF_20	**Test Category:** Performance
Test Title: Viewing poll questions	
Test Summary: When the presenter creates and deploys a poll, all participants should be able to see the questions automatically with a slight delay	
Test Steps: ● Open the UThere web page. ● Enter the credentials to sign in to the application (register if not registered). ● Click on either the “New Meeting” or “Join Meeting” buttons. ● Complete the calibration if required. ● If you have joined a meeting, request being a presenter from the host because only the host and presenters are allowed to create a poll. ● Create and deploy a poll. ● Ask participants whether they are able to see the poll questions just after the poll deployment.	
Expected Result: When the presenter creates and deploys a poll, the questions appear on participants’ screens almost at the same time as the deployment time.	
Test Priority: Medium	

Date Tested: 19.05.2023	**Pass/Fail:** Pass
Test Result: When the presenter creates and shares a poll, the questions and options appear on participants' screens in 1 second.	

6. Maintenance Plan and Details

Our application as mentioned before is a 3-tier architecture consisting of Presentation Tier (User Interface Tier) implemented in react, Application Tier (Logic Tier or Business Logic Tier) implemented in Django, and Data Tier (Data Storage Tier or Persistence Tier) using MySQL. The application has two modes, development and production. Development mode has enabled us to write codes and test them effectively in our local environment while production mode is being used for deployment.

Google Cloud Platform has been used as a server for Backend and Database, and Vercel has been used for deployment of Frontend.

We have used Vercel [15] to deploy our frontend which is an American cloud PaaS company maintaining Next.js web development framework built around Jamstack [16], a web development architecture pattern, where JAM stands for JavaScript, API and Markup. In Vercel a continuous deployment is handled through the Github repository. After giving the related Github repository and branch, with each update, it starts the deployment process. It runs the Build script and creates static files automatically. It uses the latest build, in case of failure in deployment of the new version. In Vercel, It is also possible to run checks for fast and reliable deployments. When using the Main branch Vercel assigns 3 urls, and on deployment from another branch it gives 1 url. We have used a 14 days free trial of Vercel but the plan could be upgraded in future. Its base fee will be 10$ per month.
We have used Google Cloud Run Service [17], a managed compute platform that lets developers run containers directly on top of Google's scalable infrastructure to deploy Uthere's Backend. Similar to Vercel, it provides a continuous deployment option. Providing a Dockerfile [18] in a related repository in Github, and giving related information in Google Cloud Run, we create a service trigger which will create a Docker image with each update in the related Github branch. The created Docker image can be deployed on the server after success of service.

PostgreSQL [1] database is also hosted in Cloud SQL service of Google Cloud Platform. Both local and production mode are connected to this database. Cloud SQL provides automatic backups, replications, tons of indexes, and ACID (Atomicity, Consistency, Isolation, and Durability) transactions. Reliability, scalability and security are other features of Cloud SQL.

For both, Cloud Run and Cloud SQL we are using 300$ free credit given in the beginning, it provides enough resources for demo presentations, also Agora provides 10,000 minutes per month for free plan, in case of further need the plan should be upgraded and the pricing will be 0.99$ per 1,000 minutes [19].

7. Other Project Elements

7.1 Consideration of Various Factors in Engineering Design

7.1.1 Public Health

Online meetings can be exhausting for people when they need to attend to them constantly. This exhaustion can be both physical and psychological. Psychological exhaustion is mentioned as "video conference fatigue" in the paper published about the effects of video conference fatigue on the participants' mental health during the COVID-19 era [20]. Video calls require more mental processing than face-to-face interactions because it is harder to process non-verbal cues such as facial expressions, the tone and pitch of the voice, and body language [21]. UThere aims to ease these processes by providing real-time analysis. By using UThere, users should be able to experience less fatigue because they won't need to focus on people's reactions during their presentations.

Moreover, there might be some additional features added in order to minimize the negative impact of video conferencing. There might be a time limit for each meeting and notifications should be sent to the host when this limit is exceeded. Another feature might be about adjusting the user interface of the meeting room by the audience. They may be able to choose to see only the presenter's video and screen if that helps them to focus easier. Automated attention and emotion analysis will carry out this job for them.

7.1.2 Public Safety

The biggest risk of video conferencing is exposing users' sensitive information. In order to prevent this, UThere will not permanently keep the meeting recordings of the users. Only the analysis results will be kept in the database if users are willing to acquire them later. If they want to delete their analysis from UThere permanently, they can download the report of the analysis in pdf form and delete the analysis from their account.

