Depression Monitoring using Wearable Sensors

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Abstract: ***According to the World Health Organization (WHO) "depression" is considered a mental disorder. In this decade mental ailment like depression and stress has become common as well as a crucial public health concern and has a relevant impact on society. It influences the people of all age groups, male or female, urban or rural, educated or uneducated and even employed or unemployed. In a developing country like India, a large number of people are committing suicides due to depression each year. With the advancement of technology, sensors become an extensive part of everyday life. Various researchers are trying to detect and treat depression with the use of IOT and other technologies. In this proposed work, a wearable is designed such that it captures the biological parameters experienced by the clinically depressed person while they undergo stress. IOT plays an important role in sensing, analyzing and processing the data.***

Keywords: Internet of Things, Depressive Disorders, Depression detection, Real life, Wrist device, wearable sensors, Machine learning.

I. INTRODUCTION

Depression is believed to be treatable but unfortunately, much depression and anxiety disorder victims keep suffering as they don't get the care and attention as well as support. Depression is the unbalanced feeling of sadness, exhaustion, and anxiety along with some different physical complaints. Depression is also a disease that is non-communicable and can be cured with the correct dosage of medicines and sometimes lifestyle changes.

The term Internet of Medical Things (IOMT) is becoming a common paradigm with so many advancements in the medical industry. This has increased the life expectancy of human beings, especially in developed countries [10]. The Internet of Health Things [11] or Internet of Medical Things [12] or Smart Healthcare [13] as it being called is combining the reliability and safety of conventional medical devices used for the treatment of chronic illnesses with the dynamicity and generality of Internet of Things. IOMT is providing solutions for addressing the requirements of both the aging population as well as patients with chronic diseases and providing patients mobility in contrast to the telemedicine systems.

Figure 1: - IOT Wearable Health Band

The paper is structured into some key sections. Section I contains the entire introduction of what is depression? And how the depression is detected. Section II provides the technological advancements executed by various researchers in detecting depression or treating it. The major works have been depicted in this section. Section III provides the overall architecture of the proposed system along with the detailed description of the sensors used in the proposed system. Section IV contains the results and the analysis of the proposed system whit the screen shoots of the android application. The conclusion of the survey has been summarized in Section V.

II. LITERATURE REVIEW

In the period 2005–2016, various studies were conducted to implement depression detection using a combination of signal processing and machine learning (ML). Most of them used data from a sensors like[1,2,3], ECG sensor[1,2,3], heart rate(HR) sensor[4], acceleration (ACC) sensor[5,6], electro dermal activity (EDA) sensor[1,2,3,4,5], blood volume pulse (BVP)sensor and electromyogram (EMG) sensor[2,8]. Some are more constrained, either physically (e.g., brain activity analysis [9]) or concerning privacy.

Wrist-worn EDA sensor

Adams et al. [10] collected data from seven participants as they carried out their everyday activities over ten days. They utilized smartphone audio-sensing and a wrist-worn EDA sensor. They analyzed correlations between stress self-reports and smart-phone audio-sensing. They did not use machine learning to detect stress. They concluded that context information is needed to distinguish between pleasant and negative experiences. Our proposed machine-learning method exploits context information to detect stress.

Wearable IOT (WIOT)

Wearable IoT (WIOT) can be described as the infrastructure that connects various sensors for tracking human factors such as behavior, health, wellbeing and other data. With the help of various tiny wearable body area sensors (WBAS) and internet-connected gateways, medical information can reach physicians where data is collected, managed and monitored. The authors in [11] have extended the concept of WIOT and identified its architectural components along with the support of cloud and big data. WIOT has the power to transform healthcare by early detection of diseases, lower cost of treatment and efficient means to monitor the treatment and the patient remotely.

Figure 2: - Wearable Device

Apriori Algorithm and Association Rule Mining

Predicting depression accurately is a major concern to date and hence in [13], the authors propose a model for depression prediction considering Apriori algorithm and association rule mining and 500 individuals with diverse factors of depression.

