

Mental Health Evaluation and Assistance for Visually Impaired People

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Abstract

Earlier, three-person out of every 10 persons had been suffering from mental health issues but nowadays this situation became worsened due to the pandemic. The number of individuals suffering from mental health has been increasing day by day. One of the WHO reports states that 3.8% of the population has been affected due to depression. Although such an important issue in human health, still it is one of the neglected health sectors around the world. This situation is more worsened among special need people as they feel more anxiety disorders and loneliness in comparison to their sighted peers. Technology is helping us to solve several such problems which are difficult to discuss with peers and worsen over time if not taken preventively on time. The research objective of this article is to provide a technological solution using facial expression and voice-based assistance for the mental health of visually impaired people. This would especially help in monitoring the mood of visually challenged people. Their mental health can be monitored and assistance would be provided as per the severity of the situation. Mental health is analyzed based on emotion recognition from facial expressions and psychometric evaluations. A health score would be calculated which is used to judge the severity of mental health. An assessment report would also be generated and sent to the guardian of the user. The whole application is designed with a voice assistance platform using Dart (Flutter) and Firebase as storage for all interactions with the visually challenged person.

Keywords: Mental Health, Visually impaired, Depression, Monitoring and Assistance

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1. Introduction

The statistics reported in 2021 state that, across the globe, there are 1.1 billion visually impaired people. Out of these 1.1 billion people, 43 million people are blind. 295 million people face moderate to severe vision loss whereas 258 million people face mild vision impairment [1, 2]. People with visual disabilities face a lot of challenges [3, 4], both relating to their physical and mental health. In today's world, mental health disorders like depression, anxiety, and post-traumatic stress disorder (PTSD) constitute one of the most challenging problems faced by medical scientists. Moreover, individuals with visual impairment may be at a greater risk for developing mental health problems as a cause of their loneliness, negative self-perceptions, and

inability to perform activities independently. It has already been reported in the literature that visually impaired people face more frequent mood disorders and mental health issues in comparison to their sighted peers [5, 6].

Nowadays, the problems of mental health issues and mood disorders among people are getting higher due to high stress during the COVID-19 pandemic time. The pandemic harmed everyone in one way or the other. Some people lost their family members whereas others face a huge economic loss. Presently, the situation is under control, but still lots of obstacles faced by the common man. These difficulties forced the common man towards anxiety, depression, a lonely life, etc. This pandemic made life even tougher for visually impaired people. Visually impaired people don't have friends, social support, or independence in mobility; thus, they experience more loneliness than the general

population [7]. Studies from the Royal National Institute of Blind People show that two-thirds of visually impaired individuals have feelings of being less independent since the beginning of the lockdown. They're also more likely to suffer from depression and more likely to experience detrimental health outcomes as a result of self-isolation and social distancing demanded in these times. Additionally, the shortage of knowledgeable mental health professionals with training or experience in treating individuals with vision impairment and also the risk of contracting the Covid infection may create a barrier to receiving services and less accessibility for monitoring their mental health.

To overcome the above-mentioned challenges, we have designed a solution for mental health monitoring and assistance, specially designed for visually impaired individuals. As a first step towards developing virtual agents for aiding the diagnosis of mental health disorders, we'll be using psychometric evaluations and other factors like emotion recognition from facial expressions. Based on our assessment, a report will be generated, sent, and notified to the guardians/family members of the person, and some specific coping techniques will be provided to the user.

The remaining article is further arranged as follows. Section 2 summarizes the knowledge around this problem. Based on the findings summarized in Section 2, the proposed work is discussed in Section 3. Sections 4 and 5 discuss the implementation details and results of the proposed application respectively. Section 6 concludes the learnings of this work.

2. Related Work:

This section discusses the methods to examine mental health illness among visually impaired people. Literature reports that mental health issues among the visually impaired are more severe and in large numbers than among their sighted peers. Due to loneliness and limited involvement in social activities; the problems of frequent mood disorders, and emotional disturbance among adults, and children with vision loss are more frequent [6, 7]. Literature also suggests that girls with vision loss even face more problems in comparison to visually impaired boys. Mainly mental health is evaluated by the following three approaches, so the literature is grouped accordingly as shown in Figure 1. All these three approaches and the work under each category are described as follows.

