Mental Health Monitoring

A Design Laboratory Report Submitted
in Partial Fulfillment of the Requirements
for the Degree of

Bachelor of Technology

by

Rishit Gupta and Ambesh Dixit
(210102113 and 210102122)

under the guidance of

Dr Hanumant Singh Shekhawat

to the

DEPARTMENT OF ELECTRONICS AND ELECTRICAL ENGINEERING

INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
GUWAHATI - 781039, ASSAM

CERTIFICATE

*This is to certify that the work contained in this project entitled "**Mental Health Monitoring**" is a bonafide work of **Rishit Gupta and Ambesh Dixit (Roll No. 210102113 and 210102122)**, carried out in the Department of Electronics and Electrical Engineering, Indian Institute of Technology Guwahati under my supervision and it has not been submitted elsewhere for a degree.*

Supervisor: **Dr Hanumant Singh Shekhawat**

Assistant/Associate Professor,

Department of Electronics & Electrical Engineering,

Indian Institute of Technology Guwahati, Assam.

April, 2024

Guwahati.

Acknowledgements

I would like to take this opportunity to express my deep appreciation to everyone who has been a part of my journey in completing this bachelor's project. Your support and encouragement have been instrumental in its success.

Firstly, I extend my heartfelt gratitude to my dedicated supervisor, Dr Hanumant Singh Shekhawat. His mentorship, guidance, and patience were invaluable throughout the entire project. I couldn't have asked for a better mentor.I am grateful to my friends and classmates for their camaraderie and the countless discussions that helped me shape my ideas and refine my work. I want to acknowledge the individuals who graciously participated in my research or provided their insights. Your contributions were essential to the depth and quality of this project.

The assistance provided by the library staff, research assistants, and technical support team is also greatly appreciated. To all those who have been a part of this project, whether through direct support or in spirit, I extend my warmest gratitude. Your contributions have made this endeavor a rewarding and enriching experience.

Thank you all for being a part of this academic journey.

Rishit Gupta (210102113)

Ambesh Dixit (210102122)

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Chapter 1

Introduction

1.1 Background

Mental illness represents a significant public health concern, which can affect anyone regardless of their age, gender, race, ethnicity, religion or background. According to the World Health Organisation, "In 2019, 1 in every 8 people, or 970 million people around the world, were living with a mental disorder, with anxiety and depressive disorders the most common. In 2020, the number of people living with anxiety and depressive disorders rose significantly because of the COVID-19 pandemic. Initial estimates show a 26% and 28% increase respectively for anxiety and major depressive disorders in just one year."

Despite the continuous growth in the number of mental health disorders, there is still a lack of awareness about it among the youth, and access to proper mental help still remains a challenge for many individuals. Many factors, such as social stigma, discrimination, and lack of resources, have prevented people from seeking help, which has led to many people resorting to extreme measures such as suicide. Timely detection and effective management remain the major hurdles in mental healthcare.

Recent advancements in technology, particularly in the fields of artificial intelligence (AI), signal processing, and computer vision, offer unprecedented opportunities that can totally change mental health monitoring. Among the possible opportunities is voice pattern analyses. It has been established from different research that slight variations in speech features such as tone, pitch, and rhythm are indicative of different emotions. Speech-to-text conversion is another component of technology-assisted mental health monitoring. This feature allows for automatic transformation of spoken words into written form thus making it easier to study talk data on a large scale. In this regard, real-time transcriptions can help researchers develop evidence-based interventions or support systems based on identifying patterns, trends, and triggers related to mental illnesses.

In addition to speech analysis, computer vision also shows great potential in enhancing our mental monitoring abilities. This can be done by using cameras found in smartphones and other devices to observe behavioral cues such as facial expressions and body language, thus enabling us to track mental health in a more unified way. Experts argue that the merging of these developments into one system can change the face of mental health monitoring. Through technology, we have been given new insights into mental health issues ranging from voice patterns to transcription of talk and behavioral signals detection.

1.2 Objectives and Scope

Our project aims at creating an all-encompassing system for tracking mental health with modern technologies. Firstly, we suggest developing a real-time voice analysis module capable of accurately predicting emotional states. Next, we plan to add a speech-to-text converter that would transcribe oral communications automatically. Thirdly, OpenCV should be employed so that pill consumption levels can be identified, giving insight into whether an individual actually takes it or not. Furthermore, if the person's voice is sad without any intake of tablets, then the SIM808 module will be used for sending text messages to his/her relatives for timely intervention.

