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Development of Pervasive IoT Based Healthcare Monitoring System for Alzheimer Patients

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Abstract Alzheimer is a neurological degenerative disease that steadily and gradually progresses. This disease is incurable at present and those who suffer from it have the hesitation to travel beyond their homes in comparison to normal people. The main aim of this paper is to offer a continuous mechanism that enhances the Alzheimer patient's quality of life as well as that of their caregivers. Proposed work is based on the Internet of things (IoT) based sensors data that figure out different parameters of the patient body like temperature, blood pressure, striding action, striding speed, and so on. All these sensory data will be obtained with the help of the Atmega Microcontroller. All the collected data are then sent to the cloud server with the help of parallel communication for data analysis. The desired parameter of the patient is retrieved which will help in providing real time support to the patients.

Keywords: IoT, Microcontroller, Communication, sensors, Alzheimer

1. INTRODUCTION

In Today's scenario, technological advancements are taking place everywhere whether it is in the field of Transportation, Smart City [1], and Agricultural or Health sector [2]. The world is undergoing through the demographic changes and the population of the elderly people is increasing rapidly day by day and the diseases associated with them also go hand in hand and one of them is Alzheimer's disease (AD) [3]. The major problems associated about the protection of the people having AD is that they always ran out of their senses, slight loss of memory, disarray, character changes, and aggravation. This disease is progressive and degenerative in nature which means the symptoms associated with this disease tend to increase with time and people will not able to do their day-to-day activities properly [4].

With respect to Alzheimer's sickness and other dementia patients, the expenses of treatment and care for these patients are anticipated to increment from the evaluated 203 billion USD to the estimated cost 1.2 trillion USD by 2050 in the United States [5]. Around 70% of people suffering from Alzheimer are forced to select nursing home facilities by their relatives because they cannot tolerate their erratic activities [6]. So we need to monitor the health of the patient remotely so that they can stay in their homes independently despite moving to a nursing home. Since the cost of the sensors is getting down day by day and they can also operate at a low power supply therefore we can use these sensors at home or anywhere required [7]. It requires the network of physical devices that are incorporated with an embedded device, software and network connection which helps in the sharing of



data obtained from the wearable sensors. All the web-enabled devices that can collect the data obtained from the surrounding are helpful. It measures parameters like temperature, pulse rate, respiration rate, and blood pressure [8].

The proposed IoT prototype in this paper shows restraint's interface which comprises of various wearable sensors used to gather clinical data of the patient. This level transmits continuous information remotely from wearable gadgets worn by the patient to second level of the framework by means of Bluetooth low vitality. The subsequent level comprises of an Android cell phone used to extricate patient's data from wearable sensors. Android cell phone with inbuilt remote systems administration can speak with online interface by means of General Packet Radio service (GPRS), 3G, or other Wireless Fidelity (Wi-Fi) systems [9].

In a cloud the database stores data such as heart rate, temperature, and rest of the parameters received from the sensors of the patient under observation. The k- nearest neighbour's algorithm is utilized for data analysis. The data generated from the sensors are accumulated at cloud and then sent to the doctors Personal Digital Assistant (PDA) dashboard of the android at the doctor's end [10]. This system paves the way when the patients are unable to serve themselves and in desperate need of the doctors consultation. Thus it allows the doctor to monitor the patients suffering from Alzheimer's disease remotely and hence reduce the cost incurred in the traditional therapy. So the holistic idea of the paper is to reconfigure the idea of traditional healthcare monitoring systems into smart healthcare monitoring system by integrating IoT with biosensors. When these technologies are used to keep a track of patient health to maintain their normal life and make them safe and active, they are called 'assistive' technology [11]. So in the nutshell, the proposed system design is all about providing continuous surveillance of the people by their doctors and providing quality of life to Alzheimer patient and their loved ones.

2. PROPOSED SYSTEM APPROACH

The proposed framework can utilize various sensors which empower concurrent measurement of few vital parameters from different patients. The whole procedure of monitoring the designed system begins with the collection of data from the specific patient who is suffering from Alzheimer disease, and this sensory data is sent to the Internet of things (IoT) module as shown in Fig 1. The working of the IoT module starts by receiving the data from the sensors which may or may not be in the analog form, these data which describe the various parameter measures of the patient are then converted into numerals. The work is being processed under microcontroller Atmega328. Now, the numeral data are sent to the cloud via ESP8266 Wi-Fi module where data analysis takes place, these data are then sent to the doctor's terminal. The doctor terminal is a simplified application platform, where a doctor does login with his corresponding credential details and then he can check the patient's data, after its assessment based on the obtained data he can figure out the condition of his patient and then he can simply log out from the application.