EEG signal processing

In [14] the author used EEG signal processing for depression level prediction. They used the links between sleep and depression to process a model. Insomnia is extremely common in depressed people. Three-quarters of depressed patients have sleep disorders, including insomnia and hypersomnia. The symptoms of sleep disorders and alcoholism cause a major impact on the quality of life, thus increasing the risk of suicides. The results they acquired through ANFIS were slightly better than the results of the classifier.

Linear Predictive Coding (LPC)

Depression and suicides are becoming a major health concern. With the help of Linear Predictive Coding (LPC) and Parameters based method, the authors in [18] have prepared a model of emotional speech recognition algorithm using the Tamil language. The best recognition rate obtained was 90% with the help of LPC algorithms.

I-Vector Technique and Fuzzy Membership Functions

In [17], the I-Vector technique and fuzzy membership functions have been selected to uncover depression levels in twenty patients. Differentiate between the algorithms is performed based on accuracy, balanced classification rate, peak signal to noise ratio, F-Measure, and specificity. Prior processing, has become necessary to remove silence present in the audio signals for increasing the accuracy. Fuzzy membership functions proved to be much better with an accuracy of 97%.

T-bots (Therapy Chatbot)

With the detection of the level of depression in an individual, the authors managed to provide a system to suggest remedies for lowering the level of depression in [6]. A therapy chatbot is used in this research which can act as a therapist or a friend or a well-wisher. Depressed people don't wish to visit a therapist; however, they can share their feelings with an appealing virtual therapist instead of having an alone miserable time. T-bots are very useful and can serve as a personal assistant, psychiatrist, brawl depression, can provide feedback, can identify the level of depression, can provide the therapy level, etc.

