IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

SMART WHEELCHAIR WITH INBUILT HEALTH MONITORING SYSTEM

Rajdeep Sarkar[1], Gunjan Ganguly[2], Arpan Saha[3], Souradipta Dey[4], Prof. Kuntala Das[5]

B.Tech Student [1] [2] [3] [4], Assistant Professor ECE Department [5]

Electronics & Communication Engineering [1] [2] [3] [5], Computer Science Engineering [4]

Bengal Institute of Technology [1] [2] [3] [4] [5], Kolkata - 700150

Maulana Abul Kalam Azad University of Technology, West Bengal, India

ABSTRACT: We all want to become independent, especially the ones who have to spend their entire life in wheelchairs. This Project ***"Smart Wheelchair"*** assists its users certain prospective. Normally a Wheelchair patient need to be dependent on someone to be taken care of but with this product he/she doesn't need to be dependent as technology has made us more independent. This Product has its own ***'Inbuilt Health Monitoring Facility'***. Even if for an emergency condition this framework can assist users to overcome such circumstances. We conclude with our vision for the future of Smart Wheelchair research and how to best serve people with some types of disabilities.

Keywords: Wheelchair, Independent, Health Monitoring Facility, Emergency, IOT

1. INTRODUCTION

Technology has been evolving with leaps and bounds so are we. Nowadays we can do anything we want even staying back at our homes. On one side it has helped many people and on the other side it has created major problems. Technology has made us more independent. We don't need to depend on others for majority of our work. We simply can refer to internet or use various gadgets. Keeping that in mind we have made a project that will make disabled people more independent and will monitor their health system.

The Smart Wheelchair can be easily controlled by the user because it is equipped with motors and two directional switches. This allows the user to control the wheelchair without any hard effort. The health monitoring system attached with the wheelchair will keep the doctors of the patient informed 24x7 about their health status. If any emergency occurs, all the contacts given in the database will alerted with an emergency message so that they can take quick actions to save the patient.

The paper is split into seven sections. *Section 2* talks about the system overview. *Section 3* deals with manual control and Bluetooth connections. *Section 4* is about out inbuilt health monitoring system attached with wheelchair. In *Section 5* we discussed the safety measures while *Section 6* tells us about experiment results. Section 7 talks about the Future aspects of this project. *Section 8* concludes with how this wheelchair makes the patient independent and safe.

2. SYSTEM OVERVIEW

Our entire system is applied on a wheelchair which is manually controlled by the user. Our wheelchair looks like any normal wheelchair but with enhanced features and pros. The wheelchair is equipped with DPDT switches. DPDT switch can work in two ways like a normal switch at our home. With 4 DPDT switches the user can easily move the chair in any direction he/she wants. The reason we didn't go with a joystick is because of the cost. We want to keep the price as low as possible so that everyone can afford it. The wires from the DPDT switch box directly goes to the two DC motors attached at the bottom. The motors get its power from a 12V power supply from batteries which can be recharged and reused again. **Fig.1** is the prototype of the project.

figure 1: Prototype of the Wheelchair

Now regarding the movement, we also have an alternative to the manual controls that is the wheelchair can also be controlled wirelessly from the user's phone with the help of Bluetooth. The Bluetooth module (TP-4056) attached to the wheelchair is connected with the DC Motors through an Arduino UNO (microcontroller). This means both the wired and the wireless controls can function simultaneously. These two features will allow the user move independently here and there without any difficulty.
Now, when any user purchases the chair, he/she will have to create an account in our website which comes with the wheelchair itself. As soon as the user enter his/her details, s/he'll receive her username and password and all her details will be saved in our database. The website and the database had been created by us and right now we are storing the data locally and we hope to buy a domain in near future. The wheelchair is also equipped with an inbuilt health monitoring system which is designed to keep an eye on the user's health 24*7, such as heart beats, temperature and pulse ratings. The next time the user logs in to our website he/she has to enter the log in details after which she'll be directed to a page where a graph will be shown. Now this graph represents the pulse ratings of the user who is using the wheelchair. The readings are taken from the sensors which are attached to the user's body and the ratings can be monitored from anywhere and from any country. This will help the family as well as the doctor in charge to keep an eye on the user's current health status. The pulse sensor attached to the user's body is connected to a Nodemcu through which the data is sent to our database with the help of internet. As soon as the data is saved, it is uploaded in the graph section where the user can see a graphical view which is better to analyze. In the worst case if the pulse ratings fall below the normal level, then the user might get into a critical situation. For the safety of the patient we have installed a GSM module which is connected with the database where the pulse readings are stored. If an abnormality is noticed an immediate emergency alert message is sent through the GSM module to the respective mobile numbers which are saved in the database.

