

# **AI AND VR-ENHANCED EMOTION RECOGNITION AND SENTIMENT ANALYSIS APPLICATIONS FOR RELATIONSHIP IMPROVEMENT**

TMP-2023-24-133

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Dissertation submitted in partial fulfillment of the requirements for the Special Honors Degree of Bachelor of Science in Information Technology Specializing in Information Technology.

Department of Computer Science and Software Engineering  
Sri Lanka Institute of Information Technology  
Sri Lanka

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## DECLARATION

I declare that this is my own work and this proposal does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgment is made in the text.

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Date

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# ABSTRACT

Human relationships are one of the most important elements for the existence of people as well as the existence of the world. The stronger these human relationships are, the more capable anyone can be of social happiness in the world. These human relationships affect each other's happiness, health, and well-being. Also, these relations will help the safety of mankind.

Several human relationships have been identified in the world.

- Family relationships
- Friendship relationships
- Romantic relationships
- Workplace relationships
- Community relations

However, in maintaining any relationship, one has to face various challenges. Especially when starting a new relationship there are several problems to face. If you are afraid of relationships and are an introvert, the problem goes further. Because it is not so easy for such a person to build a proper relationship in the real world. Also, even if you are already in a relationship, sometimes you have to face various difficulties in making decisions. It is a very difficult task to maintain a relationship while reducing such situations as much as possible without causing hurt to the other person. For this reason, we are creating a mobile software application and a Virtual Reality(VR) application to reduce such relationship breakdowns in the future. The purpose of the research is to identify the feelings and ideas of the person using the application and create a VR character that acts accordingly and thereby prepares the appropriate environment for the relevant person to start such a relationship in the VR environment before starting a relationship in the real world.

The advantage of this is the ability to successfully maintain a relationship without hurting anyone's feelings or regrets. Also possible to create new characters in the VR environment according to their needs. Furthermore, this VR character is powered by AI technology with Convai and Metaverse. Using AWS Polly realistic voice has been added to the characters. The BERT model, a pre-trained model, has been used to analyze the content of the conversations and text with the characters and it provides the status of conversations.

Keywords – human relationships, Convai, Metaverse, BERT, Text classification, virtual reality

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**LIST OF ABBREVIATIONS**

Abbreviation	Description
AI	Artificial Intelligence
VR	Virtual Reality
WBS	Work Breakdown Structure
CDN	Content Delivery Networks
NLP	Natural Language Processing
NER	Named Entity Recognition
BERT	Bidirectional Encoder Representations from Transformers
NPC	Non-player character

# 1 INTRODUCTION

## 1.1 Background & Literature Survey

Humans maintain relationships with each other socially for survival and reproduction [6]. The quality of human relationships is directly important for individual well-being and social harmony. But for people who are afraid to start and nurture relationships, and for people who are afraid of rejection, building good relationships will not be easy. However, it is our effort to provide a good opportunity to such people by using technology as well as to bring benefits to anyone who is involved in human relations.

Virtual reality (VR) technology has gained considerable attention nowadays. In particular, the creation of VR systems powered by the integration of AI and the application of those techniques has been seen recently [8]. This is because anyone can practice in an VR environment without harm. These systems are used to create safety in highway work zones [9], for learning activities in schools [10], to practice airplane skills, and to practice surgery in hospitals [11] in some such cases. At present, this VR environment is used for many fields, and it has been able to overcome many obstacles. Here we go beyond the traditional method and use this technology to protect, improve, and initiate new relationships.

In any relationship, certain problems and issues can arise. For example, it is common to have problems in a relationship. But we need to make sure that they are resolved and that the problems do not reoccur. But there is no successful method that we can take to eliminate and reduce those problems. Differences in personality levels of individuals and cultural levels, religions, lack of commitment, logical inconsistency, avoidance styles, etc.[7] must be considered here. In the fast-paced world, it is difficult to take the time to even think about these matters and carelessness can cause these relationships to fall apart very quickly. Also, research has found that single teens with past dating experience show more depressive symptoms than teens who are currently dating or have never dated. It can provide insight into the health breakdown caused by relationship breakdown.

Personality disorders have been identified as a major problem for a good relationship. The reactions of people high in these traits in such relationships have a strong impact on those

relationships. Such situations can occur especially due to the social change from childhood, cultural influences as well as depending on the living environment. But in moving forward with the world, we have to interact with each other, and we must be able to make those connections non-toxic [7]. However, many people are afraid of relationships because they can't handle rejection from others and are too shy to talk to another person. Also, another group of people see the breakdown of relationships due to their unbounded love for each other. It is because of lack of proper interaction and good communication.

Here we create the application so that it can be used by those who have or do not have such personality disorders. First, information is taken as input from the user and a character is created in the VR environment. After that, the user will be able to learn how to start a relationship with that VR character. Here are opportunities to learn how to improve the qualities a relationship needs, and how to use those qualities. Then he himself can get an assessment of the situation and no one gets hurt. As this can be done any time through the app, this gives the user the opportunity to gain mental awareness through frequent practice. At the end of the training, the user is provided with training evaluation reports through the application and thus can gain further insight.

According to the research background discussed above, it has been possible to provide a modern solution to several reasons for the breakdown of a relationship. This will help the user to get the desired self-confidence through this application. Finally, users are enabled to start and maintain a more flexible and optimal relationship in the real world using the trained attributes.

## **1.2 Research Gap**

According to the above background and literature survey, it seems that maintaining a good interpersonal relationship is important to maintain social well-being as well as human health. It helps to reduce the problems in life as well as to be able to live well in society and maintain mental happiness. In the busy world, it is not possible to dedicate time to relationships, and in an age where the world is developing technologically, the need to use technology to build relationships is shown here.

Research “A” has shown that positive attitudes toward a person with a mental disorder can be enhanced in a simulated virtual reality environment [1]. The author has created several flowcharts to create favorable environments and opportunities for mental health treatment by involving psychologists. A script has been created that includes how to spend a normal day of a depressed person and the opposite profile of a non-depressive person. This script contained the registry of the person's actions, as well as their thoughts and feelings as the day progressed. By creating their own flowchart version, the author has introduced a game under two levels, depressive and non-depressive. A simple level prototype environment has been created and in these two levels, the user has been allowed to gain an understanding of the mental problem and identify the difference. Everything in the environment was modeled with Unity. The proposed system utilizes a high-level virtual reality environment and covers a large area rather than being limited to a single building. The user has been provided with a system that can deal with diverse characters and engage in activities.

Research “B” focuses on providing a suitable virtual environment to develop the social skills of people with autism [2]. The research is conducted in several sessions by dividing the people into two groups under two age groups (adults, and children). All the volunteers must then show proof of their autism spectrum disorder (ASD) diagnosis from the Autism Diagnostic Observation Schedule (ADOS). Location, objectives, and scenarios have been created separately in the VR environment for the two related categories. The VR intervention also involves a coach in each session to provide feedback to the participants. Based on the results this research can conclude that VR-based intervention definitely has an impact on the social skills of ASD volunteers [2].

Research “C” using artificial intelligence, and deep learning methods can be used to prevent the effects on health and mental health. VR/AR are used together as a tool to maintain astronaut mental health and well-being uniformly and create an appropriate environment for it. Their aim here is to prevent long-term psychological effects on astronauts' health. Here you can practice in an VR environment using VR technology, [3] but there is no mobile application that can be used frequently. Also, there is no contribution of AI technology to power the VR character.

Customer relationships are built using AR technology. Here it has been shown that AR technology can be used to maintain these relationships well. [4] But here it is not possible to identify the feelings and opinions of the user.

An emotion recognition method using algorithms based on artificial intelligence and deep learning is shown here. Here, emotion recognition is done through a facial image, speech and non-verbal communication. [5] But here there is no telecommunication input or any other input for this process. And here only a process of emotional identification takes place.

Reference	Have a mobile app	Identifying the user's thoughts and feelings	Being able to practice in an VR environment.	Provide a report on the training at the end	Secure storage of training data
Research A	✗	✓	✓	✓	✗
Research B	✗	✓	✓	✓	✗
Research C	✗	✓	✓	✗	✗
Research D	✓	✗	✓	✗	✗
Research E	✗	✓	✗	✗	✗
Proposed System	✓	✓	✓	✓	✓

Table 1 Research gap compare

### 1.3 Research Problem

With the beginning of human history, the building of human relationships began. As a result of those relationships, the social environment we live in today has emerged. These human relationships have several parts and the responsibilities to be performed are different according to each relationship. These relationships should be maintained at a productive level and thus social harmony, mental freedom, and the existence of the human race will be confirmed.

Maintaining relationships in a busy society in the new world has to some extent faced a crisis. This is due to the fact that the time that can be allocated for relationships is becoming limited in the competitive world. As fig 1 there have timeline of the human relation movement.

Maintaining these relationships is somewhat problematic for people who are afraid of social relationships and are less inclined. For example, maintaining healthy romantic relationships requires skills. But many may lack such skills. In many cases, there is a chance that such relationships will fail due to reasons such as reacting in a reactive manner, not understanding the other.

