Paralyzed Patient Monitoring Equipment – IoT

Viancy V
Dept. of Information Technology
LICET
Chennai, India
viancy.v@licet.ac.in

Avinash Wilson J
Dept. of Information Technology
LICET
Chennai, India
avinashwilson.21it@licet.ac.in

Anusha P
Dept. of Information Technology
LICET
Chennai, India
anusha.21it@licet.ac.in

***Abstract* - A survey of the Global Burden of Diseases (GBD) estimated that, approximately 5.8 million people lose their lives due to stroke. Stroke is the major cause of paralysis, which affects almost 33.7% of the population with paralysis. But there is no optimal tracking system to monitor the patient's health and daily needs. In this high speed world it is not possible to constantly take care of their near ones who need their help. To overcome such difficulties paralyzed patient monitoring equipment is introduced, which checks the patient's heart rate using SEN-11574 and captures the hand gestures using MPU-6050. According to the sensor values, a patient's need is notified to the Care-Taker via mobile application using Internet of Things.**

Keywords— Paralyzed, Stroke, Patient Monitoring, Gesture.

I. INTRODUCTION

Paralysis is the loss of the ability to move and sometimes do not have any feeling in part or most of the body. This condition may be temporary or permanent. The rate of recovery also differs from person to person. The general causes for paralysis are spinal cord injury, stroke (severe or lateral) and multiple sclerosis etc. Paralysis is due to injury or disease(s) affecting the central nervous system (brain as well as spinal cord) which interrupts the nerve signals that are sent to the muscles. This may result in any one of the following conditions like complete loss of movement or weakness of any one limb, complete loss of movement or weakness of arm and leg on one side of the body, complete loss or weakening of both legs etc. to quote a few. Paralysis might also pave the way to various associated secondary states of incontinence. Nowadays, patients who are affected by paralysis are either monitored by a nurse (paid attendant) or left careless. Several times these patients are left alone without paying much attention to their basic needs by the Attendant/Care-Taker. This research work focuses on inventing wearable equipment that will help the patient to communicate instantly to the Care-Taker and also to keep track of their health conditions.

II. PARALYSIS

Paralysis occurs due to injury (or damage) in the central nervous system (CNS)[1], specifically in the spine. This causes malfunction in the way messages are passed between the brain cells and muscles resulting in paraplegia, quadriplegia, palsy or hemiplegia. The affected patients can't move or have control over the affected muscle resulting in complete paralysis. Partial paralysis is when you still have some feeling in your paralyzed muscles. [2]Localized paralysis affects only one specific area, like one's face, feet, hand(s) or even vocal cord. Generalized paralysis is more widespread which affects a huge span in the human body and is categorized by how much of the body is affected. This kind of paralysis usually depends on which portion of the brain or spinal cord is injured. According to the study, nearly 1 out of 50 people living with paralysis – approximately 5.4 million people. And that number is nearly 40 percent higher than previous estimates shown by the reports of GBD. The leading cause of paralysis was stroke, followed by spinal cord injury, spinal tumors, post-polio syndrome, Lyme disease, cerebral palsy and multiple sclerosis. In many cases, paralysis isn't curable. The attendant has to take care of the patient continuously at home which involves a lot of patience and tolerance. But, it is natural for the caretaker to become frustrated physically and emotionally. According to the survey nearly 70% of the caretakers report their depression state, 51% sleeplessness and 41% back problems. Roughly 28% of households with a person who is paralyzed make less than $15,000 per year. Hence, paralyzed patient monitoring equipment is proposed here.