3. MANUAL CONTROL AND BLUETOOTH CONNECTIONS

Everyone wants to become independent, especially the ones who have to spend their entire life in wheelchairs. Our wheelchair is designed to enable individuals to move freely indoors and outdoors by their own. It is equipped with motors with two directional switches and can also be controlled by phone. **Fig.2** shows the Manual Control and **Fig.3** shows the Bluetooth Connection.

3.a. Manual control:

Double Pole Double Throw (DPDT) has two input and 4 output. It uses polarity reversal that allows to handle two energized circuits at the same time. It has 6 terminals A, B, C, D, E and F. AF and BE are connected as shown in the figure below. C and D are connected with positive and negative terminal of the battery simultaneously. While A and B are connected with motor which act as an output [1].

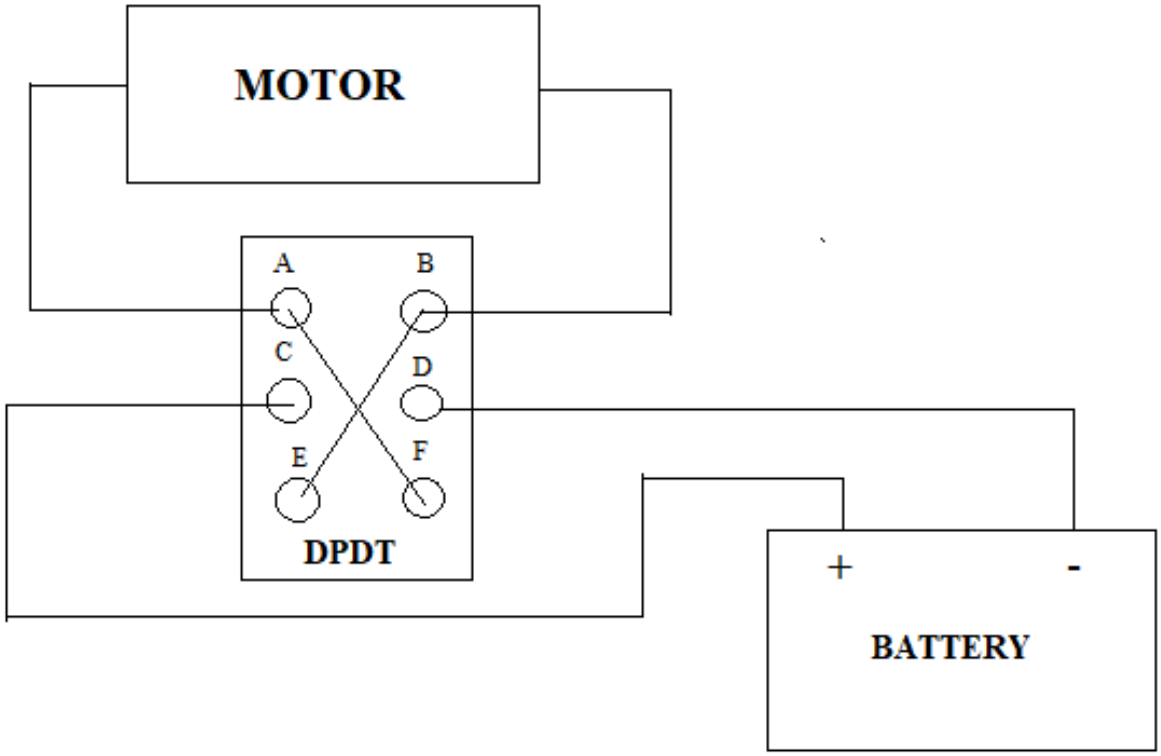

figure 2: Manual control

We have attached two DPDT switches with the wheelchair. So that patient can control the chair easily. The advantage of using DPDT is it can turn the wheelchair ON and OFF at the same time with one flick.

3.b. Bluetooth Connection:

The HC-05 is a Serial Port Protocol module. It can be used to communicate between two microcontroller or any device having Bluetooth functionalities. There are many android applications which are already available in play store which make the product easier to use[2].