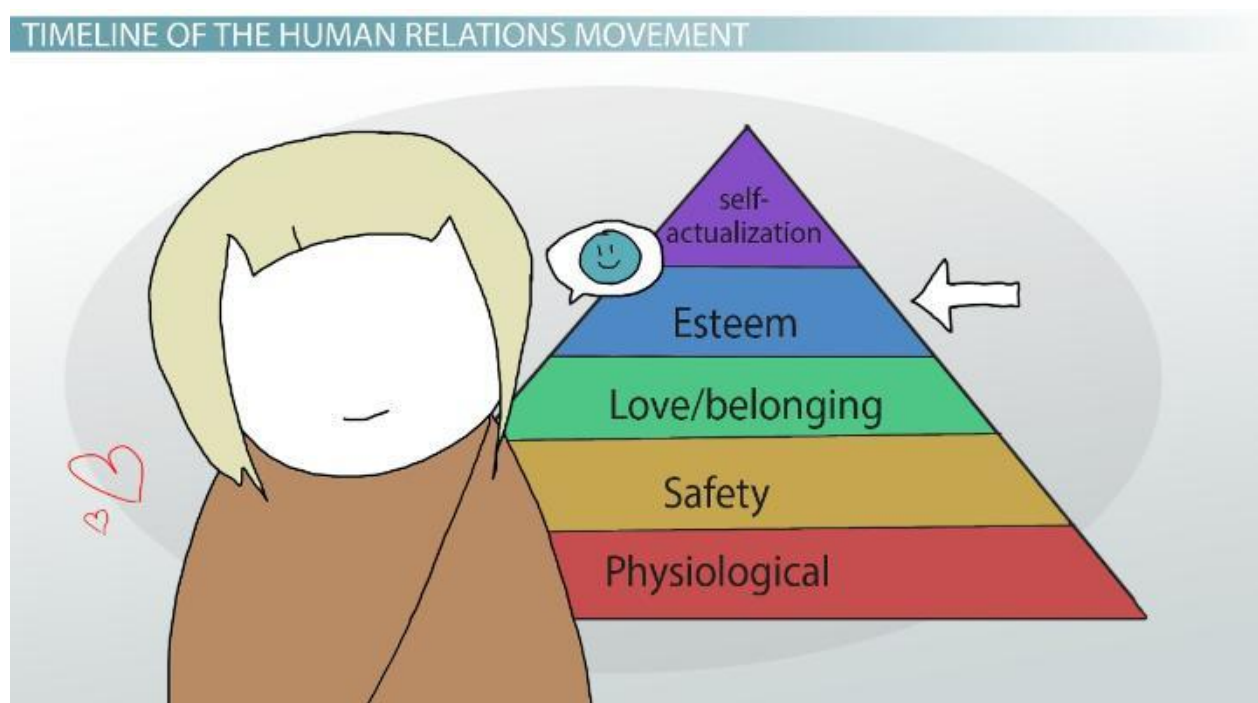


Figure 1: human relationship movement graph

On the other hand, certain personality traits can cause the breakdown of healthy intimate relationships. In globalization and competitive lifestyles, people's interpersonal skills are weak. For this reason, aggressive relationships are less likely to occur in relationships, which can directly lead to relationship dissatisfaction. If aggression is not handled properly in an interspecies relationship, it can create a wide range of problems and there is a high chance of suffering from distressing tendencies. As a fig 2 according to Google 70% of straight couples break up in the first year of their relationship. Once they reach the five-year milestone, the breakup rate drops to 20%. Such situations should not be allowed to go on for long and should be given an optimal answer at the initial stages and protect the relationship. Also, if people of different personality levels are not given the environment to maintain and protect their relationships effectively, they may even take pleasure in the suffering of others.

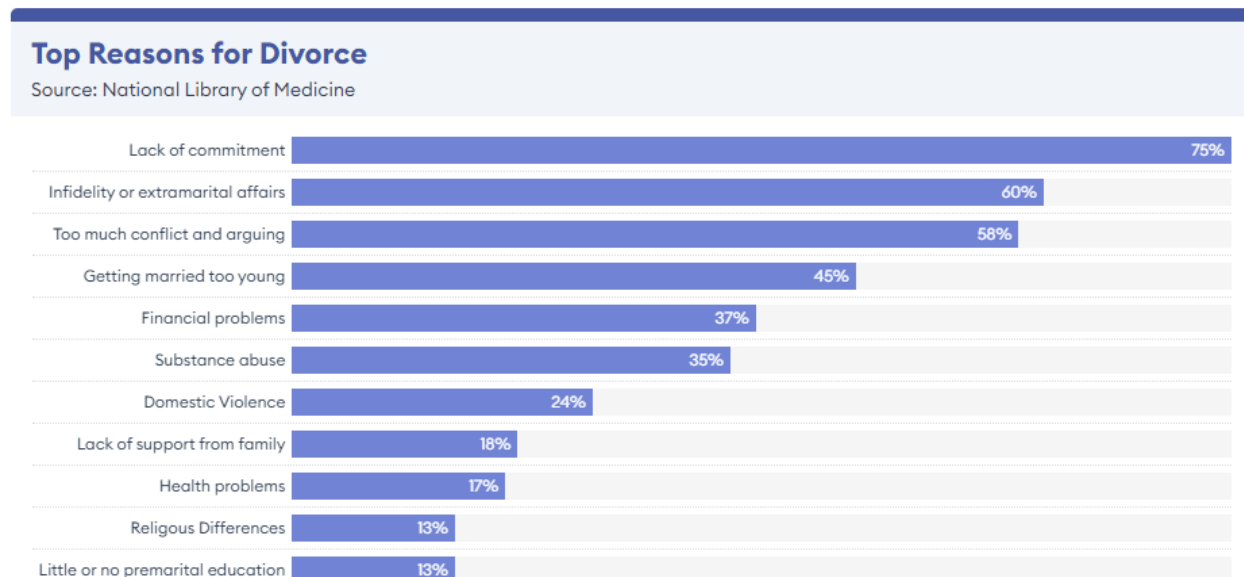


Figure 2: Top reason for divorce (Article by Christy Bieber - Herston Law Group)

Our aim here is to control the current human relationship breakdown using a mobile application. By taking users' opinions and studying them through AI technology, they can use the app to suggest them to start and maintain a productive and satisfying relationship. Here, if a person is afraid of relationships but willing to start a relationship, as well as a person who is already maintaining a relationship but does not have proper understanding, an VR environment will be



created to improve the skills required to maintain a relationship properly. This helps to control the quick breakup of relationships seen today

## **2 OBJECTIVES**

### **2.1 Main Objectives**

The grant goal of this process is to create a VR application that can practice coping skills as a flexible new approach for people who are eager to start new relationships and those who struggle with different personalities and fear relationships. The aim here is to build and maintain a relationship without causing hurt or regret to the other person. By taking the user's feelings and ideas as well as talking things as inputs and analyzing them through AI technology, the environment that the user wants to start a relationship with is prepared and good training can be obtained in this VR environment.

### **2.2 Specific Objectives**

There are 3 grant levels to complete. By completing the 3 levels, it is possible to achieve the above-mentioned grant objective.

#### **Simulating real-world**

- Develop the environment using Unity, a powerful game development platform, chosen for its versatility in creating complex VR environments, simulating real-world-like experiences, and its compatibility with various VR hardware and software. Virtual reality (VR) applications and environment can provide an immersive environment for users to express their thoughts, practice social skills, and interact with a virtual therapist.

#### **Animate VR character**

- The user is given the opportunity to create a character that suits him in the VR environment and practice the basic things needed for a relationship with that character. The VR character uses the information obtained from the previous situation to create the environment necessary for the user to make correct decisions, express ideas, and improve

communication. VR character need to have interacted with user and continue the conversation without any issues. Need to ensure good eye contact with tracking system and lip movement using lip sync.

### **Analyze the conversation**

- A conversation with an NPC end, the conversation is analyzed through a deep learning models such as BERT, LSTM, RNN. Complete conversation is analyzed through the model and the prediction needs to show the VR environment. Based on that prediction, it is hoped to allow the user to self-diagnose himself.

### 3 METHODOLOGY

The proposed AI-powered Virtual Reality (VR) character system incorporates advanced technologies and psychological intelligence to create a structured system. First, information about the relevant relationship is obtained from the user as input, and based on that information, the VR character and VR environment are prepared. The user is then allowed to practice and finally, a review of the progress is provided to the user at the end.

#### 3.1 System Architecture

Figure 3 shows the high-level architectural diagram of how the VR character powered by AI technology works in the proposed segment.

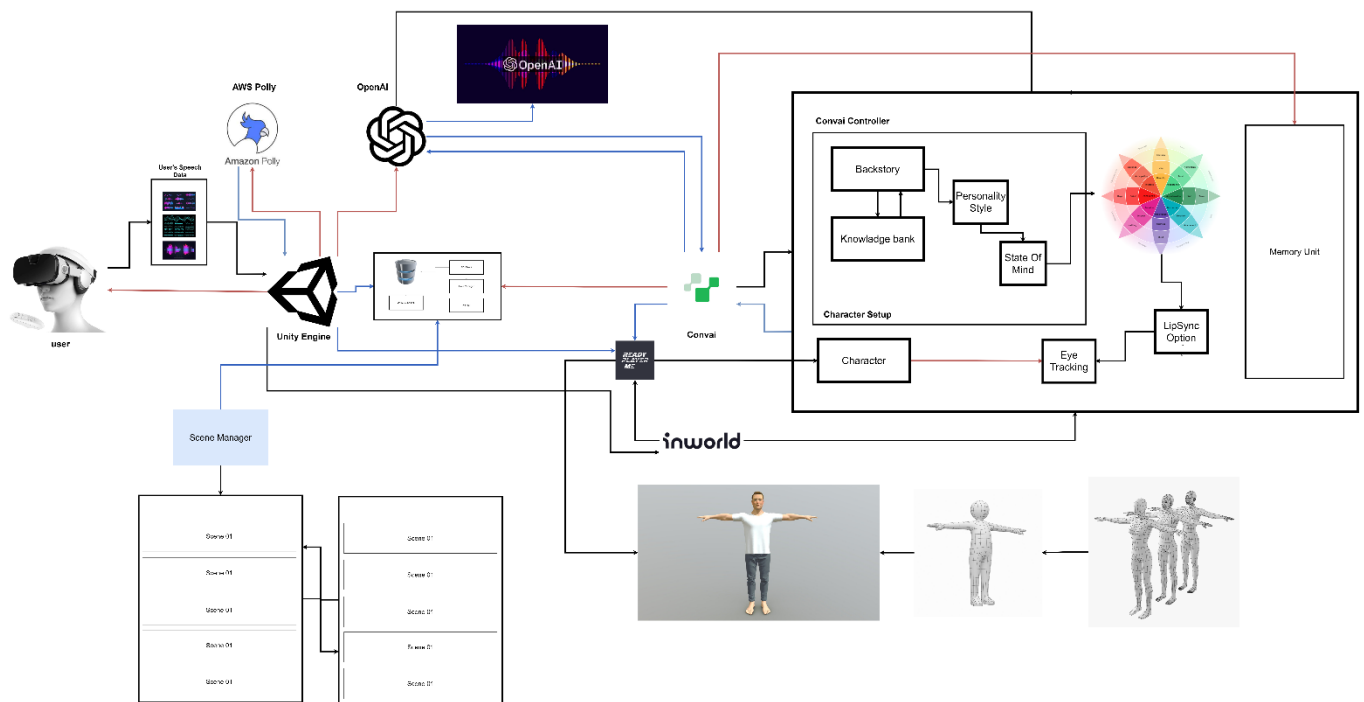


Figure 3: High-level Architecture diagram

Using VR headset user can interact with the system. Via unity engine capture the user's voice and send them to Convai, Inworld AI. AWS Polly Converts the user's speech into text and add the real-life voice to NPC. As a show in Fig 4 AWS Polly is connected to using the AWS secret key.

```
2 references
[SerializeField] private AudioSource audioSource;

0 references
public async void MakeAudioRequest(string message)
{
    var credentials = new BasicAWSCredentials(Credentials.ACCESS_KEY, Credentials.SECRET_KEY);
    var client = new AmazonPollyClient(credentials, RegionEndpoint.EUCentral1);

    var request = new SynthesizeSpeechRequest()
    {
        Text = message,
        Engine = Engine.Neural,
        VoiceId = VoiceId.Ayanda,
        OutputFormat = OutputFormat.Mp3
    };
};
```

Figure 4: Code snippet for connected AWS Polly with unity

OpenAI is connected to the system to Process and generate appropriate responses. For this used a gpt-3.5-turbo-0301 model. Using unity engine manages the 3D environment and characters. Unity act as a central platform for integrating various components.

