Mind Sculptor

An Obsessive-Compulsive Disorder(OCD) Exposure and Response Prevention(ERP) Therapy Tool

24-25J-046

Our Team

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INTRODUCTION

- Obsessive-Compulsive Disorder(OCD) is a chronic psychiatric condition characterized by persistent intrusive thoughts (obsessions) and repetitive behaviors (compulsions).
- It affects approximately 2-3% of the population and significantly impairs daily functioning and quality of life.
- Traditional ERP therapy is effective but limited by accessibility and engagement challenges.
- A comprehensive OCD ERP tool with advanced biometric monitoring and AI-driven therapeutic interventions has been identified as a valuable resource for enhancing the accessibility and effectiveness of obsessive-compulsive disorder treatment

Research Problem

- How can AI and voice analysis improve the identification of OCD presence, subtypes and severity levels?
- In what ways can biometric data and machine learning algorithms be used to create tailored ERP therapy plans for individual patients?
- How can AI-supported Interactive Voice Assistant(IVA) increase patient engagement and accessibility to ERP therapy, particularly for those with logistical or psychological barriers?

Research Objectives

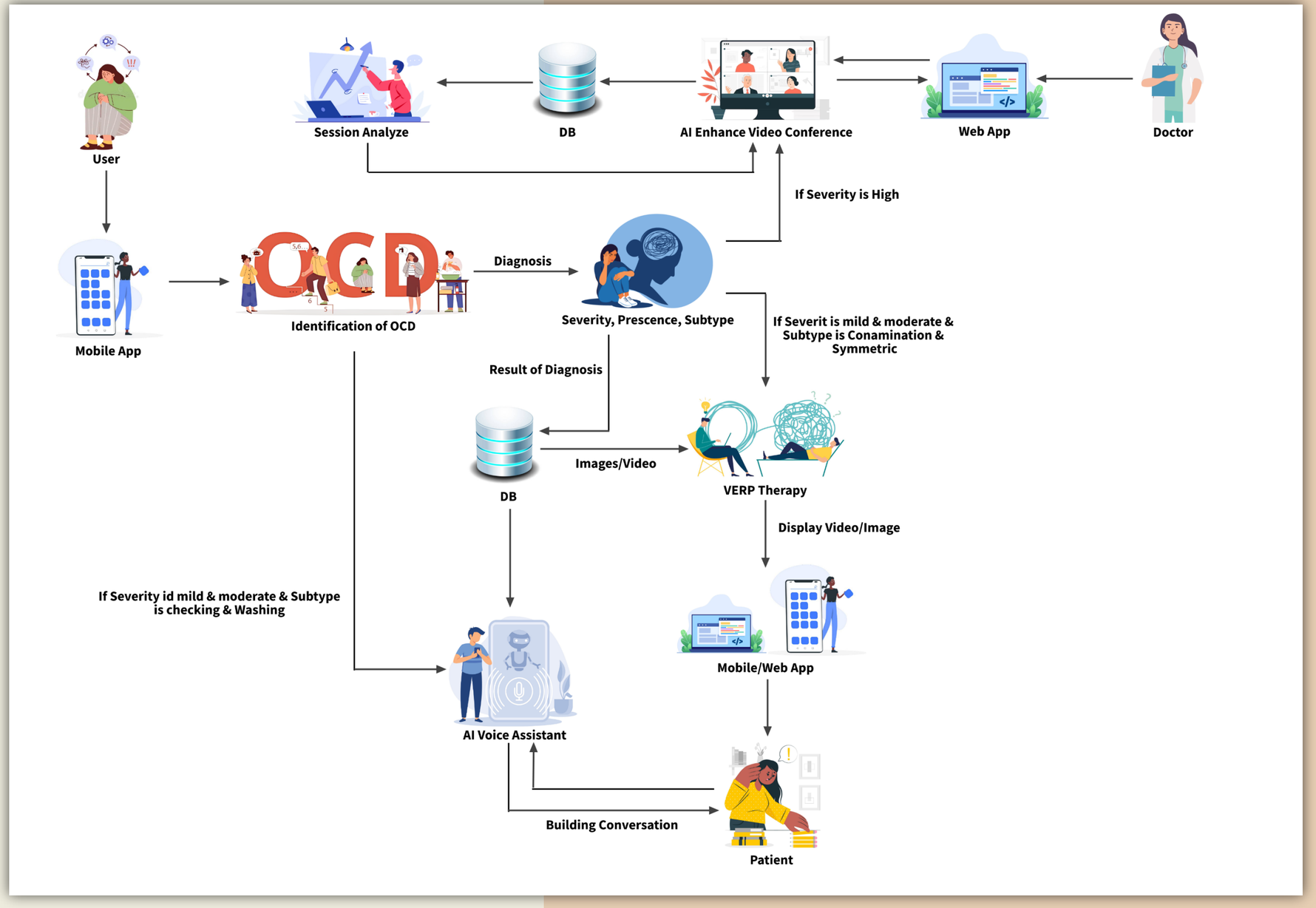
Main Objective

- Develop an Exposure and Response Prevention(ERP) Therapy tool for patients suffering from OCD.

Sub Objectives

- To enhance the diagnosis and understanding of OCD subtypes
- To develop personalized and adaptive ERP therapy plans
- To create AI-supported Interactive Voice Assistant(IVA)
- To enable remote and real-time monitoring of therapy sessions

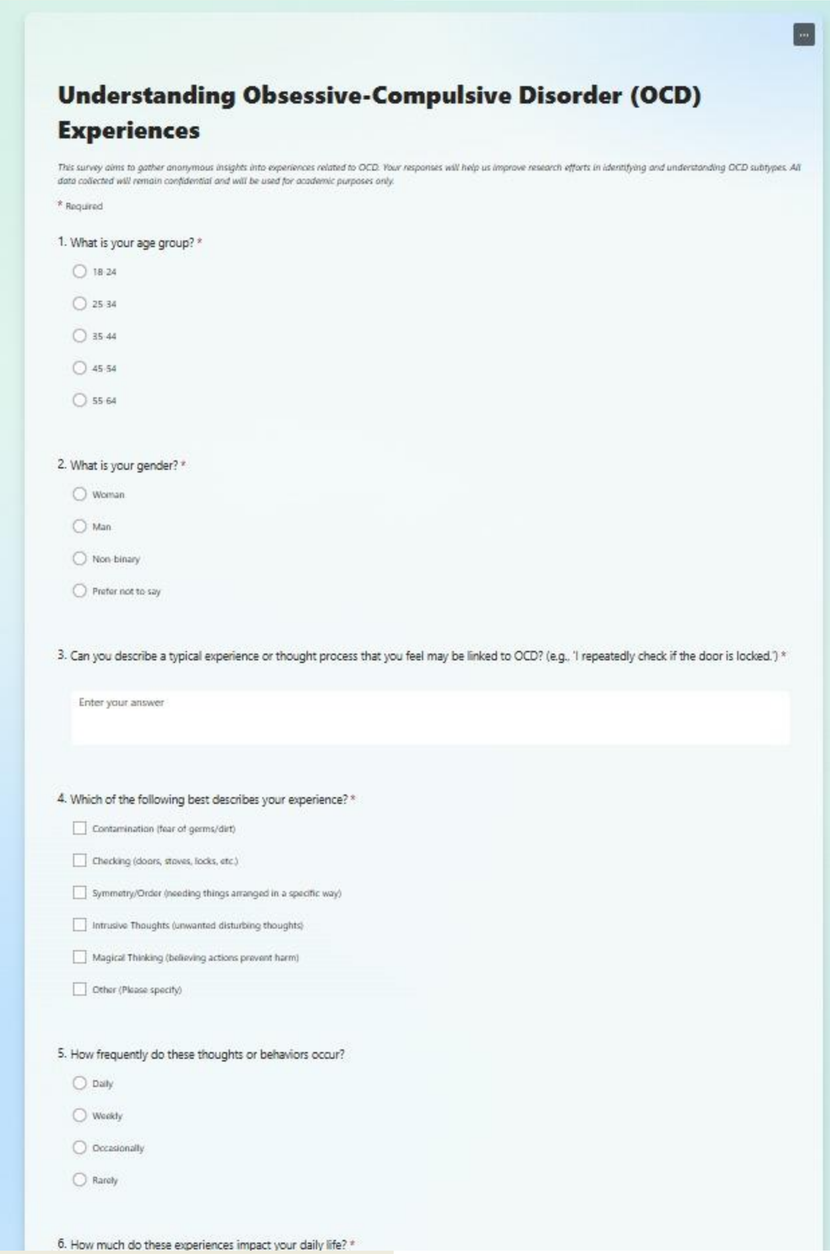
System Diagram



Data Collection

KEY MOMENTS WITH PSYCHOLOGY EXPERTS

Data Collection through FAQ



Understanding Obsessive-Compulsive Disorder (OCD) Experiences

This survey aims to gather anonymous insights into experiences related to OCD. Your responses will help us improve research efforts in identifying and understanding OCD subtypes. All data collected will remain confidential and will be used for academic purposes only.

* Required

1. What is your age group? *
   - 18-24
   - 25-34
   - 35-44
   - 45-54
   - 55-64

2. What is your gender? *
   - Woman
   - Man
   - Non-binary
   - Prefer not to say

3. Can you describe a typical experience or thought process that you feel may be linked to OCD? (e.g., 'I repeatedly check if the door is locked.') *

   Enter your answer

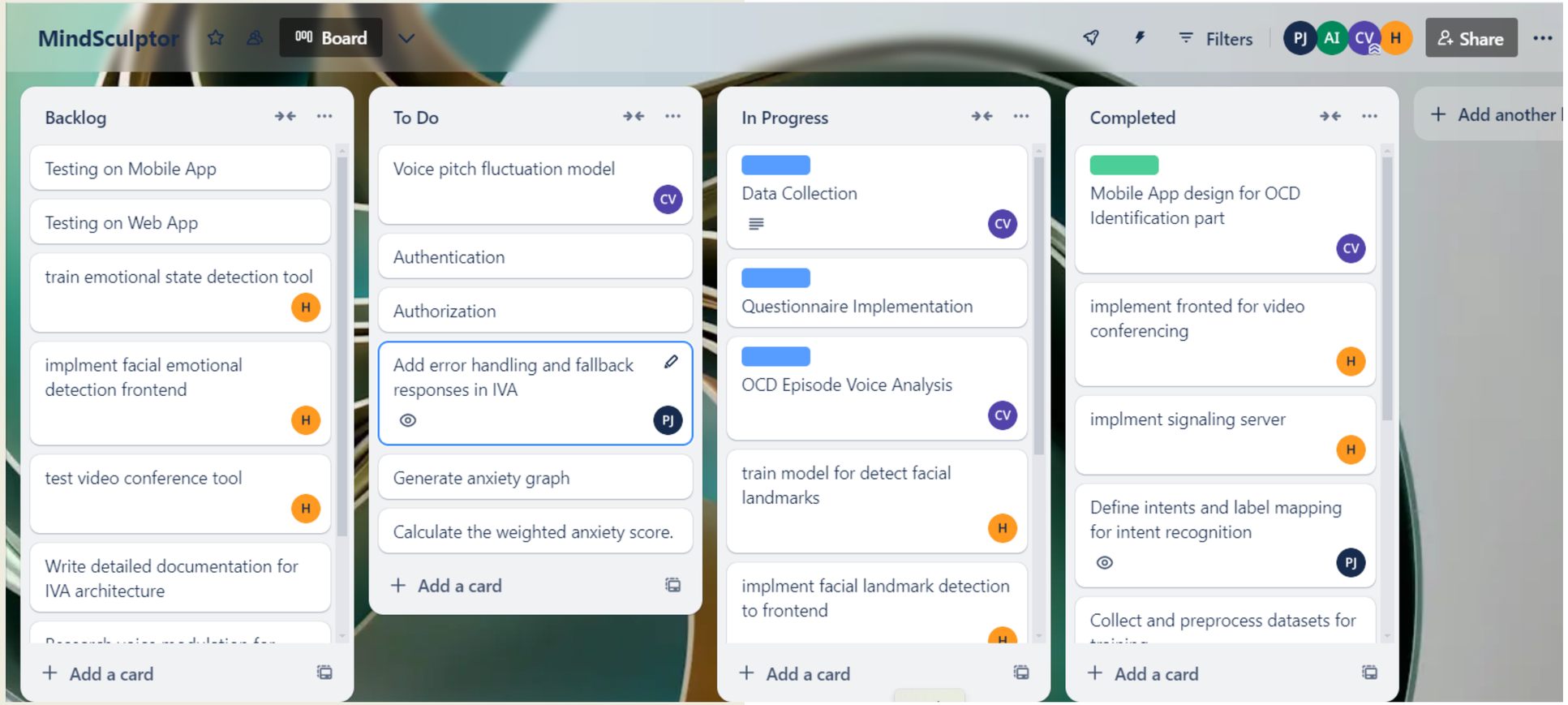
4. Which of the following best describes your experience? *
   - [ ] Contamination (fear of germs/dirt)
   - [ ] Checking (doors, stoves, locks, etc.)
   - [ ] Symmetry/Order (needing things arranged in a specific way)
   - [ ] Intrusive Thoughts (unwanted disturbing thoughts)
   - [ ] Magical Thinking (believing actions prevent harm)
   - [ ] Other (Please specify)