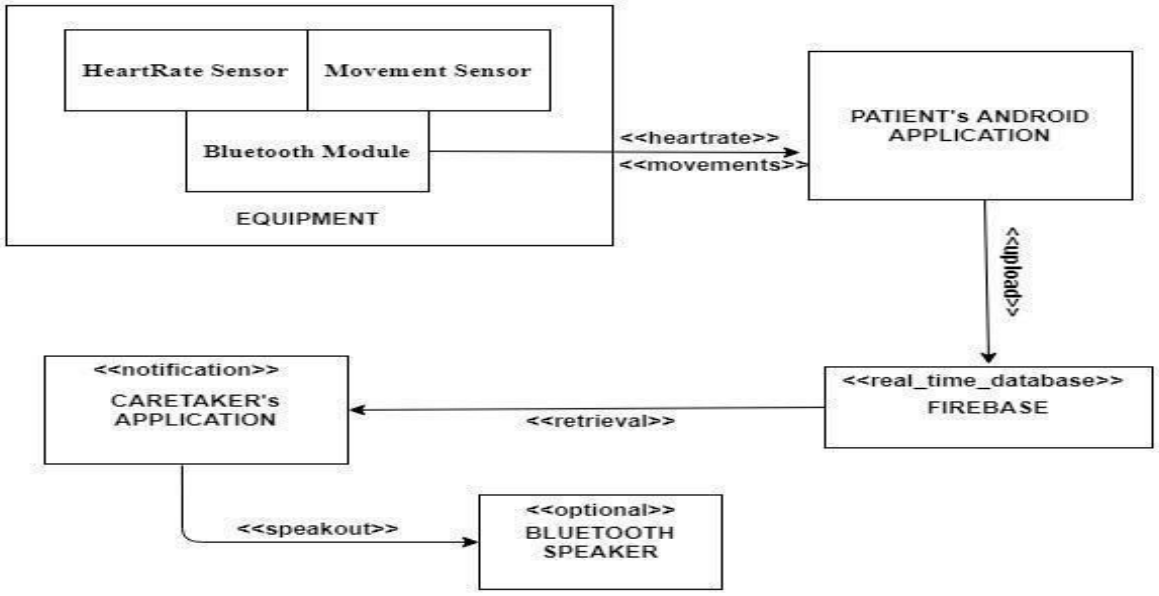
III. HARDWARE AND SOFTWARE TOOLS

A. Arduino Pro Micro

Arduino Pro Micro is a small (3.3cm in length) board that belongs to the Arduino uno family. It is the most efficient device to integrate into objects to make interactive communication which is based on the ATmega32U4 microcontroller featuring an On-Board micro-USB connector for programming. Hence no external USB interface chip is required.

B. SEN 11574

The Pulse Sensor Amped (SEN 11574) is a plug-and-play heart-rate sensor for Arduino. This sensor is highly useful for students, athletes and developers who want to integrate the live pulse rate data into their applications. It is suitable for mobile applications since it extracts power with just 4mA current draw at 5V.



C. MPU 6050

It is a Micro Electro-Mechanical System (MEMS), with a 3-axis accelerometer and 3-axis gyroscope. It is a MEMS technology for processing motions in 6 dimensions below 5V.

D. HC 05

It is a Bluetooth[3] module for wireless serial communication which makes an easy way to interface with the arduino. HC-05 has a data transfer rate of 1Mbps while operating on frequencies less than 2.45GHz in 3.3V. It is with a red LED to indicate it's the connection status.

E. Softwares

- Arduino IDE :
  The open-source Arduino Software (IDE) was used to write code and upload it to the arduino board.
- Android Studio :
  The Android Studio was used to develop both the Patient's as well as the Care Taker's mobile applications.
- Firebase :
  The Firebase Real-time Database is a cloud-hosted database. It was used to push and pull the status of the patient.

IV. PROPOSED SYSTEM

The proposed system is to monitor a paralyzed patient's pulse rate and their hand movements to notify the status of the patient to the Care-Taker. The system includes a mobile application for the Patient and Care-Taker. When the Equipment is turned on the heart rate of the patient is periodically sent to the Patient's application. The values are updated in the Real-Time Database i.e. Google's Firebase. The Care-Taker's mobile application retrieves the values from the

Firebase and sends the alert notifications along with the voice notification. Whenever the BPM[1] rate exceeds 90 or falls below[4] 60 the Care-Taker is notified with an urgent message. If the Care-Taker's mobile is connected with the household Bluetooth speaker, the needs of the patient can be known by anyone in the house, so that anybody can meet the requirements of the Patient *[optional way]*.

This system also includes the Patient's hand movement detection to notify the Care-Taker about the current needs of the Patient. Here, we are using four hand gestures to convey the needs of the Patient to the Care-Taker. The two important movements are [LEFT ROTATE→ Patient needs food/water, RIGHT TURN→ Patient needs to use the washroom]. There are two other movements to facilitate the Patient through his mobile application such as [LIFT UP→ Phone Call to a Specific Person, PRESS DOWN→ Play Music]. By making the appropriate hand gestures the patient can effectively communicate with the Caretaker as well as meet his own needs such as listening to music or hearing someone *(close relative)* who is talking through a phone call to him/her.

