IoT based smart health care

Rashbir Singh[1]

[1]Department of Information Technology, Amity University Uttar Pradesh, Noida, India, rashbits@gmail.com

Keywords: Internet of Things, Arduino, Micro-Controller, Android, Ultrasonic sensor, EEG, ECG, EMG, Temperature Sensor, Capnography, Antimony electrode sensor, Piezoelectric sensor.

Abstract

This paper proposes a model for smart healthcare and real-time management technology can be utilized both by hospitals, ambulance and even at normal day to day activity tracker and require no technical or medical knowledge to start with. As per the survey, about 40% of worlds total deaths due to any disease can be prevented if an earlier diagnosis is made. People tend to avoid health and health care practices now either it is due to the busy schedule or lack of money. So, the research work focuses on incorporating technology into people life without disturbing their daily routine and does not require septate time to use. This technology is powered by IoT and uses many biosensors to give real-time solutions, prescribe medication, earlier detection of diseases, give a better understanding of patients current health and past health and significantly reduces medical expenses and by having more information about patient health doctors can operate and treat the patient with a better approach. This technology works when the user sleeps and learn when the user performs day to day task with the help of machine learning.

1 Introduction

Due to the increase in diseases, there is a drastic increase in demand for health care and health care support facilities. Health is wealth and people nowadays are ready to spend an enormous amount of money without even giving a second thought but the need is not to spend in millions but to develop smart solutions to health-related problems. This can be achieved with the help of the combination of IoT with our day to day objects like beds and clothing. This research work proposes a model for smart healthcare system for personal, hospital and general use which is easy to operate and implement and can be utilized both by urban and rural area people. The motive of this research work is to convert a regular bed into a smart self-managing health bed and a smart healthcare clothing system to monitor your body and help one with a better understanding of one's own body. The proposed solution will provide health support and will reduce one's expenses over health and help hospitals with a better understanding of patients data which is collected daily 24X7. This can potentially reduce initial delay due to various tests the doctor has to perform on patient before operating on the patient hence the patient can be admitted for treatment which less to no delay and doctors can start operating as soon as possible and can also be used as a daily body checker which can be used to create your health database and informing the nearest hospital and relatives in case of an emergency. As there are still rural areas in India which do not have access to hospital, about 80% of Indian population still do not have proper access to health-related facilities and healthcare treatment so this proposal can help them to a great extent to manage health at their homes in a cost-effective manner and utilize it when so ever they feel. It can be used as a smart hospital beds, smart house beds or even smart ambulance bed with a health monitoring clothes which can save many life with technologies like EEG (electroencephalogram), ECG (electrocardiogram), EKG (Electrocardiogram), Temperature sensor, skin quality sensor pressure sensor and many other biomedical sensors powered by the advance technology of IoT(Internet of Things), hence connecting a regular bed to the internet and detect several health related issues and reducing overall cost of

IREHI 2018 : 2nd IEEE International Rural and Elderly Health Informatics Conference

health and time of treatment of health which can make health treatments approachable for all.

2 Literature Survey

The literature survey is consist of the analysis of deaths due to delayed diseases detection and multiple reasons regarding death in humans.

Of the fifty-seven million deaths worldwide in the year 2016, more than half (54%) were due to the top ten reasons. Ischaemic heart disease and stroke are the world's greatest top reason behind the death, considering as a combined fifteen million deaths in the year 2016. These conditions have persisted to be the major cause of death all around the world in the last fifteen years. The chronic obstructive pulmonary disease took nearly three million lives in the year 2016, while lung carcinoma (along with trachea and bronchus cancers) caused two million deaths. Diabetes alone took two million humans lives in the year 2016, up from less than one million in the year 2000. Losses due to dementias have been doubled in the year between 2000 and 2016, and hence is the fifth leading cause of deaths in the year 2016 compared to fourteenth in 2000 all around the world.

Lower respiratory diseases and infections continued to be the most deadly contagious condition, creating three million losses around the world in the year 2016 alone. The death rate due to diarrhoeal conditions reduced over nearly one million between the year 2000 and 2016 but still managed to affect two million lives in the year2016. Likewise, the deaths due to tuberculosis declined around the same time still is among one of the top ten reasons for the death of two million. As of now HIV/AIDS is no longer reason of deaths and is not in the world's list of top ten agents of death, causing deaths of one million humans in the year 2016 as related to 1.5 million in the year 2000.