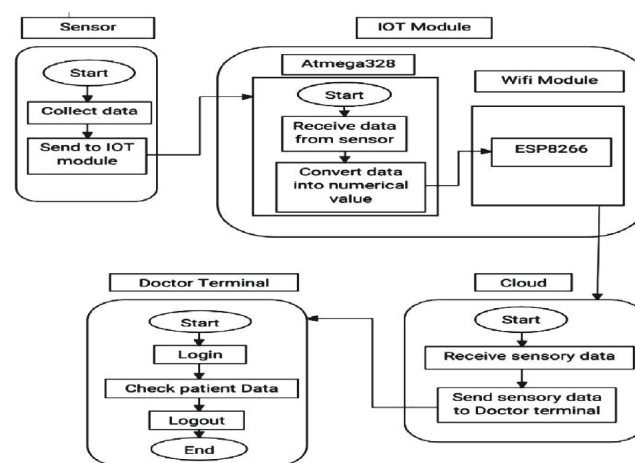


Figure 1. System Development Flowchart

3. SYSTEM IMPLEMENTATION

The working of the device takes place smartly in 5 different levels. These 5 different levels are physically divided into the following two modules

- a) The Transmitter
- b) The Receiver

In the first level, it involves the extraction of data from the sensors used such as pulse sensor, temperature sensor and gyroscope sensor. These sensors are operated through the microcontroller Atmega328. All the sensor will be connected to the chip and it will act serially in a way that only one sensor will be active at a time and will send the data to the cloud i.e. to the thingspeak platform via ESP8266 chip which is a Wi-fi module. Firstly the pulse sensor will transfer the data to the ESP8266 chip. Secondly the temperature sensor i.e. LM35 send data to the ESP8266 chip and at the last Gyroscope MPU6050 will send its data to the ESP8266 chip that will show the data related to analysis. These sensors are used to collect a number of data from various patients and normal healthy human beings so that any abrupt change in heartbeat or any other parameter of the patient can be distinguished from the average parameters measured and correlate it from the threshold data.

The initial sensory data are collected and selected through two methods [12]

- Wrapper method: This method will create all the possible subset from the dataset, thus the classification algorithm is used to induce each element from the features associated with each patient.
- Filter method: This method arranges the attributes according to the rank. It involves omitting the features with the lowest ranking one at a time.

The second level makes sure that all the sensory data collected are transferred from the microcontroller board to the cloud server platform through a communication module called ESP8266. This process is going to take place on the receiver side. Earlier approaches have been made about the diagnosis of the Alzheimer's disease and tracking of Alzheimer disease patients using the technologies like Global Positioning System (GPS), Global system for mobile (GSM), and Geographic information system (GIS) [13]. The third level is associated with the data accumulation in the cloud server. In our system design, we are using the ThingSpeak platform for the cloud services which involves various data activities and it is at this level that our interaction takes place. The IoT devices and solutions are integrated into a common platform that supports interoperable and open standards [14].

Fourth level is also called the data intelligence layer because in this layer all the data mining activities take place such as data filtration, data classification, data sorting, etc. In the intelligence layer, two learning performance evaluators are involved [15].

- Training set: It classifies and simply splits the data into training data. In this case, the result of each module can be saved and can be visualized.
- Cross-validation: It uses the average performance of these models and deletes the other remaining models. From this, it is concluded that the model saved with cross-validation and with the training set are the same.

The last and fifth level involves the creation of an app using MIT app inventor which will consist of dashboard that will carry all the data related to a particular patient, the app will maintain a 24*7 connection with the cloud server to obtain the corresponding data at real-time. The overall block diagram of the system is shown in Fig 2.