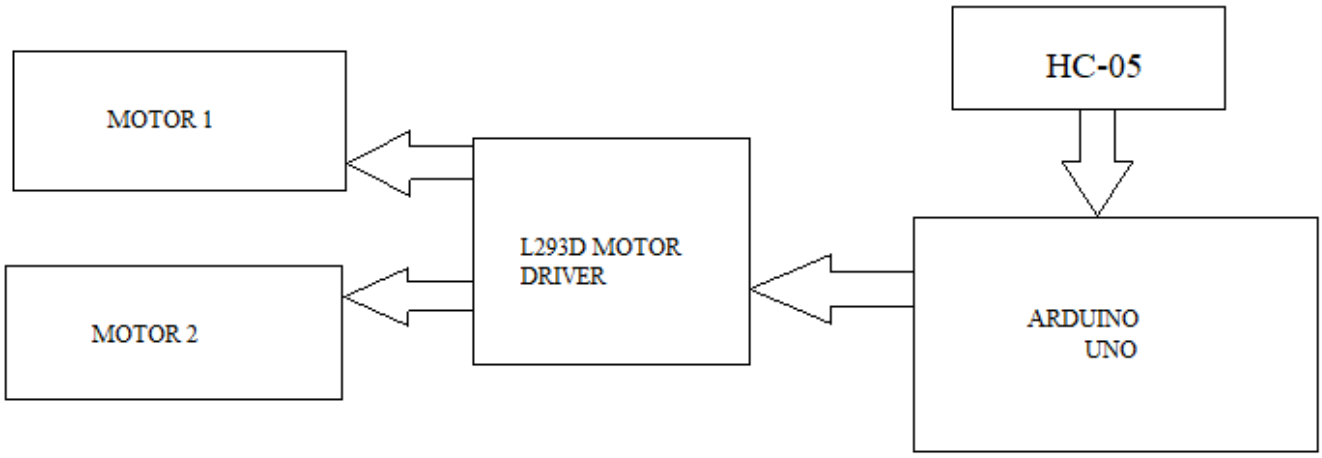

figure 3: Bluetooth connection

We have also used Bluetooth module (HC-05) in our wheelchair. The Bluetooth module is mainly responsible for connecting our chair with smart phone. As we can show in the above figure Bluetooth module is connected with Arduino UNO, which act as a central processing unit in the above circuit. It will be controlling the other devices connected with it. As Arduino could not provide sufficient voltage to the motor. We have attached a motor driver which will provide essential voltage to the motor. The wheelchair runs with the help of batteries which can charged and used again. With the help of Bluetooth patient can move in any direction such as forward, backward, right, left, forward right, forward left, backward right and backward left. Moving around the house will be much easier with the help of the motor system inside the wheelchair.

4. INBUILT HEALTH MONITORING SYSTEM

A part of the 'Smart Wheelchair' is Inbuilt Health Monitoring Facility. A major Portion of the Project can be described under the section of "Inbuilt Health Monitoring Facility". Live Tracking of Health of the Patient is very much needed in today's World as practically we are not able to be with patient 24x7. So, we have come across this project to monitor constantly and continuously the Health of the patient along with the Wheelchair and Keep updating the Family Members and Family Consultant Doctor live 24x7 by showing the graph and by Messages.

Our system has a Heartbeat Sensor attached to the hand of the patient in the Wheelchair. This Sensor is Constantly Taking Pulse Values from the patient with a delay of 30 Seconds. This Sensor is known as 'SEN – 11574'. This Sensor essentially combines a simple optical heart rate sensor with amplification and noise cancellation circuitry making it fast and easy to get reliable pulse readings. **Fig. 4** is the photo of Pulse Sensor[3].

figure 4: Pulse sensor

This Pulse Values is Directly Going to our own Databases via NODEMCU. This Database stores Each and every data (with respect to Date and Time) took by this Single Pulse Sensor.

Additionally, we have made a website in which the Family Members are allowed to login with their own ID & Password to View the live Graphs of their patient's Health Condition Live across anywhere in the world & any new user needs to Register themselves to use this Product. There's no need to be present all the time with the patient to monitor their Health Condition.

Moreover, for any Kind of Emergency (i.e. Rise of Heartbeat / Fall of Heartbeat) an emergency message will be generated immediately and will be delivered to the contacts saved in the databases (i.e. Family Consulted Doctor, Family Members) to take necessary safety measure instantly.