III. PROPOSED SYSTEM

A. SYSTEM ARCHITECTURE AND FLOW

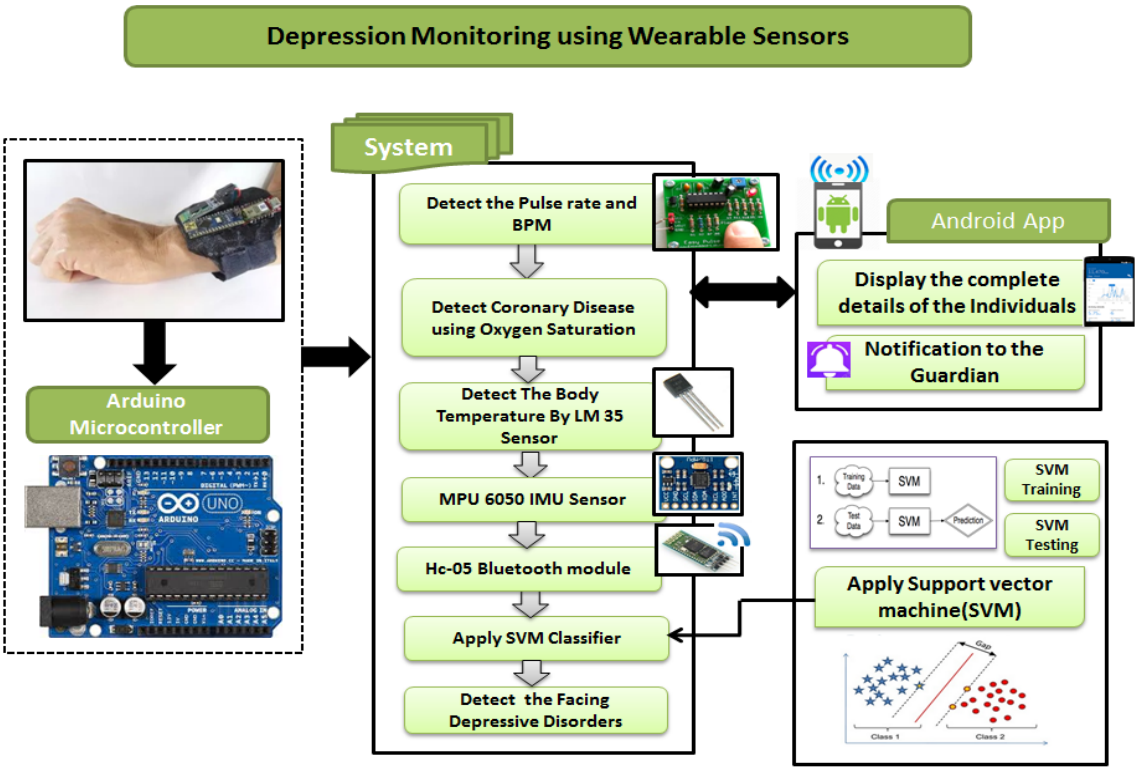


Figure 3: - System Architecture

Description: - Initially user will wear the health band and connect it to the android phone. The input in the form of signal data is obtained from the wearable (Health-Band) device. This inputted data is then sent to the smart phone using hc-05 Bluetooth module. The wearable device contains some sensors, like Temperature Sensor, BPM sensor, MPU 6050 Sensor and etc. The user can view the sensor data received from the wearable device through the system. Support Vector Machine (SVM) algorithm is applied on some features to make some decisions that mainly includes user's Position (Sitting, Standing) and detection of depressive disorders. If the individual is facing the depression then the notification is sent to the guardian (caretaker) via android application. The android application is also useful for displaying the entire details of the individual.

B. HARDWARE USED

- List of Hardware required is;
  1. Arduino UNO
  2. Temperature Sensor
  3. BPM sensor
  4. MPU 6050 Sensor
  5. HC-05 Bluetooth module

Some are elaborated as follows;

1) Temperature Sensor:-

The main purpose of the temperature Sensors is to measure the amount of heat energy or even coldness that is generated by an object or system, allowing us to "sense" or detect any physical change to that temperature producing either an analogue or digital output. Get current temperature value.

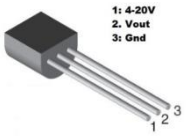


Figure 4: - Temperature Sensor

2) BPM sensor

The output in the form of the digital can be connected to microcontroller directly to measure the Beats Per Minute (BPM) rate. Get Blood Pressure value and coronary disease detection using block blood flow and oxygen rich level in blood.

Figure 5: - BPM Sensor

3) HC-05 Bluetooth module

The HC-05 Bluetooth module is considered as efficient to apply on Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. To send the data from wearable band to the smartphone

Bluetooth Sensor Module	Technical specifications of HC-05 Bluetooth

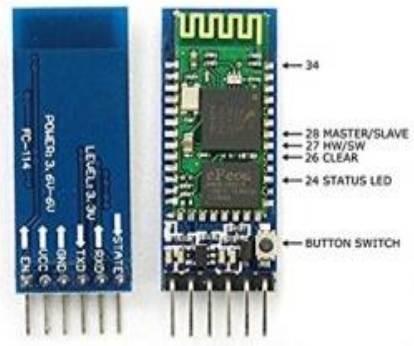


Figure 6: - HC-05 Bluetooth Sensor

Specification	Values
Bluetooth protocol	Bluetooth Specification v2.0+EDR
Frequency	2.4GHz ISM band
Modulation	GFSK(Gaussian Frequency Shift Keying)
Asynchronous Speed	2.1Mbps(Max) / 160 kbps
Synchronous Speed	1Mbps/1Mbps
Security	Authentication and encryption
Power supply	+3.3VDC 50mA