1.3 Significance

Our project utilizes technology as a means to ensure that mental health is effectively monitored. Our system combines voice analysis, speech-to-text conversion and pill detection in order to provide scalable solutions for assessing and managing mental health conditions. It also facilitates timely interventions and support by enabling real-time insights into emotional states and medication adherence. This initiative contributes towards eliminating stigmatization of the mentally ill, hence fostering inclusivity in our societies. Through technological advances, we aim to improve access to mental health care; this will greatly enhance the precision of mental care delivery, thereby leading to improved welfare and life quality for people with mental disorders.

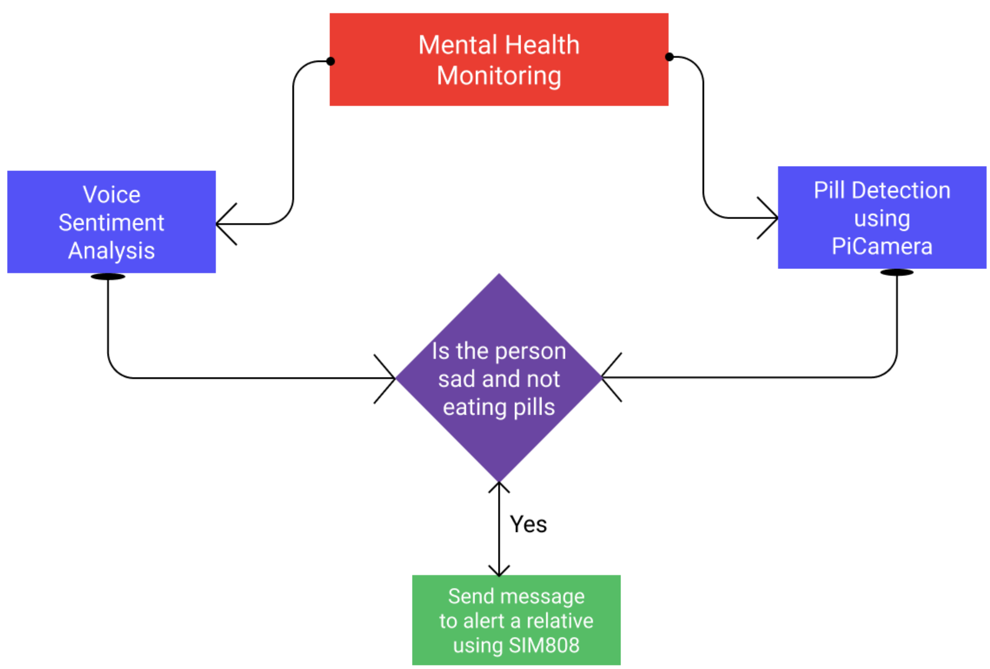

Fig. 1.1 Speech Detection and Speech-to-Text Conversion

Chapter 2

Voice sentiment Analysis

We develop the most recent developments in natural language processing to detect if a user sounds sad or happy from their voice. This helps us understand the emotional states of people through their texts, thus enabling timely assistance when it is needed.

2.1 Speech-to-Text Conversion

An important part of our mental health monitoring system is speech-to-text conversion, which changes the users' voices into written words that can be analyzed later. We employ the ‘speech_recognition‘ library to capture input from a user by using a microphone connected to his or her laptop or computer. This system eliminates background noise and ensures perfect sound quality for recording purposes.

After the voice has been recorded, we use the ‘recognize_google‘ function from ‘speech_recognition‘ to convert audio data into text. This happens with the help of Google Speech Recognition API, which is designed to translate spoken words into written format. As a result, the transcription obtained is saved as a text file on our local machine so that it can be analyzed and processed later.

2.2 SCP Module for Data Transfer

Secure Copy Protocol (SCP) module allows for secure and efficient data transfer amongst devices. This can allow one to easily transmit recorded audio files for analysis via SCP, hence enabling smooth connection between Raspberry Pi and either a laptop or PC.

With the paramiko library in Python, a secure SSH (Secure Shell) connection is formed between devices by the SCP module. The data is securely encrypted in this way to safeguard it from security threats. After making an SSH connection, the SCP module initiates an audio file transfer using the scp library's SCPClient class. This feature allows users to conveniently upload files from their local file system onto the Raspberry Pi's remote file system.