Though in foreign Countries, Smart Wheelchair is Present but Inbuilt Health Monitoring Facility in Smart Wheelchair is rare to find.

5. SAFETY MEASURES

Several safety measures have been taken to protect the users. One out of them is alerting via SMS. Signals detected are then processed and analyzed before sent via SMS to alert medical experts or family members. It is beneficial in terms of cost, no complicated settings, save time and even very helpful for patient whom lives alone.

Also, a website has been made where the users health details will be stored and protected via password set by them.

5.a. Heart beat Rate:

When the heart beats, a pressure wave moves out along the arteries at a few meters per seconds (appreciably faster than the blood actually flows). This pressure wave can be felt at the wrist, but it also causes an increase in the blood volume in the tissues, which can be detected by a Pulse Sensor[4]. ***Table 1*** shows the average heartbeat rate range versus the age of person.

Table 1 : Table of Pulse rate

AGE	RANGE	AVERAGE RATE
<1 year	80-180	130
1-3 years	80-160	120
4-8 years	70-120	125
9-11 years	60-110	85
12-16 years	60-110	85
>16 years	60-100	80

5.b. About the equipments

A Heartbeat sensor is a monitoring device that allows one to measure his or her heart rate in real time or record the heart rate for later study. It provides a simple way to study the heart function. This sensor monitors the flow of blood through the finger and is designed to give digital output of the heartbeat when a finger is placed on it. When the sensor is working, the beat LED flashes in unison with each

heartbeat. This digital output can be connected to the microcontroller directly to measure the Beats per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse. The Pulse Sensor is a well-designed plug and play heart-rate sensor for Arduino. It also includes an open-source monitoring app that graphs your pulse in real time.
The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board
The Arduino GSM Shield allows an Arduino board to connect to the internet, make/receive voice calls and send/receive SMS messages. The shield uses a radio modem M10 by Quectel (datasheet). It is possible to communicate with the board using AT commands.

5.c. System Block Diagram and Working Principal

It is a simple and low-cost optical technique that can be used to detect blood volume changes in the microvascular bed of tissue. **Fig. 5** shows the block diagram of the circuit. Hardware development involves design and development of sensor circuit. The whole program is written and assembled using ARDUINO IDE.

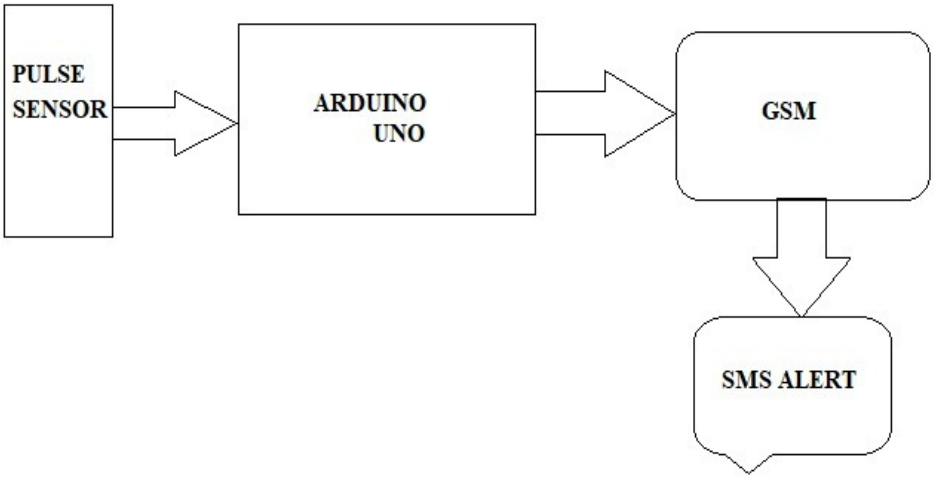

figure 5: Block diagram of the circuit

When the finger is placed on the pulse sensor, it detects the pressure pulse. For every age group a maximum range is set in the ARDUINO. If and only that range is exceed it will trigger GSM module[5] to send an alert message to the contacts saved in the database.