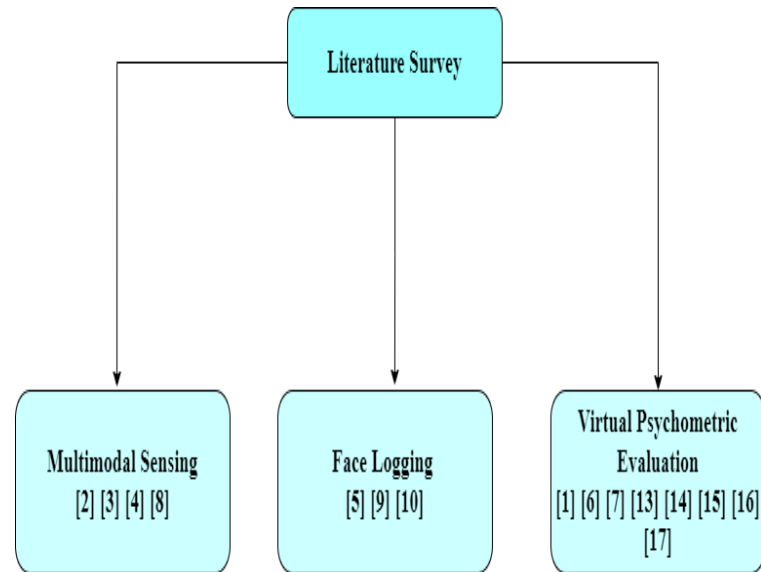


Figure 1: Diagrammatical classification of research papers

2.1 Multimodal sensing for Mental Health Monitoring -

Multimodal sensing works on the concept of multi-task learning. The multi-task learning framework is better than the single-task learning framework because related tasks are interdependent [8, 9]. If related kinds of tasks are solved in a joint framework, they will provide better results. This approach uses machine learning methods to extract meaningful information from sensory devices like smartwatches, embedded sensors (accelerometer, fingerprint, etc.), video captures, social media activity, etc. Mainly SVM and tree-based classifiers were used for detection.

Ghosal et al. [8] presented their findings by incorporating multimodal information into Dialogue graph convolution networks. Akhtar et al. [9] show that learning networks with multimodal representation are better and it can assist us in the early prediction of mental health disorders. This approach is taken up by the research community because of the automatic monitoring of mental health conditions using sensory devices [10, 11]. However, this approach had high complexity for combining the results from multiple sensors and required high computing power.

2.2 Facial Logging for Mental Health Analysis -

Mental health could be predicted according to the user's context which includes human posture, activity, location, etc. Wang et al. [12] concluded from their study that the user's context can be recognized in a better way with visual information in comparison to sensor-based information.

In this approach, Computer vision and Human Labeling techniques have been used to assess a person's mental health using their facial features. Computer vision techniques use facial expression recognition and facial landmark recognition to mark the region of interest and compute the

mental health status whereas, human labeling involves crowdsourcing techniques (like PyBossa) for evaluating the images on the grounds of facial expression, context, etc. [13, 14].

2.3 Virtual Psychometric Evaluation - This approach is based on computerized assessment techniques including objective, projective, and open-ended questionnaires. These questionnaires have been designed to test various factors related to personality traits, abilities, attitudes, etc. While designing the questionnaires, it has been kept in mind they should be concise and cover all aspects. The collected data is either transmitted to a psychologist or the result is automatically computed for further analysis. This computerized procedure is more efficient and flexible than direct human intervention. One of the studies done by Jaiswal et al. shows that there is no significant effect even if the human interviewer is replaced by a virtual agent [15]. Rather it requires less human effort and saves time in comparison to long sessions.