5. How frequently do these thoughts or behaviors occur?
   - Daily
   - Weekly
   - Occasionally
   - Rarely

6. How much do these experiences impact your daily life? *

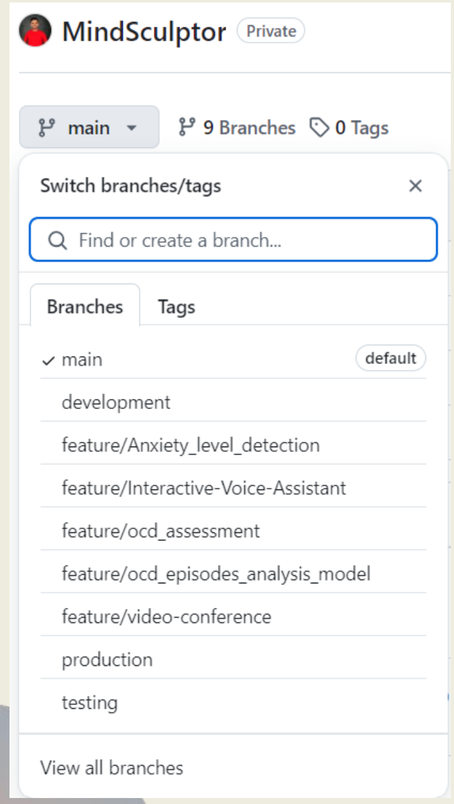
Best Practices Followed

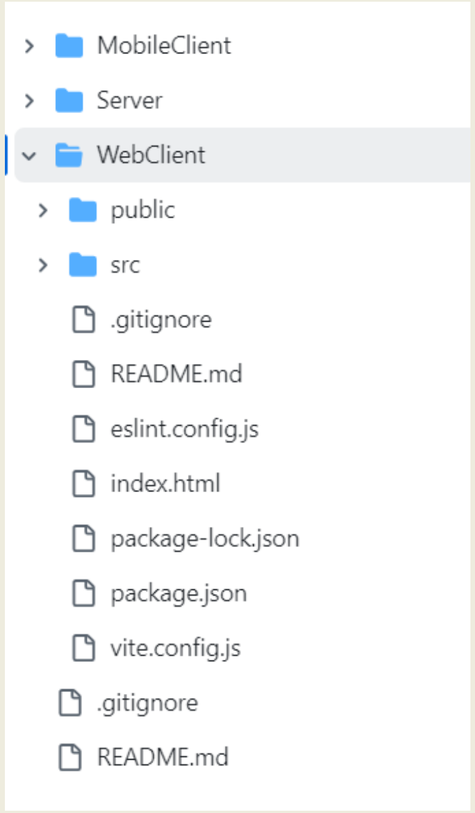
- Proper usage of Comments.
- Project Management performed using Trello.

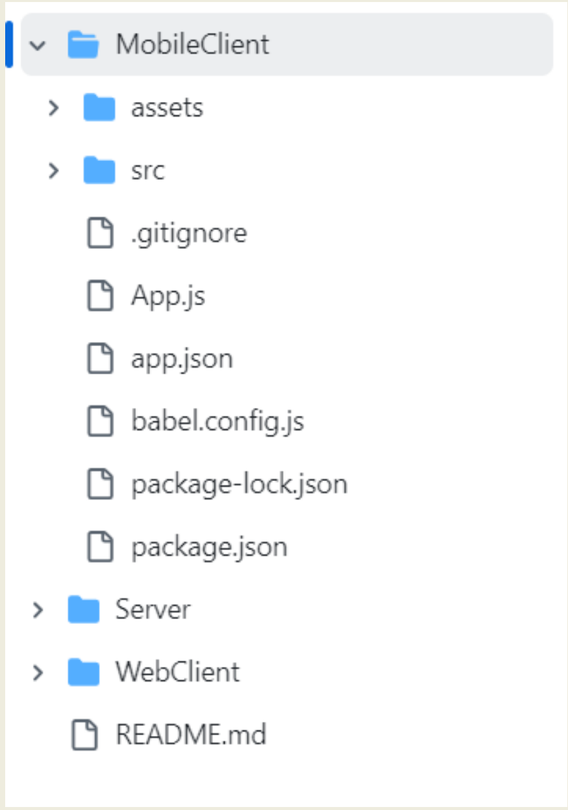


Best Practices Followed

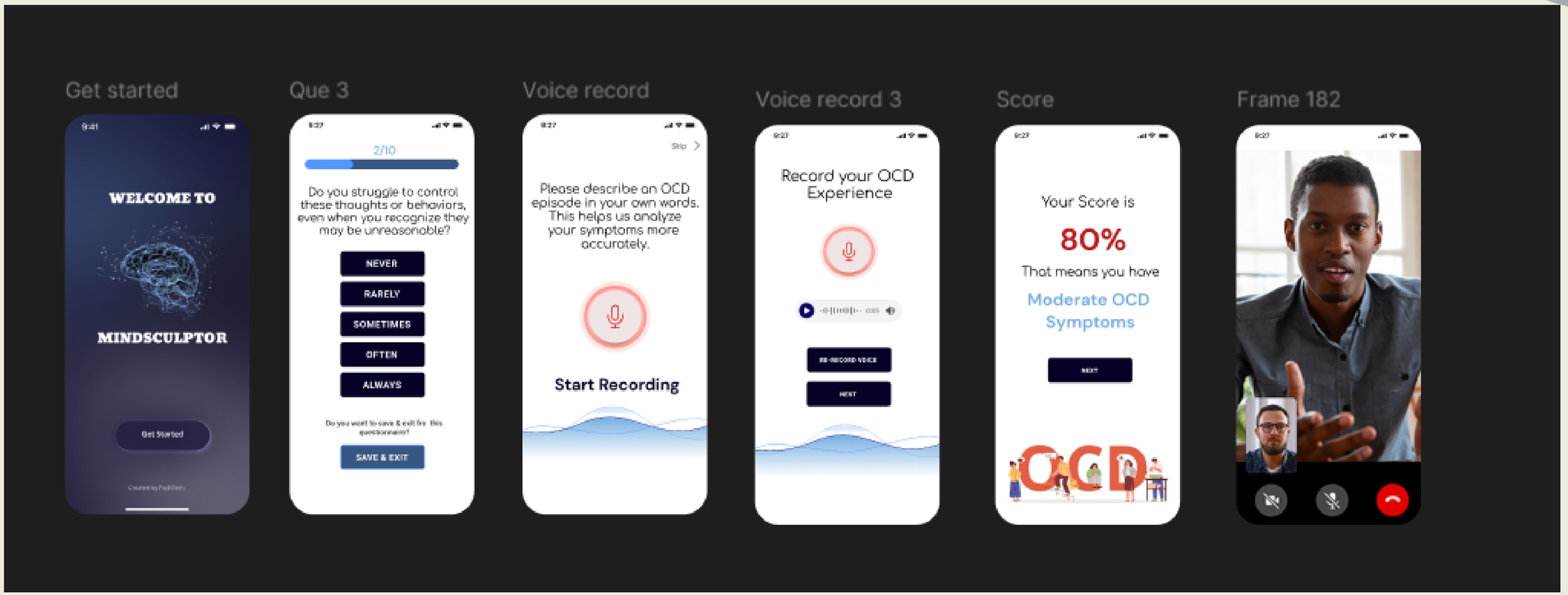
Optimized Feature-vise and Environment-vise branching



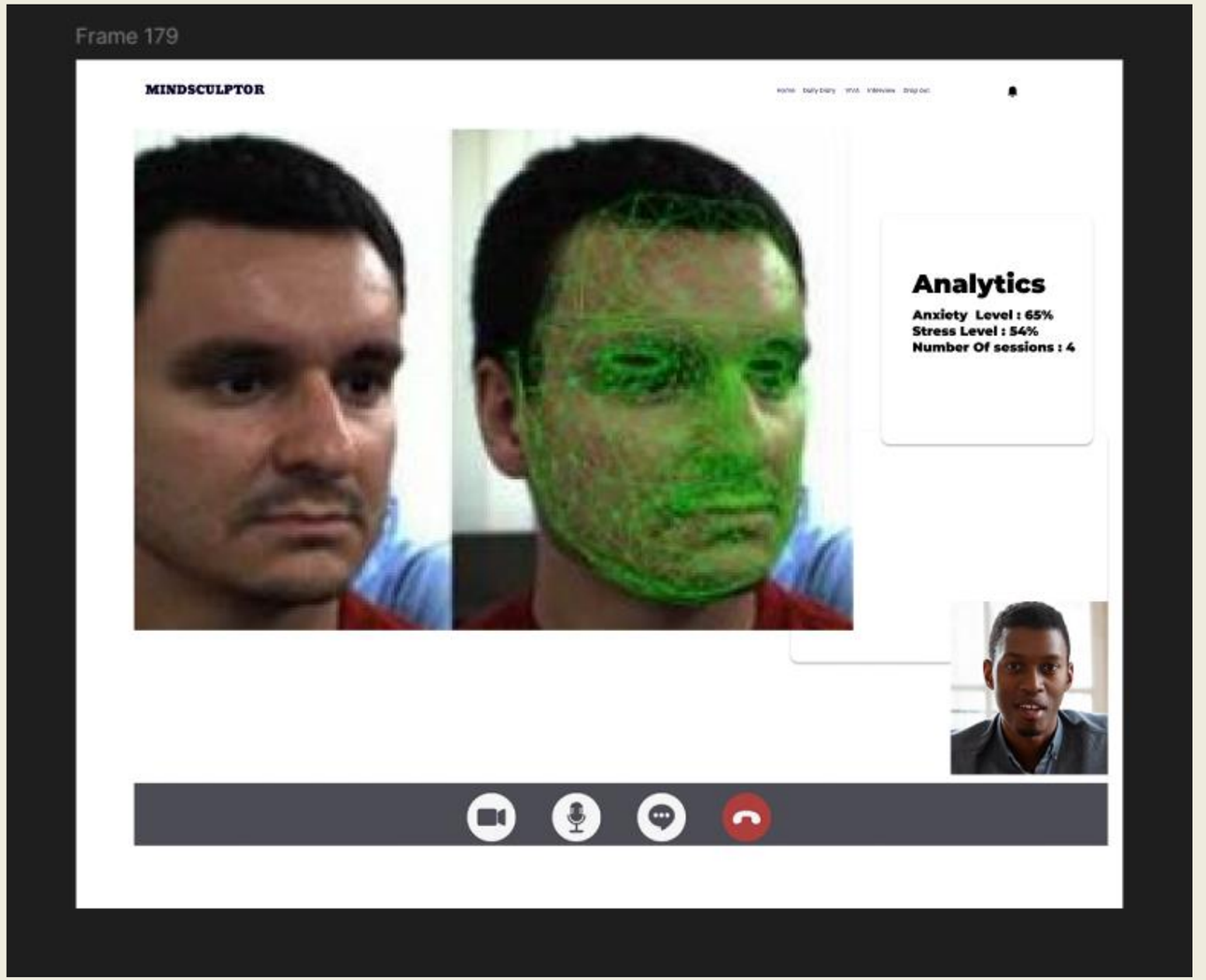




UI Design - Mobile



UI Design - Web



Identify the presence, severity, and sub types of OCD in patients

IT21219498 | Vithanage C.S.