Another aspect of video conferencing in terms of safety is about keeping the meetings secure. There should be some authentication process during joining the meetings. We are planning to implement this authentication feature with the help of Agora SDK. Another useful feature to ensure safety might be enabling the host to mute participants or remove them from the meeting. In this way, unwanted people can be suspended from the meetings.

7.1.3 Public Welfare

There is no effect of public welfare on UThere because it is a web application that will be used by individuals for their personal usage.

7.1.4 Global Factors

There is no current global factor that should be considered during the design of the UThere. However, COVID-19 could be given as an example that shaped the video conferencing tools' functionalities and design enormously. So it can be suggested that there might be new occurring needs as a result of global factors in the future. That is why UThere should be implemented in a scalable manner.

7.1.5 Cultural Factors

There might be different communication styles among different cultures. In the study of culture, specific countries fall on the context spectrum. This spectrum is a cultural dimension that can be used to explain variations in communication across cultures [22]. As a result of this difference, there might be differences between people in terms of their gestures during the meetings. While the high-context communication style tends to be more expressive with gestures, in the low-context communication style gestures are less expressive. This will be considered during the implementation of the attention and emotion analysis in UThere. If the dataset for emotion recognition includes people from different cultures, the analysis result would be more accurate.

7.1.6 Social Factors

Humans can have social biases and this is one of the main risks of Artificial Intelligence. While implementing UThere's attention and emotion analysis algorithms, we should be careful about potential biases. This analysis should not be affected by the people's race, gender, or age. For emotion recognition, this can be done by using a more inclusive dataset. For the attention analysis, traits that will be used to determine the attention scale should be independent of race, gender, or age. We will track eye gaze, eye blick, and lip movements which can not cause a bias.

7.1.7 Economic Factors

UThere targets both businesses and education participants as a user group. Economically, it is more feasible for businesses to pay for UThere services while for the users who will use UThere for educational purposes it is less likely. Due to this reason, UThere should be free of charge initially. If there would be potential additional services required by the businesses, there might be different plans for the different user groups. There might be UThere Enterprise which will require a monthly or annual payment subscription and provides extra features.

Factor	Effect Level	Effect
Public Health	8	Warnings for the meeting time, setting analysis preferences
Public Safety	6	Ability to delete analysis, ability to remove user from the meeting
Public Welfare	0	None
Global Factors	2	Scalable development
Cultural Factors	4	Using more inclusive dataset
Social Factors	5	Removing the biases
Economic Factors	2	No fees for the application until some point. Enterprise version when needed.

Table 1

7.2 Ethics and Professional Responsibilities

In UThere, since the process is based on users' facial expressions, it is crucial that their privacy will not be violated for us to comply with ethical rules. In the database system, photos or videos of the users will not be held to respect the privacy of the users. Only data that are related to the emotions of the users will be stored for analyzing and offering analyzed information to the presenter. Collected data will not be shared with any third party companies for business purposes.

The protection of data becomes more significant over time. To process the data of the users, it is important to conform to the purpose limitation principle which means that data of the users can be collected or used for specific necessary purposes. These purposes also have to be transferred to the data owner in a well-defined way. Hence, UThere will collect the necessary data of the users when it is approved by users.

During implementation, when an open source software is used, it is important to take into account licensing it. These packages may have some disadvantages in terms of privacy. Some of

the licenses ask to share all of the enhancements [23]. To avoid violation of privacy, licenses that do not require sacrifices were chosen when it is needed.

7.3 Teamwork Details

7.3.1 Contributing and Functioning Effectively on the Team

- **Zoom & Whatsapp:** Zoom and WhatsApp are being used as communication channels. WhatsApp is used for less important and urgent matters such as meeting planning or fast communication. Zoom is being used for having weekly meetings and also to make video calls when face-to-face meetings are not possible, to discuss important matters of the project, and collaborate.

- **Trello:** Trello is a project management tool for tracking project development. The work assigned to team members is accessible through Trello.

- **Weekly Meetings:** We are having regular weekly meetings, usually on Fridays, to catch up and analyze where we are standing and have a clear vision of the progress.

- **GitHub:** GitHub is used for version control. Allowing us to collaborate on different branches makes it possible to track the work done and collaborate effectively.