Various types of questionnaires for screening of mental health have been conveyed in the literature like PHQ-9, GAD-7, LVQoL, IVI, NEI-VFQ, etc. The severity of depression has been administered using Patient Health Questionnaire (PHQ-9) whereas the Generalized Anxiety Disorder (GAD-7) questionnaire is used for anxiety assessment [15]. A questionnaire designed by the national eye institute is known as NEI-VFQ (National eye institute visual function questionnaire). This questionnaire is specially designed for visually disabled people. Depression anxiety stress scales (DASS) provide us the questionnaires for depression, stress, and anxiety assessment. These questionnaires help us in capturing patient data in real time. It is considered a feasible tool for mental health monitoring and treatment in real-life conditions.

Authors of [16, 17] have shown the impact of vision disability on doing the daily chores and as a result the quality of life. Omar et al. had shown that there is a strong linkage between visual impairment and mental health. They concluded a patient's life can be improved if mental health is evaluated on time. Zheng et al. [18] showed the increased mortality rate among visually impaired people due to the impact of their disability on their mental health. The author also discussed preventive healthcare practices. Demmin and Silverstein presented that individuals with visual impairment are at greater risk for developing mental health problems, such as depression and anxiety in their research and proved it as well [19].

It can be concluded from the studied literature, that mental health is an important concern nowadays, but people hesitate in discussing this matter in front of others because it is viewed as a negative stigma in our society [20, 21]. It has also been seen that if mental disorders are not taken care of in advance, then people think about suicidal attempts. There is a strong linkage between mental health and suicides. Each suicide will not only impact their family and friends but

even has a long-lasting impact on the community and country. It has also been talked about previously that people with vision loss have additional mental health issues [22]. Thus, preventive solutions are needed for these special need people but very little work has been carried out in this direction. The following section discusses the proposed solution.

3. Proposed Work:

To handle all the above-mentioned challenges, a solution named **Mentquipo** for mental health monitoring and assistance has been proposed. The whole work of mental health analysis and assistance is divided into three phases as depicted in Figure 2. General behavior and mood analysis of the person is done in phase 1. The user's expression is captured through the camera. Facial recognition technology in terms of a Python script has been designed which analyses the captured facial expression and tags the image to different emotion categories. The major considered emotion categories are anger, contempt, disgust, fear, happiness, neutral, sadness, and surprise. A combined inference of mood analysis and expression will be produced as the output of phase -1 and stored in the database.

In the second phase, a voice assistant asks various psychometric questions to the user. Questions and their options are designed based on widely accepted scientific questionnaires, patient health questionnaires, depression anxiety stress scales, and the national eye institute visual function questionnaire. The voice assistant asks questions and users will provide the answer as per their mood and behaviours. The answers provided by the user will be recorded and stored for further analysis. Each option is associated with a certain weight age. This weight age is fixed as per the domain the question lies in and the questionnaire standards. All the selected options' weight ages are aggregated to form a complete score.

