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Calmify: Novel Way to Monitor the Mental Health using IoT

Harmanjot Singh
harmanjotsingh.in@gmail.com
Jodhamal Public School, Jammu, Jammu and Kashmir

ABSTRACT

Emotional and mental health is important as it encompasses our psychological, emotional and social wellbeing. It plays a vital role in the health of our relationships, allowing us to adapt to changes in life and deal with adversity. The Covid-19 pandemic has had a major impact on our lives. Many of us are facing challenges that can be stressful, overwhelming and cause strong emotions in adults and children. One in four people in the world will be affected by mental or neurological disorders at some point in their lives. Around 450 million people currently suffer from such conditions, placing mental disorders among the leading causes of ill-health and disability worldwide. Considering this as quintessential and need of the hour, I have developed Calmify a full mental wellness Tech package to help and discover ways to take a healthy approach to your emotional wellness. It includes a mobile application along with a novel and innovative Mental Wellness Smart Glove, which will surely help people to cope with stress in a healthy way. IoT technologies have a great potential in mental health for diagnoses, treatment, and care due to the increased ability to collect real-time data indicating patterns of activity and behaviour of people. On that note, I developed Calmify as a IoT based Bio Medical Embedded System that aims to provide a mental health solution that is efficient, cost effective, feasible, easy to use and most importantly affordable for everyone. The smart glove is a wearable device that can monitor the mental wellbeing of the patient and provide ML predictions on the onset of serious mental health issues using psychophysiological signals obtained from unobtrusive smart sensors embedded in the glove which can be carried during the daily life routines of individuals. Overall, it will be helpful in providing proactive healthcare to the patients.

Keywords— *Mental Health, Emotional Wellbeing, stress detection, mental health problems, mobile application, mental wellness smart glove, wearable device, sensors, Internet of Things (IoT), Bio Medical Device, Embedded Systems, monitoring solution, machine learning , prediction, daily lif e psychophysiological data*

1. INTRODUCTION

1.1 Problem Statement

People with a strong mind are mentally tough and can adapt well to any situation in life. In today's world, everyone is stressed, anxious and worried. Regardless of the circumstances, the best support for a person is their mental strength and wellbeing. Daily life Stress is a pertinent and escalating problem of modern society. It has become an inescapable part of our daily lives. If stress is not handled properly, it could result in serious health issues and in some severe cases, even physical injury. Researchers have found that stress should be handled when the symptoms originate initially to avoid long-term consequences. In other words, early detection will decrease the damage to our mental health and prevent it from becoming a chronic disease. Henceforth, this paper sets out to address this problem and propose a IoT based mental health monitoring system that makes use of smart unobtrusive physiological sensors and advanced ML algorithms that can be realistically applicable to daily life to help in care of the mentally ill and used as a tool to track their health real time through the Calmify Application on the smartphone.

1.2 About the System Functionality

The whole mental health monitoring system revolves around 2 key parts i.e. the software (Calmify-Mental Healthcare App) and the hardware (Calmify-Mental Wellness Smart Glove). The integration of the software and the hardware allows us to create a system centered on Mobile-IoT that collects information from different biomedical sensors, processes them to display the health vitals of the patient in real-time, makes predictions for the onset of some serious issue, and provides an alerting system by sending a SMS to the doctor as well as the guardian including the location of the person whenever there are abnormal changes in the vitals and immediate care is needed in a timely manner. All data is then recorded and saved in a database so that it can be accessed later for future analysis.

1.3 Advantage over present health care tools

In the market today, there are many types of measurement tools for health care of the mentally ill such as heart rate monitor, blood pressure monitors etc. Nevertheless, these tools are unique devices but they are costly, difficult to calibrate for a normal person and not easily portable. Above all, even if a

person opts to go to the hospital for his monitoring, it will cost serious amounts of money that is not affordable and viable in the present covid times. Therefore, Calmify will address all these issues making it easy to wear and carry, simple to use, and affordable for everyone. With the advent of IoT Telemedicine, the device will ensure that it cuts down unnecessary hospital visits to far away places for people who do not have access to medical facilities. It will allow them to consult with their doctors remotely from any corner of the world and will surely help them in recovering from their illness soon.

2. RESEARCH METHODOLOGY

The research methods implemented for developing Calmify Smart Glove and App include the following:

2.1. Calmify-Mental Wellness Smart Glove:

2.1.1. Brief of the Glove:

It is an innovative smart glove that is able to sense various vital signals of your body, helping you to keep track of your mental wellness and health, with ease while staying safe at your house during the Covid-19 pandemic. Calmify – Smart Glove is a low-cost IoT wearable device developed keeping in mind the hardships that people with mental problems go through. It has ML/AI integrated for the early detection of mental-health problems and thus helps in diagnosing them at an early stage and providing proactive medical treatment. Its main aim is to make the lives of people with mental-health problems safer and improve their mental health and wellbeing. It also makes it easier for doctors to arrive at a more accurate and faster diagnosis, with the help of real-time monitoring of users.