Project Specification Document:

- Bilgehan: Functional Requirements
- İlke: Nonfunctional Requirements
- Melike: Introduction, Description
- Kimya: Constraints and Risks
- Yuşa: Professional and Ethical Issues

Analysis and Requirements Report:

- Bilgehan: Use Case Diagram, Use Case Textual Representations, User Interface, Risks and Alternatives, Project Plan
- İlke: Functional Requirements, Scenarios, Use Case Diagram, Use Case Textual Representations, User Interface, Planning for New Knowledge and Learning Strategies
- Melike: Introduction, Use Case Diagram, Object and Class Model, Sequence Diagrams, Consideration of Various Factors in Engineering Design
- Kimya: Use Case Diagram, Ensuring Proper Teamwork, Pseudo Requirements, Gantt chart, Object and Class Model
- Yuşa: Activity Diagram, Use Case Diagram, Current System, Ethics and Professional Responsibilities

Detailed Design Report:

- Bilgehan: Test Cases
- İlke: Persistent Data Management, Access Control and Security, Subsystem Services
- Melike: Introduction, Purpose of the System, Design Goals, Factors in Engineering Design
- Kimya: Current system architecture, Teamwork Details
- Yuşa: Subsystem Decomposition, Software/Hardware Mapping

Final Report:

- Bilgehan: Test Cases, Functional Requirements
- İlke: Final Architecture and Design Details, Nonfunctional Requirements
- Melike: Development/Implementation Details, Introduction
- Kimya: Maintenance Plan and Details, Conclusion and Future Work
- Yuşa: Other Project Elements

Implementation:

- Bilgehan: User Interface (UI) Design and Implementation, Agora Integration, Share Screen Feature, Meeting Analysis Settings, Contact Form, Displaying Attention and Emotion Analysis Related Results
- İlke: Eye Tracking, Talking Detection, Blinking Detection, Edit Profile Info, Encryption of cookies, Attention Scoring, Create Different Meetings, Calibration Page, Contact Form Send Mail
- Melike: Eye Aspect Ratio, Lip Distance, Face Pose and Iris Calculation, Emotion Classification Implementation, Feature Extractor Module, Dataset Preperation Module, Dataset Labeling, Attention Model Training and Hyperparameter Tuning, Implementation of FastAPI server (for getting images from frontend to backend), and Video Recording/Sending functionalities in React, Poll, Alert All.
- Kimya: Authentication and backend of Profile, Logout, Settings, Contact form, Join meeting and default Django SQLite database integration and database migration to Postgre(for increased efficiency), Hosting backend to Google Cloud, Hosting Frontend to Vercel, Deployed backend-frontend servers integration, Token based authentication, Unauthenticated user permission management in backend, Profile Page Setting Display
- Yuşa: Agora Integration, User Interface (UI) Implementation, Join Meeting Feature, Deploying to Google Cloud Platform

7.3.2 Helping Creating a Collaborative and Inclusive Environment

- **Collective ownership:** There is no area-specific work allocation to anyone such as working only on the backend, frontend, or machine learning. Especially in the development stage, the allocation is based on scenarios. All team members take part in all of the crucial development stages. Therefore, all group members take responsibility for

the project equally. Anyone can change anything by discussing it with the group members.

- **Pair programming/planning:** Open to discussion parts of the project such as small design decisions (features, object and class models, etc.) are being done in pairs. Moreover, any part of the project involving complex algorithms is done through pair programming.

As a group, we have been in constant and direct communication. Besides complex situations in the previous semester, such as integration of different parts, pair programming has been done this semester too. Some examples are real time video conferencing integration of backend and frontend research and investigation done by Melike, Bilgehan, Ilke, Yusa, Kimya, or Hosting options research and configuration investigation done by Kimya and Yusa. Some other examples are Meeting page screen share, leave meeting, etc. functionalities done by Ilke and Bilgehan and machine learning embedding inside django for deployment done by Kimya and Melike.

7.3.3 Taking Lead Role and Sharing Leadership on the Team

- **Experience-based leadership and work allocation:** Any of the group members have an area of expertise and provide help and feedback for the other team members.

  In our group, all group members have taken the lead role in different areas of the project.

  - Bilgehan: He had a lead role in Frontend development working with Ilke and Yusa. He was also responsible for testing the Frontend API endpoints. He was responsible for the initialization of the project. Initial planning and requirement specification were done under his leadership.
  - İlke: She was responsible for making sure tasks were distributed timely and evenly, she was also the lead role in the research and development of the eye gaze algorithm. She will also be responsible for finalization. She will make sure of the quality of the final deliverables and the failure rate of test cases.
  - Melike: She had the lead role in the research and implementation of emotion detection algorithms and attention score calculation. She was responsible for face pose and eye blink detection development. Real-time data processing speed and video frame transference will be evaluated under her supervision.
  - Kimya: She was responsible for Backend and Database Integration, and she tested Backend API endpoints. Implementation specification and frameworks and implementation planning was coordinated by her. Hosting and deployment planning and integration was done under her supervision.