6. Experimental Results

In this section we analyze the system performance in real operation environments.
The first experiment was conducted to evaluate the system ability for responding to the user command via two switches. A user drove the prototype of the wheelchair in the cluttered lab environment by the full manual control and the semi-auto control. Apparently, we can see that by using switches, the user is able to reach the checkpoints and successfully completed the maneuvering task without collision.
In addition to switches connecting the chair with phone via Bluetooth connection is also done. Apparently, the semi-autonomous mode requires less effort from the user than the manual since he/she needs to interact only when wishing to change the direction to travel. From our testing, we drove the chair using phone and it worked perfectly. **Fig. 6** shows the connection between ARDUINO, Motor and cellphone.

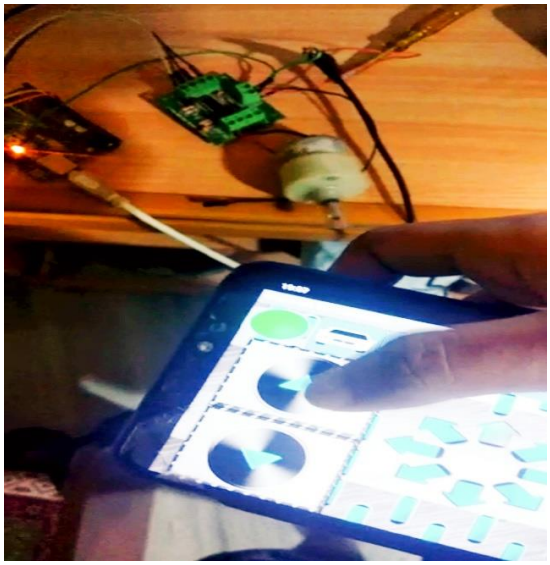

figure 6: Connection between ARDUINO, Motor and Cellphone

Thirdly we have made a website where every health update will be stored and shown to the user. It has three pages and all of them have no issue while working. It perfectly stores users registered data in the database. **Fig.7** and **Fig.8** shows the website and database respectively.