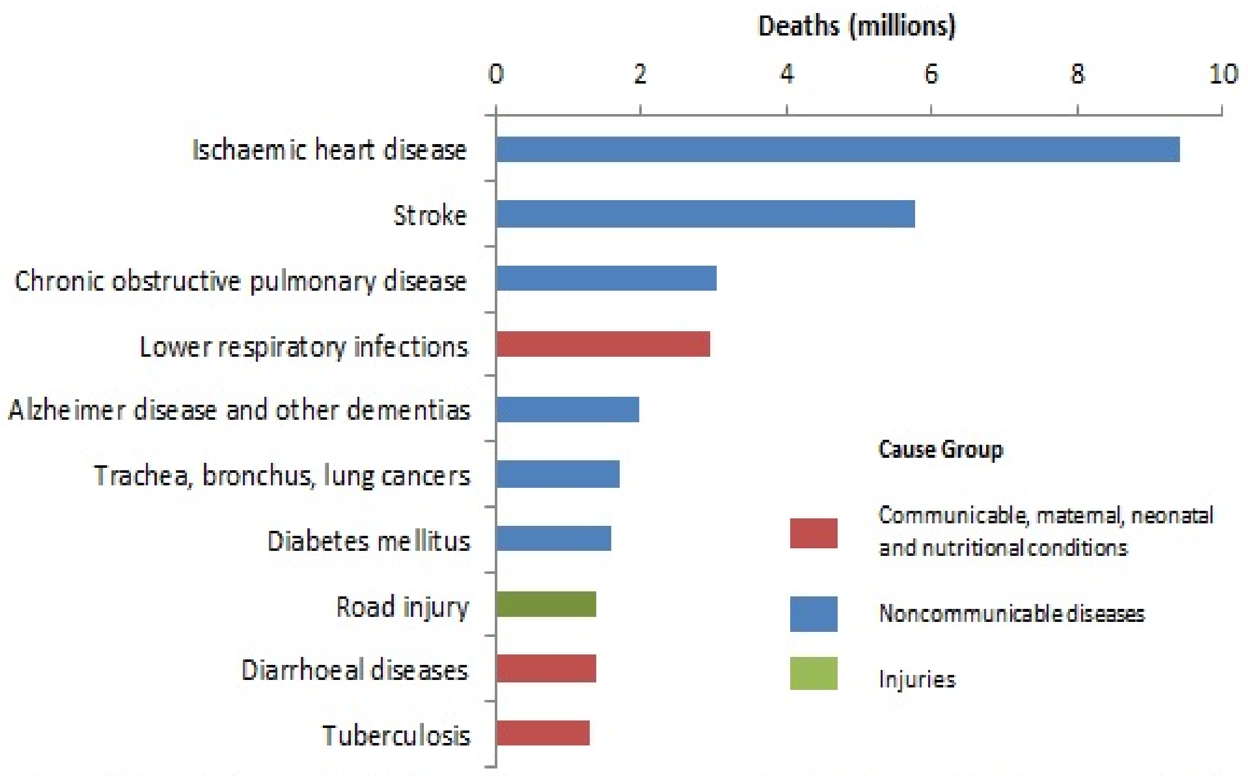


Figure 1. Top 10 Causes of deaths in year 2016 around the world [1]

Road injuries took almost 1.4 million humans lives in the year 2016 and from that nearly three-quarters i.e 74% of what remained men and boys. Figure 1. shows the top 10 Causes of deaths in the year 2016 around the world.

Similarly, Late determination of diseases remains one of the usual medical failures. It might occur if the doctor fails in the diagnoses of a patient correctly and it takes a prolonged duration of time than exacted for a reliable diagnosis to be made. When a Late determination of diseases occurs, the valuable medication time is wasted. In some circumstances, this can create added difficulties for the patient, prolonged healing period, with additional medical debts and even can result in loss of life.

The late determination of diseases can happen due to several reasons. Doctor negligence, complicated medical history, incomplete patient information or simply due to testing errors all can contribute to a late determination of diseases.

The failure to determine the cause of disease immediately, and thus treat immediately, heart disease may lead to serious outcomes such as cardiac arrest. Both men and women can undergo chest pains leading up to or directly at the point of a heart attack. However, other symptoms may indicate a heart attack. These may incorporate shortness of breath, pain in the jaw or neck area, or even fatigue.

Some illnesses or conditions could or could not be analyzed because their symptoms and signs may be similar to that of other medical conditions. For example, failure in the detection of chronic obstructive pulmonary disease (COPD) in the first exhibition of symptoms could result in quicker progression. This condition has indications that evolve with time into some serious conditions. Signs such as a cough, chest pain and shortness of breath may be similar to symptoms of other conditions, and in some cases, may lead to a delayed diagnosis. There are many other types of ailments that can lead to an unwanted condition or progression if not properly detected in a timely manner. [2]

The leading causes of death in the world are cancer, chronic lower respiratory diseases, heart disease, stroke. Together they accounted for sixty-three percent of all deaths in the year 2010 alone. According to the report, in CDC 's journal, Morbidity, and Mortality, analyzed premature deaths from each cause for each state from the year 2008 to the year 2010.

The study suggests that:

- Thirty-four percent of premature deaths caused due to heart diseases, prolonging about 92,000 lives

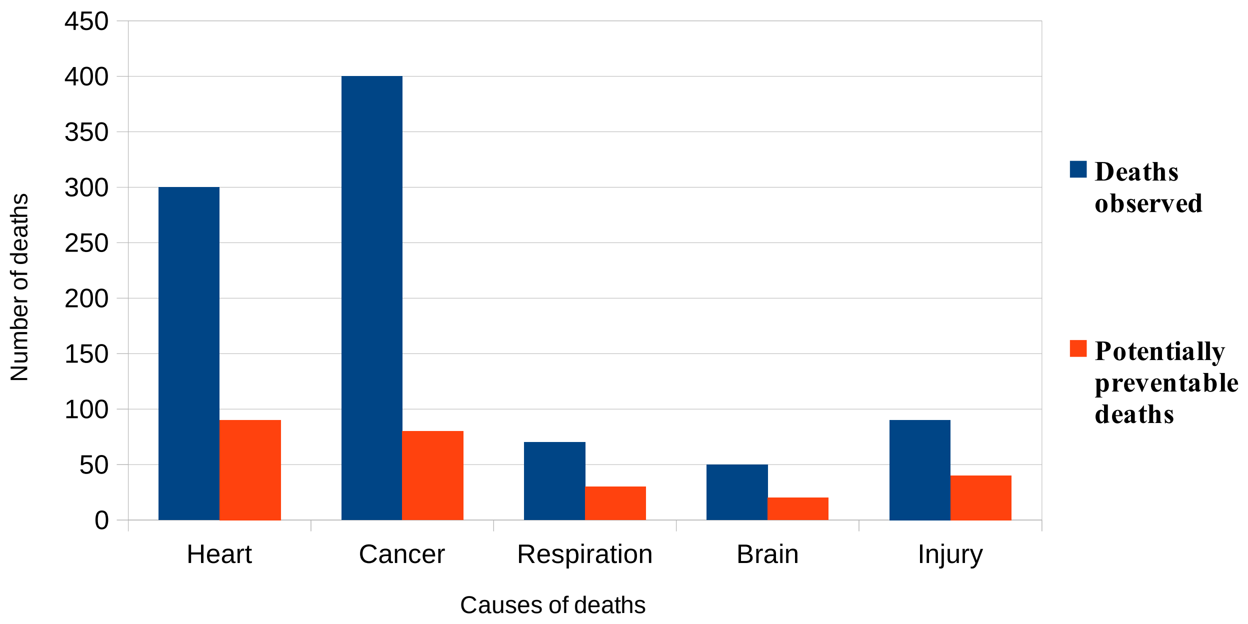


Figure 2. Potentially Preventable Deaths from the Five Leading Causes of Death[4]