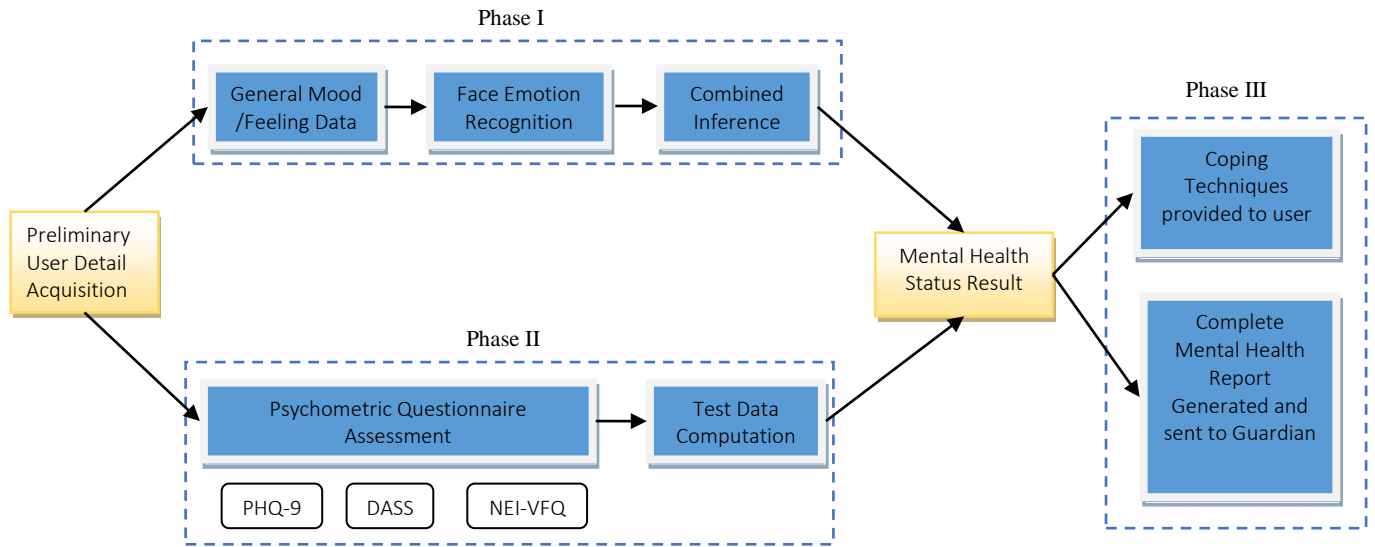


Figure 2: Control flow of the proposed work

As specified above and depicted in Figure 2, resultant of phase 1 is giving out behavior analysis based on facial recognition. The result of phase 2 is generated scores from asked questionnaires. These two are combined to produce a more reliable prediction. Based on these phases, a mental health status result will be computed. As a result, we will generate a few coping strategies like meditation, and breathing exercises personalized for the user to follow and a complete MHS report will be generated. This report will be sent and notified to the user’s guardian/family members. This work is depicted through phase 3 in Figure 2.

4. Implementation details

A solution in form of the application **Mentquipo** for the monitoring and assistance of the visually impaired has been designed. The whole application is based on a voice assistance platform, which will be responsible for all interactions with the disabled person. The user’s psychometric assessment is done through speech provided by the application. A Snippet of the implementation of voice recording is shown below in Figure 3.

```

public class VoiceRecorder extends Activity {
    private TextView list;
    private TextView create;
    private TextView goback;

    @Override protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.voicerecorder);
        GlobalVars.lastActivity = VoiceRecorder.class;
        list = (TextView) findViewById(R.id.voicerecorderlist) ;

        create=(TextView) findViewById(R.id.voicerecordercreat
        e) ;

        goback = (TextView) findViewById(R.id.goback) ;
        GlobalVars.activityItemLocation = 0;
        GlobalVars.activityItemLimit = 3;

        //HIDES THE NAVIGATION BAR
        if (android.os.Build.VERSION.SDK_INT > 11) {
            try {
                GlobalVars.hideNavigationBar(this) ;
            } catch (Exception e) {}
        }
    }
    ....
}
  
```

Figure 3: Snippet of Voice implementation

For building the mobile application, Dart (Flutter) [23] is used. For interacting and navigating the application, voice assistance is provided. Firebase is used as database storage for storing the details of the user and guardian. Figure 4 shows the code snippet to notify the family members or

guardians. The code snippet of picture uploading in Python notebook and classifying it as different emotions has been shown in Figure 5.

```

public static String getMessagePhoneNumber(String value) {
    String val1 = value.substring(value.indexOf("|") + 1, value.length());
    return val1.substring(0, val1.indexOf("|"));
}
public static String getMessageContactName(String value) {
    String val1 = value.substring(value.indexOf("|") + 1, value.length());
    String val2 = val1.substring(0, val1.indexOf("|"));
    return GlobalVars.detectNumberOrContact(val2);
}
public static String getMessageBody(String value) {
    return value.substring(0, value.indexOf("|"));
}
public static String getMessageDateTime(String value) {
    String val1 = value.substring(value.indexOf("|") + 1, value.length());
    String val2 = val1.substring(val1.indexOf("|") + 1, val1.length());
    return val2.substring(0, val2.indexOf("|"));
}
public static String getMessageID(String value) {
    return value.substring(value.lastIndexOf("|") + 1, value.length());
}