Convai and Inworld AI acts as middleware to enhance character interactions. Also add various functions to the VR character like lip sync, eye tracking. With Unity scene manager, manages different scenes and scenarios within the Unity environment. Using BERT Deep learning model (BERT) analyzed conversation with an NPC.

This system combines many advanced technologies to create an interactive virtual environment. It aims to provide an immersive user experience with speech processing, analyzing, detailed character modeling and real life environments. The above High-level Architecture diagram explains the relationship of various technologies to achieve this goal.

## 3.2 System workflow

The VR character is assigned under 3 grant scenarios. First of all, data is obtained from the user and an understanding of the VR character to be created based on that data is obtained.

The VR scheme is awarded under several grant blocks. First, the user is given the opportunity to choose a suitable environment. Scenes are controlled separately through the Unity scene manager. After selecting the environment the user can directly join the virtual environment. The user has the ability to delete characters and create characters. Information related to the characters is given to the characters as backstory. They are processed through openAI. All conversations with the NPC are sent to a flask server through an API endpoint. After that, the quality of the conversation is measured through the model.

As a final step, information about the conversation made with the NPC is collated. Based on that information, the user is given a final-level assessment of his training. At the end of one training course, the relevant information is stored in a database and the user can access the information later. According to the final summary provided, the user can understand his conversation style, and relationship style.

<b>Technologies</b>	Python, TensorFlow, IntelliJ Idea, NLTK, C#
<b>Techniques</b>	Data augmentation
<b>Algorithms</b>	BERT, LSTM, RNN
<b>Software</b>	Unity engine
<b>Functions</b>	Lip sync, Eye Tracking

Table 2: Used technology

### 3.2.1 Problem Statement

This research component discusses the solution to the problem of human relationships and mental health. Facilitate the VR environment with Convai and Metaverse characters. This will allow user to engage with the new environment and practice with virtual character how to handle the relationship and get advice virtual counselor. Furthermore, users have been provided to new opportunities to analyze conversations and measure the quality of the conversation. The main objective of this research is to make awareness to people regarding human relationship and mental health.

### 3.2.2 Component System Architecture

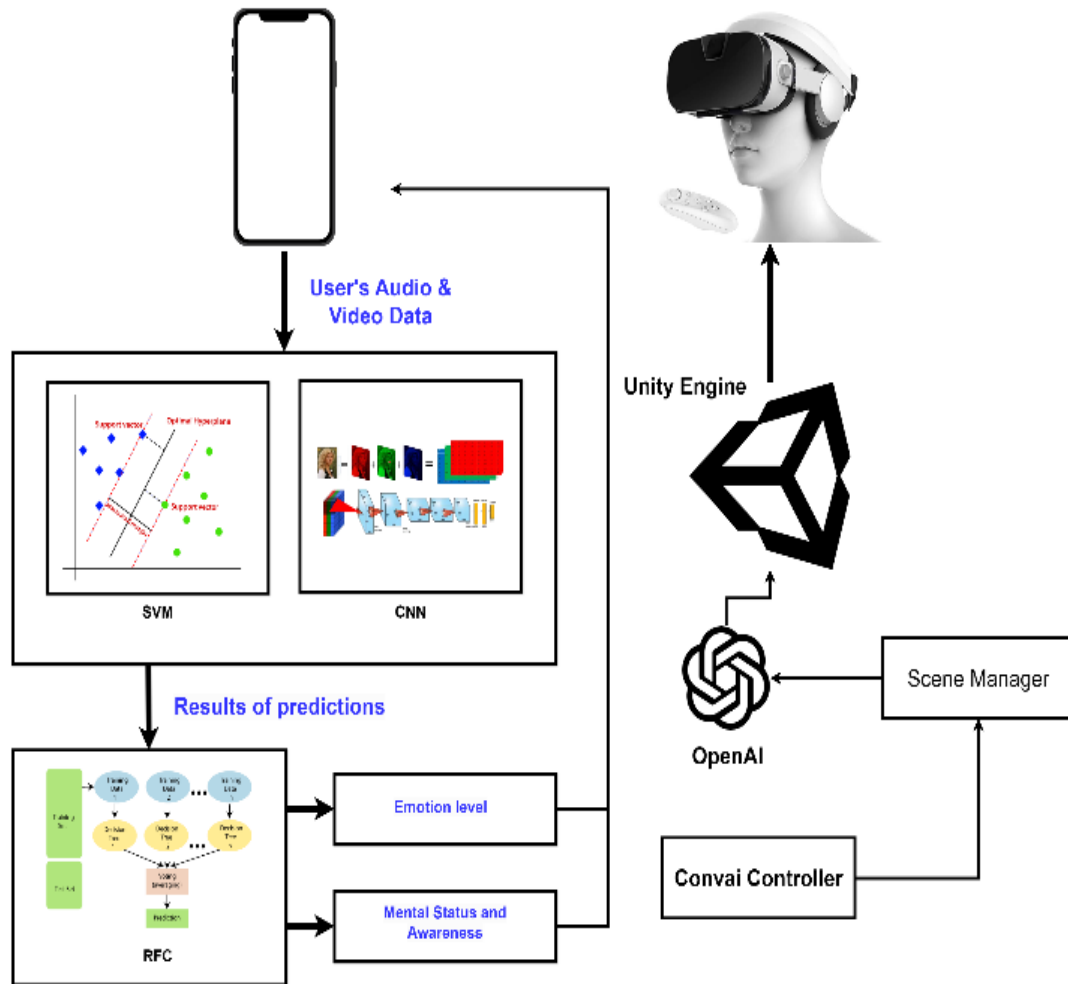


Figure 5: Component System Diagram

### 3.2.3 Virtual reality environment implementation.

The development was carried out using Unity. The primary objective of this part was to develop a virtual reality (VR) application and environment that can provide an immersive environment for users to express their thoughts, practice social skills, and interact with a virtual therapist. As a fig 5 uses a premade prefabs design and develops a couple of scene in unity.

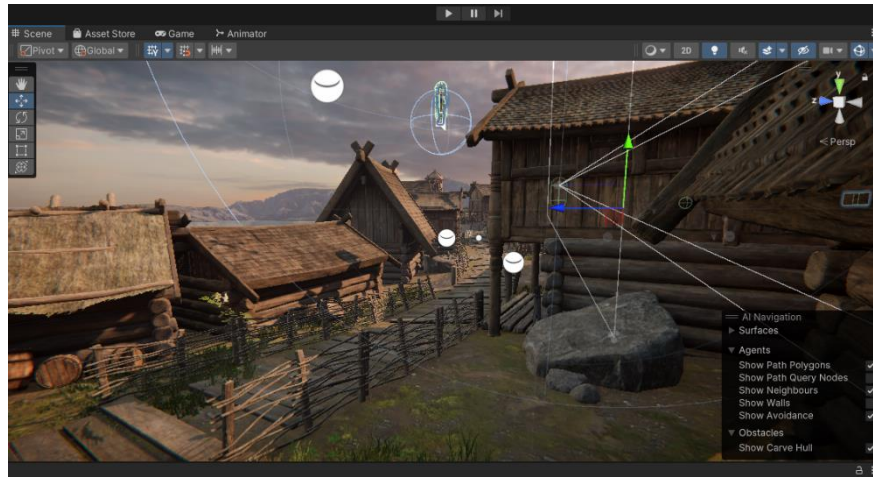


Figure 6: Premade prefab design

As a fig 6 the environment of the prototype consists of real-world houses, cities, villages, people, forests, rivers, etc. Using the Unity Engine, the environment has been designed to resemble the real world. For this, Unity Asset, Unity Pro Builder, Unity package (for 3D modeling), and third-party API have been used and features like Lip sync and eye contact have been used to show the true nature of the characters. Character creation is done using readyplayerme.

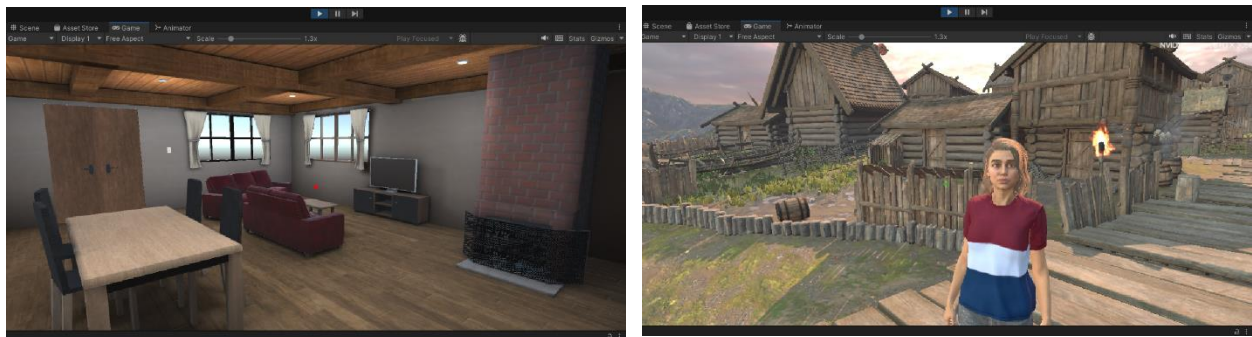


Figure 7: Prototype consists of real-world houses, People

### 3.2.4 Virtual reality Character implementation.

Characters can show a range of emotional responses like real-world interactions by giving them a new shape. The character is given a specific background and set of instructions. Characters are meticulously crafted using a special knowledge base based on their behavior, appearance, and knowledge. That way VR character is trained separately to act and react concerning their designed roles in the software. As a shown in Fig 8 Convai connects with Unity using API key.

```
public class ConvaiSetup : EditorWindow
{
    private const string API_KEY_PATH = "Assets/Resources/ConvaiAPIKey.asset";
    private const string API_URL = "https://api.convai.com/user/referral-source-status";

    [MenuItem("Convai/Convai Setup")]
    public static void ShowConvaiSetupWindow()
    {
        ConvaiSetup wnd = GetWindow<ConvaiSetup>();
    }

    [MenuItem("Convai/Documentation")]
    public static void OpenDocumentation()
    {
        Application.OpenURL("https://docs.convai.com/plugins-and-integrations/unity-plugin");
    }

    public class UpdateSource
    {
        [JsonProperty("referral_source")] public string referral_source;

        public UpdateSource(string referral_source)
        {
            this.referral_source = referral_source;
        }
    }
}
```

Figure 8 Code snippet for connecting Convai with Unity

The characters have been created using Convai, Inworld and Metaverse using high-quality textures through Unity. Ensures characters exhibit realistic body movements with textures syncing.