Table 1: - Technical specifications of HC-05 Bluetooth

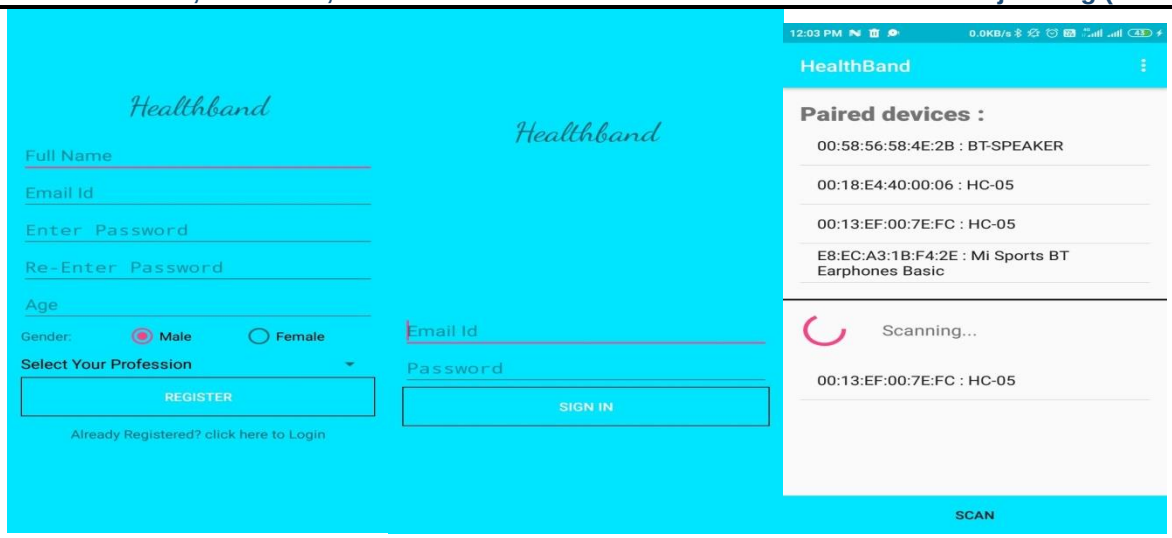
4) MPU 6050 Sensor

The MPU 6050 is a 6 DOF (degrees of freedom) or a six-axis IMU sensor, which means that it gives six values as output: three values from the accelerometer and three from the gyroscope. The MPU 6050 is a sensor that relies on MEMS (micro electro mechanical systems) technology. To return sedentary, Idle and sitting positions.

Figure 7: - MPU 6050 Sensor

IV. RESULT AND ANALYSIS

Health Band Android Interface Developer



(a) Registration Activity **(b) Login Activity** **(c) Devices Paring Activity**

(d) Sensors values from wearable band with its graph and SVM result.

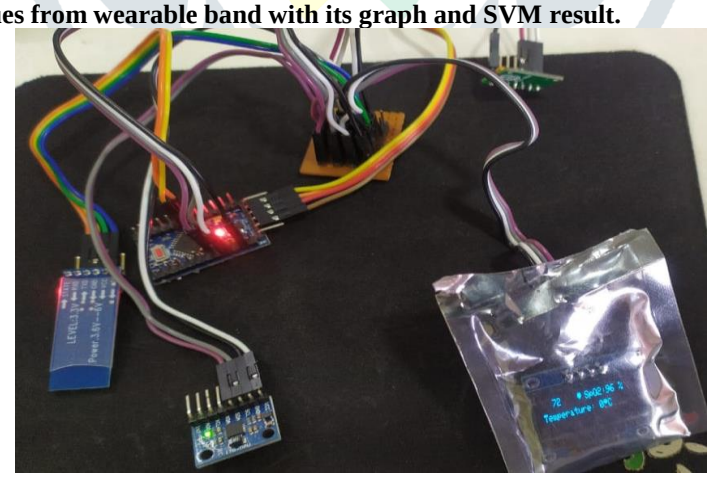


Figure 8: - Installation of smart wearable band system.

Table 2: - Wearable Sensors and their output values

Sr No.	Name of the Sensor	Value of the sensor
1	Plus Rate Sensor (Max30100)	60 to 190 bpm SPO2 -90% to 100%
2	Temperature Sensor(Lm 35)	−40°C to 110°C
3	Gyroscope Sensor (MPU 6050)	+/- 250, +/- 500, +/- 1000, +/- 2000

V. CONCLUSION AND FUTURE SCOPE

Depression is a non-communicable disease and can be cured with the correct dosage of medicines and sometimes lifestyle changes. In this paper, we have analyzed the different techniques used by different researchers until now. Based on this analysis, some technologies and sensors can be combined to detect depression. Sensors with android applications are more of the new IOT can be utilized for creating a model that could help the people to detect depression and can hence visit the doctors and psychiatrists respectively. In this proposed solution a mobile application is developed which is automated to display the detail of the health band information of the individual. The mobile app as well as sends the notification to the caretaker of the individual on emergencies.
In further the enhance in the system is possible as depending on the SVM rate automatic audio of happy songs, positive happy quotes or video links can be popped out on the mobile screen or laptop.

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