- Twenty-one percent of premature deaths caused due to cancer, prolonging about 84,500 lives
- Thirty-nine percent of premature deaths due to the condition of chronic lower respiratory diseases, prolonging about 29,000 lives
- Thirty-three percent of premature deaths caused due to stroke, prolonging about 17,000 lives
- Thirty-nine percent of premature deaths occurred due to the unintentional injuries in the body, prolonging about 37,000 lives[4]

3 Proposed System

The proposed system consists of the following modules. The description of each module is given below.

3.1 EEG (electroencephalogram) sensor

An electroencephalogram (EEG) is a used to discover inconveniences related to an electric movement of the brain.
An EEG tracks and insights, mind wave fashion. Little metallic plates(electrodes) with small electric wires are placed above the head of the user, the amplifier amplifies the electromagnetic brain waves and captures and plot a real-time graph of the electric movements inside the brain. The graph is shown which show us the events and impacts happened inside the brain. A persons day to day activity and his interest creates an electric brainwaves into a recognizable pattern. Through an EEG, therapeutic specialists can scan and anticipate the seizures and different issues and can give the recommendation changes in lifestyle/medication to help the person.

3.2 ECG (electrocardiogram) sensor

An ECG Sensors with electrodes attaches right above to the chest area in order to detect every produced heartbeat. The electrodes of ECG sensor then convert every produced version of heartbeat into a raw electric signal. ECG Sensors are very less in weight and slim while having the capability to accurately measures continuous heartbeat produced by the heart and generates rate data of the heartbeat. This device is being used for the cardiovascular health analysis by the medical assistant and trained doctors.

Electrodes of an ECG Sensor consist of three pins which are connected by a thirty inches ling cable which makes It easy for ECG sensor to connect and communicate with the microcontroller placed at the waist, pocket or different location on the body. In addition to this, the cable is a plug-in male sound plug which makes the cable to easy to remove or connect it into the amplification board. The sensor assembled on an arm pulse and a leg pulse. All of every sensory electrode of the ECG has methods to be assembled on the body.

This research work uses the AD8232 module which has nine connections from the IC that are being used to solder wires, pins and other connectors as well. The pins are namely - GND, LO+, OUTPUT, LO-, 3.3V, SDN which provides required pins for operating and monitoring with the microcontroller board. It also provides three pins namely as - RA which is for the Right Arm, LA which is for the Left Arm, and RL which is for the Right Leg and pins to attach and use for custom sensors. Moreover, there is an LED indicator light that will pulsate as according to the rhythm of a heartbeat.

3.3 EMG (Electromyography) sensor

The EMG sensor which measures the muscle activation on to the concept of electric potential and is called as electromyography (EMG) and is traditionally been used in the field of research in the medical profession and for the diagnosis of neuromuscular dysfunctions. Though, with the development of ever smaller and smaller yet powerful integrated circuits and microcontrollers, making it possible for the EMG circuits and sensors to find their way into the field of Prosthetics, Robotics, and other control systems.

This research work uses Myoware Muscle sensor (AT-04-001), which is suitable for producing raw electric EMG signal which is Analog output signal and can be analyzed with the microcontroller based application, the Myoware Muscle sensor which is designed for a reliable EMG output and has low power consumption. It operates with the single power supply ranging from +2.9V to +5.7V with protection for polarity reversal and provides an additional feature with this sensor which is that the user can easily adjust the sensitivity gain of the electrodes. These sensors are suitable for the purpose of the wearable device and are the compact ones, hence it is easy to handle and measure the muscle activation signal.

3.4 Antimony electrode sensor

Antimony electrodes are medically useful as because they are low in cost and have a simple construction as there is no glass part to break. There is only a resistance which is of few hundred ohms between an antimony pH electrode and the reference electrode so if the voltage is generated it would be easy to record it with the simple low-impedance recorder which is connected to the microcontroller.

Antimony is a unique metal with the characteristic of a direct relationship between pH and its measured potential. The voltage or electric potential difference developed between that in antimony and a copper or copper sulfate reference electrode which varies between approximately ranging from 0.1 volts to as high as 0.7 volts due to variations in the pH.

3.5 Temperature Sensor

A temperature sensor IC can operate over the nominal IC temperature range of -55°C to +150°C. This sensor is consists of a material that performs the operation according to temperature to vary the resistance. This change of resistance is sensed by the circuit and it calculates temperature. When the voltage increases when the temperature also rises. We can see this operation by using a diode.

This research work is using LM35 as the body temperature monitoring sensor which will be connected to the microcontroller. The LM35 temperature sensors series are precise integrated-circuit temperature sensors, whose voltage output is linearly proportional to that of Celsius temperature. The LM35 temperature sensor operates between the range of -55˚C to +120˚C. The following are the features of LM35 Temperature Sensor:

- Calibrated directly in degree Celsius (Centigrade)
- Rated for range between −55˚ to +150˚C
- Suitable for applications which requires remote access
- Is lower in cost due to wafer-level trimming
- Operates in voltes between the range of 4Vs to 30Vs
- Self-heating factor is low
- ±1/4˚C of typical nonlinearity

The LM35 can be attached easily in the same way as that of other integrated circuit based temperature sensors. It can be placed or established on a surface and its temperature range will be around 0.01˚C of the surface temperature.

