

# CS 492 Senior Design Project

Detailed Design 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 will analyze the faces of the participants during the meetings and give real-time feedback to the presenters. Presenters will be notified of their audiences' common emotional state. They will be notified when the attention span of the participants drops or increases. We will evaluate participants' attention according to their eye, mouth, and face movements. Moreover, we will implement eye gaze tracking techniques which can help presenters to identify which parts of their presentation are eye-catching.

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.

# **1.1 Purpose of the System**

The purpose of our application is to improve the effectiveness and engagement of virtual meetings. By using machine learning algorithms to analyze participants' attention and emotional responses, hosts can identify areas of falling short and make adjustments to improve the overall experience.

By analyzing participants' emotional responses, hosts will identify when participants are disengaged or uninterested in the discussion. Then, they can adjust the meeting agenda or communication style to increase engagement and collaboration. Thus, by tracking attention and engagement, hosts can identify areas where the meeting may be lacking in terms of effectiveness. This can help them adjust the meeting structure or content to achieve better results. By analyzing participants' attention patterns and emotional responses, hosts will identify which meeting features or topics are the most effective and make adjustments to optimize future meetings. Moreover, hosts will be aware of whether the audiences are looking at the screen or not by eye gaze tracking results.

We aim to improve meeting efficiency both short and long term. Hosts will be able to receive real-time analysis results during the meeting to react instantly. Also, they will acquire a detailed report of the whole meeting. In this way, they can evaluate and reflect on their performance after the meeting.

# **1.2 Design Goals**

# **1.2.1 Privacy and Security**

- Personal data collected from users, such as camera records, will only be used for attention and emotion tracking, and not for any other incompatible purposes such as sharing with third-party companies.
- Processing of user data will only take place with explicit and informed consent, provided via a specific consent form.
- The user's face or video records will not be retained in the database.
- Required security precautions such as XSS, CSRF, hashing, etc. will be implemented.

# 1.2.2 Scalability

- UThere will be designed to be scalable and capable of handling increased workloads, such as adding more than 5 users to a meeting.
- We will implement highly independent services that can communicate with each other through APIs. This will help improve scalability by allowing individual components to be scaled independently as needed.

## **1.2.3 Performance**

- UThere will be a real-time system that processes users' faces and shows the current attention level to the presenter.
- The system can process up to 5 users' faces with a minimal time lag between the time data is produced and processed.
- The attention level presented should be highly accurate.

### 1.2.4 Robustness

• The system will be designed to handle disturbances such as invalid or erroneous input by error handling and prevent crashes under stressful environmental conditions.

## 1.2.5 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.

# 1.3 Definitions, Acronyms, and Abbreviations

UI: User Interface
XSS: Cross-site scripting
CSRF: Cross-site request forgery
AES: Advanced Encryption Standard
AI: Artificial intelligence
TCP/IP: Transmission Control Protocol/Internet Protocol
HTTP: Hypertext Transfer Protocol
SDK: software development kit
DevOps: Developer Operations

# **1.4 Overview**

UThere aims to improve the effectiveness and engagement of virtual meetings by using machine learning algorithms to analyze participants' attention and emotional responses. The purpose of the system is to create a more efficient and intelligent meeting experience for both presenters and audiences.

It aims to enhance the video conferencing experience by analyzing participants' faces during meetings and providing real-time feedback to presenters. With UThere, presenters can receive notifications about their audience's common emotional state and changes in attention span. This is done by evaluating participants' attention based on eye, mouth, and face movements. Additionally, UThere utilizes eye gaze tracking techniques to help presenters identify which parts of their presentation are most engaging.

Overall, UThere seeks to optimize the meeting experience for both presenters and audiences by providing a more efficient and intelligent video conferencing solution. By leveraging advanced facial recognition and eye-tracking technologies, UThere can help presenters deliver more impactful presentations while keeping their audience engaged and focused.