Specialization: Software Engineering

Introduction

Background on OCD

- Obsessive-Compulsive Disorder (OCD) is a mental health condition characterized by unwanted and intrusive thoughts (obsessions) and repetitive behaviors (compulsions).
- It affects individuals' daily functioning and quality of life.

Importance of the Study

- Identifying the presence, severity, and sub-types of OCD can lead to better diagnosis, treatment, and understanding of the disorder.
- Accurate assessment helps in providing tailored interventions and improving patient outcomes.

Research Questions

Primary Questions

- How can the presence of OCD be accurately identified in patients using modern technological methods?
- What are the most effective techniques to determine the severity of OCD symptoms?
- How can different sub-types of OCD be classified and differentiated in patients?

Secondary Questions

- Can voice recordings and speech analysis provide additional insights into OCD symptoms?
- What algorithms and techniques are most suitable for these assessments?

Objectives

Main Objective

- **Develop a comprehensive assessment method for identifying the presence, severity, and sub-types of OCD in patients.**

Sub Objectives

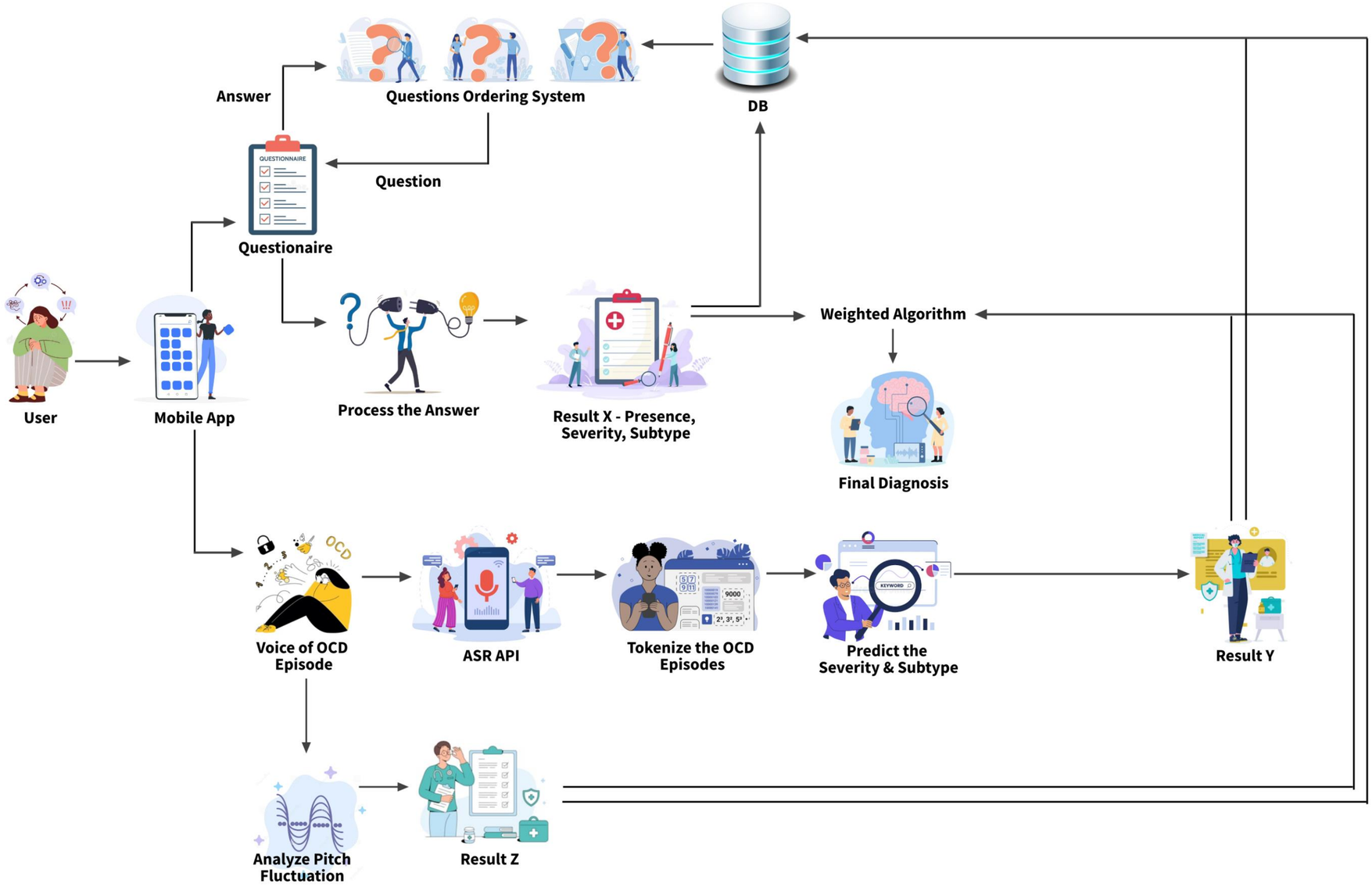
- **Questionnaire-Based Assessment:**
Implement a dynamic questionnaire to provide a preliminary diagnosis based on user responses.

- **OCD Episodes Analysis:**
Leverages **BERT** for fine-tuned multi-class classification to identify OCD subtypes and severity levels from episode descriptions

- **Voice Pitch Fluctuation Analysis:**
Analyze voice pitch fluctuations to assess emotional state and severity of OCD.

- **Final Diagnosis:**
Combine results from all sub-components to produce a comprehensive OCD diagnosis.

Methodology – System Diagram



Methodology – Technologies, Techniques, Algorithms

Technologies

- Expo
- React Native
- Python
- Flask
- MongoDb
- Matplotlib & Seaborn
- Jupyter
- Librosa
- NLTK
- Scikit-learn
- Hugging Face Transformers
- WordCloud

Techniques

- Speech recognition
- Fine-Tuning BERT
- Text Preprocessing

Algorithms

- BERT
- Decision Tree algorithm
- Weighted scoring algorithm

Methodology – Evidence of Completion

Overview of Achievements

Implemented Models:
OCD Episode Analysis Model (Subtype & Severity Prediction).

Data Preparation:
- Generated and processed a realistic OCD dataset with over 1,000 episodes.
- Balanced coverage of all subtypes and severity levels.

Questionnaire Development:
Dynamic questionnaire system based on Y-BOCS and OCI-R standards.

Model Deployment:
Developed Flask-based APIs for real-time predictions.

Methodology – Evidence of Completion

Data Collection and Preprocessing

Dataset Highlights:

	A	B	C	D	E	F
1	episode_text	presence	severity	subtype		
2	Repeatedly washing hands after a brief touch of a door handle.	1	2	Contamination		
3	Inspecting the stove multiple times to ensure it is off before leaving the house.	1	3	Checking		
4	Reorganizing books on a shelf until they look perfectly aligned.	1	1	Symmetry and Ordering		
5	Avoiding discarding an old receipt due to fear of losing valuable information.	1	0	Hoarding		
6	Feeling momentarily uncomfortable about a misplaced item.	0	0	Normal		
7	Experiencing persistent thoughts of harm coming to a loved one without taking any actions.	1	3	Intrusive Thoughts		
8	Wiping down a phone screen with sanitizer after using it in public.	1	1	Contamination		
9	Double-checking that the car is locked when leaving a parking lot.	1	2	Checking		
10	Briefly ensuring the lights are off before leaving a room.	0	0	Normal		
11	Keeping expired coupons, believing they might still be useful.	1	2	Hoarding		
12	Rearranging picture frames repeatedly until they feel 'balanced'.	1	3	Symmetry and Ordering		
13	Using tissues to touch door handles in a public restroom.	1	1	Contamination		
14	Adjusting a crooked picture frame once.	0	0	Normal		
15	Worrying persistently about causing an accident, despite no evidence.	1	2	Intrusive Thoughts		
16	Examining locks on all windows multiple times before bedtime.	1	3	Checking		
17	Making a note to check a bill once more for accuracy.	0	0	Normal		
18	Saving old newspapers 'just in case' they are needed for reference.	1	1	Hoarding		
19	Changing clothes after coming into contact with someone who sneezed.	1	2	Contamination		
20	Struggling to suppress distressing images of catastrophic events.	1	3	Intrusive Thoughts		
21	Aligning objects on a desk until the arrangement feels 'just right'.	1	1	Symmetry and Ordering		
22	Repeatedly returning to check whether the oven was turned off.	1	2	Checking		
23	Rechecking a shopping list for forgotten items.	0	0	Normal		
24	Refusing to throw away broken electronics due to sentimental value.	1	3	Hoarding		
25	Avoiding handshakes to prevent exposure to germs.	1	1	Contamination		
26	Experiencing repetitive fears of making offensive remarks accidentally.	1	2	Intrusive Thoughts		
27	Tidying a workspace at the start of the day.	0	0	Normal		
28	Obsessively adjusting tableware placement during a meal.	1	3	Symmetry and Ordering		
29	Quickly verifying that the car's lights are off after parking.	1	1	Checking		
30	Casually confirming that a front door is locked before sleeping.	0	0	Normal		
31	Reluctantly keeping old clothes that no longer fit.	1	2	Hoarding		
32	Washing hands until the skin becomes irritated after perceived contamination.	1	3	Contamination		
33	Rinsing a coffee mug after noticing a stain.	0	0	Normal		
34	Struggling with distressing doubts about harming someone accidentally.	1	3	Intrusive Thoughts		
35	Adjusting curtains to ensure they hang evenly.	1	2	Symmetry and Ordering		
36	Rechecking all appliances multiple times before leaving the house.	1	3	Checking		
37	Briefly confirming an alarm is set before bed.	0	0	Normal		
38	Keeping empty boxes in case they become useful for storage.	1	1	Hoarding		
39	Wearing gloves to avoid contact with communal surfaces in public.	1	2	Contamination		

Preprocessing Techniques:

Advanced Preprocessing

```python
def preprocess_text(text):
    # Convert text to lowercase
    text = text.lower()
    # Remove punctuation and numbers
    text = re.sub(r"[^a-z\s]", "", text)
    # Tokenize the text
    tokens = word_tokenize(text)
    # Remove stop words
    tokens = [word for word in tokens if word not in stopwords.words("english")]
    # Join the tokens back into a single string
    return " ".join(tokens)
```