The smart glove has various medical sensors that capture the real time health vitals of the patient and transmits that data to a cloud database which in turns displays the health condition of the patient on the Calmify App.

The advantage of using wearable technology is that it allows us to monitor people with mental health issues continuously and remotely and provide proactive support, like sending care to the doorstep of patients, instead of the patient coming to the hospital for care. This has a major impact on people living alone and do not have access to hospitals. On any disturbance or changes in the routine activities of a person, alert mechanism sends signals to family members and concerned health providers.

2.1.2. Specifications:

There are two key parts to the solution –

- Hardware: The smart glove has various medical sensors that capture the real time health vitals of the patient and transmits that data to a cloud database which in turns displays the health condition of the patient on the Calmify App.
- Software: Machine learning and artificial intelligence (AI) that will evolve as a decision support system for doctors.

The integration of the hardware and the software enables to: predict the onset of certain types of mental health issues so that patients could be provided with an intervention that makes their lives safer (like being given an emergency medication that helps to abort the attack) or be taken to hospitals or care centers that could provide the necessary support.

It even helps doctors make data-driven decisions, instead of assumption-driven decisions, enable them to check the efficacy of medications based on actual data streaming from patients, and provide customised management plans to each patient instead of generalising the care.

2.1.3. Features:

The workflow of the Glove is illustrated in Figure 1 as well as Figure 2.

2.1.3.1. Measurement of the Sensors (Sensor Layer):

- Electrodermal Activity: Using a Galvanic Skin Response Sensor that can detect the emotions of the persons.
- Heart Rate Variability: Using optical heart rate sensor that measures pulse waves
- Pulse Oximetry: Using the concept of photoplethysmogram sensor that can non invasively measure the SpO2 levels and Pulse Rate
- Blood Pressure Trend: Using an algorithm integrated in the optical sensor to estimate the blood pressure without a cuff.
- Movement, position and Orientation: Using a robust accelerometer and gyroscope, we can detect anxiety tremors and shakings.
- Electromyography: Using a non invasive EMG sensor that can detect stress levels by measuring the muscle tension
- Skin Temperature: Using an infrared sensor that can measure the temperature of the body
- GPS/GSM/GPRS: It is used to find the location of the patient using GPS and then send it via SMS using GSM to alert the guardians and doctor in case of an emergency situation.
- Respiration Trend: An algorithm is applied to the PPG readings in order to calculate the estimate respiration rate of the patient.

2.1.3.2. Network Layer:

A low energy Bluetooth module/ Wifi Module for transmitting the data received from the sensors to Cloud DB.

2.1.3.3. Processing Layer:

- A microcontroller has been used to process the raw data received from the sensors.
- An IoT Hub has been used as a cloud database that can perform algorithmic calculations using the ML/AI software and provide further predictions and results.

2.1.3.4. Application Layer:

Calmify App will be used to display the health vitals of the patient and provide predictions in the real time to the doctors. The app could also be accessed by the patient's family so that they can actively monitor the mental state of the patient.