# 2. Current Software Architecture

There are already some similar products to UThere. Zoom, Microsoft Teams, Cisco Webex, Affectiva, and Attention Insight are some examples. These are the comparison of the most popular three products:

## 2.1 Zoom:

- Ideal for: Small to medium-sized businesses, remote teams, and individuals looking for an easy-to-use video conferencing platform.
- Pros: Zoom is known for its ease of use and reliability, with a user-friendly interface making it easy to start and join meetings. It is also affordable, with both free and paid plans starting at a relatively low cost.
- Cons: Some users have reported security concerns, such as Zoom bombing incidents, where uninvited guests join a meeting and disrupt it. However, Zoom has implemented various security measures to address these issues [1][2][3].
- Zoom does not have a native emotion recognition or attention analysis mechanism. There only are some third-party tools, such as Zoom add-ons, offering emotion analysis features. [4]

## 2.2 Microsoft Teams:

- Ideal for: Businesses of all sizes looking for a collaboration platform that includes video conferencing, chat, and file sharing.
- Pros: Microsoft Teams integrates with other Microsoft products like Outlook, Word, and Excel, making it a great choice for businesses that already use these tools. It also offers advanced features like AI-powered transcription and translation services.
- Cons: Some users have reported that the interface can be overwhelming, with too many options and features to navigate. It is also more expensive than other options, as it is included in Microsoft 365 plans [5][6][7].
- Microsoft Teams does not have native emotion recognition and attention analysis mechanisms. Microsoft offers a range of Cognitive Services that include emotion recognition capabilities, but these services are typically intended for developers to integrate into their applications rather than being directly available within Teams. [8]

# 2.3 Cisco Webex:

- Ideal for: Large businesses, government agencies, and educational institutions looking for a secure and scalable video conferencing platform.
- Pros: Cisco Webex is known for its security features, with end-to-end encryption and compliance with industry standards. It also offers advanced features like AI-powered transcription and translation services and integrates with third-party tools like Google Drive and Microsoft Office.
- Cons: Some users have reported that the interface can be confusing, with too many options and features to navigate. It is also more expensive than other options, with a free plan that only allows up to 50 participants [9][10][11].
- Cisco offers a range of APIs that include speech recognition and natural language processing capabilities however there are no native emotion recognition and attention analysis mechanisms [12].

Cisco Webex and Microsoft Teams seem to have the common problem of not having a user-friendly UI, which UThere offers. On the other hand, Zoom's biggest problem has been security issues. Competing with such a large company in terms of security might not apply to us at this stage due to a lack of resources, but using Django Framework which has been designed with security in mind provides us with several built-in features to write secure code. For example, Django has built-in protection against XSS, CSRF, SQL injection, and clickjacking [13]. It also includes password hashing, session management, and user authentication. Using the latest versions of Django, keeping UThere secure will not be a problem.

As mentioned above, none of the current systems have a native implementation for emotion and attention analysis. The addition of these features to video conferencing apps represents an innovative use of machine learning and computer vision technologies to improve the user experience and communication effectiveness of video conferencing. It has the potential to revolutionize the way people interact with each other in a virtual environment, making it more natural and intuitive.

# 3. Proposed Software Architecture

# 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.

# 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.



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 [14]. 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, encryption, and access control.

Firstly, 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 [15]. Besides, a permission system, provided by Django, will be used to specify what tasks users are permitted to carry out [16].

Secondly, HTTP cookies may store private user data including session IDs, login information, etc [17]. Therefore, it is crucial to encrypt the HTTP cookies to shield sensitive data from unwanted access or manipulation. On the client side of the application, we will encrypt the cookies by using the AES algorithm. The server side also has its encryption mechanism. Django provides security features such as CSRF, session security, and XSS. The use of encryption mechanisms on both sides of the application increases security.

Finally, In Django, decorators may be used to implement access control in views. For example, it is usual practice to use the "@login\_required" decorator to restrict access to views to only authorized users [18].

# 4. 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 [19]. The presentation tier is the user interface tier. Its goal is to handle client requests and provide information to clients[19]. 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 [19]. The data tier stores the data and consists of the database servers [19].