Python

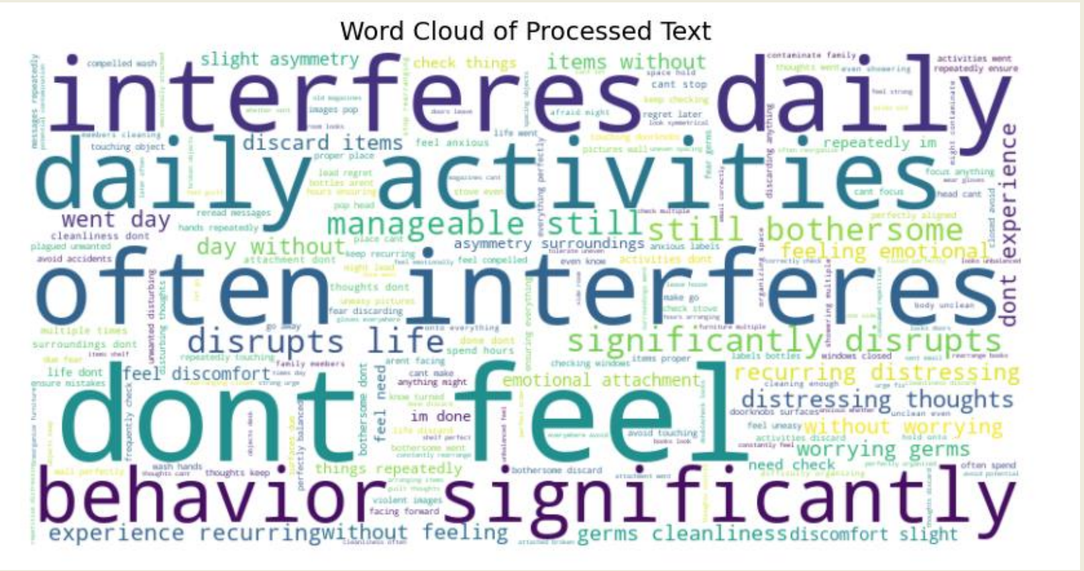
Apply text preprocessing

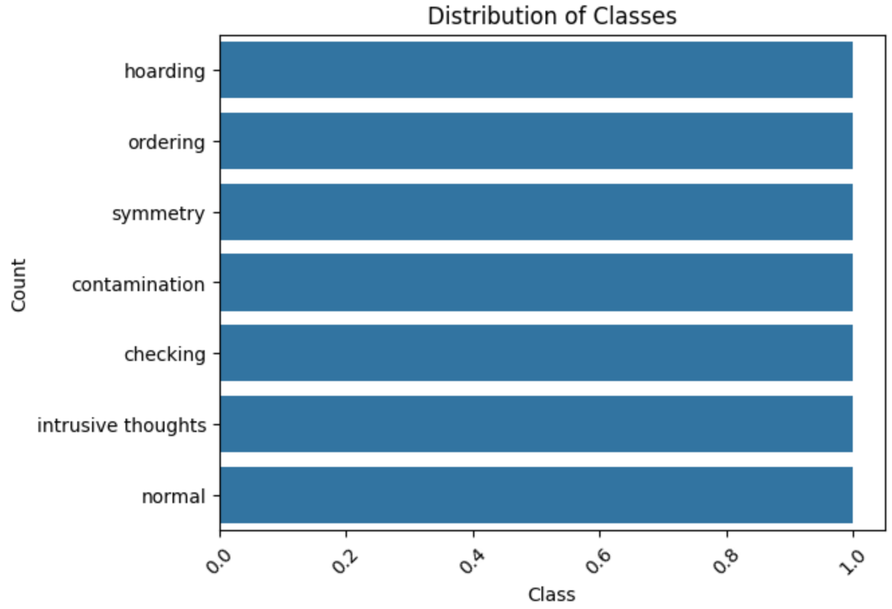
```python
data["processed_text"] = data["episode_text"].apply(preprocess_text)
```

Python

Methodology – Evidence of Completion

Data Visualization





Full Classification Report:

	precision	recall	f1-score	support
0	1.00	1.00	1.00	192
1	1.00	1.00	1.00	66
2	1.00	1.00	1.00	61
3	1.00	1.00	1.00	81
accuracy			1.00	400
macro avg	1.00	1.00	1.00	400
weighted avg	1.00	1.00	1.00	400

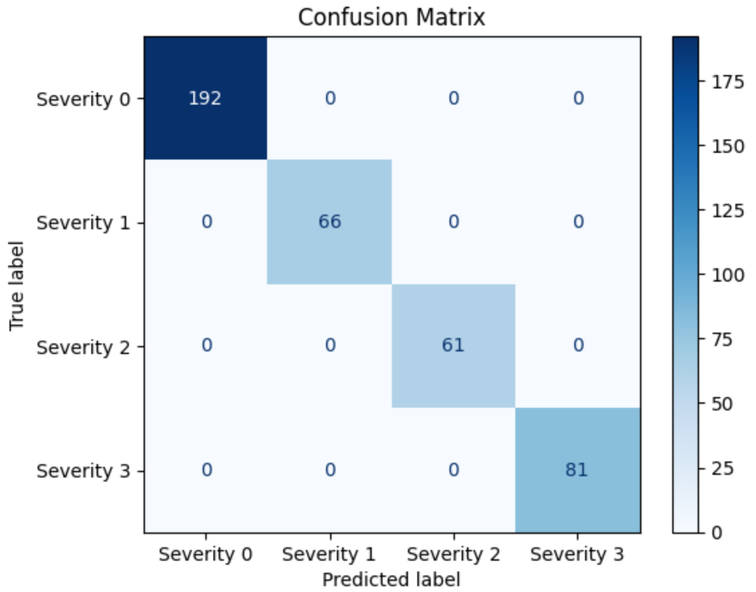
Methodology – Evidence of Completion

Evaluation Results

[500/500 12:53, Epoch 5/5]

Epoch	Training Loss	Validation Loss	Accuracy	Classification Report
1	0.000200	0.000112	1.000000	precision recall f1-score support normal 1.00 1.00 1.00 223 intrusive thoughts 1.00 1.00 1.00 26 checking 1.00 1.00 1.00 25 contamination 1.00 1.00 1.00 36 symmetry 1.00 1.00 1.00 28 ordering 1.00 1.00 1.00 39 hoarding 1.00 1.00 1.00 23 accuracy 1.00 400 macro avg 1.00 1.00 1.00 400 weighted avg 1.00 1.00 1.00 400
2	0.000100	0.000056	1.000000	precision recall f1-score support normal 1.00 1.00 1.00 223 intrusive thoughts 1.00 1.00 1.00 26 checking 1.00 1.00 1.00 25 contamination 1.00 1.00 1.00 36 symmetry 1.00 1.00 1.00 28 ordering 1.00 1.00 1.00 39 hoarding 1.00 1.00 1.00 23 accuracy 1.00 400 macro avg 1.00 1.00 1.00 400 weighted avg 1.00 1.00 1.00 400
3	0.000100	0.000040	1.000000	precision recall f1-score support normal 1.00 1.00 1.00 223 intrusive thoughts 1.00 1.00 1.00 26 checking 1.00 1.00 1.00 25 contamination 1.00 1.00 1.00 36 symmetry 1.00 1.00 1.00 28 ordering 1.00 1.00 1.00 39 hoarding 1.00 1.00 1.00 23 accuracy 1.00 400 macro avg 1.00 1.00 1.00 400 weighted avg 1.00 1.00 1.00 400
4	0.000000	0.000033	1.000000	precision recall f1-score support normal 1.00 1.00 1.00 223 intrusive thoughts 1.00 1.00 1.00 26 checking 1.00 1.00 1.00 25 contamination 1.00 1.00 1.00 36 symmetry 1.00 1.00 1.00 28 ordering 1.00 1.00 1.00 39 hoarding 1.00 1.00 1.00 23 accuracy 1.00 400 macro avg 1.00 1.00 1.00 400 weighted avg 1.00 1.00 1.00 400
5	0.000000	0.000031	1.000000	precision recall f1-score support normal 1.00 1.00 1.00 223 intrusive thoughts 1.00 1.00 1.00 26 checking 1.00 1.00 1.00 25 contamination 1.00 1.00 1.00 36 symmetry 1.00 1.00 1.00 28 ordering 1.00 1.00 1.00 39 hoarding 1.00 1.00 1.00 23 accuracy 1.00 400 macro avg 1.00 1.00 1.00 400 weighted avg 1.00 1.00 1.00 400


```
Evaluation Results: {'eval_loss': 3.0792783945798874e-05, 'eval_accuracy': 1.0, 'eval_classification_report': '                    precision    recall  f
1-score   support\n\n            normal       1.00      1.00      1.00       223\nintrusive thoughts       1.00      1.00      1.00        26\n
checking       1.00      1.00      1.00        25\n     contamination       1.00      1.00      1.00        36\n          symmetry       1.00      1.00
1.00        28\n          ordering       1.00      1.00      1.00        39\n          hoarding       1.00      1.00      1.00        23\n\n          acc
uracy                           1.00       400\n         macro avg       1.00      1.00      1.00       400\n      weighted avg       1.00      1.00
1.00       400\n', 'eval_runtime': 5.7731, 'eval_samples_per_second': 69.287, 'eval_steps_per_second': 4.33, 'epoch': 5.0}
```

Methodology – System, Personal, and Software Specification Requirement

Functional Requirements

- Develop a dynamic 15 to 20-questions questionnaire with algorithmic question ordering to assess OCD presence, severity, and subtype.
- Capture and convert patient voice recordings to text using ASR API, and identify severity and the subtype using finetuned BERT model.
- Analyze pitch fluctuations using Librosa to derive insights into the patient's emotional state and behavior.
- Integrate results from questionnaire, OCD episode analysis, and pitch analysis using ensemble learning for a final diagnosis or severity level.

Non-Functional Requirements

- Ensure efficient processing of questionnaire responses and voice data with minimal latency.
- Design an intuitive, user-friendly mobile application interface accessible to users with varying technical expertise.
- Support multiple users and large datasets, scaling to accommodate growth.
- Implement strong encryption for data security, ensuring compliance with GDPR, HIPAA, and other regulations to protect patient confidentiality and handle sensitive information securely.

Software requirements

- Python
- Flask
- React Native
- Librosa
- ASR APIs
- Jupyter
- NLTK, scikit-learn

Personal requirements

- Dr. Roshan Fernando: Psychiatrist guiding the overall research project, providing insights into OCD diagnosis and treatment methodologies.
- Ms. Sandaru Fernando: Psychologist assisting in the development of the dataset and providing expertise in psychological assessment.

Methodology – Completion and Future Works

60% Completion of the component

- Created a Comprehensive Dataset
- Developed **BERT-based models** for predicting
- Implemented **dynamic questionnaire** based on Y-BOCS and OCI-R standards.
- Integrated Flask APIs for real-time predictions of subtype and severity.
- Integrated the dynamic questionnaire with Mobile App.

40% Future Enhancements

- Implement the Speech to Text Conversion of OCD episodes using ASR Api.
- Implement voice pitch fluctuation analysis part.
- Combined the results of Questionnaire, OCD Episode analysis and Voice Pitch Analysis.
- Implement the UI Design and API Integrations.
- Integrate and Test the application.

References

[1] B. Pascual-Vera, M. Roncero, G. Doron, and A. Belloch, “Assisting relapse prevention in OCD using a novel mobile app–based intervention: A case report,” *Bulletin of the Menninger Clinic*, vol. 82, no. 4, pp. 390–406, Dec. 2018, doi: https://doi.org/10.1521/bumc.2018.82.4.390.

[2] M. Gershkovich et al., “Integrating exposure and response Prevention with a mobile app to treat Obsessive-Compulsive Disorder: Feasibility, Acceptability, and preliminary Effects,” Behavior Therapy, vol. 52, no. 2, pp. 394–405, Mar. 2021, doi: 10.1016/j.beth.2020.05.001.

[3] T. D. Hull and K. Mahan, “A Study of Asynchronous Mobile-Enabled SMS Text Psychotherapy,” *Telemedicine journal and e-health : the official journal of the American Telemedicine Association*, vol. 23, no. 3, pp. 240–247, 2017, doi: https://doi.org/10.1089/tmj.2016.0114.

[4] E. McIngvale, C. Bakos-Block, J. Hart, and P. S. Bordnick, “Technology and Obsessive Compulsive Disorder: An Interactive Self-Help Website for OCD,” *Journal of Technology in Human Services*, vol. 30, no. 2, pp. 128–136, Apr. 2012, doi: https://doi.org/10.1080/15228835.2012.699368.