This assumes that the ambient air temperature around it is just about the same as that if surface temperature and if the air temperature is much lower or higher than that of the surface temperature then the actual temperature of the LM35 would be at a mean temperature between the surface temperature and that of the air temperature.

3.6 Capnography

Waveform capnography represents the amount of carbon dioxide (CO2) in exhaled air, which assesses ventilation. It consists of a number and a graph. The number is capnometry, which is the partial pressure of CO2 detected at the end of exhalation. This is end-tidal CO2 (ETCO2) which is normally 35-45 mm Hg. The capnograph is the waveform that shows how much CO2 is present at each phase of the respiratory cycle, and it normally has a rectangular shape. Capnography also measures and displays respiratory rate. Changes in respiratory rate and tidal volume are displayed immediately as changes in the waveform and ETCO2.

In people with healthy lungs, the brain responds to changes in CO2 levels in the bloodstream to control ventilation. We assess this by observing chest rise and fall, assessing respiratory effort, counting respiratory rate, and listening to breathing sounds. ETCO2 adds an objective measurement to those findings. The patient’s respiratory rate should increase as CO2 rises, and decrease as CO2 falls.

If a patient has slow or shallow respirations, and a high ETCO2 reading, this tells us that ventilation is not effectively eliminating CO2 (hypercarbia) and that the brain is not responding appropriately to CO2 changes. This may be caused by an overdose, head injury, or seizure by measuring the end-tidal CO2 (ETCO2, the level of carbon dioxide released at the end of
expiration) through a sealed mask, EMS technicians can receive an "early warning" of a patients worsening condition.
With accurate and instantaneous CO2 measurements required for Capnography, the COZIR high-speed wide range CO2 sensor seemed like the perfect solution to the problem.

3.7 Piezoelectric sensor

The piezoelectric effect is used by the piezoelectric sensor. This sensor measures the change in force, temperature, acceleration, pressure, and strain and is hence used in conversion into an electrical charge. The piezoelectric sensor shows three main

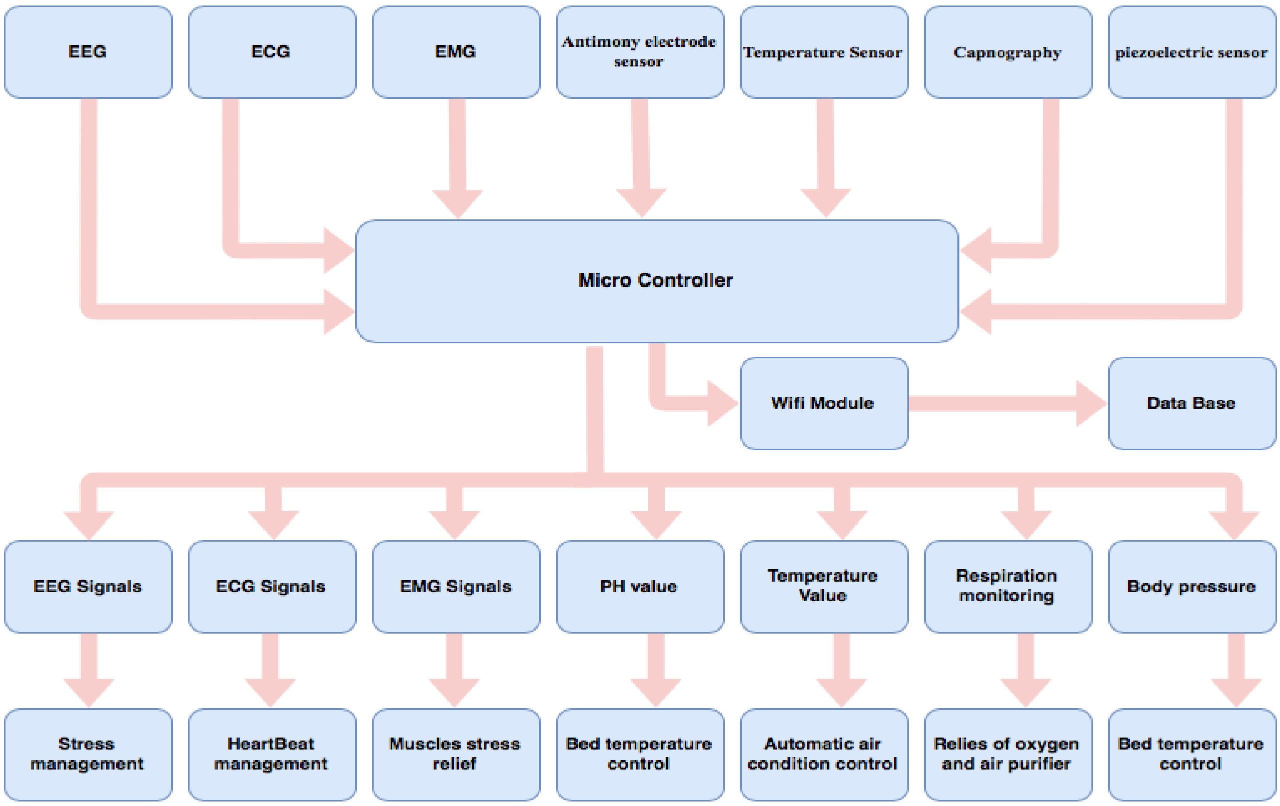


Figure 3. Proposed Model Architecture

operations that are transverse effective, transducer effect, and shear effect.

In this research work, we used the piezoelectric sensor to detect where the user is applying more body weight to give a better understanding on ones applied body weight pressure while doing daily tasks like walking, sitting and sleeping and detect the pattern and suggest remedies to improve the one's sense of

Figure 4(a). Front View

applied body weight pressure.

Moreover to use piezoelectric sensor while sleeping which can be placed inside the bed to detect ones overnight movement while sleeping, posture and body weight distribution. Which will be used to adjust the bed temperature required according to what is suggested by the doctors. So, as to maximize the health benefits.