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**.

# 4.1 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.



![](_page_11_Figure_4.jpeg)

### 4.1.1 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.

### 4.1.2 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.

### 4.1.3 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.

### 4.1.4 Meeting

The Meeting subsystem has "Meeting UI Manager" which uses real-time analysis, polls, reactions, 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.

# 4.2 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.

![](_page_13_Figure_0.jpeg)

Figure 4

### 4.2.1 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 [20]. The UThere system uses them to control how various "Viewsets" respond to requests for a certain URL.

### 4.2.2 Authentication Manager

UThere system uses Django's built-in authentication system [21].

### 4.2.3 Analysis Manager

The analysis manager has two subsystems: the "Attention Analysis" subsystem and the "Emotion Analysis" subsystem. The "Attention Analysis" subsystem calculates the attention score of the users by using the talking detection, drowsiness detection, eye blink, and eye tracking info of the user. The "Emotion Analysis" subsystem classifies the emotional status of the participants together with their valence and arousal scores, which are two dimensions commonly used to describe and measure emotions [22].

### 4.2.4 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 [23]. "Models" contains the source of information about the data [24]. Each model in Django correspondence to a single database table[24].

### 4.2.5 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.

# 5. Test Cases

# **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 of changing 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

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

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

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

**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

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

<b>Test ID:</b> TC_F_07	Test Category: Functional

**Test Title:** Reminding the user 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

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

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

<b>Test ID:</b> TC_F_10	Test Category: Functional	
<b>Test Title:</b> 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

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

<b>Test ID:</b> 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 which 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

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' session to be active has been reached, the user should be automatically directed to the login page.

Test Priority: Low

**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.

- 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.
- Check another participant's screen to control whether the screen you are sharing is the same with 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

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 presenter.

**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" 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 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 presenter.

**Expected Result:** At the meeting, only the host who starts the meeting is able to give permission to participants for being presenter. 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

Test ID: TC_F_16
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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.

- 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 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

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

Test ID: TC_F_18
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**Test Category:** Functional

Test Title: Checking input data type

**Test Summary:** Input data types should be checked to prevent any inconsistency with the database.

- Open the UThere web page.
- Navigate to the registration page.
- For instance, enter a full name including special characters such as ,  $\in$  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

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

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

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.
- In 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

**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

Test ID: TC\_F\_23

Test Category: Functional

Test Title: Matching password and password verification fields

**Test Summary:** In the registration page, the inputs entered into 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 password and password verification fields, an error message of "Passwords do not match" is shown on top of the input area.

Test Priority: Low

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

#### Test Category: Functional

**Test Title:** Notifying the presenter about the decrease below 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

Test I	D: TC	F 2	6

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

Test ID: TC\_F\_27

Test Category: Functional

Test Title: Password length validity

Test Summary: The password should include at least 8 characters.

#### **Test Steps:**

- Open the UThere web page.
- Navigate to the Registration page.
- Enter a password with less than 8 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 8 characters, an error message of "Password shorter than 8 characters! Registration unsuccessful!" is shown.

Test Priority: Low

Test ID: TC_F_28	Test Category: Functional			
Test Title: Email address validity				
Test Summary: The email address should be valid to register successfully.				
<ul> <li>Test Steps:</li> <li>Open the UThere web page.</li> <li>Navigate to the Registration page.</li> <li>Enter an invalid email address such as at</li> <li>Enter valid data into full name and pass</li> <li>Accept terms and conditions</li> <li>Click on the Sign Up button.</li> </ul>	n email address without '@' sign. word fields.			
<b>Expected Result:</b> 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

<b>Test ID:</b> TC_F_29	Test Category: Functional
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**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

<b>Test ID.</b> 1C_F_50	Test ID:	TC	F	30	
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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

# **5.2 Non Functional Test Cases**

Test ID: TC_NF_01	Test Category: Security
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**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

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

Test ID: TC_NF_03	Test Category: Security
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**Test Title:** Storing video recordings of participants

Test Summary: The meeting participants' video recordings shouldn't 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