```

Figure 4: Implementation details of notification to family members

```

from fer import FER
import matplotlib.pyplot as plt
img = plt.imread("sad1.jpg")
detector = FER(mtcnn=True)
print(detector.detect_emotions(img))

```

Figure 5: Classification of Face emotion into categories

5. Results:

To use the application, **Mentquipo**, designed for the monitoring and assistance of the visually impaired, the guardian of the visually impaired person will sign up and

log in to the application. Screen details are shown in Figures 6 (a) and 6 (b). Figure 6 (a) shows the initial login screen where the user enters the application with the email ID and password. It is one-time login only. As visualized in Figure 6 (b), in the signup form, the information about the patient as well as their guardian would be collected and stored in the Firebase database. This information is collected once only and it would be further utilized at the time of authentication as well as to send the final mental health report to them.



Figure 6 (a): One-time user login

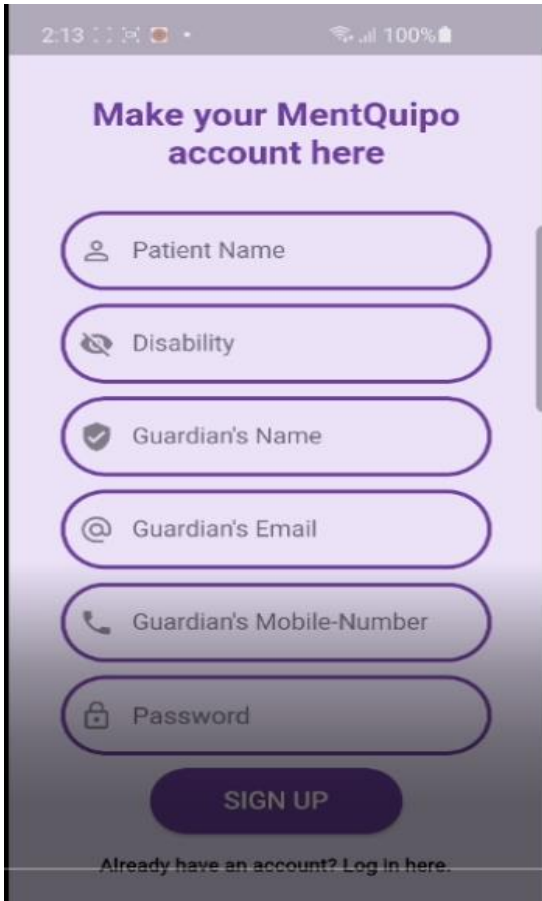


Figure 6 (b): User signup with guardian details

The whole application is based on a voice assistance platform to make it easily accessible to especially visually impaired users. For this purpose, the Alan voice platform is used. As soon as the user logs on to the system, he or she needs to greet to start Alan's voice interaction. User general mood is asked at that time and then the psychometric questionnaires namely PHQ, DASS, and NEI-VFQ would be conducted as shown in Figure 7.

The questions asked by the voice assistant have a corresponding set of options from which the user has to answer based on their emotions and experiences. For further analysis, the collected responses are preceded from the Alan voice platform to the flutter side of our application. Each of the options has a certain weightage according to the questionnaire standards and the domain that the particular question lies in, which are aggregated to form a complete score concerning every category: depression, stress, and anxiety.



Figure 7: User responding to DASS questions via speech

The visual function score is calculated by finding the mean of the scores of the individual responses to the questions. Then based on the scores, the user's mental health severity in each of the categories is determined from the severity scales of VFQ and DASS. Scales and their ranges concerning each category have been shown in Tables 1 and 2. In the questionnaire, the severity of the mental state is determined by its closeness to one of the extreme ends 0 and 100. In the end, the user's facial expression is captured as shown in Figure 8 and his emotion is analyzed. For emotion detection, a Python script is being designed that detects a variety of facial expressions and recognizes them. It classifies them into main categories which are anger, contempt, disgust, fear, happiness, neutral, sadness, and surprise.