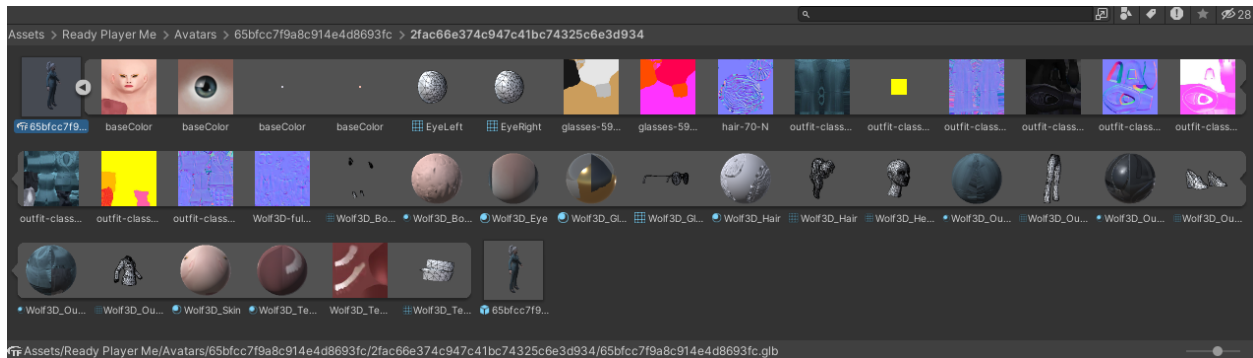


Figure 9 Textured overview used for character



The data obtained by Convai is driven by AI in Unity and Convai and realistic lip-sync, eye tracking, and body movements have been included for the characters. It has the ability to deal with NPCs as well as in real life when responding.

```
// UU
weight = 1.0f;
HeadSkinnedMeshRenderer.SetBlendShapeWeight(3 + firstIndex,
    _frame.Ou * weight * alpha * weightMultiplier
    + HeadSkinnedMeshRenderer.GetBlendShapeWeight(3)); // V_Tight_0

// Adjust the jaw and tongue bone rotations based on the specific viseme values.
jawBone.transform.localEulerAngles
    = new Vector3(0.0f, 0.0f, -90.0f - (
        0.2f * _frame.Th
        + 0.1f * _frame.Dd
        + 0.5f * _frame.Kk
        + 0.2f * _frame.Nn
        + 0.2f * _frame.Rr
        + 1.0f * _frame.Aa
        + 0.2f * _frame.E
        + 0.3f * _frame.Ih
        + 0.8f * _frame.Oh
        + 0.3f * _frame.Ou
    ))
    / (0.2f + 0.1f + 0.5f + 0.2f + 0.2f + 1.0f + 0.2f + 0.3f + 0.8f + 0.3f)
    * 30f);

// Tongue Bone
tongueBone.transform.localEulerAngles
    = new Vector3(0.0f, 0.0f, (
        0.1f * _frame.Th
        + 0.2f * _frame.Nn
        + 0.15f * _frame.Rr
    ))
    / (0.1f + 0.2f + 0.15f)
    * 80f - 5f);
}
```

Figure 10 code snippet for Lip sync implementation

The characters in the virtual environment should be designed so that the characters can be animated so that they can interact well with the user and engage in activities. In events related to the characters, the animation has been added to the characters based on the change of the X and Y axis through a vector so that they can perform tasks such as walking and jumping in the Terrain GameObject. As shown in the image below, moving direction and speed are controlled.

```

1 reference
private void MovePlayer()
{
    Vector3 horizontalMovement = Vector3.zero;

    if (canMove && !EventSystem.current.IsPointerOverGameObject())
    {
        Vector3 forward = transform.TransformDirection(Vector3.forward);
        Vector3 right = transform.TransformDirection(Vector3.right);

        float speed = ConvaiInputManager.Instance.IsRunKeyHeld() ? runningSpeed : walkingSpeed;

        Vector2 moveVector = ConvaiInputManager.Instance.GetPlayerMoveVector();
        float curSpeedX = speed * moveVector.x;
        float curSpeedY = speed * moveVector.y;

        horizontalMovement = forward * curSpeedY + right * curSpeedX;

        if (_characterController.isGrounded && ConvaiInputManager.Instance.WasJumpKeyPressed()) _moveDirection.y = jumpSpeed;
    }

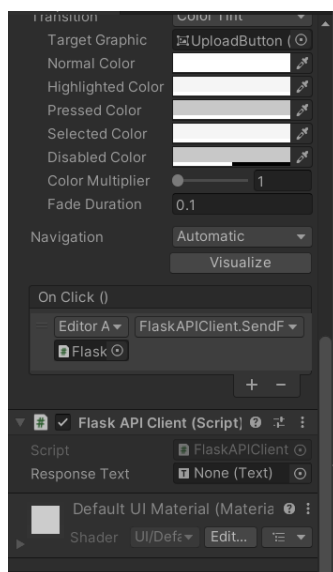
    if (canMove)
        // Apply gravity only when canMove is true
        _moveDirection.y -= gravity * Time.deltaTime;

    // Move the character
    _characterController.Move((_moveDirection + horizontalMovement) * Time.deltaTime);
}

```

Figure 11 code snippet for Lip sync implementation

An API was created to send the conversation between the user and the NPC to the model. Converts the current response audio file into a TEXT file to log the entire conversation. Then the TXT file is sent to the model through the Flask server. As shown in the fig12 API are attach to onClick function in unity script.



```

1 reference
private IEnumerator PlayAudioInOrder()
{
    while (!_stopAudioPlayingLoop)
    {
        // Check if there are audio clips in the playlist
        if (_responseAudios.Count > 0 && isCharacterActive)
        {
            ResponseAudio currentResponseAudio = _responseAudios[0];

            // Set the current audio clip to play
            if (!currentResponseAudio.IsFinal)
            {
                _audioSource.clip = currentResponseAudio.AudioClip;
                _audioSource.Play();
                SetCharacterTalking(true);

                // Assumes _chatUIHandler could be null
                if (_convaiChatUIHandler != null)
                {
                    if (!string.IsNullOrEmpty(currentResponseAudio.AudioTranscript))
                    {
                        _convaiChatUIHandler.SendCharacterText(characterName,
                            currentResponseAudio.AudioTranscript.Trim());
                    }

                    yield return new WaitForSeconds(currentResponseAudio.AudioClip.length);

                    _audioSource.Stop();
                    _audioSource.clip = null;
                }

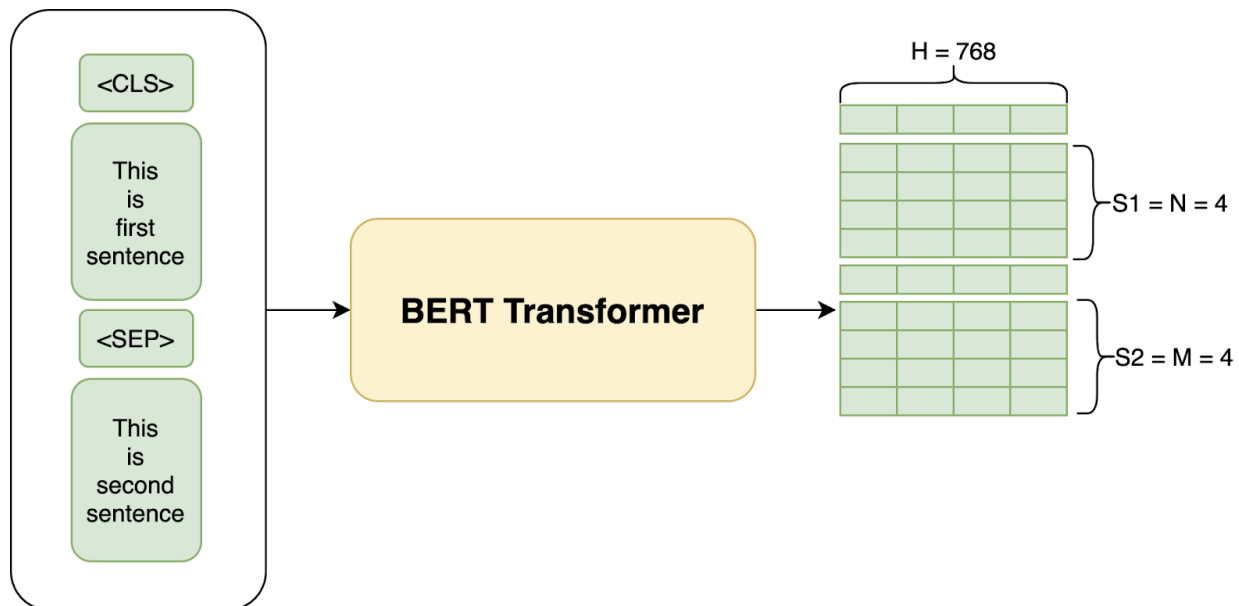
                _responseAudios.RemoveAt(0);
            }
            else
            {
                yield return new WaitForSeconds(0.1f);
                SetCharacterTalking(false);
            }
        }
    }
}

```

Figure 12 Flask API integration with unity

### 3.2.5 Model Implementation.

A conversation with an NPC end, the conversation is analyzed through a deep learning model. BERT (Bidirectional Encoder Representations from Transformers), a pre-trained model, has been used for this. As shown in fig 11 BERT is based on the Transformer architecture introduced by Vaswani et al. in their 2017 paper "Attention is All You Need." Transformers are designed to handle sequential data, making them ideal for NLP tasks. BERT has a Self-Attention Mechanism inherited from Transformer Architecture. Self-attention allows each position in the input sequence to attend to every other position. This mechanism helps capture dependencies regardless of their distance in the sequence. Since Transformers do not have a built-in notion of sequence order, positional encodings are added to the input embeddings to provide information about the position of each token in the sequence.