All the above technologies will be combined into a common processing unit of a microcontroller which will be continuously capturing all the outputs from different sensors and storing it on the database while connecting over an MQTT client. While remedies will be provided in real time with different means like using oxygen tanks, heating elements, air conditions, air purifies and massage pads. So, it

Figure 4(b). Back View

can not only collect data of one's body while the person is sleeping, sitting, walking and carrying out day to day activities but also it will provide the real-time solution to the abnormality in a human body. This research work propose a wearable smart clothing which can be used by user to detect ones heart health (EKG), brain health (EEG), muscles condition (EMG), sweat quality and its PH (Antimony electrode sensor), Respiration (Capnography) and his body weight distribution and centre of gravity shift (piezoelectric) which will be placed in both clothing and bed.

The bed will be equipped with heating elements to control the temperature of the bed only in the area where the user is sleeping which will be sensed with the help of piezoelectric. A small oxygen tank will be placed over the headrest area if user CO2 exhaled during respiration is detected to be abnormal in order to provide the required amount of oxygen supply, while the user behaving choices either to use oxygen tanks, air purifier or both. If stress is detected with the help of EEG then various remedies like playing meditation sound like alpha music will be taken with the help of speakers attached to the bed. Small massaging motors inside the bed will help is muscle relief. The wearable clothing with the heating element will help in managing healthy body temperature which is required for the body to function properly and will maximize physical and mental output.

As being powered with technology of IoT(Internet of Things) it will not only be providing remedies in physical world in real time but also the data collected will be user specific and will be used by doctors for better understanding of patients health as the data is collected everyday and stored it can be used in early disease detecting like cancer, high or low blood pressure, distress, respiratory diseases, low Na+ ions level in body fluid, fever, etc.

4 Methodology

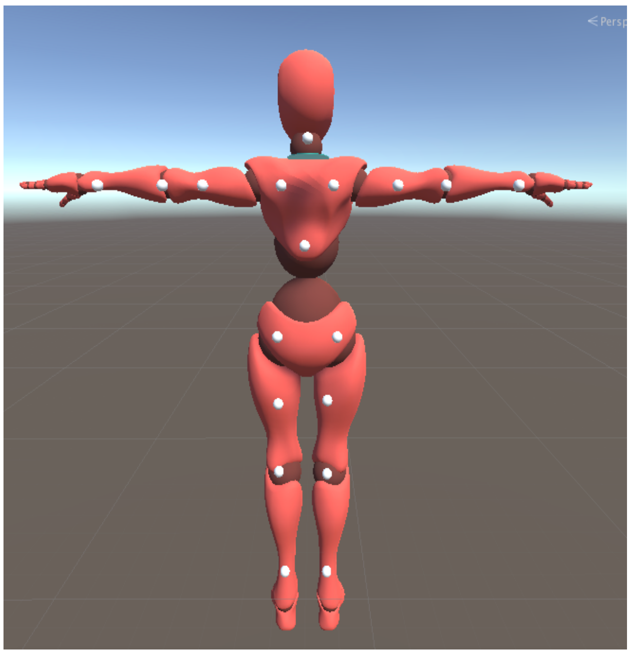
In this research work main seven components are being used i.e.

- EEG
- EKG
- EMG
- Antimony electrode sensor
- Temperature Sensor
- Capnography
- Piezoelectric sensor

Various components of the proposed model monitor different parts of human body and the output from different components when analyzed in combination provides a detailed information about the human user like:

- Ones sleep pattern
- Ones body natural centre of gravity
- Variation of body temperature with time
- Ones lungs capacity