Enhanced Exposure and Response Prevention Therapy

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Specialization: Software Engineering

Introduction

Background

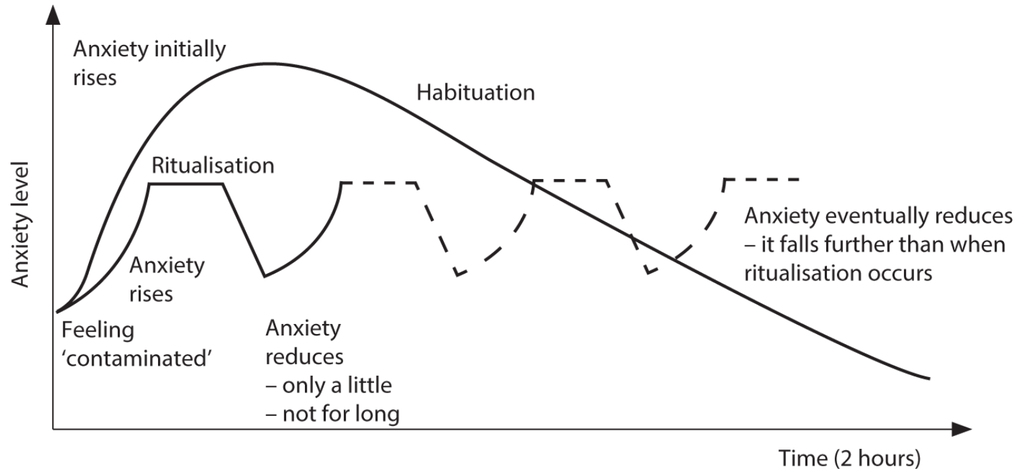
- Exposure and Response Prevention(ERP) therapy is commonly used treatment by psychiatrists for patients diagnosed with Obsessive-Compulsive Disorder(OCD).
- Exposure and Response Prevention(ERP) therapy, have proven effective in reducing symptoms and improving outcomes for OCD patients.
- Enhanced Exposure and Response Prevention(VERP) is an innovative approach to treating OCD patients.
- VERP uses advanced technology to simulate OCD-inducing scenarios and integrates biometric data to enhance the effectiveness of traditional exposure therapy.
- VERP can be used to treat patients with symmetric OCD, contamination OCD, sexual orientation OCD.

Introduction

Importance of the Study

- First, the patient is exposed to an OCD-inducing scenario using images/videos.
- Then the anxiety graph is generated using patient self-reported data and bio metric data.
- Patients can seek the therapy on their own without consulting a doctor and reduce the symptoms of the OCD.
- Patients can monitor the effectiveness of treatment by analyzing anxiety charts.

Contamination OCD



Anxiety graph

Research Questions

- How can we virtually expose patients to OCD inducing scenarios?
- How can response prevention therapy be implemented using modern technology?
- How can the accuracy of response prevention therapy be increased using modern technology?

Objectives

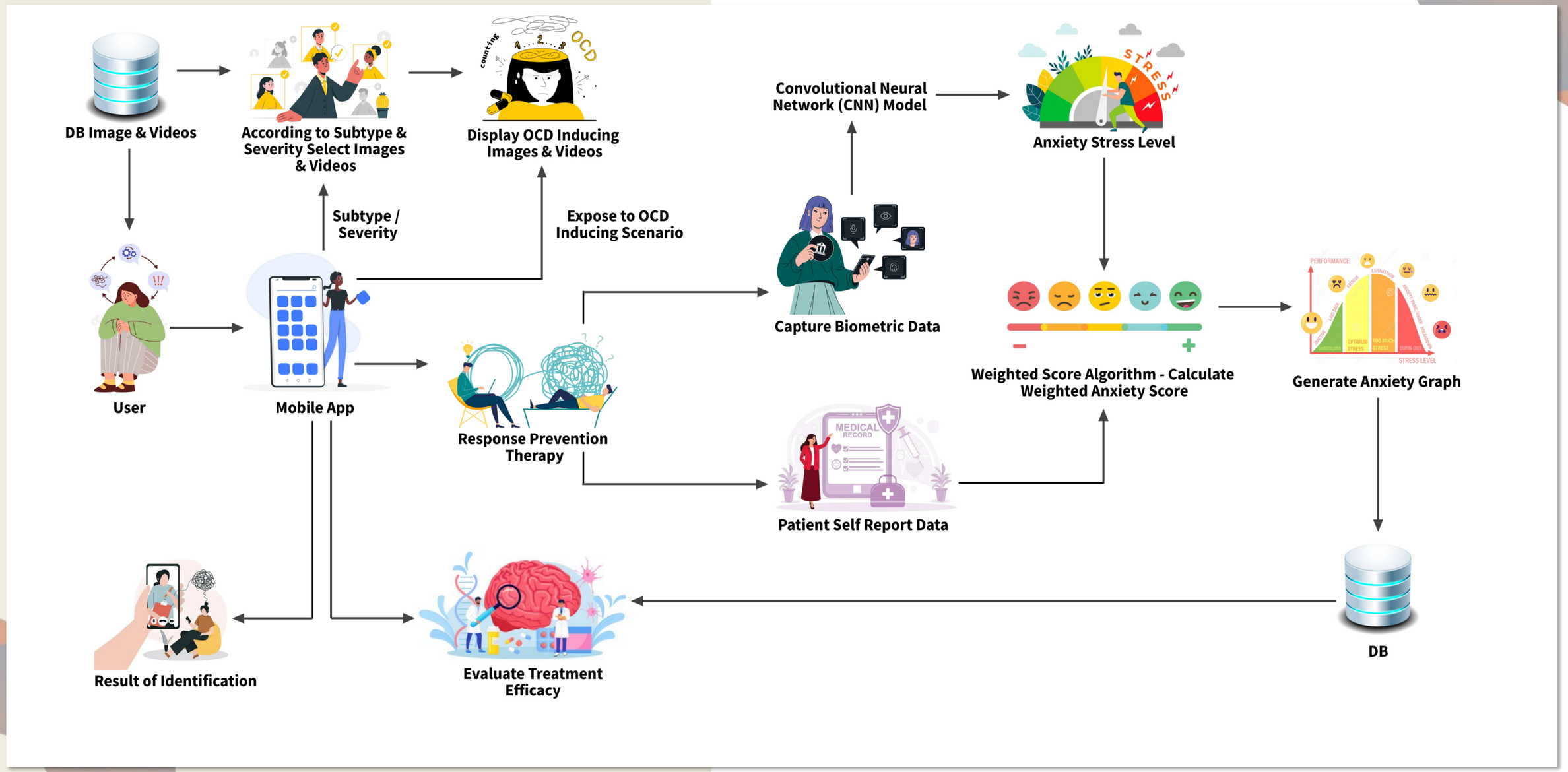
Main Objective

To develop a therapy system that utilizes virtual simulations and biometric data to effectively treat Obsessive-Compulsive Disorder (OCD).

Sub Objectives

1. Simulate real-life scenarios using tailored videos and images to expose the patient to OCD triggering scenario.
2. Capture biometric data and patient self-reported data during therapy session.
3. Generate the anxiety graph using captured biometric data and self-reported data.
4. Analyze anxiety graphs to predict the patient's treatment efficacy.

Methodology – System Diagram



Methodology – Technologies, Techniques, Algorithms

Technologies

- React
- Expo
- React Native
- TensorFlow
- Python Flask
- NodeJs
- MongoDb/Mysql
- Vscode
- Google Colab

Techniques

- Facial recognition
- Emotion detection
- Machine learning
- Deep learning
- Graph visualization.

Algorithms

- Convolutional Neural Network (CNN)
- Decision Tree algorithm
- Weighted scoring algorithm

CNN architectures

- VGG-Face
- Google Facenet
- OpenFace
- ResNet
- MobileNet

Evidence of completetion

Data Collection

Data pre-processing

Used Convolutional Neural Network(CNN) architectures for training model to detect anxiety level

Train several models using different CNN architectures to select the best architecture

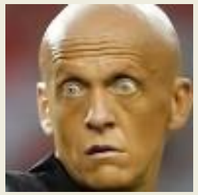
Visualized the accuracy and training and validation loss of trained models

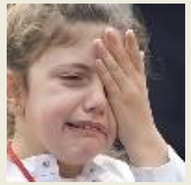
Exposure of patient to visual elements based on subtype and severity of the OCD

Data Collection and Pre-processing

Dataset name - AffectNet






Emotion Type	Image Count
Angry	599
Disgust	599
Fear	599
Happy	599
Neutral	600
Sad	599
Surprise	599
Total	4194

Data pre-processing

```
train_datagen = ImageDataGenerator(
    zoom_range=0.2,
    shear_range=0.2,
    horizontal_flip=True,
    rescale=1./255
)

train_data = train_datagen.flow_from_directory(
    directory="/content/AffectNet",
    target_size=(224, 224),
    batch_size=32,
)

train_data.class_indices
```

```
Found 10468 images belonging to 7 classes.
{'anger': 0,
 'disgust': 1,
 'fear': 2,
 'happy': 3,
 'neutral': 4,
 'sad': 5,
 'surprise': 6}
```

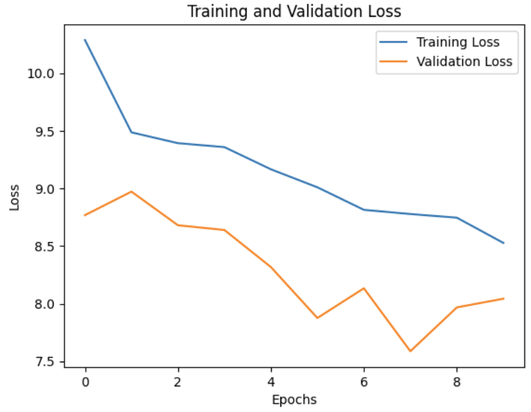
```
val_datagen = ImageDataGenerator(rescale=1./255)

val_data = val_datagen.flow_from_directory(
    directory="/content/AffectNet",
    target_size=(224, 224),
    batch_size=32,
)
```

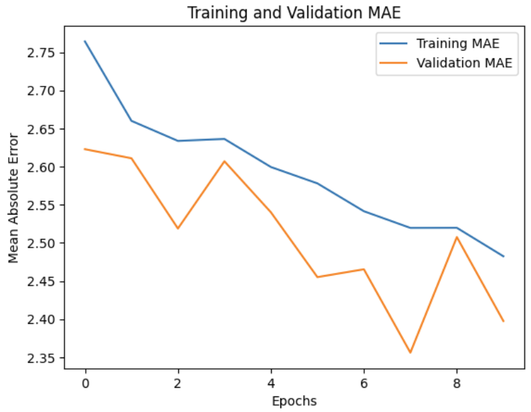
```
Found 10468 images belonging to 7 classes.
```

CNN Architectures

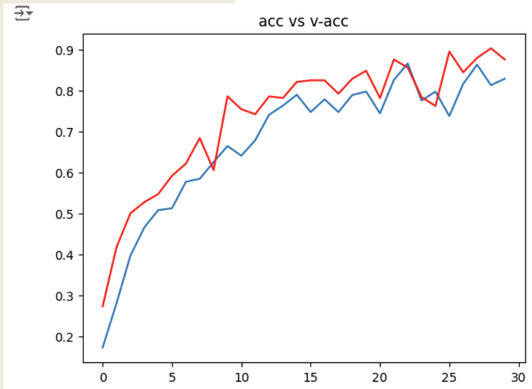
ResNet50

```
48/48 ━━━━━━━━━━━━━━━━━━━━ 290s 6s/step - loss: 1.6329 - mae: 0.9442
Validation Loss: 1.6322, Validation MAE: 0.9529
Model saved as resnet50_anxiety_model_k.keras
```

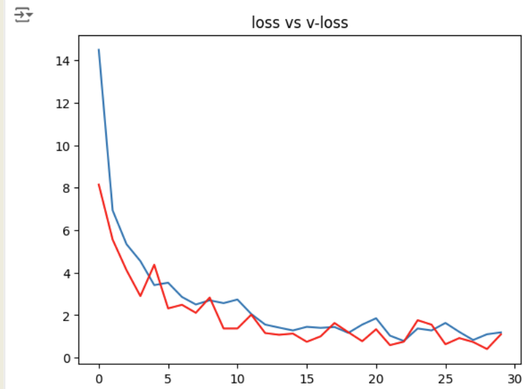




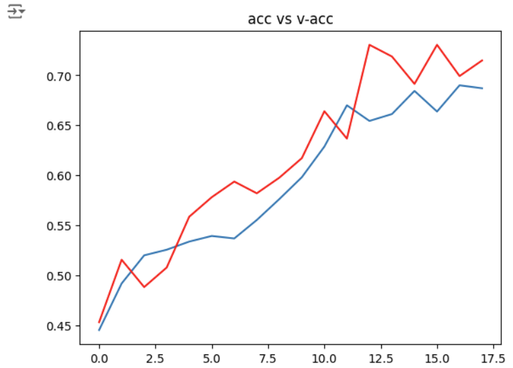
MobileNet




```
plt.plot(h['loss'])
plt.plot(h['val_loss'], c='red')
plt.title('loss vs v-loss')
plt.show()
```



VGG16




```
[22] plt.plot(h['loss'])
     plt.plot(h['val_loss'], c='red')
     plt.title('loss vs v-loss')
     plt.show()
```

Accuracy = 89.45

Methodology – System, Personal, and Software Specification Requirement

Functional Requirements

- Display appropriate image/video based on the OCD sub type and severity of the patient.
- Capture accurate anxiety/stress level using emotion detection during the therapy.
- Capture the patient self-reported data.
- Calculate the weighted anxiety score accurately using facial expression data and user input data.
- Generate the anxiety graph using the weighted anxiety score.
- Analyze anxiety graphs of the patient.