Table 1: DASS Scale

Grades	Depression	Anxiety	Stress
Normal	0-2	0-2	0-4
Mild	3	3	5
Moderate	4-5	4	6
Severe	6-7	5-6	7-8
Very Severe	8-12	7-12	9-12

Table 2: VFQ Scale

Grades	poor	moderately bad	fairly good	good
Scale	0-25	26-50	51-75	76-100

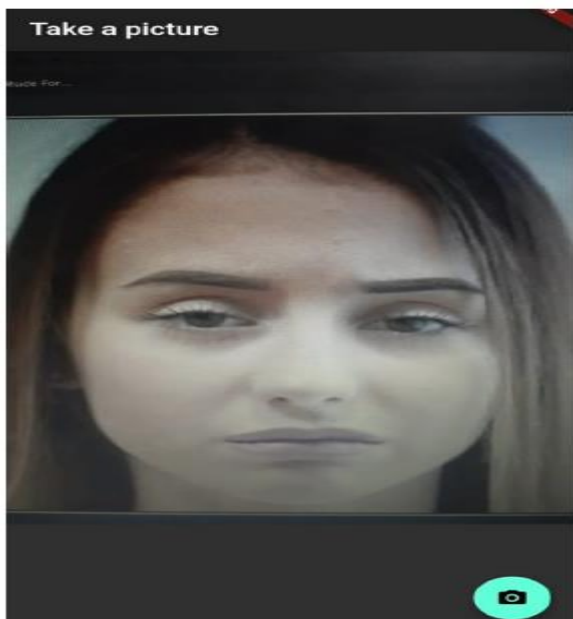


Figure 8: User’s facial expression captured

Based on the above phases, a mental health status result will be computed, and a complete mental health report will be generated in a pdf format. This report would be mailed and notified to the user’s guardian/family members as depicted in Figure 9. A short meditative exercise is played to follow along for making the user feel better and relaxed.

to me, Niharika

This is Minor pdf



Got it, thanks!

Received, thank you.

Thank you, I got it.

Figure 9: Automatically mailing of report PDF to the guardian

Mentquipo, a solution for mental health assessment has been evaluated on the population size 20. However, due to space limitations, three different test cases have been shown here in which the users had to respond to the questions asked from the psychometric questionnaires. Based on their answers, their result was computed. The result from the DASS and PHQ assessment is shown in Table 3.

Table 3: Assessment result

Test case 1	Test case 2	Test case 3
<ul style="list-style-type: none"> The Depression score was 7 and it lay in the severe category. The anxiety score was 3 and it lay in the mild category. The stress score was 6 and it lay in the moderate category. 	<ul style="list-style-type: none"> The Depression score was 3 and it lay in the mild category. The anxiety score was 8 and it lay in the very severe category. The stress score was 6 and it lay in the moderate category. 	<ul style="list-style-type: none"> The Depression score was 3 and it lay in the mild category. The anxiety score was 4 and it lay in the moderate category. The stress score was 10 and it lay in the very severe category.

The screenshots of the overall mental health status report on three different test cases are shown in Figures 10, 11, and 12 respectively.