V. OUTPUT SNAPS

Fig 2. Wearable Device's Prototype

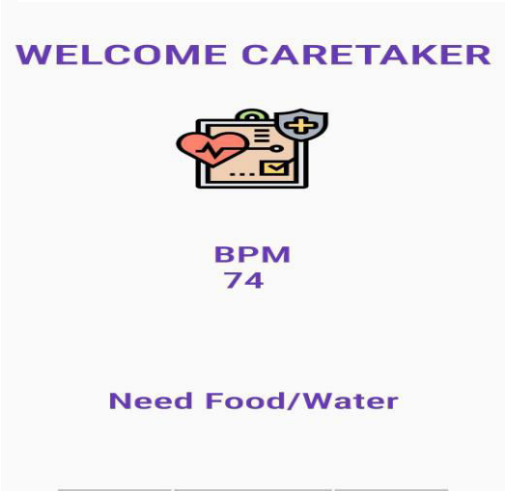


Fig.3. the Care Taker's mobile application

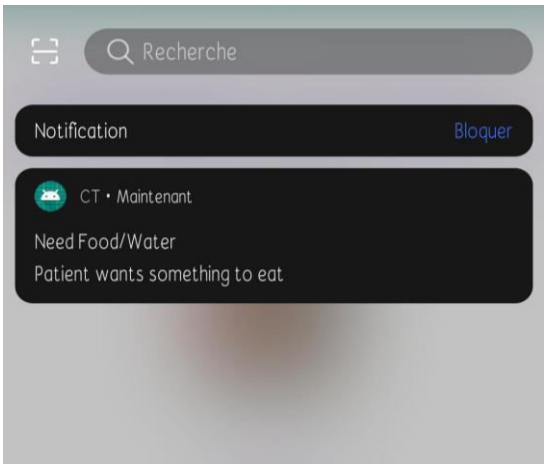


Fig.4. the Care-Taker is notified based on patient's movements

VI. SPEAK OUT MODULE

```
TextToSpeech textToSpeech; //Init
textToSpeech = new TextToSpeech (
getApplicationContext () , new TextToSpeech .
OnInitListener() {
  @Override
  public void onInit ( int status) {
// Default settings as English
    textToSpeech . setLanguage (Locale.US);
  }
});
//method call
textToSpeech. speak ( ( String )
charSequence_toSpeakOut, TextToSpeech .
QUEUE_FLUSH , null );
```

VII. EXISTING SYSTEMS

The available systems come up with a glove like structure that covers the full hand of the patient completely. Hence, it may cause discomfort to the patient in wearing it for a long time. In other cases, the complete arduino board itself is attached to the hands of the user to monitor their status. This too is similar to the previous case. In yet another case the system includes a GSM[5] module kit, which in turn increases the fabrication cost of the device[6].

VIII. ADVANTAGES

Hence, when compared with the other available technologies, the paralyzed patient monitoring equipment which is proposed here, is much advantageous in effectively monitoring the patient's status. Being a wearable device, if fabricated in a rubberized material can be easily worn by the patients. Also the proposed equipment is cost efficient than the other existing systems in terms of simplicity and the sensors that are used.

IX. FUTURE WORK

In future, Artificial Intelligence based patient idleness monitoring module along with a self-speech training module can be introduced in the patient's application to keep the patient aware of himself. Also, the patients can be directly linked with his doctor to track the activities of the patient to provide even more personal care depending upon the wants and the status of the patient's health.

X. CONCLUSION

This IoT based paralyzed patient monitoring equipment is a wearable device and serves as an efficient system for the paralyzed patients. The system is inexpensive and helps the patients notify their Care-Taker in case of any needs through their hand gestures. Also, the equipment monitors the vital framework of the patient such as heart rate and if the parameter goes from normal range to an unsafe range, the patient's relative/caretaker is immediately notified so that critical care can be given to the patient before he/she reaches a dangerous state.

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AUTHORS BIOGRAPHY

V VIANCY, is an Assistant professor in Loyola-ICAM College of Engineering and Technology. She has nine years of working experience as assistant professor in the department of Information Technology. She has published research papers in various International conferences and Journals. Her main research work focuses on the Internet of Things, Machine Learning and Computer Networks.

AVINASH WILSON J, is a student pursuing B.Tech.IT in Loyola-ICAM College of Engineering and Technology. He is a highly proactive student who has published various papers in international conferences. His research domains focus on the Internet of Things and Data Science.

ANUSHA P, is an undergraduate student in the Information Technology program at the Loyola-ICAM College of Engineering and Technology and will be graduating in 2021.Her research work concentrates on the Internet of Things and Machine Learning.