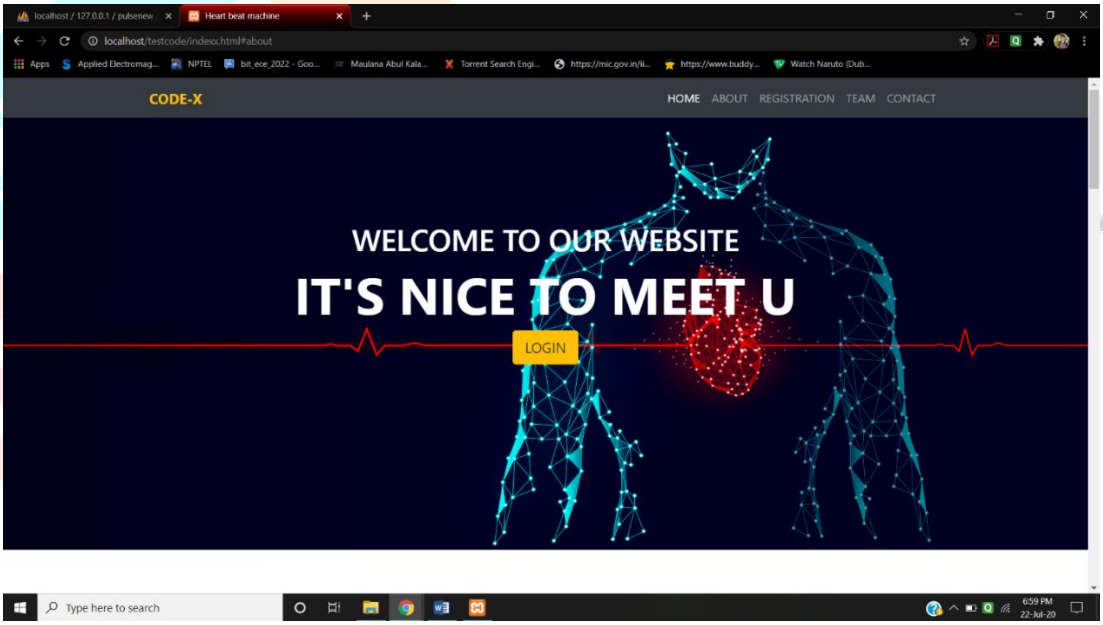

figure 7: Front page of Website

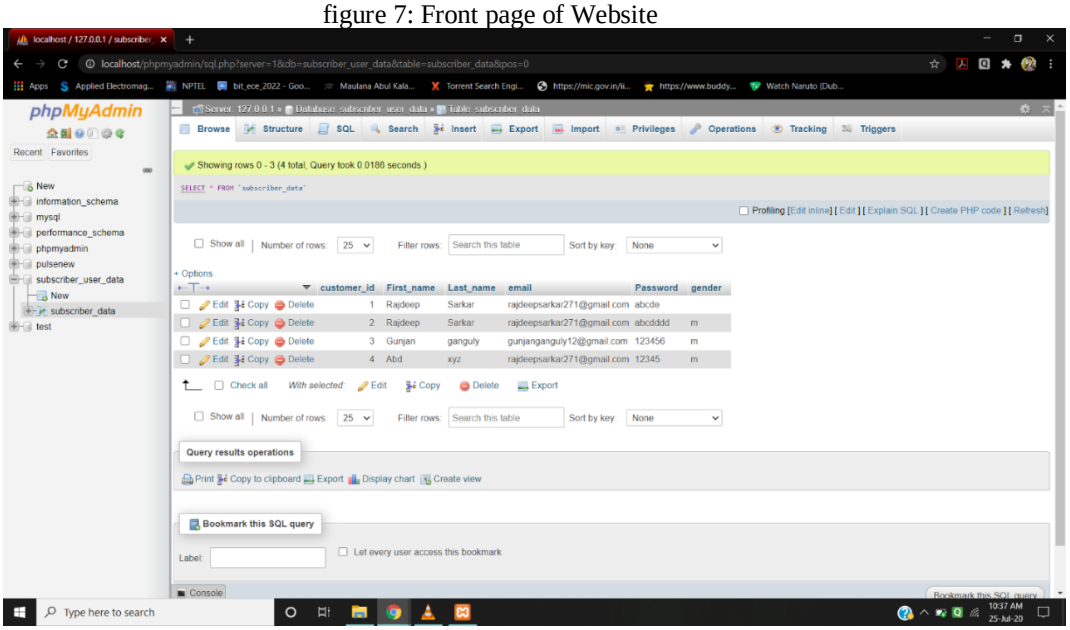

figure 8: Database

A Heartbeat sensor is a monitoring device that allows one to measure his or her heart rate in real time or record the heart rate for later study. It provides a simple way to study the heart function. For Testing, a user has tested his pulse rate. This Pulse Values is directly stored to our Databases[6] via NODEMCU[7]. This Database stores Each and every data (with respect to Date and Time) took by this Single Pulse Sensor and w.r.t the values stored a pulse graph is showed as an output which refresh every after a span of time. We got desired outcome from our test. **Fig.9** shows the pulse rate stored in database and **Fig.10** shows the outcome Graph.