*Figure 13 BERT Transformers: How Do They Work.*

## Data Preprocessing

Reprocessing is a critical step that involves cleaning the raw text data and transforming it into a format suitable for model training. Here preprocessing has been done using methods like Tokenization. Fig 12 shows the Tokenization method used in BERT model training.

```
class EmotionDataset(Dataset):
    def __init__(self, df, tokenizer, max_len):
        self.df = df
        self.tokenizer = tokenizer
        self.max_len = max_len

    def __len__(self):
        return len(self.df)

    def __getitem__(self, index):
        text = str(self.df.loc[index, 'text'])
        emotion = self.df.loc[index, 'emotion']

        encoding = self.tokenizer.encode_plus(
            text,
            add_special_tokens=True,
            truncation=True,
            max_length=self.max_len,
            return_token_type_ids=False,
            padding='max_length',
            return_attention_mask=True,
            return_tensors='pt',
        )

        return {
            'text': text,
            'input_ids': encoding['input_ids'].flatten(),
            'attention_mask': encoding['attention_mask'].flatten(),
            'emotion': torch.tensor(emotion, dtype=torch.long)
        }
```

Figure 14 Code snippets for Tokenization

## Data Augmentation

First, it creates variations in text data to improve the robustness and generalization of machine learning models. Here the data size is increased by referencing the data to different formats. This has been done through several methods of Random Swap, Random Insertion, and Synonym Replacement as shown in Fig 13.

```
def random_insertion(words, n):
    new_words = words.copy()
    for _ in range(n):
        add_word(new_words)
    return new_words

def add_word(words):
    synonyms = []
    counter = 0
    while len(synonyms) < 1:
        random_word = words[random.randint(0, len(words)-1)]
        synonyms = get_synonyms(random_word) # type: ignore
        counter += 1
        if counter >= 10:
            return
    random_synonym = synonyms[random.randint(0, len(synonyms)-1)]
    random_idx = random.randint(0, len(words)-1)
    words.insert(random_idx, random_synonym)
```

Figure 15 Code snippet for Random Insertion

## Model Training

Fine-tuning BERT involves training the model on a specific task. Here this model is tuned to analyze the text. Iterate over the dataset for a fixed number of epochs. This tunes the model using a training loop by performing a forward pass and a backward pass. 10 epochs have been used for this.

```
Epoch 1
100%|██████████| 500/500 [04:00<00:00, 2.08it/s]
100%|██████████| 63/63 [00:11<00:00, 5.72it/s]
Train Loss: 0.5819 | Train Acc: 0.7950 | Val Loss: 0.1923 | Val Acc: 0.9256
Epoch 2
100%|██████████| 500/500 [03:58<00:00, 2.09it/s]
100%|██████████| 63/63 [00:10<00:00, 5.73it/s]
Train Loss: 0.1516 | Train Acc: 0.9397 | Val Loss: 0.1517 | Val Acc: 0.9330
Epoch 3
100%|██████████| 500/500 [03:59<00:00, 2.09it/s]
100%|██████████| 63/63 [00:11<00:00, 5.68it/s]
Train Loss: 0.1033 | Train Acc: 0.9506 | Val Loss: 0.1497 | Val Acc: 0.9430
Epoch 4
100%|██████████| 500/500 [03:59<00:00, 2.09it/s]
100%|██████████| 63/63 [00:10<00:00, 5.73it/s]
Train Loss: 0.0921 | Train Acc: 0.9564 | Val Loss: 0.1349 | Val Acc: 0.9365
Epoch 5
100%|██████████| 500/500 [03:59<00:00, 2.09it/s]
100%|██████████| 63/63 [00:10<00:00, 5.73it/s]
Train Loss: 0.0764 | Train Acc: 0.9614 | Val Loss: 0.1586 | Val Acc: 0.9390
Epoch 6
100%|██████████| 500/500 [03:59<00:00, 2.09it/s]
100%|██████████| 63/63 [00:10<00:00, 5.73it/s]
Train Loss: 0.0731 | Train Acc: 0.9649 | Val Loss: 0.1668 | Val Acc: 0.9405
Epoch 7
100%|██████████| 500/500 [03:59<00:00, 2.09it/s]
100%|██████████| 63/63 [00:10<00:00, 5.75it/s]
Train Loss: 0.0610 | Train Acc: 0.9717 | Val Loss: 0.1605 | Val Acc: 0.9410
Epoch 8
100%|██████████| 500/500 [03:59<00:00, 2.09it/s]
100%|██████████| 63/63 [00:10<00:00, 5.75it/s]
Train Loss: 0.0544 | Train Acc: 0.9769 | Val Loss: 0.1808 | Val Acc: 0.9400
Epoch 9
100%|██████████| 500/500 [03:59<00:00, 2.09it/s]
100%|██████████| 63/63 [00:10<00:00, 5.73it/s]
```

Figure 16: Train the model using 10 epoch

## Error Handling

Several questions arose while sending the complete chat to the model. First, due to a server error, the TXT file was not properly attached to the respective endpoint. As shown in the image below, there is no log file, so the prediction was not received properly.

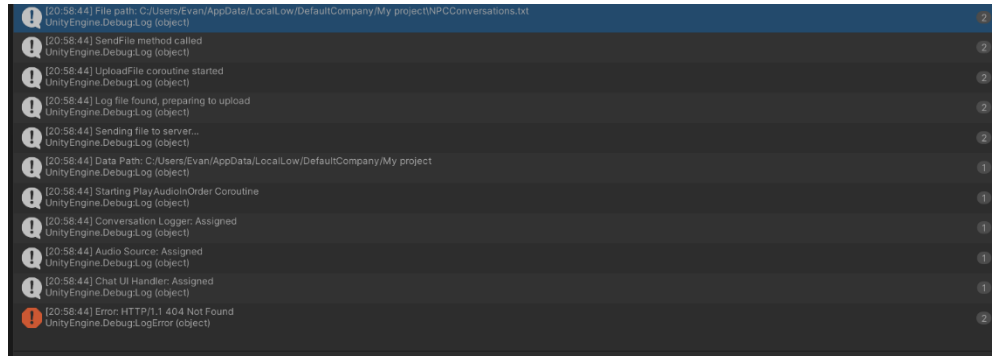


Figure 17 Internal server error.

After that, the data was received correctly through the flask server to the relevant end point, but a problem arose in the prediction of the model. The request did not bind properly. As shown in Fig 18 there was a problem with the arguments of the data referred through the Unity engine. Although the response was often correct, the prediction time increased.

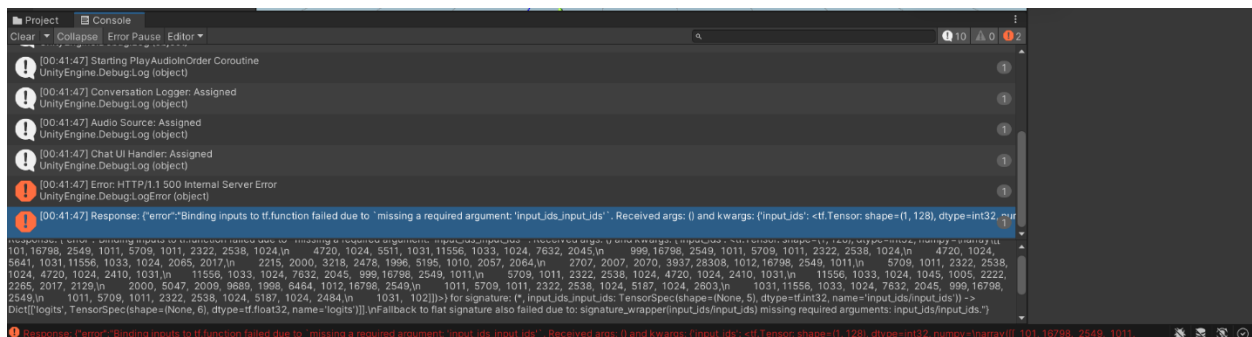


Figure 18 arguments error of the data referred

### 3.2.6 Software solution

Agile Scrum Methodology is the software development life cycle suggested for this. This methodology offers a fast model for software development. In particular, Scrum is known as the most popular software development life cycle today. Also, parts of this method should not be followed by alternatives. Here the opportunity is provided to apply the measures according to the need. Compared to existing methodologies, this framework is very agile and stable, enabling complex problems to be solved comprehensively. [10,11,12,13]



Figure 19: Agile Scrum Methodology

- **Requirement Gathering and Analysis**
- **Interviews and Feedback**

A survey and interview sessions are conducted to find out user needs and their expectations. This enables correct inputs to function. Here, by using a questionnaire, a selected group of people will focus on the problems they face while building relationships.

- **Collecting information from Helping Hands in SLIIT**

The purpose of this is to discuss with the counselors who provide counseling services in the Helping Hands unit of our university. Currently, we have engaged a consultant who provides consulting services for this. There, she discussed the issues of grants for the weak for the relationships that she encountered daily. Based on that information, we use that information to shape our VR character backstory and build the relevant environment.

- **Gathering data Using Google Form**

Through a Google form designed for different age groups, information about people's relationships is provided here. It contains questions that can be filled out by anyone, whether in a relationship or not.

- **Feasibility study (Planning)**

- **Technical Feasibility**

The technical status of our proposed solution is evaluated here. The technical profile required for the development of the mobile software application to be created, as well as the technical knowledge and requirements required to carry the system forward successfully, are considered here.

- **Economic feasibility**

The economic feasibility assessment of our project is considered here. Here the initial investment required to develop and operate the mobile application is estimated. Here this is estimated using ROI. A thorough cost-benefit analysis looks at whether the benefits outweigh the costs of the work. The goal is to create an efficient system with value by using less.



- **Scheduled feasibility**

Here the focus is on whether the feasibility assessment created here can be completed within the expected time frame. This involves considering various emergency risks and opportunities and providing a solution within a specific time frame by flexibly adapting to the circumstances. Therefore, the proposed section should be completed within the relevant period.

- **Design**

After the planning is completed under various criteria, user experience and visual design are done at this stage.