Non-Functional Requirements

- The application should be reliable and efficient.
- Interfaces should be user-friendly.
- The application should be compatible with different devices.
- Patient data must be secure.
- The results of VERP therapy must be accurate.

Software requirements

- Python
- Node
- React
- Vscode
- MongoDB/
- Google Colab

Personal requirements

- Guidance of external supervisors to acquire knowledge of healthcare domain.
- Data set to train the CNN model.

Completion and Future work

50% Completion of the component

- Collect data and pre-process the data.
- Train the CNN model to capture the anxiety level of the patient.
- Train several models using different CNN architectures to identify the most suitable model.
- Develop the backend API for retrieve visual elements based on the patient's severity and subtype of the OCD.

50% Future enhancements

- Fine tune the CNN model to achieve more accuracy.
- Implement the API to collect user data during the VERP therapy.
- Calculate the weighted anxiety score using user entered data and biometric data.
- Generate the anxiety graph using the weighted anxiety score.

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AI Supported Interactive Voice Assistant

IT21234484 | Jayasinghe P.T.
Specialization: Software Engineering

Introduction

Stigma in Society

- Mental health disorders are often stigmatized, leading to fear of judgment or discrimination.
- This stigma prevents many from openly discussing their struggles or seeking help, worsening their condition over time.

Reluctance to Seek Help

- Concerns about being labeled or misunderstood result in a hesitation to pursue traditional therapy.
- Cultural pressures and misconceptions around mental health reinforce the idea that seeking help is a sign of weakness.

Geographical Barriers

- Access to mental health services is severely limited in rural and remote areas, where traveling to see a therapist can be impractical or impossible.
- These geographical challenges create a significant gap in mental health care for those living in underserved regions.

Research Questions

How can AI supported Interactive Voice Assistant enhance accessibility and personalization of ERP therapy for OCD patients?

Objectives

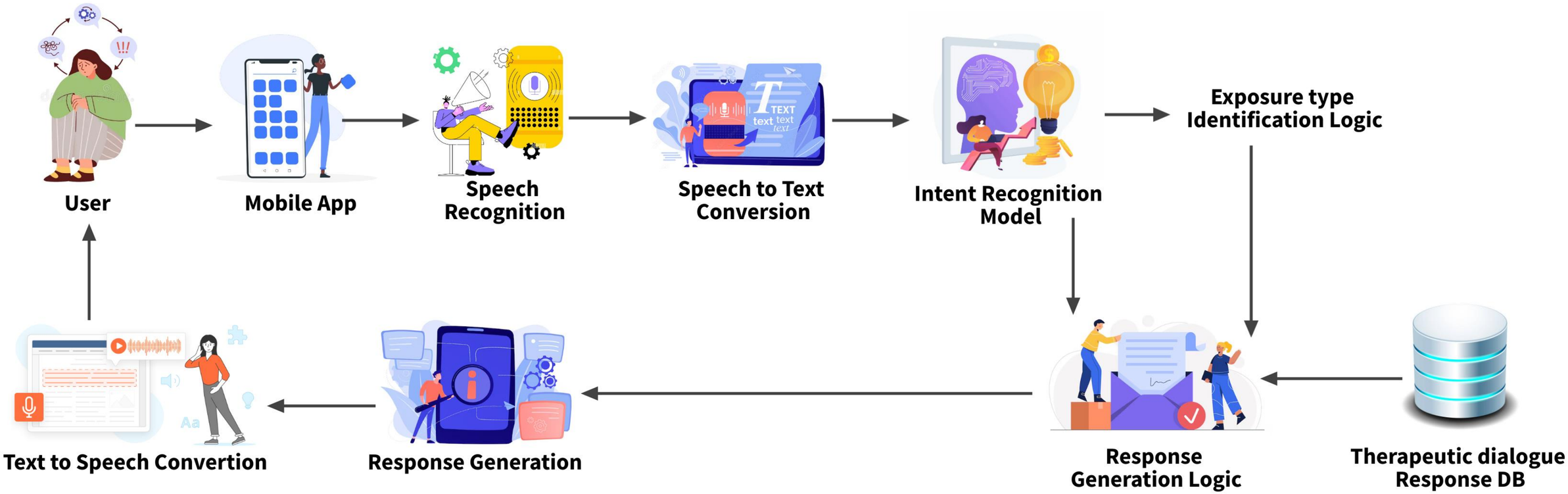
Main Objective

- Implementation of an AI-Supported Interactive Voice Assistant for ERP Therapy in OCD

Sub Objectives

- Conduct ERP Therapy Sessions for Contamination OCD Subtype.
- Identification of Exposure Type and Severity Level of patients.
- Generate Appropriate Therapeutic Responses
  - Utilize patient input to dynamically generate and provide personalized therapeutic responses during the therapy session.
- Evaluate Patient Progress and Emotional Response

Methodology – System Diagram



Methodology – Technologies, Techniques, Algorithms

Technologies

- Expo
- React Native
- Flask
- NodeJs
- MongoDb/Mysql
- Python
- Vscode
- Google Colab
- Transformers
- TensorFlow

Techniques

- Natural Language Processing
- Speech recognition
- Keyword detection
- Machine learning
- Rule-based Logic

Algorithms

- Matching Algorithm for Keyword-Based Exposure Type Detection.
- State-Based Rule Logic for Conversational Flow
- Metrics: Confusion Matrix, Classification Report.
- Loss and Accuracy Tracking Across Epochs.

Methodology – Evidence of Completion

Data Collection

Data pre-processing

Data Visualization

Fine-tuned DistilBERT for lightweight and efficient intent classification.

Tuning hyper-parameters and retrained models to select the best architecture

Implemented state-based rule logic for seamless conversational flow.

Used keyword-matching algorithms for real-time exposure type identification

Data Collection and Pre-processing

Collected conversation data

Therapist: Hi! I'm here to help guide you through today's exposure exercise. Are you ready to start?

Patient: I think so, but I'm feeling a bit anxious.

Therapist: That's completely okay. It's natural to feel anxious when doing these exercises. We're going to take it one step at a time. Let's start by finding an object that you would normally avoid touching, like a doorknob or a table surface in a public place. Do you have something in mind?

Patient: Yes, there's a doorknob here that I usually avoid touching without a tissue.

Therapist: Great. For today's exercise, we're going to touch the doorknob with your bare hand. Remember, the goal here isn't to prevent anxiety but to feel it and let it pass on its own. Are you ready to give it a try?

Patient: I think I can try, but I'm worried about germs.

Therapist: That's understandable. Remember, touching the doorknob doesn't guarantee illness. Remind yourself that your mind may be exaggerating the risk right now. Let's try it together. Just take a deep breath, place your hand on the doorknob, and hold it there for a few seconds. Go ahead whenever you're ready.

Patient: [Touches doorknob] Okay, I did it. But I feel so uncomfortable!

Therapist: That's completely normal! Notice that feeling without trying to change it. Let's take a few deep breaths together. [Pauses] How is your anxiety level right now, from 1 to 10?

Patient: Probably around an 8.

Therapist: That's intense, but it's a great step forward. Try to keep your hand relaxed and avoid rushing to wash it. Can you hold off for just a few more moments?

Patient: Okay, I'll try.

Therapist: Excellent. Remind yourself that you're building resilience. This discomfort will fade with time. You're teaching your mind that not washing immediately doesn't lead to danger. How are you feeling now?

Patient: It's still high, but maybe down to a 6.

Therapist: That's progress! Each time you do this, it will become a bit easier. Today, you've shown courage by facing your fear. When you're ready, you can let go of the doorknob.

Patient: I did it! I'm still uncomfortable, but I feel like I accomplished something.

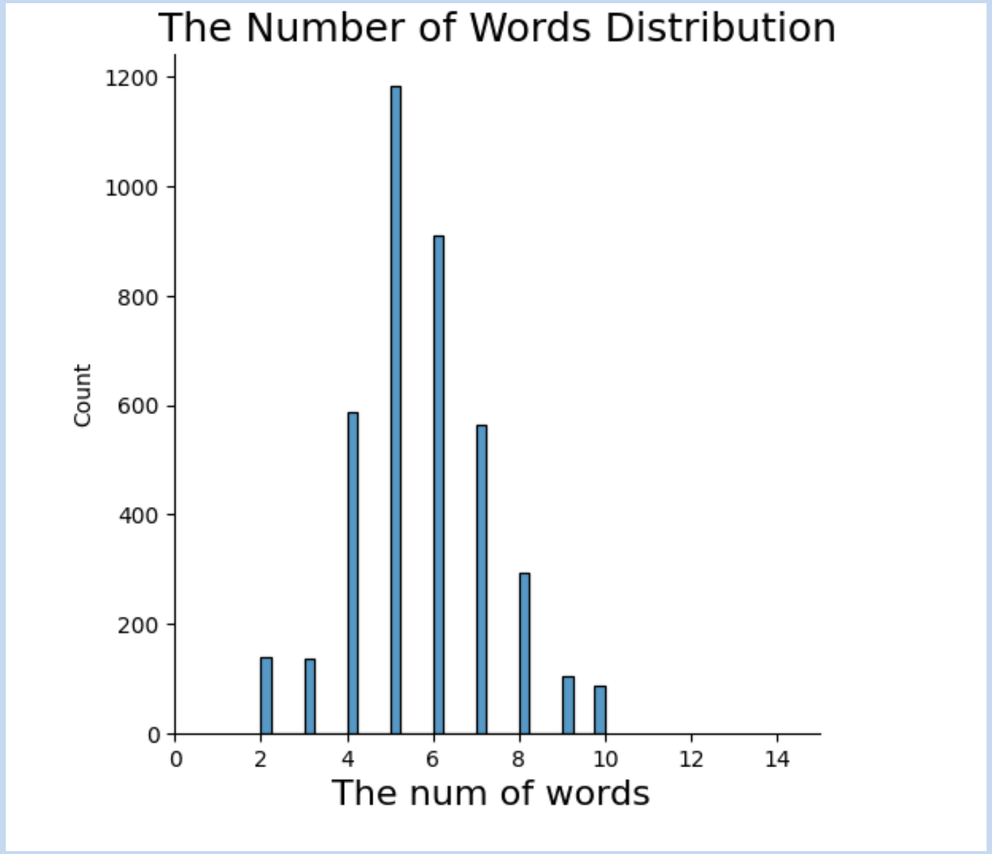
Therapist: You absolutely did. Small steps like these make a big difference. Keep this up, and remember that you have the power to tolerate the discomfort. I'm here whenever you're ready to practice again. Great job today!