- Amount of oxygen absorption capability



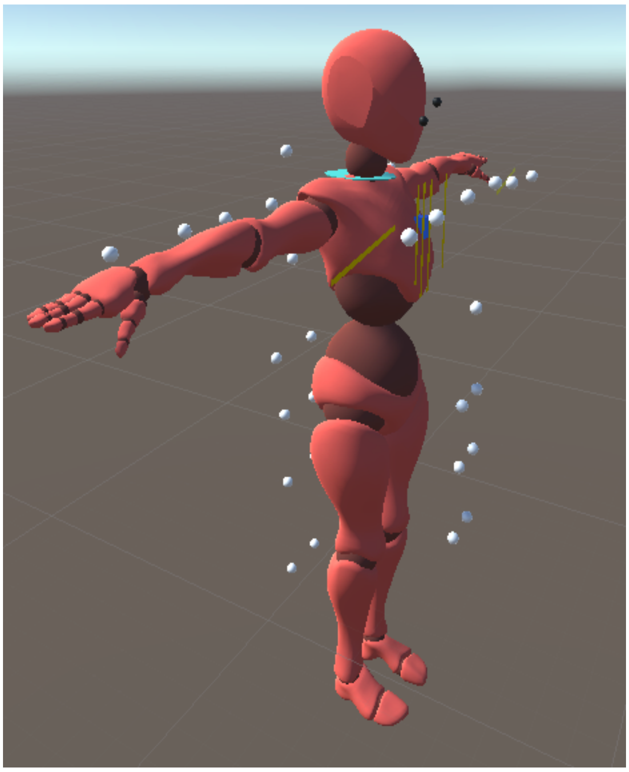


Figure 4(c). Left View

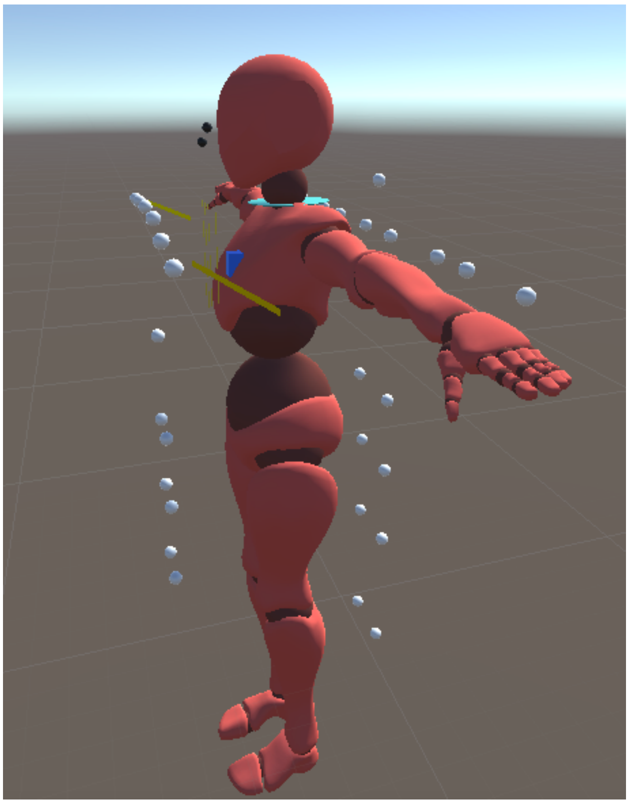


Figure 4(d). Right View

- Bodies immunity and resistance to diseases
- Cardiovascular health
- Muscular health
- Quality of ones sweat
- Acidity and basicity of fluids
- Mental health
- Stress and hypertension

Doctors cannot gain much information with the short-term test to know all the physical and mental health issues before operating on the patient. But the model proposed by this research work can help doctors with a better understanding of patients health and his medical background and can provide the best suitable treatment to the patient. Hence resulting in elongation on one's life and disease free healthy life. This proposed model can even reduce medical expenses by using a machine learning model based on the K-NN algorithm to suggest user with best remedies for small health-related issues like cold, headache, cough etc and can judge the acuteness of the fever which can help the user to know the severity of the disease.

The model is based on a single controller and multiple sensor methods where several sensors are connected to a single microcontroller and are dependent on the microcontroller to supply sensors with power, process the output from sensors use decision tree to provide real time solutions and collect and upload the received data onto the database. The microcontroller is powered by 5Vs supply and various other sensors are connected to the different I/O pins of the micro controller and ground of each sensor is connected to the common microcontroller ground. As being so low in power consumption it requires a low input electric supply. And can be attached to various objects as desired by the user. In this model the IoT based mechanism is attached to two day to day objects making them smart i.e.

- Wearable clothing (thin and comfortable vest and pants)
- Beds (Room beds, ambulance beds or hospital beds)

A wearable smart full body cloth will be having different components placed at various locations in order to monitor different parts.

Figure 4 shows the wearable smart health management clothing which is displaying where will different sensors be placed and their significance in those positions. Figure 4 shows four views from different angles i.e.

- Figure 4(a) shows depiction of placement of sensors and heating element from front.
- Figure 4(b) shows depiction of placement of sensors and heating element from back.
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- Figure 4(c) shows depiction of placement of sensors and heating element from left.Figure 4(d) shows depiction of placement of sensors and heating element from right.

Figure 4(a) shows green straight line above chest and stomach area and above arm are that is showing the placement of insulated Teflon wire or heating pad to heat the coating when the temperature detected is too low. The temperature sensor along with CO2 can be seen around the sky blue portion of the neck is.

Whereas two black dot/spheres can be seen on the forehead area and ear lobe area. These are EEG sensors which are two small electrodes connected to the brain region to detect brains different alpha, beta, gamma, theta and delta brain waves generated and amplify them to record users brain activities.

A blue colour object can be seen around the area above where there is the heart, it is an ECG sensor to monitor cardiovascular health. Then white spears can be seen in figure 4(a), figure4(b), figure 4(c) and figure 4(d) which are

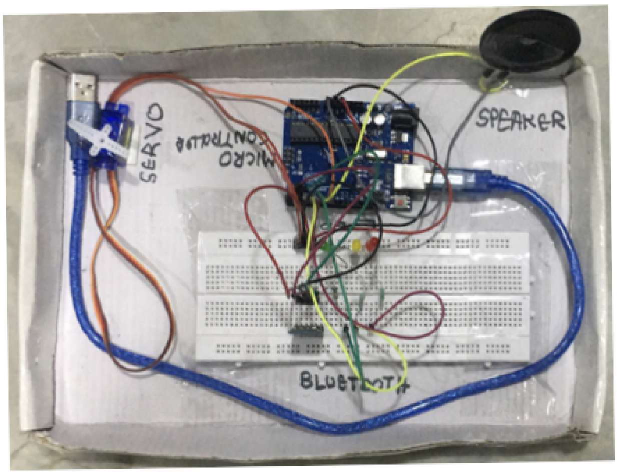

Figure 5.EEG based stress management and detection with alpha music to calm the mind

nothing but combination of EMG and piezoelectric material sensor around the body to provide the detailed information about persons muscles and pressure applied to carry out day to day activities.

All the above sensors and temperature management system is fully controlled with the help of an android application and data received is with the help of the microcontroller. The heating pad will connect to the ground for the ground wire and digital input pin of the microcontroller so the functionality can be controlled over android application on can be automated with a click. Following the similar mechanism, all the sensors ground will be connected to the common ground of the microcontroller and for the sensors.

ECG is consist of three electrode RA (Right arm), LA (Left arm) and RL (Right leg) microcontroller 3.3V -will be used as a power supply for the ECG module, whereas L0+ and L0- pin is connected to microcontroller digital pin and output of ECG module will be connected to the analog. For EEG this research work uses neurosky mindwave with two electrodes and connect the ground of EEG with the ground of microcontroller while using digital pins as transmission and receiving pins. And the piezoelectric material is used to judge the amount of pressure according to the electricity generated when the piezoelectric material in under pressure. EMG sensors are plages above main muscles groups like bicep, tricep, shoulder, chest, abdomen, thighs, calves etc.

All the collected data is then transmitted over MQTT broker where the microcontroller act as an MQTT publisher, publishing the data to the MQTT broker and MQTT receiver is android application and online cloud database.