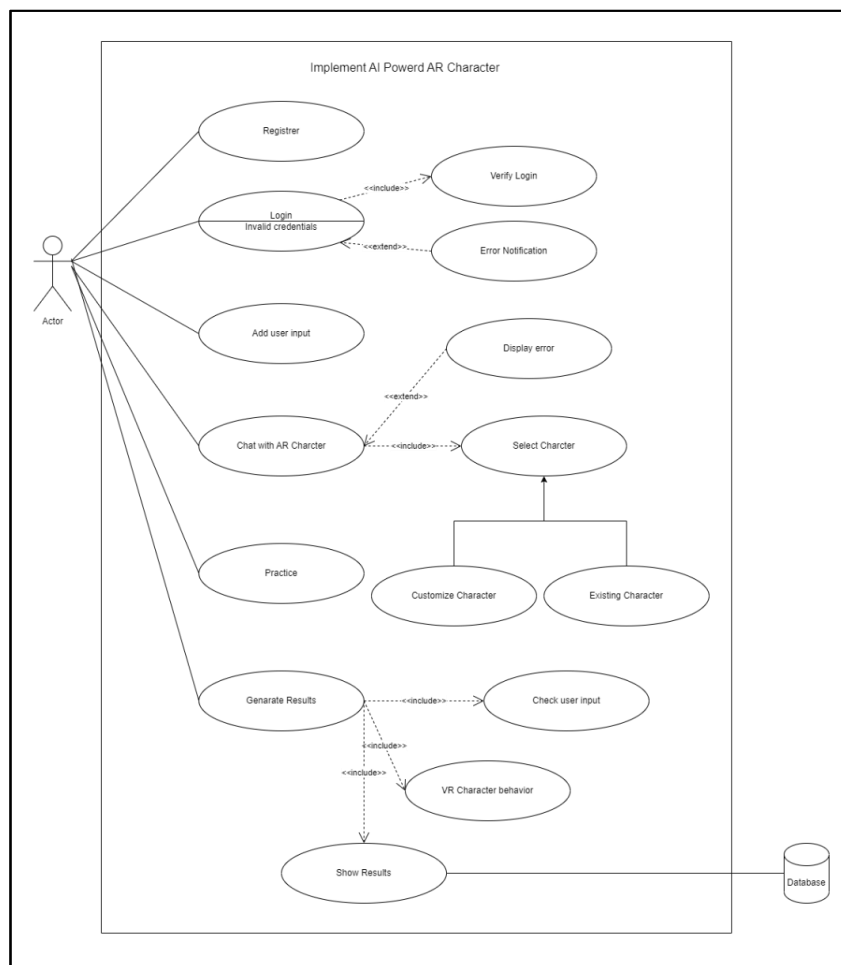


Figure 20 ER Diagram for VR component

- **Implementation**

The steps are to implement the proposed improved VR application methodology and make the application a reality. The following steps are to be followed to create the application so that users can meet their usability needs. In this phase, the AI-powered VR character is made a reality to help users build relationships by communicating the pre-made plan.

- Creating a VR application using Unity Engine.
- Integrate AWS Polly, OpenAI, Convai, InworldAI, and Metaverse with Unity. It can enable real-life interaction with VR character
- Here, using NLP frameworks and using Python programming language, API/library is used to perform Behavior Modeling, Voice Recognition model, and emotion analysis required for VR characters and understanding user inputs and generating responses.
- Visual appearance, animations, and movements of the VR character are created using Blender. Some features are add using Convai API
- At the end of the conversation with NPC, analysis is done using a deep learning model. A pre-training model called BERT has been used for this purpose.
- Integrated graphics engines into development environments (Unity3D) for visually appealing real-world VR experiences.

- **Testing**

Ensure that the application works seamlessly provides a valuable training environment to users and identifies potential issues before the application reaches its intended audience. This test is done in several stages. This app is free of bugs and focuses on the quality of the app.

## **Unit testing**

The components of the system are taken separately and tested by the developers to evaluate them. Here the parts like algorithm testing, user input testing etc. are done. The primary objective of unit testing is to ensure that the relevant components behave as expected and produce correct outputs

### **Integration testing**

Focus on cooperation between all systems and interactions between subsystems. Here we look at the problems that may arise in making all the components work as an integrated system. The primary objective of integrity testing is to ensure that the system is functioning correctly and meeting its intended requirements.

### **Scenario Testing**

The focus here is on how well the designed application performs in real-world scenarios. Ensures that the application functions correctly and meets user expectations, and determines the behavior of the application in various contexts and situations. This can detect problems that cannot be seen through traditional functional testing.

### **3.2.7 Commercialization**

This program is introduced as a mobile application that can be used to create better human relations even for those who are afraid of building relationships. This is also available in two versions, the first version is free and the second version has to be paid by the user. The free version has the ability to get simple level characters and the character-building option is not provided. The number of times you can practice is limited to 5 per day. The paid version allows the user to build characters as he likes and the number of times he can train per day is not limited.

### **Target Audience**

- Teenagers
- Workers
- Parents

### **Versions**

- **Free Version** - Identification of emotion.  
Relation build-up tracking system.  
Provide advice on how to manage the situation.  
Realtime notifications.
- **Paid version** - Can Enable VR application  
Can Enable VR environment and customization  
Severity level of the tracking system  
Severity level of counsellor and other tips

### **Marketing Plan**

- No age limitation for users.
- No need to advanced knowledge of technology

## **4 PROJECT REQUIREMENTS**

## **4.1 Functional requirements**

- The application should be able to properly analyze the user's input through AI technology.
- The application should be able to adjust the VR character and environment by properly analyzing the user's input.
- The application should be able to provide accurate feedback and feedback to the user through the VR character.
- The application should be able to keep a retrospective memory of the feedback given to the user through the VR character when the same user uses the application for the same task.
- The behavior of the VR character and the spoken dialogues should resemble the behavior of a normal human.

## **4.2 Non-Functional requirements**

- Performance - It should be able to respond quickly without getting stuck to give the user a better experience.
- Security and Privacy - Better security measures should be maintained to protect users' information.
- Ethical Considerations - The advice given through the app's AI technology should be culturally sensitive and ethical for all. Those conditions should be respected.
- Availability - Anyone looking to build a relationship should be able to use this app.
- Compatibility - The phone app should run on any existing phone and OS regardless.

### **4.3 System requirements**

- Unity engine is used to build the VR application.
- Blender, Maya, or 3ds Max is used to create the 3D model
- Uses Unity as one of the VR Development Platforms.
- Tensor Flow is used as a machine learning framework for behavior generation.
- Node.js is used for Server-side Programming and RESTful API is used as Web APIs.
- Encryption techniques like AES, and SSL/TLS are used.
- Amazon uses Cloud Front as a Content Delivery Network (CDN).
- Visual Studio IntelliJ is used for coding.

### **4.4 User requirements**

- The user should be able to customize the appearance, traits, and personality of the VR character
- The user should be able to select from a variety of relationship scenarios to practice
- The user should be able to share their emotions and thoughts with the VR character by voice command
- The user should be able to track their progress and improvement in relationship-building skills