Data pre-processing implementation

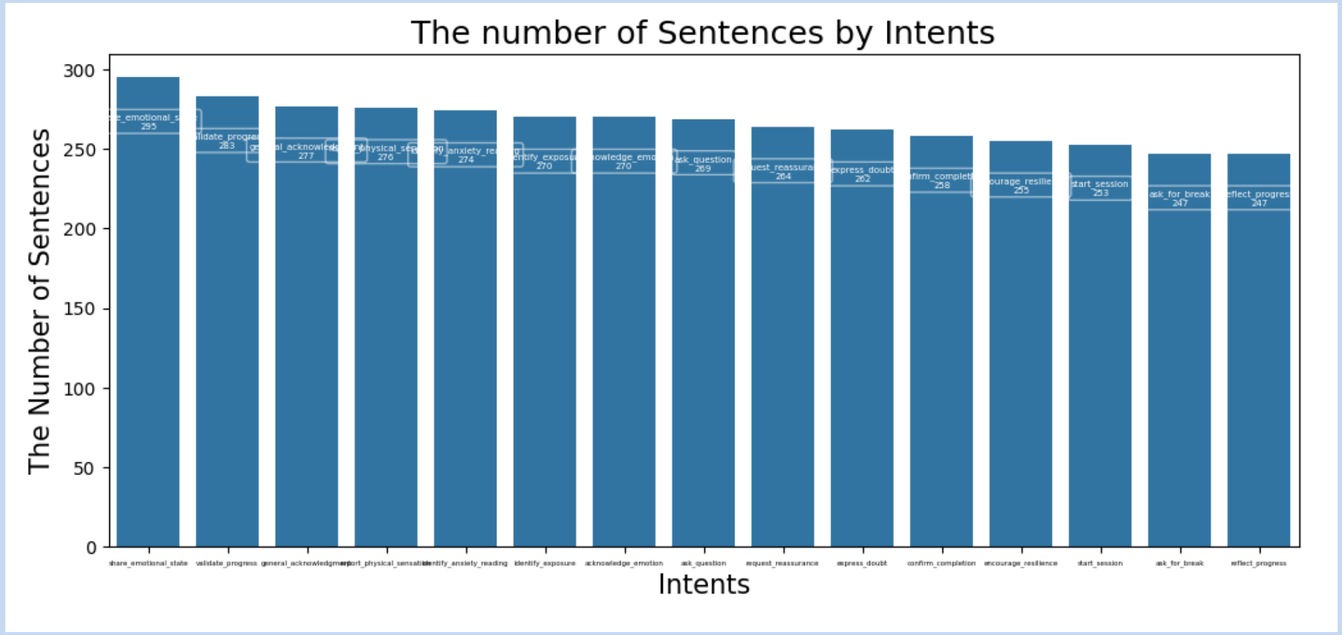
```
# Data Preprocessing
def preprocess_text(text):

    # Remove special characters and punctuations
    text = re.sub(r'[^\w\s]', '', text)  # Remove punctuations

    # Convert to lowercase
    text = text.lower()

    # Remove stopwords
    text = ' '.join(word for word in text.split() if word not in stopw)

    return text

# Apply preprocessing to the 'Text' column
df['Text'] = df['Text'].apply(preprocess_text)

# Display the first few rows after preprocessing
print("\nPreprocessed Dataset Preview:")
print(df.head())
```

```
Preprocessed Dataset Preview:
                          Text                     Intent
0              hand feels sticky  report_physical_sensation
1  feeling strange sensation palm  report_physical_sensation
2                      sure safe        request_reassurance
3              dont think manage              express_doubt
4                   okay ill try     general_acknowledgment
```

Data Visualization



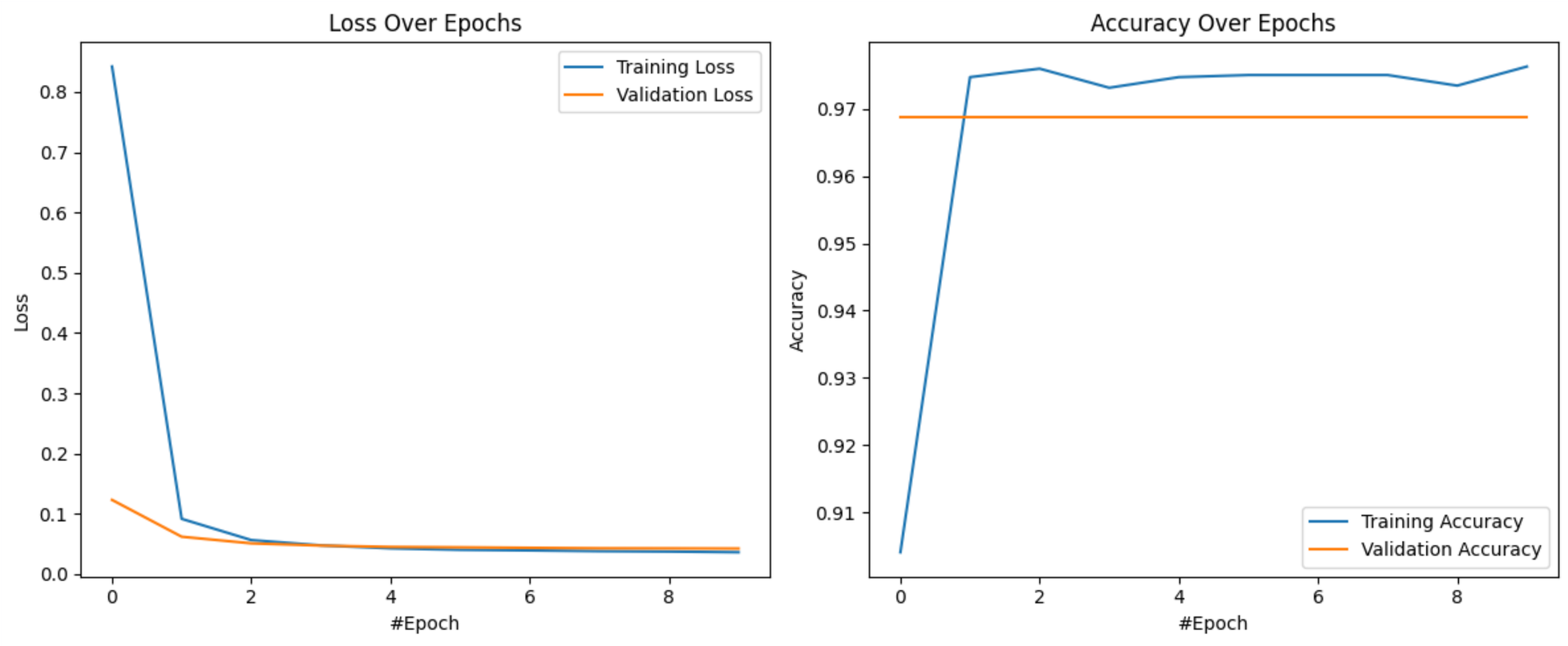

```
Dataset Info:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4000 entries, 0 to 3999
Data columns (total 2 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   Text    4000 non-null   object
 1   Intent  4000 non-null   object
dtypes: object(2)
memory usage: 62.6+ KB
None

Missing Values:
Text      0
Intent    0
dtype: int64
```



Intent Recognition DistilBERT Model

Loss – 0.0425

Accuracy – 0.9688



Functional, Non-Functional and Personnel Requirements

Functional Requirements

- Train and fine-tune a DistilBERT-based model for identifying user intents from natural language input.
- Implement keyword-matching algorithms to identify exposure types in real-time.
- Design and implement a state-based logic flow for seamless and responsive conversational management.
- Maintain a conversation state to track user progress and provide feedback dynamically.

Non-Functional Requirements

- Ensure seamless processing of audio data and keyword identification with minimal latency.
- Implement a robust and user-friendly interface that allows easy interaction between the IVA and patients.
- Ensure scalability to support a growing number of users and expanding datasets
- Provide strong data encryption and compliance with GDPR, HIPAA, and other regulations for handling sensitive patient information.

Personal requirements

- Dr. Roshan Fernando: Psychiatrist guiding the overall research project, providing insights into OCD diagnosis and treatment methodologies.
- Ms. Sandaru Fernando: Psychologist assisting in the development of the dataset and providing expertise in psychological assessment.

Completion and Future Works

65% Completion of the components

- Fine-tuned a DistilBERT-based model for accurate intent classification.
- Designed and implemented a keyword-based extraction system for identifying exposure types from user inputs.
- Developed and tested a robust rule-based conversational flow tailored to OCD treatment.

35% Future Enhancements

- Extend the IVA functionality into a React Native mobile application for better accessibility.
- Implement the Speech-To-Text and Text-Speech functionality.
- Optimize response generation.

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[3] Replika: A chatbot designed for companionship and support, offering personalized conversations but not specialized for therapeutic interventions like ERP. [Online]. Available: https://replika.ai. [Accessed: Jan. 20, 2024].

[4] Youper: An AI-powered emotional health assistant that tracks mood and offers CBT-based exercises but does not specifically focus on ERP for OCD. [Online]. Available: https://www.youper.ai. [Accessed: Jan. 20, 2024].

AI-Enhanced Video Conferencing ERP Therapy

IT21209420 | Mallawaarachchi D.E.H.

Specialization: Software Engineering

Introduction

Background on OCD

- Traditional ERP therapy for OCD needs a lot of time and specialized care, making it hard for many people to access.
- Stigma around mental health makes people hesitant to seek help, which worsens their symptoms.

Importance of the Study

- AI-enhanced video conferencing can make ERP therapy more accessible and offer personalized, real-time care.
- Using biometric analysis, this method can better monitor anxiety and stress levels, improving treatment results.

Research Questions

Primary Questions

- How does AI video therapy help OCD patients access treatment better than in-person therapy?
- How effective is AI video therapy in reducing OCD symptoms?
- How do patients feel about using AI video therapy? Is it easy and acceptable?

Secondary Questions

- How does biometric analysis help track and improve outcomes in AI video therapy?
- What are the cost differences between AI video therapy and traditional methods for patients and providers?