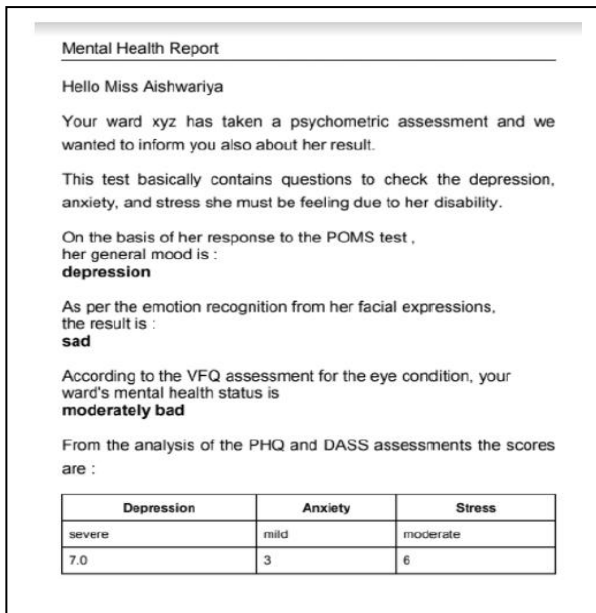


Figure 10: PDF report for a test case- 1

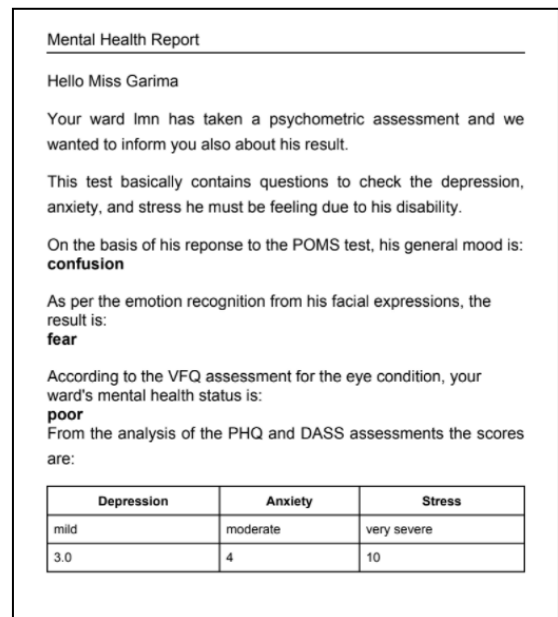


Figure 12: PDF report for test case-3

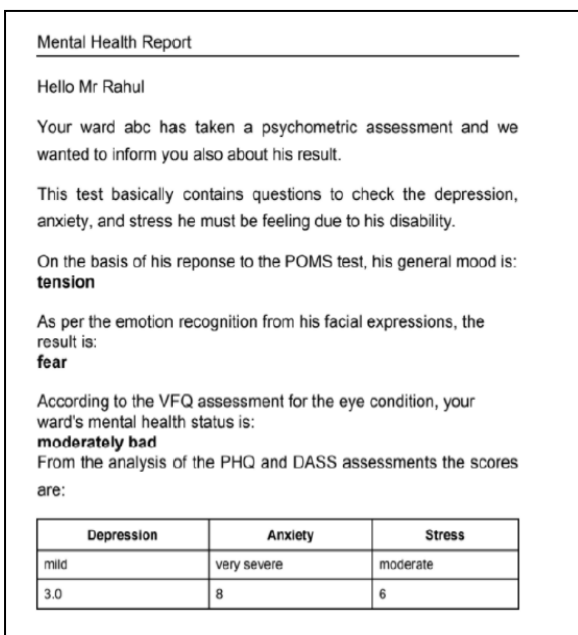


Figure 11: PDF report for test case-2

Conclusion & Future Work:

The WHO report of the year 2021 states that 3.8% of the population is suffering from depression and it is more severe in visually impaired people because they are dependent on others for all activities. They have negative self-perceptions and feel lonely. A mental health evaluation and assistance solution have been made for the visually impaired which takes user inputs via speech, in a questionnaire format and scans images for the user's facial expression. Based on these inputs, the application predicts the outcome of the mental health status of the user, whether they are experiencing any severe condition of depression, anxiety, or stress. Our application framework is based on using psychometric questionnaires (PHQ, DASS, and VFQ), facial expression analysis of images clicked from a phone camera, and feeding it to facial emotion recognition in Python script for emotion detection of the user. The algorithm behind the application computes the mental health result based on these factors and notifies the user's guardian and provides coping techniques like meditation and breathing exercises based on the user's mental health status.

In the future, this solution can experiment with large population sizes. To test the effectiveness of the proposed solution, these results could be verified by a specialist doctor. Rather than just three categories, more categories related to mental health can be incorporated in the future.

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