We use the SCP module to transfer data so that we can be sure our recorded audio remains safe and confidential. This enables us to easily integrate audio recordings into the mental health monitoring process, thus enabling quick response and intervention based on user utterances.

2.3 Sentiment Analysis with vaderSentiment

We utilize the VaderSentiment module, which is a lexicon-based sentiment analysis. It assigns sentiment scores to individual words and phrases in the transcribed text, enabling the determination of the overall sentiment of the user's message.

Through analyzing the sentiments expressed by users orally, our system can point out patterns and trends that may indicate several emotional states, for example, happy, sad, or neutral. In this way, our system can provide personalized support and material that takes into account an individual's current state of mind

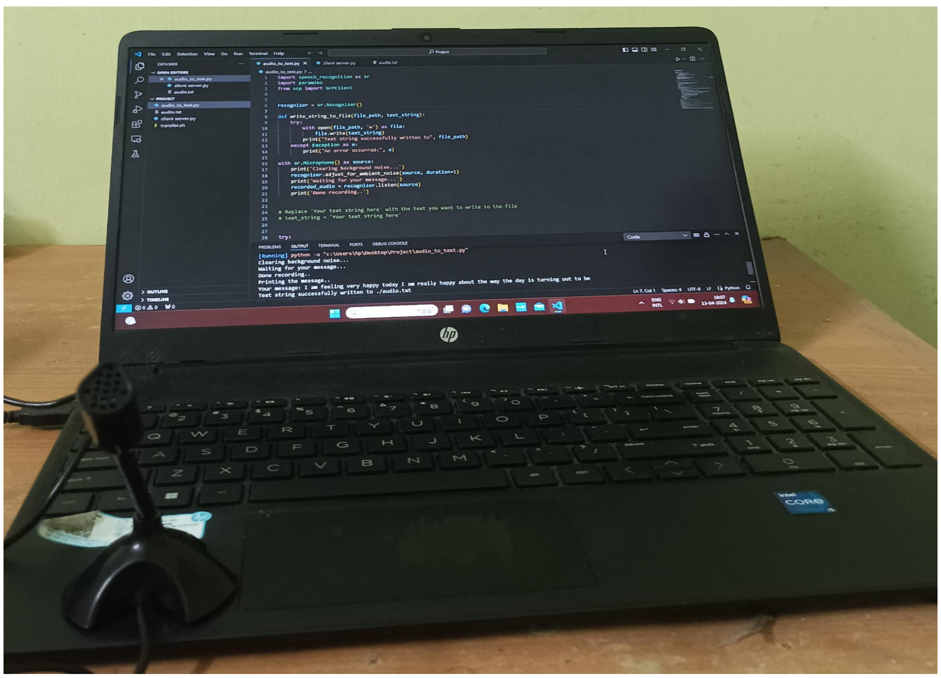

Fig. 2.1 Speech Detection and Speech-to-Text Conversion

Chapter 3

Pill Detection

For efficient mental health management, it is important that the medication be taken without fail. Unfortunately, many patients find it hard to adhere to their scheduled regimens, leading to ineffective treatment interventions and worsening of symptoms. This chapter addresses this matter by introducing an element of pill monitoring into our mental health surveillance system. Usual ways of checking whether or not medication has been taken include asking patients directly or doing random checks by medical professionals, but these methods are not reliable at all times. To improve on this, we have used computer vision technology that automatically monitors and measures drug intake in a non-invasive manner that does away with any biases.

3.1 PiCamera Setup

The PiCamera setup enables the Raspberry Pi to capture high-resolution images for subsequent analysis. For this, we need to connect the PiCamera module to GPIO (General Purpose Input/Output) pins on Raspberry Pi, carefully insert the ribbon cable into the CSI (Camera Serial Interface) port located on the board, and ensure that we enable the camera interface in settings from the Raspberry Pi once the camera has been connected.

Next, we install the necessary software requirements to control and capture images using the PiCamera module. This usually entails installing picamera Python library which provides a high-level interface for use with the PiCamera module programmatically. Henceforth, the Raspberry Pi is set up in such a manner that it captures images and stores them in the Downloads folder. These images are used as data input for the next pill detection algorithm. In a controlled environment, by taking pictures, we are able to have consistent image quality, hence improving accuracy in the pill detection process.

3.2 Pill Detection Algorithm

Here, we develop an OpenCV-based pill detection algorithm. OpenCV refers to Open Computer Vision Library which provides a real-time optimized Computer Vision library, tools, and hardware for image processing. With the help of OpenCV, the captured images are analyzed using specific algorithms designed for detecting pill objects within them. Initially, we perform some pre-processing such as grayscale conversion, Gaussian blur, and Canny edge detection on these captured images.