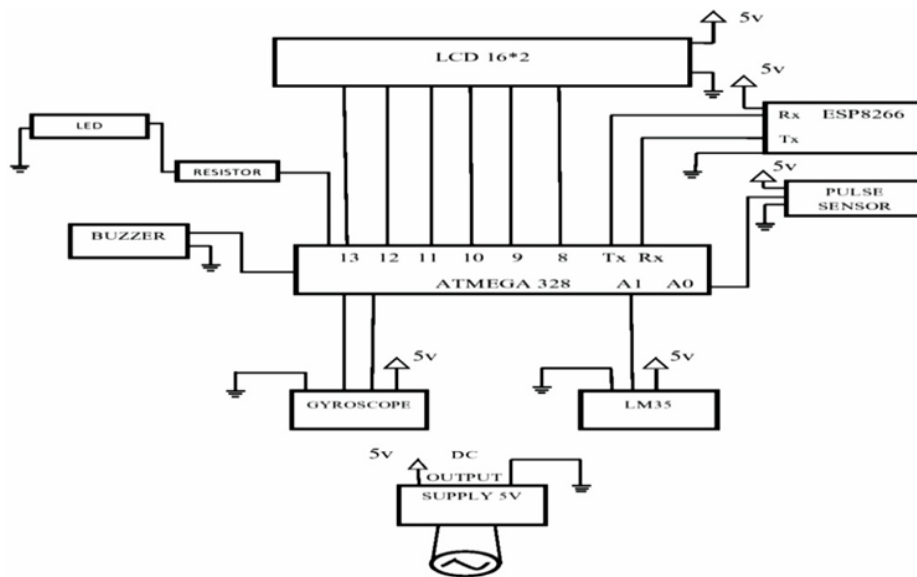


Figure 2. Block Diagram of System

The hardware system designed by integrating all the modules and methods as discussed in the above sections is shown in Fig 3. The hardware consists of the transmitter and the receiver sections after mounting all the components on the Printed circuit board (PCB). The ESP8266 chip output will get into the cloud platform i.e. Thingspeak platform as demonstrated on the connected Laptop in the proposed hardware design. Various functions that the hardware is performed such as the most fundamental one is the storage of the data in one database for all the sensors through various API settings. Data visualization is also performed through various channels setting on the same platform.

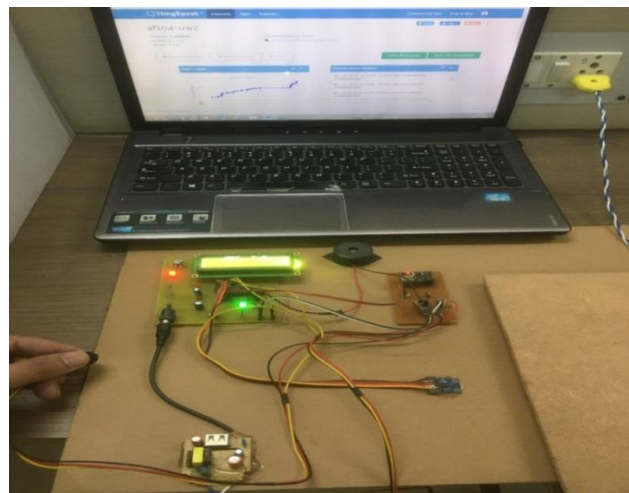


Figure 3. Proposed System Hardware Design

4. RESULTS AND DISCUSSIONS

This section deals with the results obtained from our proposed system. When the patient suffering from Alzheimer's disease wears the sensors like pulse sensor, LM35 temperature sensor, MPU6050 sensor, and so on, it helps in retrieving the real-time measures of the necessary parameters like temperature, pulse rate, etc. Then this data is sent to the cloud server with the help of the Wi-Fi module i.e. ESP8266. Fig 4 shows the channel statistic of field 1 and field 2 that consist of temperature sensors and pulse sensor databases on Thingspeak, a MATLAB analytic open IoT

platform [16]. Fig 5 and Fig 6 illustrates the reading of temperature at 108.46 F and 88.25 F respectively that are obtained from the LM35 sensor having the measure of temperature in Fahrenheit unit on the Y-axis and date & time values on the corresponding X-axis. Similarly, Fig 7 and Fig 8 depicts the readings of the pulse rate in BPM obtained with the help of pulse sensor on the Y-axis and the date & time values on the corresponding X-axis at 146 BPM and 92 BPM respectively.

The results as shown in the below figures shows the complete working of the proposed system and this data will move forward to the intended potential user in the filtered form after the MATLAB analysis and visualization performed on the Thing Speak platform.