5 Capability

A practical implementation of EEG was taken with the help of neurosky mind wave to measure patients mental state. EEG detects different alpha, beta, theta and gamma brain waves along with users concentration and meditation level. The headgear has one electrode for frontal lobe and one electrode for an ear. As soon as the electrodes are at their desired places the EEG begin sensing brain data and then that data is used to make the prediction in out K-NN based classification model.

Five classifications are being made i.e.

- Eyes open
- Eyes close

$$\int_a^b f(x)dx \qquad \text{Equation 1}$$

- Relaxed

$$\int_a^b f(x)dx \approx (b-a)((f(a)+f(b))/2) \qquad \text{Equation 2}$$

- Excited
- Not excited

5.1 Data acquiring

The training dataset is from reference [R.G. Andrzejak et all, 2001]. The dataset has five sections divided as dataset A discussed as Z, dataset B discussed as O, dataset C discussed as N, dataset D discussed as F and dataset E discussed as S each containing set of EEG fragments with the recording of the electromagnetic movement of a healthy person for 23.6 Sec. Dataset A and dataset B have are having data related to EEG chronicles from healthy volunteers with categorization as eye open and eyes close, individually.
The second dataset characterised in reference [Dharmawan, Z., 2007] is included healthy people who volunteered and analysed under EEG to collect the data as playing particular PC computer games with a class as excited, not excited and relaxed on the basis of the various different values of the alpha, beta, theta and gamma.

5.2 Data extraction

Ambiguous data are removed and the data is polished/refined to get more refined information for unique groups differently. The element utilized here is categorized underneath the graph. The trapezoidal rule can be used to find the area under the graph which is formed in the dataset from the first source which is in raw graphical form. On numerical examination, the trapezoidal governs (likewise alluded to as the trapezoid control or trapezium run) is a strategy for approximating the particular imperative

The equation 1 shows the differentiation with the upper bound as (b) and lowers bound as (a) The working of the trapezoidal rule can be

S.No	Gamma	Theta	Alpha	Beta	Classification
1	1.609	0.0968	0.0697	2.0751	Eyes open
2	2.1102	0.1515	0.1014	2.6351	Eyes open
3	1.6851	0.1152	0.079	2.2138	Eyes open
4	2.1054	0.268	0.165	3.7274	Eyes open
5	1.6558	0.1632	0.109	2.1241	Eyes open
6	1.8004	0.1133	0.0711	2.3644	Eyes open
7	2.0154	0.1357	0.0989	3.496	Eyes open
8	1.3267	0.0781	0.0499	1.9388	Eyes open
9	1.0111	0.1119	0.0765	1.4273	Eyes open
10	1.2582	0.0911	0.064	1.6643	Eyes open
11	1.6092	0.0958	0.0617	2.0651	Eyes open
12	2.1002	0.1505	0.1012	2.6341	Eyes open
13	1.685	0.1122	0.0796	2.2118	Eyes open
14	2.1052	0.267	0.166	3.7284	Eyes open
15	1.6458	0.1732	0.1092	2.124	Eyes open
16	1.8	0.1137	0.0721	2.364	Eyes open
17	2.0152	0.1359	0.098	3.4969	Eyes open
18	1.3367	0.0881	0.049	1.9398	Eyes open
19	1.0211	0.1019	0.0755	1.4283	Eyes open
20	1.2581	0.0912	0.062	1.6663	Eyes open
21	1.7572	0.0957	0.1202	3.4040	Eyes open
22	1.3870	0.1046	0.0655	2.9863	Eyes open

Figure 6(a). Training Dataset

S.No	Gamma	Theta	Alpha	Beta	Classification
1	69.4383	45.8321	49.4259	221.6474	
2	69.6446	46.5568	57.7681	102.4994	
3	91.8594	42.6131	51.5499	103.0682	
4	67.4971	40.4624	59.9489	174.7884	
5	84.6949	36.1484	72.1629	134.2374	
6	67.0467	62.3433	60.2728	189.6933	
7	79.9600	51.1087	37.0466	129.3347	
8	86.5892	42.7766	49.2190	147.3661	
9	88.7903	36.4910	34.4092	197.5100	
10	66.3496	42.6570	42.2607	220.0897	
11	76.9733	59.2717	47.9967	160.7117	
12	95.7824	48.1827	85.6501	219.9220	
13	93.5209	35.8558	50.6149	98.5616	
14	70.8636	42.8352	77.9335	183.5369	
15	74.8070	45.6797	50.9562	198.5286	
16	87.6967	42.4205	38.7483	139.3835	
17	82.0244	44.9508	80.3661	190.7009	
18	93.7250	58.3833	58.0030	128.3926	
19	80.1814	38.4987	65.4532	101.0202	
20	87.5264	43.1170	41.0551	159.5389	
21	1.9815	0.2416	0.0527	3.4226	
22	1.4755	0.1190	0.1611	3.2706	
23	1.2579	0.1332	0.0541	3.3734	