## 4.5 Wireframe on Mobile Application Side

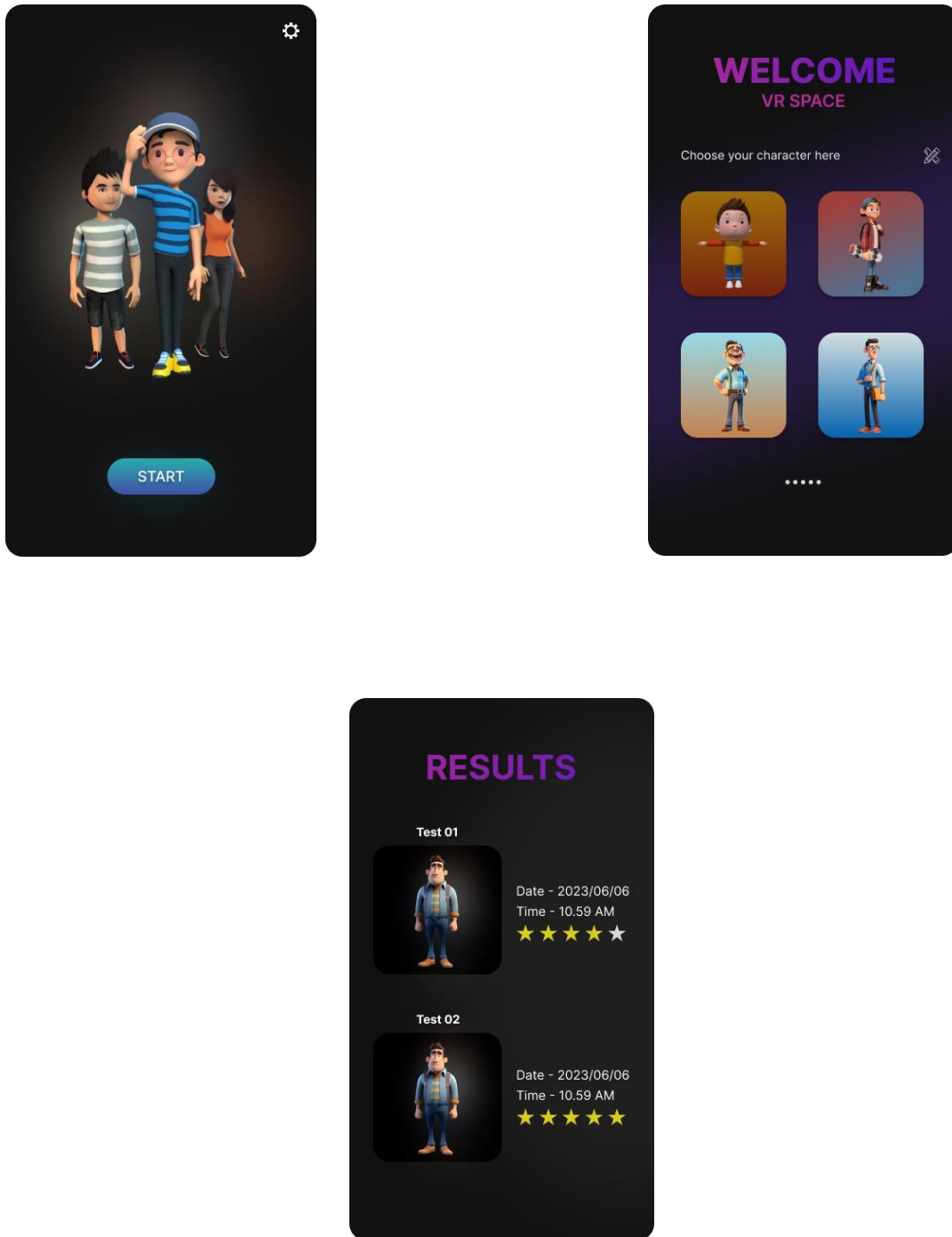


Figure 21 Mobile Application Side Wireframe

## 5 GANTT CHART

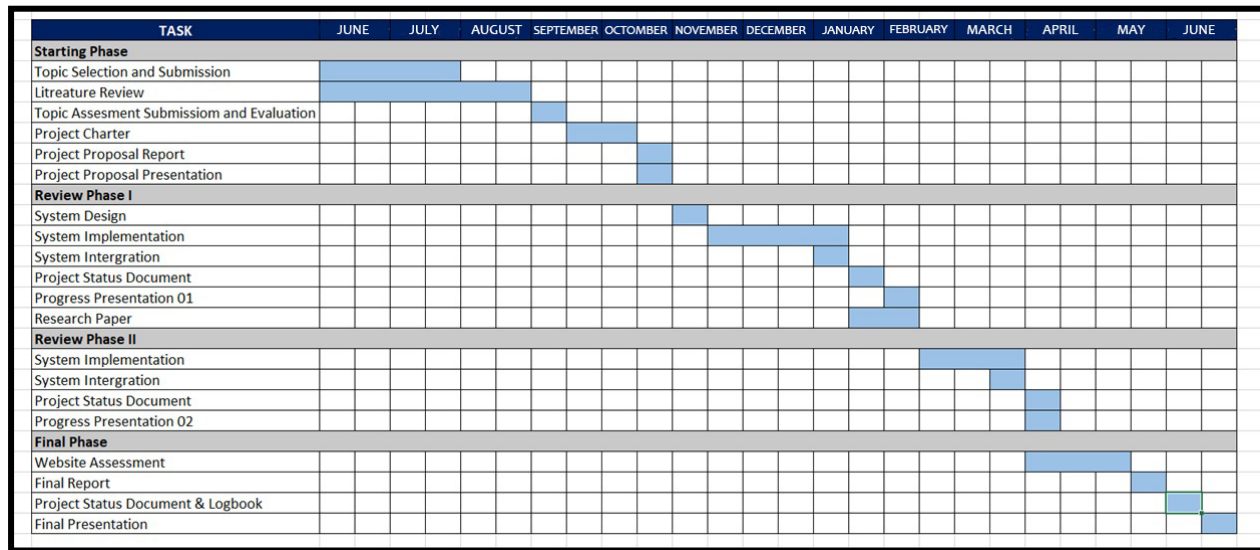


Figure 22 Gantt chart

### 5.1 Work Breakdown Structure (WBS)

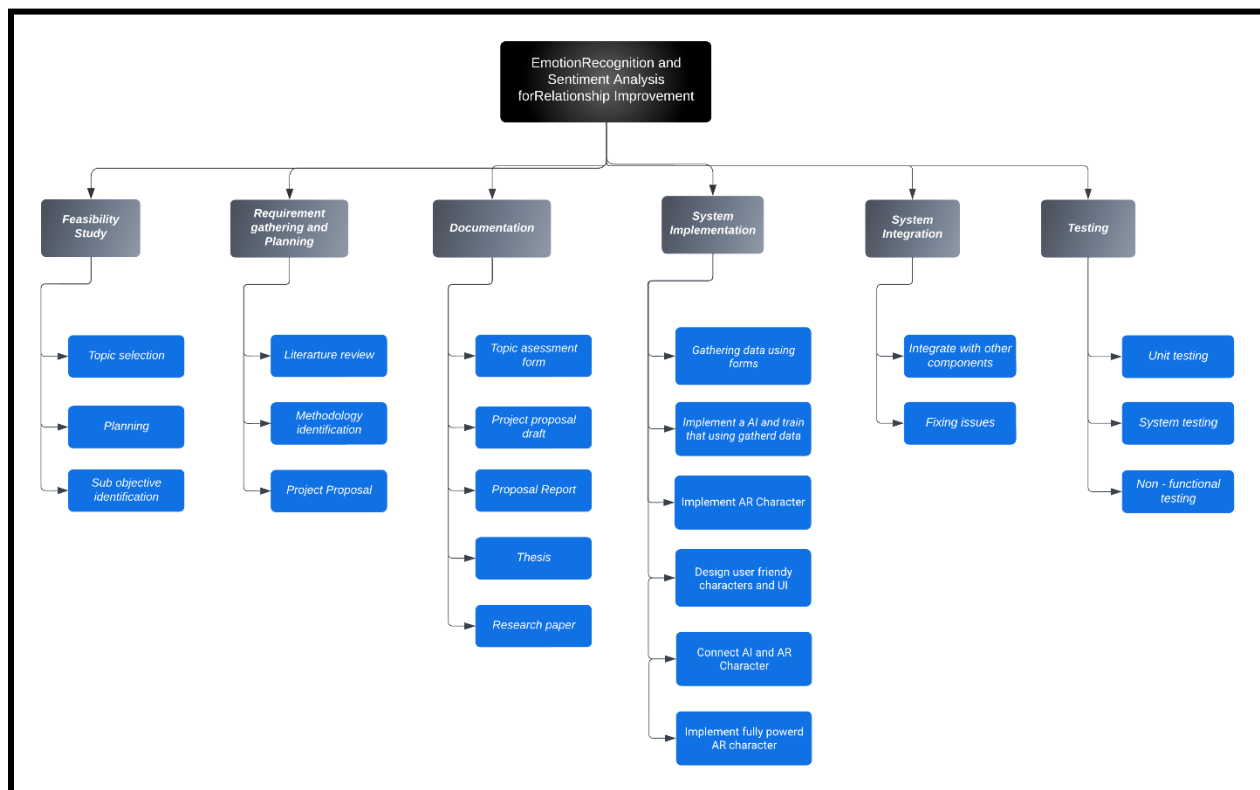


Figure 23 Work Breakdown Structure



## 6 BUDGET AND BUDGET JUSTIFICATION

Requirement	Cost(Rs.)
Mobile app hosting charge – Play store	5 000.00
Cloud service	6 000.00/month
Internet Charges	5 000.00
<b>Total Cost</b>	<b>16 000.00</b>

Table 3 budget justification

## 7 RESULTS AND DISCUSSIONS

### 7.1 Results

#### 7.1.1 Environmental selection

The user should select the relevant virtual environment according to his/her own preference. Several separately designed environments are provided as suggestions. Environments are created so that they can be changed separately through the Scene manager in Unity. It is possible to perform navigation through the hand controller of the Oculus Rift.

Fig 6.1 illustrates the view of each separate environment.

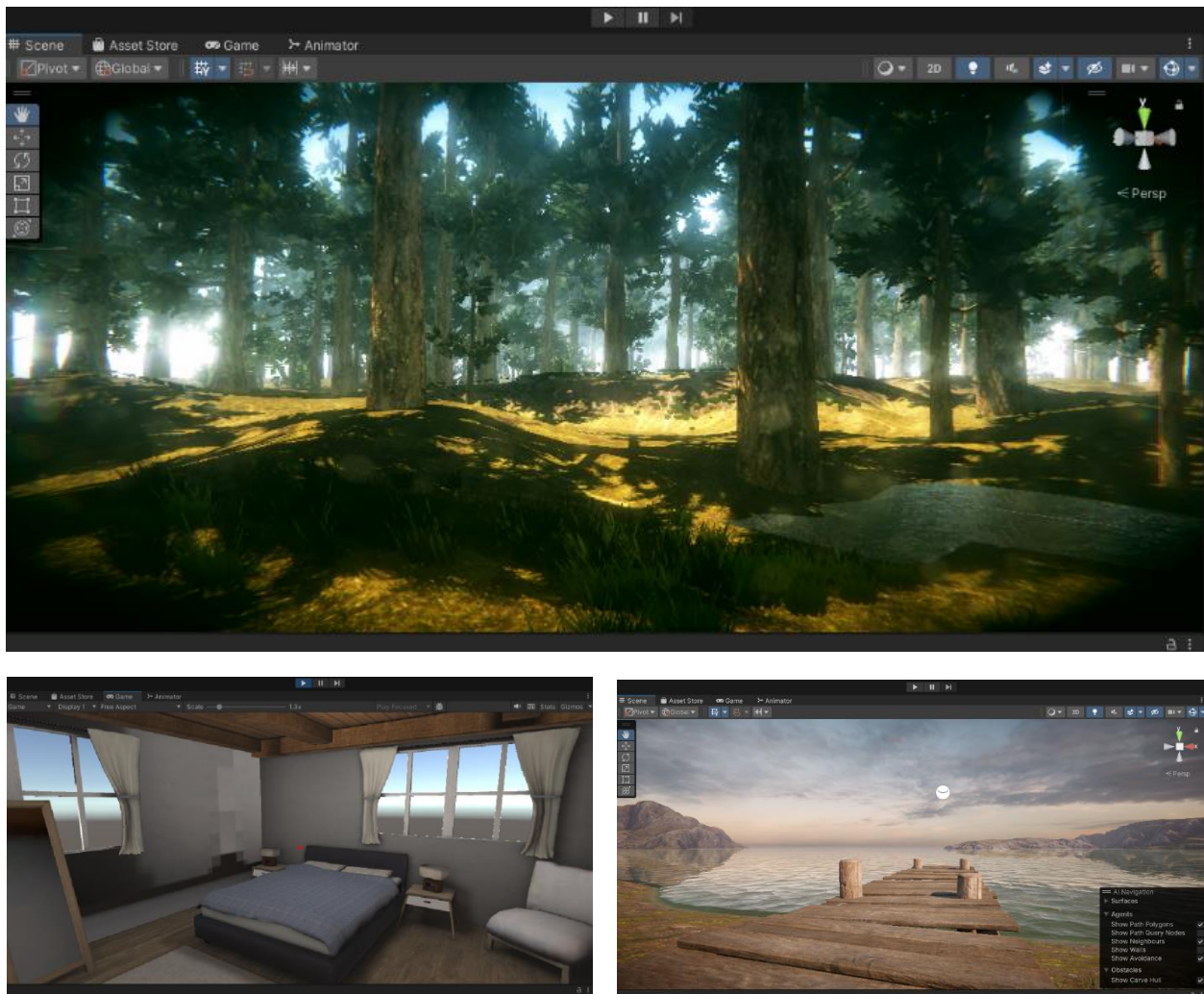


Figure 24 Separate environment for users

### 7.1.2 Character selection

After selecting the virtual environment, the user has to select the relevant character as required. In this virtual environment, characters with different characteristics and background stories are used. Conavai, InwordAI, and metaverse have been connected with unity to add attributes to these characters. Added lip sync and eye tracking option with NPC.