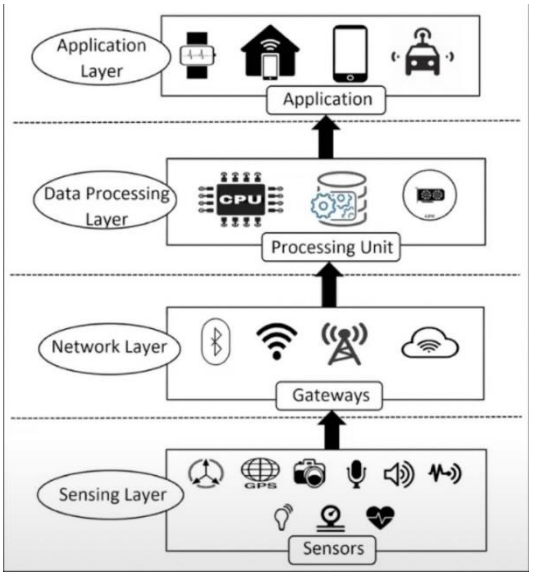


Figure-1 Workflow of the IoT Glove

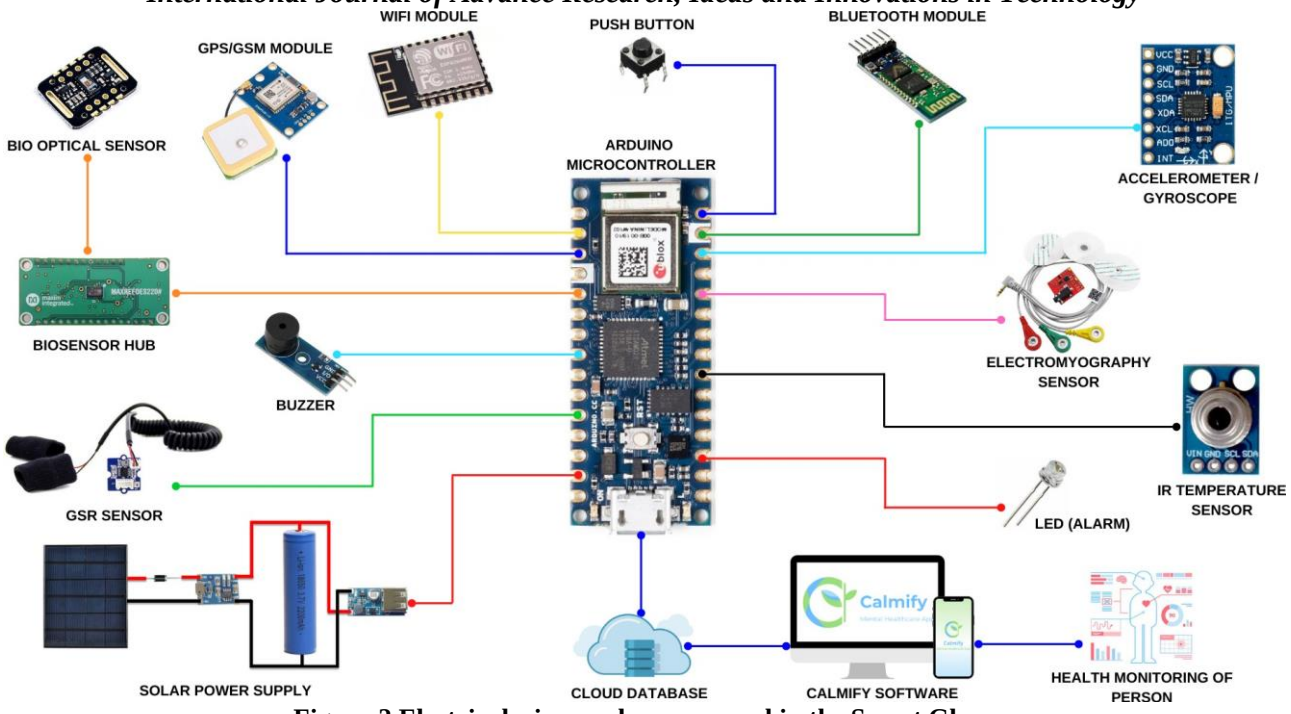


Figure-2 Electric devices and sensors used in the Smart Glove

2.2. Calmify-Mental Healthcare App:

2.2.1. Core Features of the App:

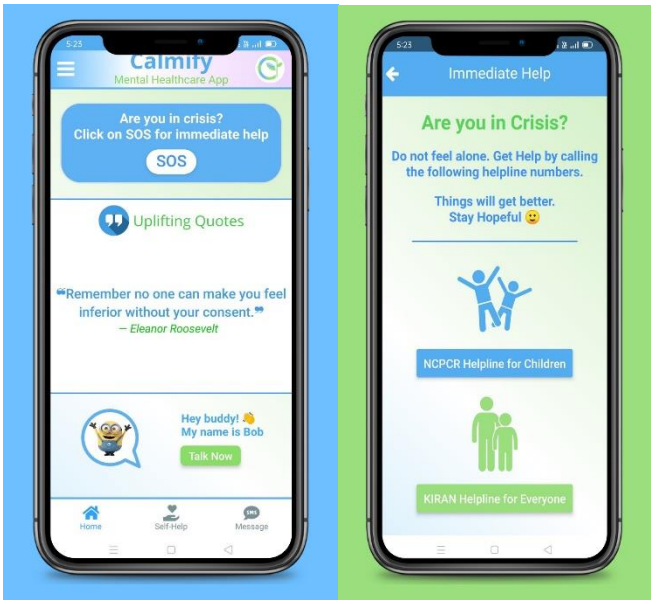
Below are the core features which I have put in my app by which you can help yourself, others and the community to manage stress, anxiety, grief and worry during the pandemic:

- Emergency Helpline Numbers in the form of a SOS button to help you urgently.
- Various valuable tips to cope up with stress, anxiety, grief, demotivation, insomnia and other mental health problems.
- The app also comes with an interesting feature, a Chat Bot which acts as a friend and makes the app interactive.
- A customised bottom navigation bar which helps you to conveniently navigate between various screens.
- Uplifting Quotes and Affirmations to motivate and cheer up the user.
- Helpful breathing exercises with images that play a crucial role in making the user relaxed