Figure 6(b). Test Dataset

ExampleSet (100 examples, 7 special attributes, 4 regular attributes) Filte

Row No.	Classif...	predict...	confide...	confide...	confide...	confide...	confide...	Gamma	Theta	Alpha	Beta
1	?	Excited	0	0	0	0	1	69.438	45.832	49.426	221.647
2	?	Excited	0	0	0	0	1	69.645	46.557	57.768	102.499
3	?	Excited	0	0	0	0	1	91.859	42.613	51.550	103.068
4	?	Excited	0	0	0	0	1	67.497	40.462	59.949	174.788
5	?	Excited	0	0	0	0	1	84.695	36.148	72.163	134.237
6	?	Excited	0	0	0	0	1	67.047	62.343	60.273	189.693
7	?	Excited	0	0	0	0	1	79.960	51.109	37.047	129.335
8	?	Excited	0	0	0	0	1	86.589	42.777	49.219	147.366
9	?	Excited	0	0	0	0	1	88.790	36.491	34.409	197.510
10	?	Excited	0	0	0	0	1	66.350	42.657	42.261	220.090
11	?	Excited	0	0	0	0	1	76.973	59.272	47.997	160.712
12	?	Excited	0	0	0	0	1	95.782	48.183	85.650	219.922
13	?	Excited	0	0	0	0	1	93.521	35.856	50.615	98.562
14	?	Excited	0	0	0	0	1	70.864	42.835	77.933	183.537
15	?	Excited	0	0	0	0	1	74.807	45.680	50.956	198.529
16	?	Excited	0	0	0	0	1	87.697	42.420	38.748	139.383
17	?	Excited	0	0	0	0	1	82.024	44.951	80.366	190.701
18	?	Excited	0	0	0	0	1	93.725	58.383	58.003	128.393
19	?	Excited	0	0	0	0	1	80.181	38.499	65.453	101.020
20	?	Excited	0	0	0	0	1	87.526	43.117	41.055	159.539
21	?	Eyes open	1	0	0	0	0	1.982	0.242	0.053	3.423
22	?	Eyes open	1	0	0	0	0	1.476	0.119	0.161	3.271
23	?	Eyes open	1	0	0	0	0	1.258	0.133	0.054	3.373
24	?	Eyes open	1	0	0	0	0	1.252	0.125	0.095	3.539

Figure 7. Prediction made using K-NN

understood as by approximating the region underneath the diagram of the element f(x) as a trapezoid and computing its locale.

With this, we can derive the different values for different waves. It takes after that the district of the recurrence groups (delta, theta, alpha, beta) is ascertained for every EEG section.

5.3 Training data and Test Data

The acquired data is then divided into two parts i.e.

- Training Dataset
- Test Dataset

Training data set is used for teaching purposes of the system while the test dataset is used for the purpose of testing the prediction accuracy of the model. Training dataset is consist of 800 classified data as Eyes open, Eyes Close, Relaxed, excited and Not Excited. Figure 6(a) shows the snap of training dataset and figure 6(b) shows the snap of test dataset. Attributes

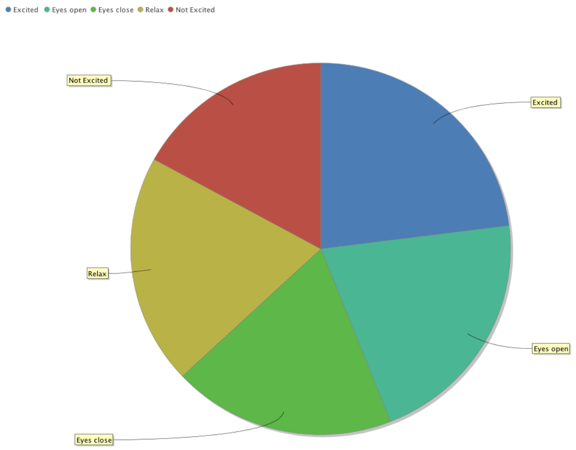

Figure 9(a). Prediction Pie Chart

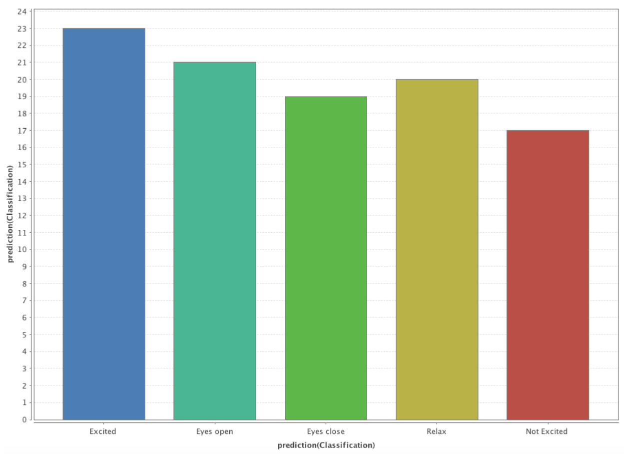

Figure 9(a). Prediction Bar Graph

that were used for making prediction were

- Gamma
- Theta
- Alpha
- Beta

Test dataset is consist of 100 datasets which are unclassified and prediction is made for those 100 datasets.

5.4 Accuracy and prediction of model

Figure 7 shows the prediction made by the K-NN model using 5 nearest neighbours i.e K = 5. Figure 8 shows the accuracy level which is 97.50% for the particular model and on the basis of prediction a pie chart and bar is obtained as shown in figure 9(a) and figure 9(b) showing the mental state of the user during real-time testing where

accuracy: 97.50%

	true Eyes open	true Eyes close	true Relax	true Not Excited	true Excited	class precision
pred. Eyes open	15	2	0	0	0	88.24%
pred. Eyes close	0	13	0	0	0	100.00%
pred. Relax	0	0	15	0	0	100.00%
pred. Not Excit...	0	0	0	15	0	100.00%
pred. Excited	0	0	0	0	20	100.00%
class recall	100.00%	86.67%	100.00%	100.00%	100.00%	

Figure 8. K-NN prediction model with 97.50% accuracy

- Red is for Not excited
- Blue is for Excited
- Yellow is for relax
- Green is for Eyes closed
- Sea blue is for Eyes open

6 Conclusion and Future Scope

This system is successful in provided automated health benefits at home with high accuracy and reducing the expenses on overall health care, generating data of persons mental and physical health at each moment and successful in early detecting of diseases and can save many people from injury or even deaths. It is easy to use and provide health care support even when the user is sleeping. With accuracy as high as 97.50% it can completely revolutionize people's idea about healthcare and management.

Research paper only proposes wearable and bed smart health care but can be used in cars, ambulances for patients health test while en route hospital, or can be used as a point of treatment in small hospitals in absence of doctors. Applying technologies like artificial intelligence and machine learning alongside the proposed model can help people on masses.

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