- Yuşa: He was responsible for Agora SDK integration with Bilgehan and İlke, he is also responsible for researching and evaluation of Google Cloud and hosting options with Kimya.

7.3.4 Meeting Objectives

During the implementation phase of the project, significant progress has been made towards achieving the stated objectives. Most of the planned functionalities and features have been implemented successfully.

Wide range of features are implemented which includes integration of Django, React, and Agora SDK for video conferencing functionality. The core functionalities of the system such as user authentication, real-time video communication, scaling average attention and emotion score, and screen sharing have been developed. These features have been tested and meet the project's requirements.

By using Google Cloud and Vercel platforms, the system has deployed successfully. Google Cloud provides a reliable cloud system and Vercel is utilized for hosting frontend components ensuring performing user experience.

Although eye gaze tracking is one of our initial objectives, this feature could not be fully implemented in the current phase because of time constraint. Yet, the significance of it is known and it will be addressed in future work.

Various bugs and issues are encountered and resolved during testing features of the project. However, a few minor bugs still exist in the system which will be handled in future work.

7.4 New Knowledge Acquired and Applied

Throughout this project, we have gained extensive knowledge in various aspects such as frontend development, backend development, machine learning, and cloud systems. Firstly, we gained expertise in React, a JavaScript library utilized for developing user interfaces. In addition to this, we acquired knowledge in Django, a Python web framework, used for building the backend of the application. Also, we used Agora SDK which provided us necessary tools and functionalities for implementing real-time communication features.

By using Google Cloud, understanding of deploying applications is expanded. We were able to securely host and adapt the scalability of the project by using Google Cloud. Moreover, by using Vercel, we obtained knowledge about deploying the frontend part of the application.

Through a combination of online tutorials and documentations, we obtained knowledge in Django [24]. Backend of our video conferencing application is successfully developed by studying Django's architecture.

We engaged in online courses and documents to gain experience in React [25]. Thanks to these resources, we obtained a great deal of knowledge which enabled us to build an interactive and intuitive user interface for our video conferencing application.

By exploring Agora SDK documentations and utilizing sample code which is provided by the SDK, we integrated real-time communication capabilities into our project [26]. This knowledge is applied to implement features such as audio and video streaming, screen sharing.

We acquired knowledge in deploying applications using Google Cloud through its documentation, some tutorials, and practical experimentations [27]. Various deployment methods are researched and the most effective one for our application is chosen.

For acquiring machine learning algorithms, some previous knowledge and tutorials are utilized. Literature review is also conducted to acquire the foundation of algorithms.

Youtube provides a comprehensive library of video tutorials which is very helpful in terms of learning complex concepts and initialization of a concept [28]. Video tutorials mostly provide step-by-step instructions which allows us to gain a practical understanding of how implementations are done.

Stack Overflow was utilized when bugs and issues were encountered [29]. It provides a vast repository of questions and answers for various kinds of programming languages, frameworks, and technologies.

As a result, in every part of the project, we have experienced numerous difficulties and we tried to solve them by acquiring information from various resources. This project provided us expertise in backend and frontend development, real-time communication integration, machine learning algorithms, and cloud deployment.

8. Conclusion and Future Work

For Uthere there are several options for further progress. Even though we have high accuracy of attention analysis (89%), it could be improved. Eye tracking is not currently used in machine learning algorithms of attention analysis and it could be embedded. Most of the main functionalities have been successfully implemented, and in future, reactions to presentation can be added to the application. Also, we have considered adding a graphical representation, with

time-averageAttention axis in the meeting page. However, due to limited space in the meeting page, it was not possible to show the graphics in a user-friendly way in the allocated time before the demo presentation. Meeting page UI structure can be reorganized to make it possible to show the graphical representation of attention information. Currently such graphics are represented at the end of the meeting report, which was our plan from the beginning.

We have created our own dataset by each team member recording themselves and labeling the records. Current dataset size is 5806 video recordings of 5 seconds. This dataset can be enlarged and diversified by people of other nationalities, or age to both increase the accuracy and make sure UThere does not allow any discrimination or cause inequality to any group of people.

To address application latency, allocating more resources from cloud servers would help to decrease the response time and improve the responsiveness. Furthermore, in case of getting sufficient funding, UThere can have its own Content Delivery Network (CDN) services and servers. There is a 5-person limit for meetings, due to resource constraints. This limitation can be overcome in future for larger sized meetings or even removing the restriction altogether.

Overall, UThere has laid a strong foundation and demonstrated promising capabilities in attention analysis and meeting management. By implementing the suggested improvements and expanding its resources, UThere can continue to evolve into a powerful and inclusive platform for virtual meetings and collaboration.

9. References

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