Create a custom character using readyplayerforme and add them to Unity as shown in fig#.



Figure 25 Customize characters

Using AWS Polly, tried to provide high-quality voices for NPCs as if they were in the real world. But later, through the audio engine in the Convai, a real-life voice simulation was given to the NPC.

### 7.1.3 Start the conversation

Using the controller of the VR headset, select a character you like and when that character comes close, it is identified by a trigger area. After that, as shown in fig 26 the microphone is activated

by pressing the X button on the controller. After that we can talk to the character as we want. The entire conversation is prompted on a small screen as a subtitle. It is capable of knowing how well the virtual character can recognize the user's dialogue.



Figure 26 Oculus Rift Right Controller

Usually the trigger area is used near the character. As soon as the user reaches the trigger area, it is notified by a small prompt. Using the VR headset, you can not only talk to the VR characters but also perform activities.

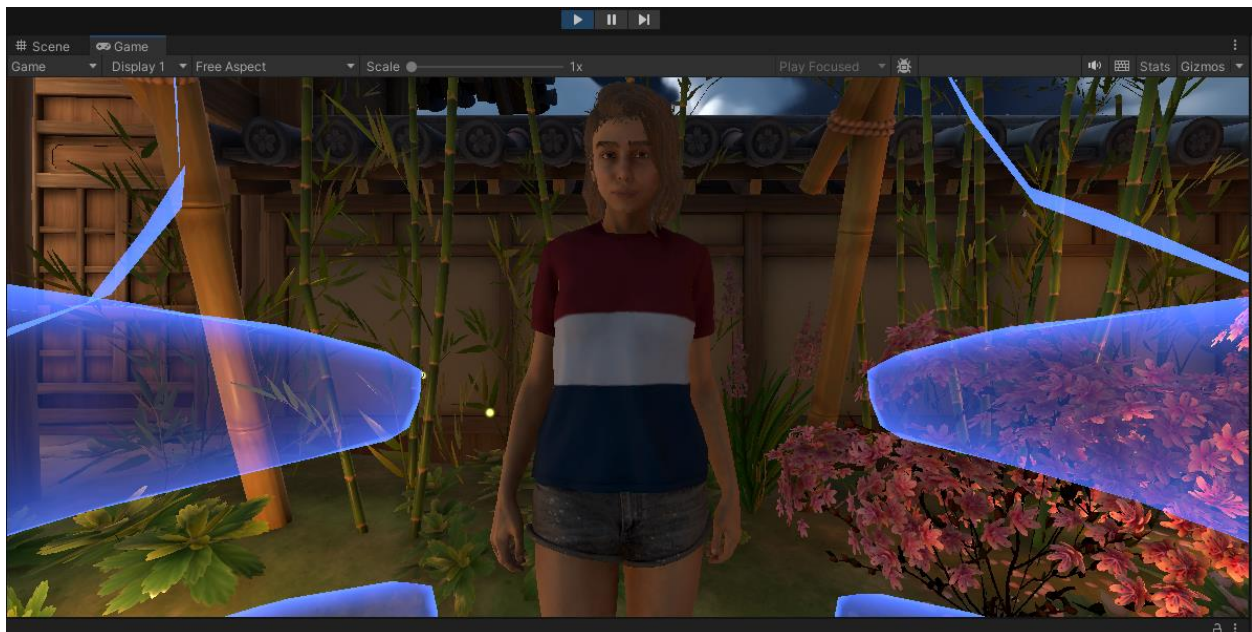


Figure 27VR view of the environment

## 7.1.4 Deep Learning Model Testing

A conversation with an NPC end, the conversation is analyzed through a deep learning model. BERT, a pre-trained model, has been used for this. The complete conversation is analyzed through the model and a prediction is made. Based on that, it is hoped to allow the user to self-diagnose himself. It is possible to judge the progress achieved in the development of abilities by the results of training in the training environment several times.

Fig 6.1 illustrates the view of the extracted audio conversation to text format.

```
User: Hi
Counselor: Hello! How can I assist you today?
User: what are you know?
Counselor: As a Health Counselor, I have knowledge and expertise in maintaining good mental health and building healthy relationships. How can I help you with any specific concerns or questions you may have?
User: Hi. My relationship is broke up.
Counselor: I'm sorry to hear that you're going through a breakup. Would you like to talk about it and explore ways to cope with this difficult time?
User: Ah, I don't understand what to talk about.
Counselor: It's completely normal to feel confused and unsure after a breakup. We can discuss your feelings, thoughts, and any concerns you may have about moving forward. It can be helpful to have someone to talk to during this time.
User: Okay, can you give me an address for How to, I? restart my Relationship.
Counselor: Restarting a relationship involves open communication and understanding. It's important to reflect on what went wrong, discuss it with your partner, and see if both of you are willing to work on the issues together. Would you like to explore some strategies on how to approach this conversation?
User: Yeah, yeah, sure.
Counselor: Great! Here are a few strategies to consider when restarting a relationship:

1. Reflect on the past: Take some time to think about what led to the breakup and what you can learn from it. Identify any patterns or behaviors that may have contributed to the problems.

2. Open and honest communication: Have a calm and honest conversation with your partner about your feelings, concerns, and desires for the future. Listen actively and try to understand their perspective as well.

3. Take responsibility: Acknowledge your own mistakes and shortcomings, and be willing to make changes and improvements. Encourage your partner to do the same.

4. Rebuild trust: Trust is crucial in any relationship. Be patient and consistent in your actions to rebuild trust. This may involve setting boundaries, being reliable, and following through on your commitments.

5. Seek professional help if needed: If the issues are complex or you're struggling to make progress on your own, consider seeking the guidance of a couples therapist or relationship counselor.

Remember, rebuilding a relationship takes time, effort, and mutual commitment. It's important to be patient and realistic about the process.
```

Figure 28 Extracted audio conversation in text format

The BERT model was trained using a dataset with about 10000 data rows. BERT is initially pre-trained on a large corpus, such as Wikipedia and BookCorpus. BERT, however, is trained bidirectionally, meaning it considers the context from both directions simultaneously. This is achieved using Masked Language Modeling (MLM). During training, 15% of the tokens in the input sequence are randomly masked. The model then attempts to predict the masked tokens based on the surrounding context.

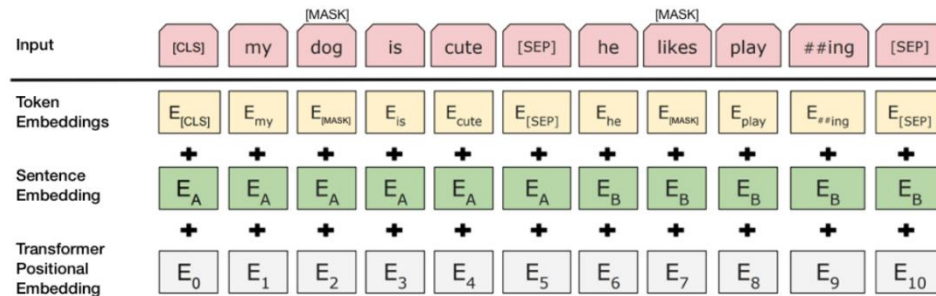


Figure 29 Embedding process for the BERT

After training the model it archive 76% accuracy. Instead of performing a single attention function, the Transformer employs multiple attention heads to capture different aspects of the relationships between words.

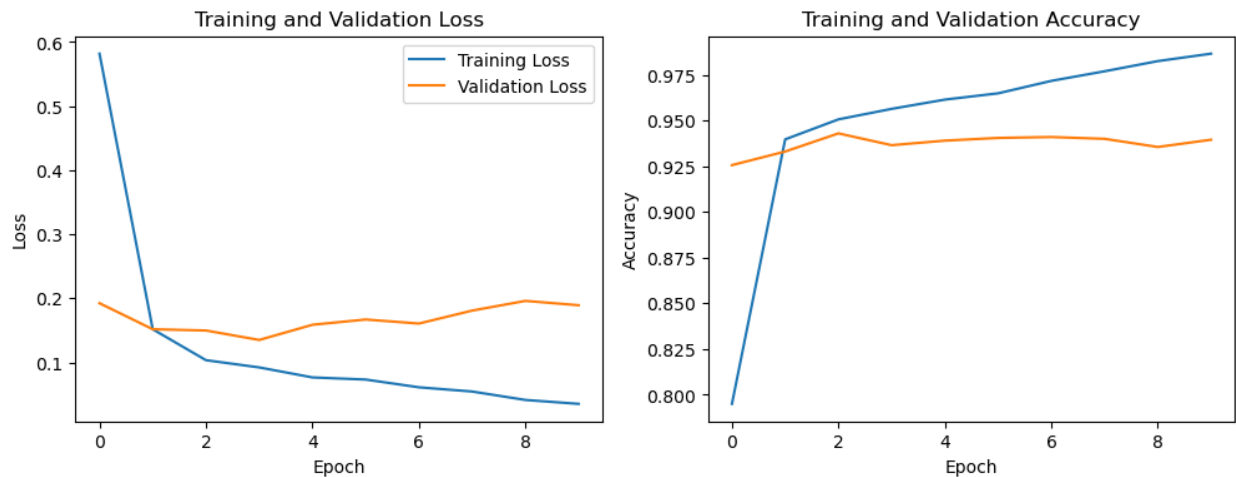


Figure 30 Model validation loss and accuracy

## 8 CONCLUSIONS

The main objective of this study was to develop mobile and VR applications to identify and mitigate human relationship problems. In addition, if suffering from depression or a mental problem, it is recognized and referred to the user for professional advice. Also after the end of the conversation in the VR environment, the user has the ability to analyze the conversation through the BERT model and get an understanding of the quality of the conversation.

In this research component, a user-interactable virtual environment has been created through the Unity engine using Conavi and metaverse. At the end of each conversation, text classification is done through BERT, a pre-trained model of the conversation.

Furthermore, the entire system ('MOODMate') will be expanded to identify patients suffering from excessive stress and alert the relevant police and emergency services about it. This application is available to users in two ways. As the VR version and the mobile version. This will be developed as a commercial platform for people suffering from mental stress and people with interpersonal problems.



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