Objectives

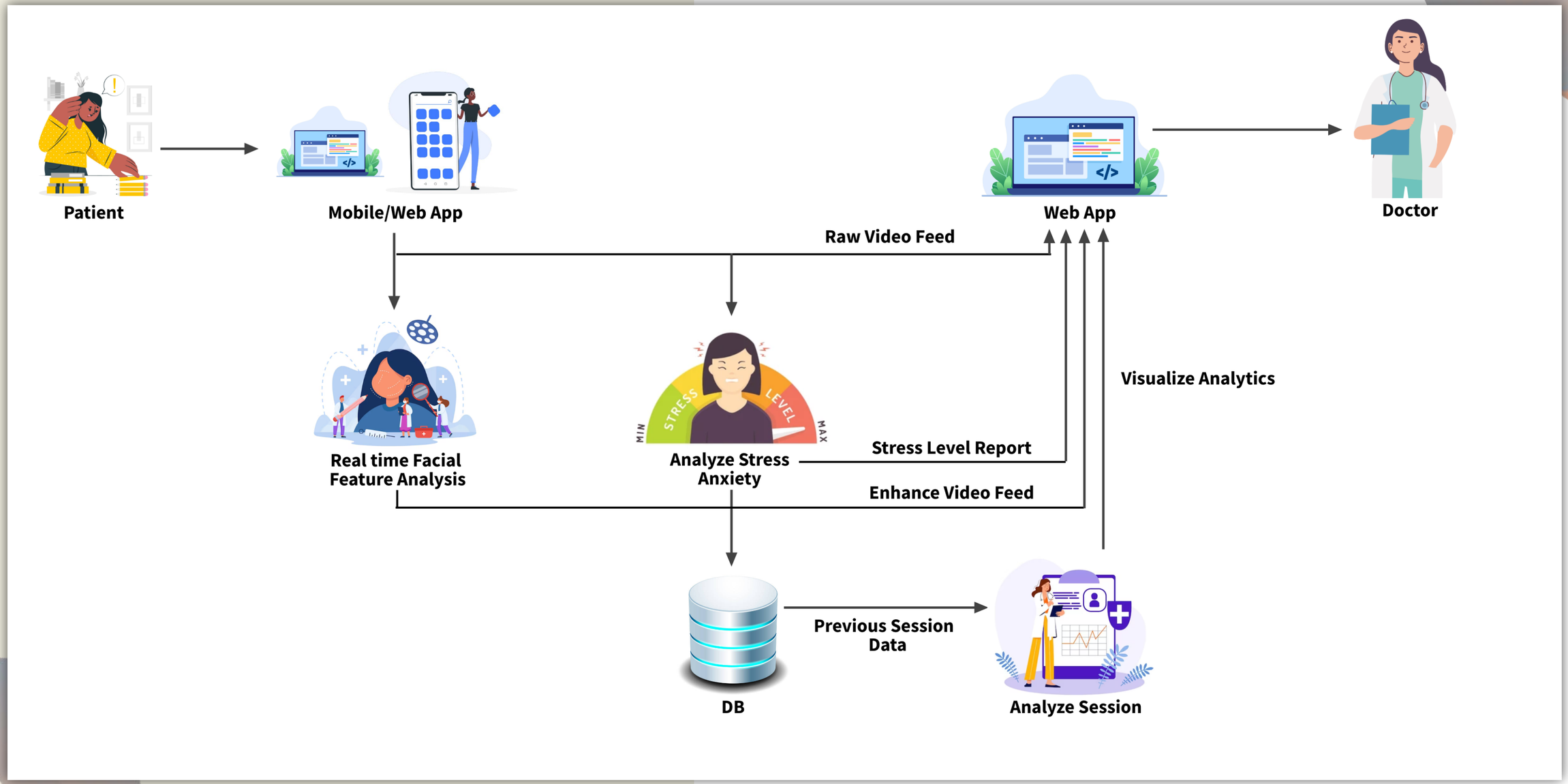
Main Objective

- **Develop an AI-Enhanced Video Conferencing ERP Therapy tool to facilitate more accessible, personalized, and effective OCD treatment.**

Sub Objectives

- **Real-time Biometric Detection:** Implement AI models to capture and analyze facial features for anxiety and stress detection during therapy.
- **Seamless Video Conferencing:** Develop a platform for uninterrupted audio-video communication between patients and therapists.
- **Session Analytics:** Provide detailed session metrics and predictive analytics to monitor patient progress.
- **Enhanced Feedback:** Display critical facial expressions alongside live video for accurate therapist assessment.

Methodology – System Diagram



Methodology – Technologies, Techniques, Algorithms

Technologies

- WebRTC
- Node.js
- socket.io
- React
- React Native
- Python Flask
- MongoDB
- Google Colab

Techniques

- Facial Recognition
- Emotion Detection
- Real-time Facial Landmark Detection
- Data Normalization
- Feature Engineering
- Data Validation

Algorithms

- MediaPipe(CNN)
- Gradient Boosting Regression

Methodology – Evidence of Completion

Data Collection

Data pre-processing

Data Visualization

Trained a Gradient Boosting Regressor

Implemented video conferencing frontend using React

Developed a signaling server using Flask to manage WebRTC connections

Implemented facial feature analysis using MediaPipe

Data Collection and Pre-processing

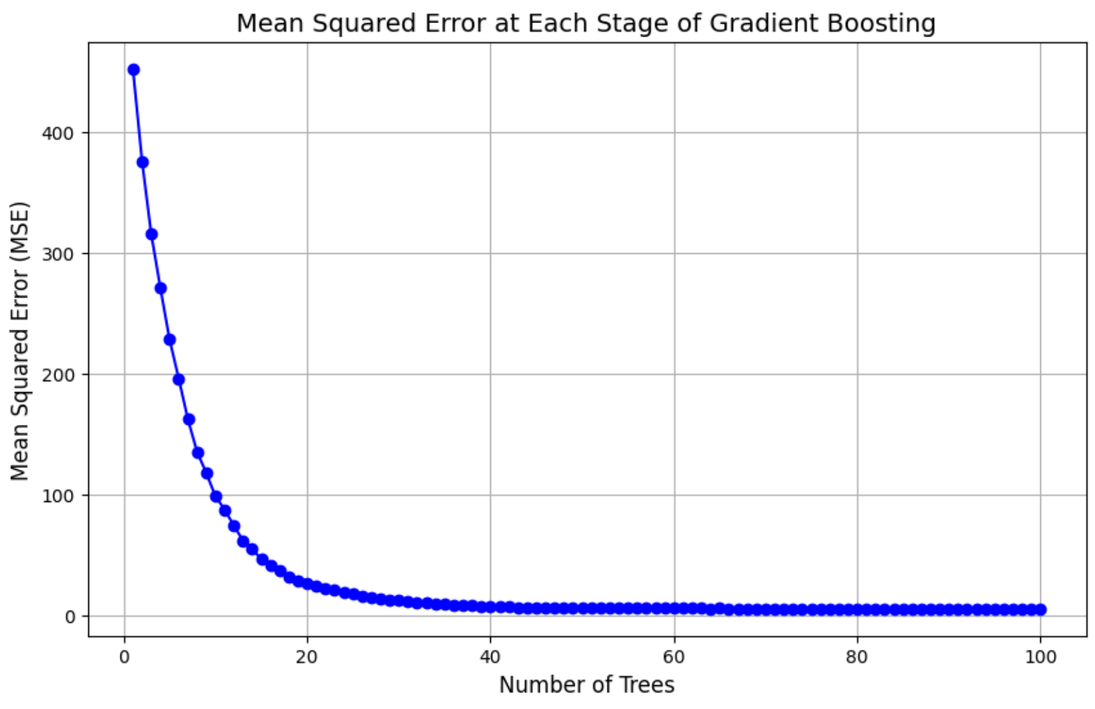
Collected ERP session anxiety details

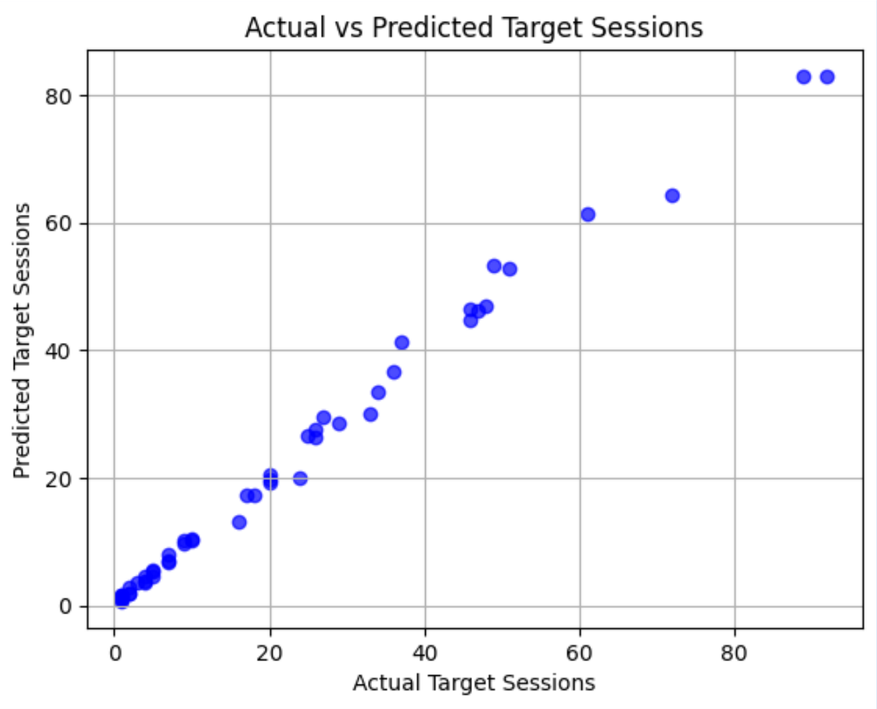
```
Session: session_1
0 85
300 83
600 83
900 82
1200 74
1500 74
1800 65
2100 58

Session: session_2
0 82
300 75
600 71
900 70
1200 70
1500 59
1800 52
 2100 50

Session: session_3
0 79
300 78
600 76
900 75
1200 73
1500 63
1800 53
2100 44
```

Data pre-processing implementation

```python
import pandas as pd
import numpy as np
from sklearn.preprocessing import MinMaxScaler


df = pd.read_csv(f"{target_path}/session_anxiety_data.csv")# Load the dataset


scaler = MinMaxScaler()
df["anxiety_level"] = scaler.fit_transform(df[["anxiety_level"]])# Normalize anxiety levels range [0, 1]

df = df[df["time_seconds"] % 300 == 0] #Filter rows to keep only data recorded at consistent 5 minute intervals


Q1 = df["anxiety_level"].quantile(0.25) # Remove rows with outlier anxiety levels
Q3 = df["anxiety_level"].quantile(0.75)
IQR = Q3 - Q1
df = df[~((df["anxiety_level"] < (Q1 - 1.5 * IQR)) | (df["anxiety_level"] > (Q3 + 1.5 * IQR)))]



session_features = df.groupby("session_id").apply(lambda x: pd.Series({ # Extract session level features
    "patient_id": x["patient_id"].iloc[0],
    "doctor_id": x["doctor_id"].iloc[0],
    "average_anxiety": x["anxiety_level"].mean(),
    "anxiety_reduction_rate": (x["anxiety_level"].iloc[0] - x["anxiety_level"].iloc[-1]) / (x["time_seconds"].iloc[-1] / 300),
    "session_duration": x["session_duration"].iloc[0],
    "anxiety_variance": x["anxiety_level"].var()
})).reset_index()
```

Data Visualization





Methodology – Software, Personal, and Software Specification Requirement

Functional Requirements

- Real-time biometric analysis results should be displayed accurately to the therapist.
- Seamless audio-video communication should be maintained throughout therapy sessions.
- Session analytics should provide detailed and accurate metrics.
- Critical facial expressions and emotional states should be highlighted accurately for therapist monitoring.

Non-Functional Requirements

- Interfaces should be user-friendly and intuitive.
- The platform should be compatible with different mobile devices.
- The application should be reliable and maintain high availability.
- Results should have high accuracy in biometric analysis and emotion detection.
- The platform should be efficient in processing and displaying real-time data.

Personal requirements

- Dr. Roshan Fernando: Psychiatrist guiding the overall research project, providing insights into OCD diagnosis and treatment methodologies.
- Ms. Sandaru Fernando: Psychologist assisting in the development of the dataset and providing expertise in psychological assessment.

Completion and Future Works

65% Completion of the components

- Developed the frontend for the video conferencing tool, leveraging WebRTC for seamless real-time communication.
- Implemented a signaling server using Python Flask to facilitate video conferencing connections and signaling.
- Trained and deployed a predictive algorithm to estimate the required number of therapy sessions.

35% Future Enhancements

- Enhance the accuracy of the anxiety level detection model to ensure more precise predictions.
- Implement a robust authentication mechanism and streamline the video conferencing experience for smoother interactions.

References

[1] S. Domb, E. Manly, and D. Elman, “Pandemic patch-up: Using Zoom™ videoconferencing software to create a virtual teaching clinic,” *Canadian Family Physician*, vol. 67, no. 1, pp. 65–68, Jan. 2021, doi: https://doi.org/10.46747/cfp.670165.

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[4]K. G. Lockwood *et al.*, “Evaluating a New Digital App–Based Program for Heart Health: Feasibility and Acceptability Pilot Study,” *JMIR Formative Research*, vol. 8, pp. e50446–e50446, May 2024, doi: https://doi.org/10.2196/50446.

Thank You!