2.2.2 Working of the App (Screens):

- Home Screen: This screen comes with emergency helpline numbers for immediate help which can be accessed by clicking on the SOS button. It also displays various uplifting quotes to motivate the user. Last but not least, an AI ChatBot is available which can be used by the user to lighten up their mood.
- Self Help: This screen comes with valuable and informative tips that every mentally ill person should know. These tips have been recommended by doctors and are useful in helping yourself.
- Message a Loved One: This screen holds the most innovative and novel feature of the app which is messaging your loved ones for immediate help without even opening the app. The feature works on push notifications which are always displayed on the status bar and lock screen of the app after initialisation. When the user clicks on this notification, an urgent SMS asking for help is sent to the close one of the user along with the location of the person. This core feature can be really helpful in emergency situations as the function can be performed without even opening the app.

2.2.3 Output of the App (Screenshots):



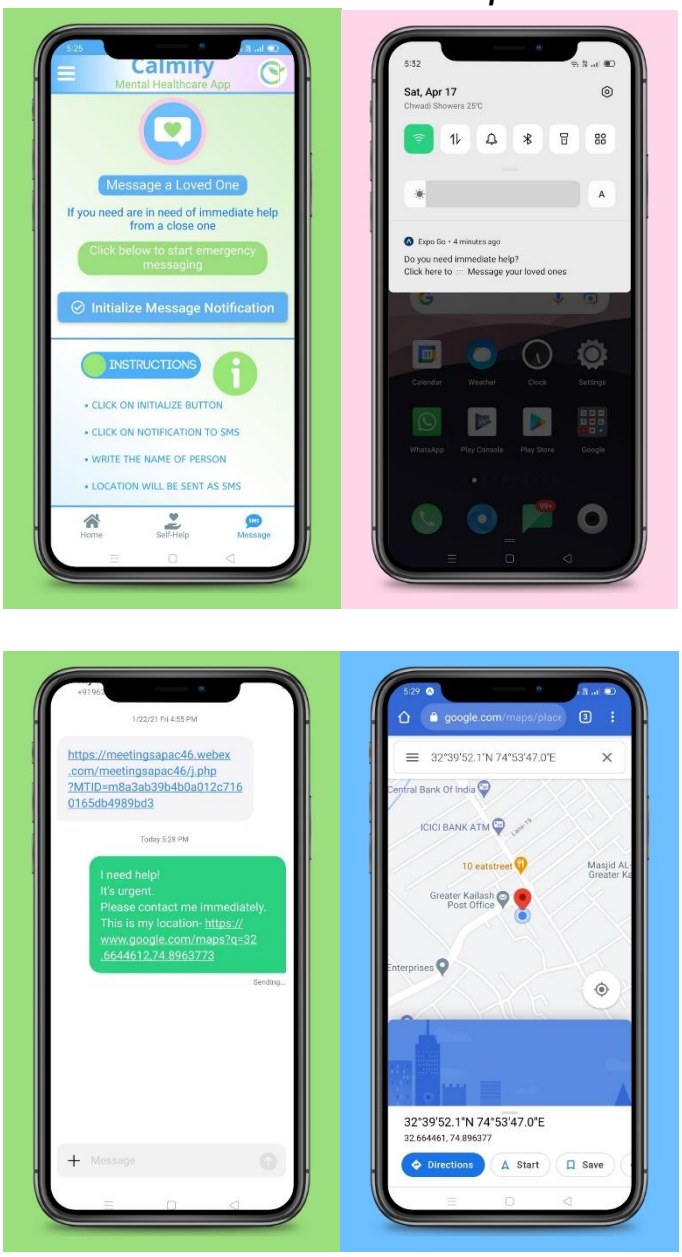


Figure-3 Screenshots of the App

3. CONCLUSION

Using the proposed system, this will surely have a positive impact on the targeted mental health behaviours or clinical health outcomes with fewer errors. As people suffering from mental health problems usually refrain from sharing their sufferings with others, so my target goal of this project is able to see where one stand mental health wise and how he/she can fix it by using this system. Since our system employs unobtrusive wearable devices, it can easily be used in the daily life of individuals. It can track the stress levels in real-time and intervene if an extreme level of stress is detected. After the detection, various stress management methods can also be offered through the Calmify App to alleviate the high level of stress and give a stress free life to people.

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BIOGRAPHY

Harmanjot Singh
Grade 9 Student, Jodhamal Public School, Jammu, Jammu and Kashmir, India