Afterwards, the detected edges detected dilatation process is done whereby it expands as well as links edge pixels to shape sturdier contours. In this way, the image can be handed over for pill detection using Hough Circle Transform. When pills are found in the scene, they are then identified and counted. Based on this, the algorithm is able to count them and thus provide information about how many pills have been discovered by looking at an image. This figure of count is compared with already saved figures of the detected number of pills. The given information is useful in tracking medication adherence trends over time and detecting any issues or anomalies that might arise through examining pill consumption pattern shapes

Fig. 3.1 Image clicked by Raspberry Pi for Pill Detection

Chapter 4

Remote Communication using SIM808

We add SIM808 module into our mental health monitoring system to allow remote communication with specific contacts who are triggered by extreme conditions detected by the system. Sometimes, a person's family may be living far away; hence, they would want to know if their loved one has taken his/her pills or not and his/her current mental state.

4.1 SIM808

The SIM808 module brings essential GSM/GPRS communication capabilities and SMS notification functionality. This compact design is made to integrate seamlessly with our system architecture, which supports several microcontrollers, such as Raspberry Pi. The SIM808 uses a simplified communication protocol based on an AT command interface. Standardized interfaces of this feature make it easy to communicate between Raspberry Pi and other components of the system. Such elements, for instance, support standardized and unified development when it comes to controlling data from various sources in a given application within an IoT setting. It is important to monitor applications designed for remote systems because they can be used irrespective of where a user is located and provide timely interventions.

Additionally, to enhance the flexibility of the monitoring system, the SIM808 module could also receive SMS notifications. This means Raspberry Pi components can trigger SMS notifications through it because this module works with them in this regard. So, if there may be firewalls and security restrictions that exist, these are how we can build our messages to send across any network by tweaking so that there is no other way for the two devices to talk directly. Such preemptive communication guarantees prompt interventions and, hence, better patient results overall. Our mental health monitoring system is more effective when the SIM808 module incorporates seamless integration and many functions like no other.

4.2 Integration with Raspberry Pi

Having a proper connection between the Raspberry Pi and the SIM808 module is crucial for sending messages under specific circumstances. To establish this connection, serial communication protocols are utilized. The SIM808 module connects to the Raspberry Pi via the UART (Universal Asynchronous Receiver-Transmitter) interface. In this arrangement, the TX pin of the Raspberry Pi is connected to the RX pin of the SIM808 module, and vice versa. This setup enables bi-directional communication, enabling the Raspberry Pi to transmit commands and data to the SIM808 module and receive feedback and notifications in return.

When we connect the transmitter and receiver pins, the Raspberry Pi and SIM808 module can exchange data, communicate, and control each other. This physical connection sets the stage for software interaction, with the Raspberry Pi sending AT commands to the SIM808 module over the UART interface to trigger SMS notifications and perform tasks. Ensuring a dependable physical connection between the transmitter and receiver pins of the Raspberry Pi and SIM808 module ensures seamless communication and coordination, enabling the system to send crucial SMS alerts to designated contacts. This enhances the system's capability to provide assistance. and intervene for individuals being monitored.

4.3 Triggering Message Sending

We develop a function called 'send_sms', which comprises of several steps to start and complete the process of SMS transmission. The first thing it does is to establish a serial connection with the SIM808 module, by using the class serial.Serial from the serial module. It is through this connection that Raspberry Pi communicates with the SIM808 module. Then, configure the SIM808 for SMS text mode via the AT+CMGF=1 command. This mode allows interpreting commands related to short messages or even handling them in a good manner. After configuring, we need to set the recipient's phone number using the AT+CMGS command. This process includes inserting the phone number into the command string as an argument.

Once we have provided the relative's phone number, we can then include the message text as an argument to form the body of the SMS when creating it. To accomplish formatting and comprehension by the SIM808 module, this message content has been converted into bytes before being sent out. Finally, after typing in the message text, you enter Ctrl+Z (ASCII code 26) to show the end of the message, and the send button is pressed; this makes the SIM808 module forward such an SMS to target users. After sending the data, the program checks for a response from the SIM808 module to confirm whether the transmission was successful. Once the response is received, the program then closes the connection to the module to free up resources.