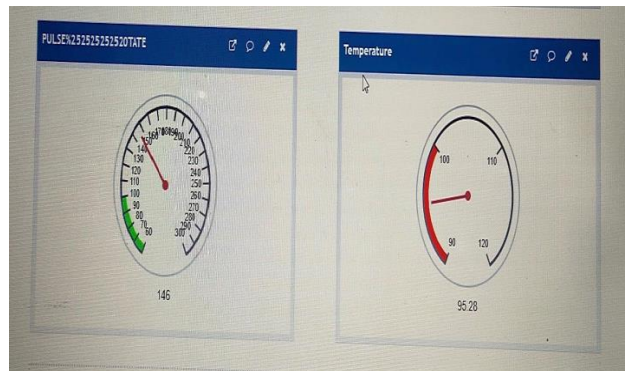


Figure 4. Channel stats of the field 1 and field 2 chart

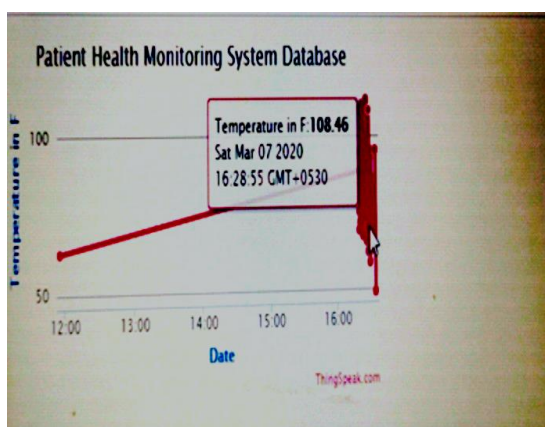


Figure 5. Temperature sensor reading at 108.4 F

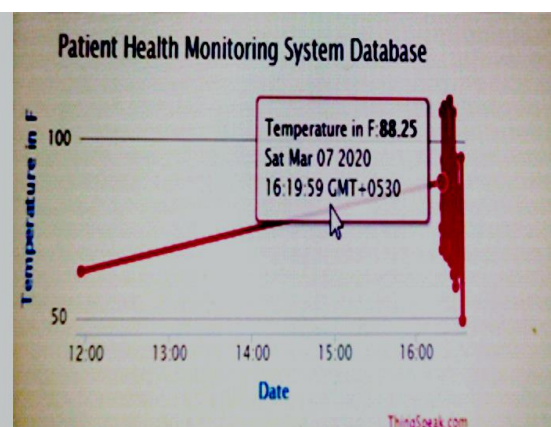


Figure 6. Temperature sensor reading at 88.2 F

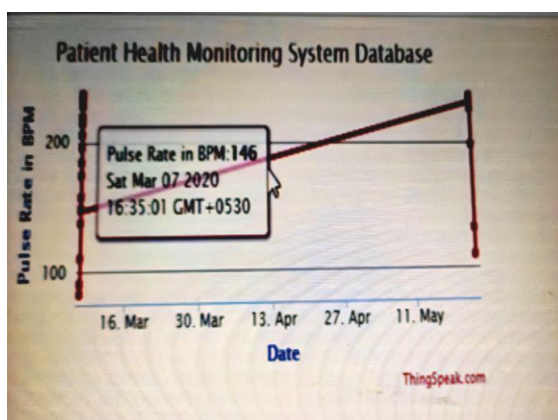


Figure 7. Pulse sensor reading at 146 BPM

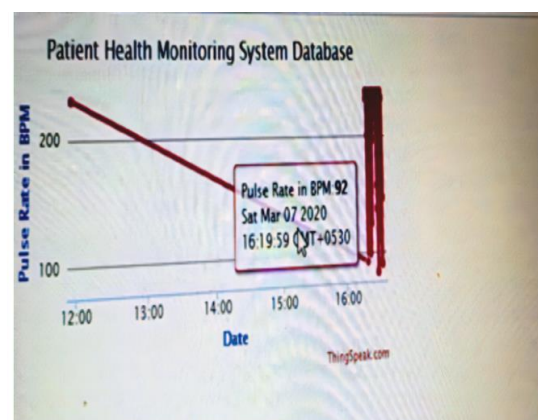


Figure 8. Pulse sensor reading at 92 BPM

The dynamic estimation gives the analysis of data to the doctor or caretaker to offer proper treatment depending on the scores obtained in the state of mind expectation of the senior citizen. Hence in a nutshell we can say that our proposed healthcare system will be regarded as smart healthcare monitoring system for elderly Alzheimer patients that can help a majority of the people or the sufferers out there in a very economical way and can be used as a virtual 24*7 assistance clinic.

5. CONCLUSION

The overall conclusion of this device is to make an optimistic approach for Alzheimer patients to monitor their daily life. We know that this disease is incurable but with this device, we can somehow manage to make their life normal. Although it cannot guarantee the complete normal routine because it does contain technical equipment which has its limits but it can be a great initiative. The wireless health system not only monitors the patient's current report but also transmits the vital physiological signs to the medical personnel and its capabilities. It also brings down the measurement time and helps in obtaining care at the golden time during emergencies which can lead to better treatment outcomes. Thus, the proposed wireless health monitoring system in the paper plays a major role in delivering quality care for Alzheimer disease patients. Further, this work could be extended with the machine learning aspect, where cloud data can be used to predict the status of patient before the situation gets worst for the patient

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