Test ID: TC_NF_04	Test Category: Performance	
Test Title: Delay of the real-time attention and	emotion analysis	
<b>Test Summary:</b> Real-time attention and emotion analysis feedback should be given within an acceptable time range.		
<ul> <li>Test Steps:</li> <li>Open the UThere web page.</li> <li>Enter the credentials to sign in to the application (register if not registered).</li> <li>Navigate to the Profile page.</li> <li>On the third tab of the page, check your meeting analysis preferences.</li> <li>Make sure "Hide Real-Time Emotion Analysis", "Hide Real-Time Attention Analysis", and "Hide Real-Time Analysis" items are toggled off.</li> <li>Click on the "Join Meeting" button and attend a meeting.</li> <li>Complete the calibration if required.</li> <li>Request being a presenter from the host because only the host and presenters are allowed to see the real-time analysis feedback.</li> <li>Start your presentation and check when the feedback starts to be given after you start the presentation.</li> </ul>		
<b>Expected Result:</b> Real-time attention and emotion analysis feedback is given without much delay so that the presenter is not misled.		

Test Priority: High

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

Test ID: TC_NF_06   Test Category	y: Security
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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

Test ID: TC\_NF\_07Test Category: UsabilityTest 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

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

Test ID: TC_NF_09	Test Category: Usability
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**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

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

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

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 [25].

**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

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.

- 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

Test ID: TC_NF_14	Test Category: Performance
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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

Test ID: TC_NF_15	Test Category: Security	
Test Title: Hiding entered password		
<b>Test Summary:</b> 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

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

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

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

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

	Test ID: TC_NF_20         T	Test Category: Performance
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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

- 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

# 6. Factors in Engineering Design

### **6.1 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 [26]. 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 [27]. 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.

### **6.2 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.

### 6.3 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.

# 6.4 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.

# **6.5 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 [28]. 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 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.

### **6.6 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.

## **6.7 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. Teamwork Details

## 7.1 Contributing and Functioning on the Team

- **Discord & Whatsapp:** Discord and WhatsApp are being used as communication channels. WhatsApp is used for less important and urgent matters such as meeting planning or fast communication. Discord 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:

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

Analysis and Requirements Report:

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

Detailed Design Report:

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

Implementation:

- <u>Bilgehan:</u> User Interface (UI) Design and Implementation, Agora Integration, Share Screen Feature, Meeting Analysis Settings, Contact Form, Displaying Attention and Emotion Analysis Related Results
- <u>İlke:</u> Eye Tracking, Talking Detection, Blinking Detection, Edit Profile Info, Encryption of cookies, Attention Scoring, Create Different Meetings, Calibration Page, Contact Form Send Mail
- <u>Melike:</u> Face Pose Estimation, Drowsiness Detection, Emotion Recognition, Audience Attention Model Training, Implementation of FastAPI server (for getting images from frontend to backend)

- <u>Kimya</u>: Authentication and backend of Profile, Settings, Contact form, Join meeting and default Django SQLite database integration and database migration to Postgre(for increased efficiency)
- <u>Yuşa:</u> Agora Integration, User Interface (UI) Implementation, Join Meeting Feature, Deploying to Google Cloud Platform

# 7.2 Helping to Create 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. At times of complex situations such as integration of different parts pair programming has been done, some examples are frontend backend integration done by Bilgehan and Kimya, Agora Integration by Yusa and Bilgehan and Ilke, or ML integration into backend planning by Kimya and Melike. Having knowledgeable and passionate people in different areas helped us to gain new knowledge using each other's expertise besides having a high-functioning team.

## 7.3 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.

• <u>Bilgehan:</u> 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.

- <u>llke:</u> 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.
- <u>Melike</u>: 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.
- <u>Kimya:</u> 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.
- <u>Yuşa:</u> He was the lead role in Agora SDK integration and implementation, he is also responsible for DevOps and deployment of the project. Google Cloud, Dockerization, and hosting options are researched, evaluated, and implemented under his supervision.

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