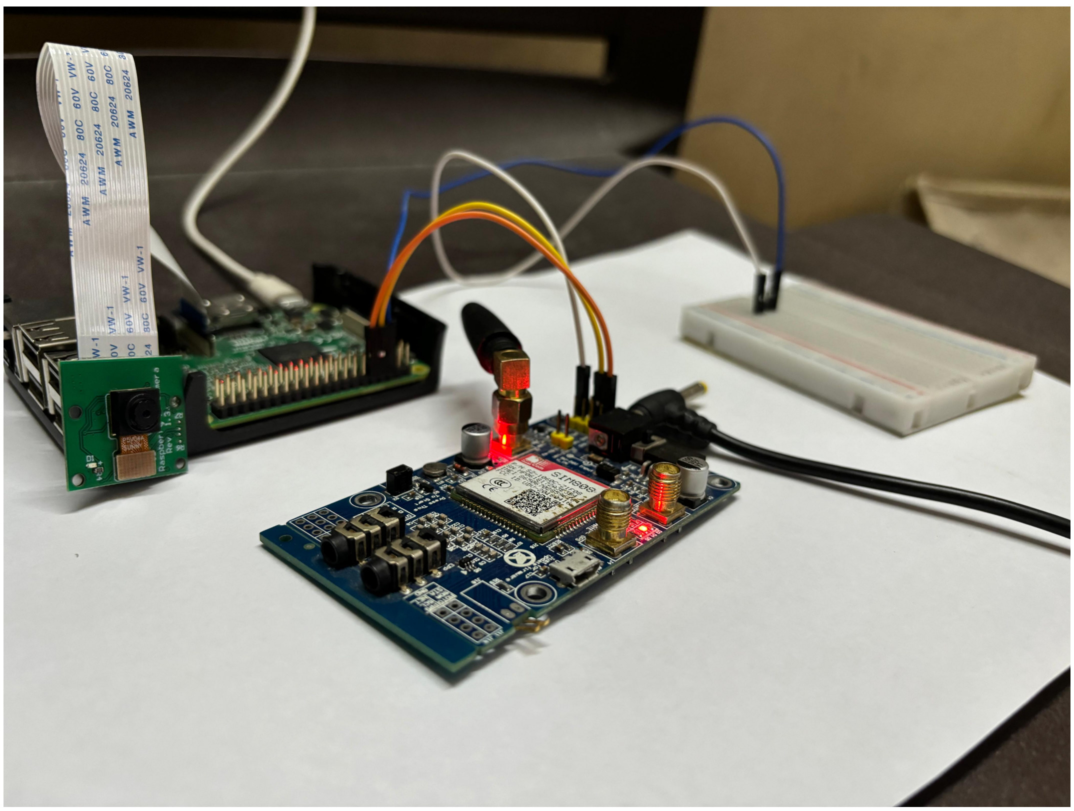

Fig. 4.1 Raspberry Pi with PiCamera and SIM808 Module for Remote Monitoring

Chapter 5

Conclusion and Future Work

In conclusion, our project on monitoring mental health has demonstrated how technology can be utilized to tackle mental well-being issues with creative solutions. Through the utilization of voice-based sentiment analysis and pill detection with the PiCamera, we have created a holistic system that can monitor important mental health indicators and provide interventions when needed. In addition to that, pill detection can help users monitor whether they are taking pills and help people who are struggling to manage their medications.

We can, therefore, make changes to our work so that we improve it in the future. The adaptation of algorithms to better identify if someone is happy or sad has been suggested as another area of research. This is followed by more advanced machine learning techniques for predictive modeling, which are also useful in determining mental health problems before they get worse, and as a result, this may help reduce suicidal cases. Improving on the user interface and accessibility features of our system would possibly enhance engagement and encourage users to stay with the process of monitoring. Ensuring that it is efficient, however, will require collecting feedback from end-users during the development phase and hence incorporating them into the design of such systems.

In terms of future development, enhancing the system's functions to incorporate more monitoring factors like sleep patterns, physical activity levels, or social interactions could offer a more comprehensive understanding of users' mental health. Furthermore, carrying out long-term studies to assess how effective and impactful the system is in real-life situations will be essential for confirming its usefulness and informing future improvements.

In general, our mental health monitoring project is a positive advancement in using technology to aid mental well-being and enhance outcomes for those dealing with mental health challenges. We wish to create a strong and user-focused solution through constant innovation and improvement. Our goal is to empower individuals to manage their mental health and lead a healthier and happier life.

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