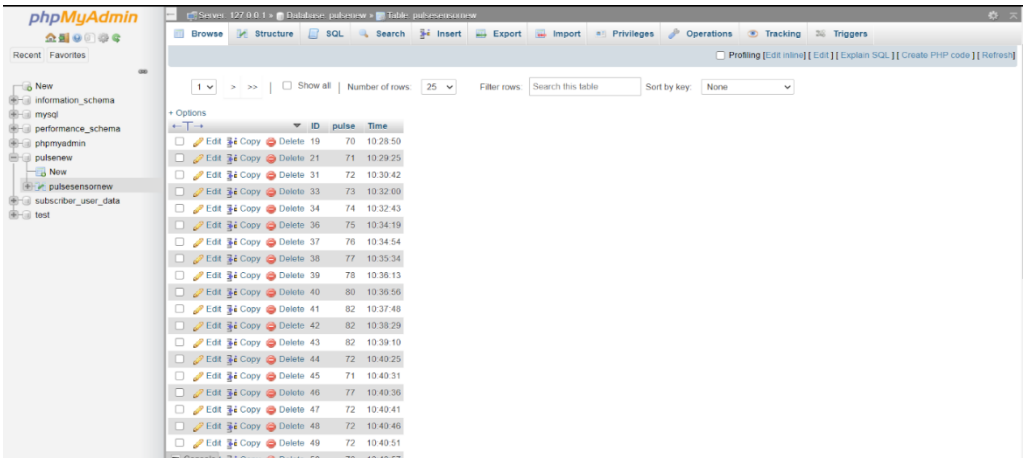

figure 9: Pulse rate stored

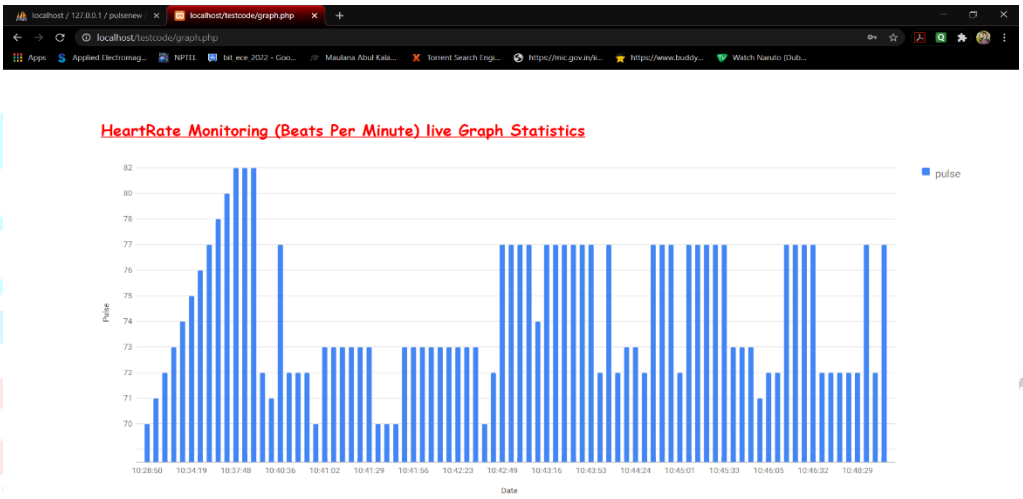

figure 10: Pulse rate graph

For testing the safety measures taken by us i.e., Heartbeat monitoring alert via SMS, we intentionally tested heart patient to test working of GSM module. The **Fig.11** shows the connection between Pulse Sensor, ARDUINO[8] and GSM module.

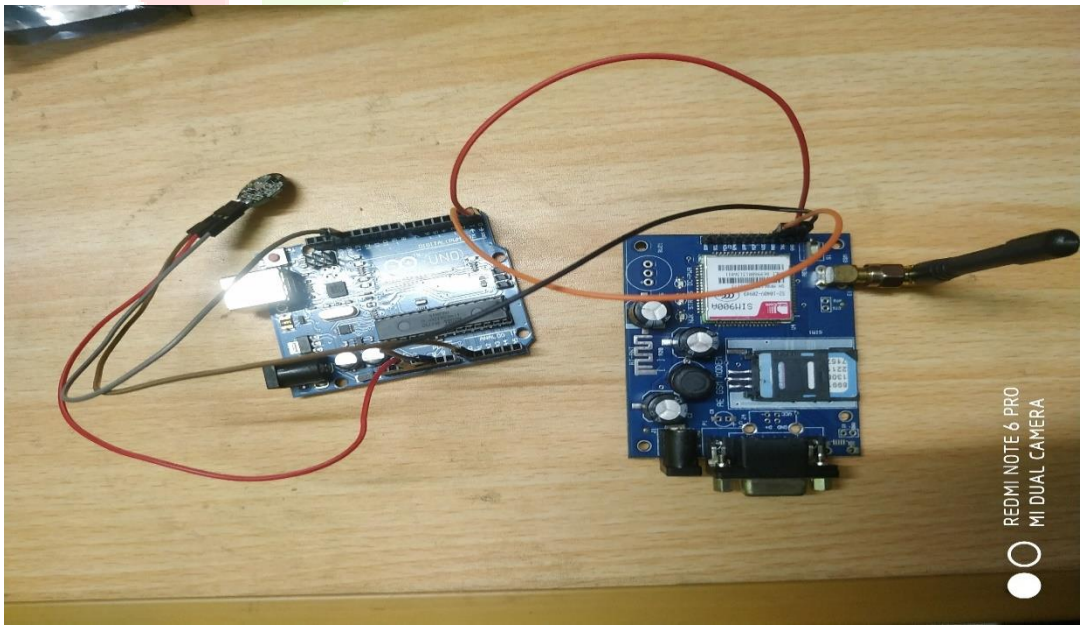

figure 11: Connection between Pulse Sensor, ARDUINO and GSM module

When the pulse rate rose above the stored pulse rate that has been coded in Arduino then GSM module successfully sent automatically an alert message to the contacts present in database**. Fig. 12** shows the alert message that has been sent.

figure 12: Alert messages

7. Future aspects and challenges

7.a. Challenges:

Smart wheelchairs will remain fruitful ground for technological research for many years to come. Smart wheelchairs are excellent test beds for sensor research, particularly machine vision. Smart wheelchairs also provide an opportunity to study human-robot interaction, adaptive or shared control, and novel input methods, such as voice control, EOG, and eye-tracking. In our country there has been a little effort on smart wheelchair. Very few smart wheelchair researchers have involved people with disabilities in their evaluation activities. Furthermore, no smart wheelchair has been subjected to a meticulous, controlled evaluation that involves extended use in real-world settings. Conducting user trials with smart wheelchairs is difficult for several reasons. Some wheelchair users do not show any immediate improvement in navigation skills when using a smart wheelchair on a closed course in a experimental setting. This could be because the smart wheelchair does not work very well or the wheelchair user was already so proficient that little improvement was possible. Users who have the potential to show large performance gains, on the other hand, often have little or no experience with independent mobility and may need a significant amount of training before they are ready to participate in valid user trials. The primary obstacle to conducting long-term studies is the prohibitive hardware costs associated with constructing enough smart wheelchairs. Long-term studies are necessary, however, because the actual effects of using a smart wheelchair for an extended period of time are unknown.

7.b. Future Aspects:

The distinction between using a smart wheelchair as a mobility aid, a training tool, or an evaluation instrument is also worthy of study. A study conducted by Worcester Polytechnic Institute showed that users who are accustomed to their wheelchairs have little to no tolerance for the failures of "new features", which means full autonomy plays an important role in users' acceptability. To emphasize these trends, we propose and discuss the following future directions which would be the priorities for Smart wheelchair research[9] .

7.b.1. Human-Smart Wheelchair Interaction Model:

The human- Smart Wheelchair interaction model plays a vital role in the formation of a Smart Wheelchair. The boosting learning technique[10][11] could be utilized to build an efficient interaction model between user and Smart Wheelchair. The developed model may take into account sensor feedbacks, such as from Emotive sensors and various environment sensing sensors including Oculus virtual reality sensors, laser scanners, cameras and global positioning system (GPS). The Smart Wheelchair uses these control signals to navigate and operate its robotic arms. Human user thinking will be captured and analyzed through an advanced signal processing model. The output signals will control the operations of the Smart Wheelchair including wheel motors as well as robotic arms. A shared control scheme could be developed to allow effective collaboration between user and Smart Wheelchair, as well as to adapt Smart Wheelchair's assistance to the variations in user performance and environmental changes[12].

7.b.2. Autonomous Navigation:

Current Power Wheelchair users still have to face many difficulties with daily maneuvering tasks, and would benefit from an automated navigation system. Future Smart Wheelchair users will be able to select from several autonomous or semi-autonomous operating modes, using the input methods they are most comfortable with. They will direct their Smart Wheelchair to navigate along preprogrammed routes with little physical or cognitive effort indoors and out, passing through doors and up-and-down elevators. The Smart wheelchair will communicate with the user when it is appropriate in order to reduce anxiety, and build an individualized profile. These profiles will track such variables as preferred input method, wheeling speed, turning speed, and amount of verbal feedback, just to name a few.

7.b.3. Smart Wheelchair with Smart Home:

Smart Wheelchairs will be integrated into the smart home, providing a logical user experience and control over all household appliances. When the users are outdoor a renounceable roof will provide shelter from the elements, and additional safety at night while driving in traffic. Optical stereoscopic and spherical vision imagery will be combined with infrared laser data to produce a virtual point cloud matrix of the user's surroundings. Objects in the matrix are identified using machine vision, visual tracking, and gesture recognition algorithms. Localization information from the IMU and GPS, onboard data collected, and Bluetooth beacon data flooding public spaces, will all help guide the Smart Wheelchair to a particular destination. We believe that given liability concerns, Smart Wheelchairs in the future should be treated like Plug-in Electricity Vehicles that are registered and insured. Users should be certified, or licensed, for operation after passing a standardized wheelchair skills test[13] [14].

8. Conclusion

The main motive of our project is to serve people who spend their entire life on wheelchair. Keeping the cost in mind we designed a chair for any person who already owns a wheelchair. By giving a little extra he/she can use all the features of the chair. This smart wheelchair will make them more independent than before. They can do their work all by themselves, they won't be needing an extra hand to help them out in every task. With the Bluetooth feature the user can control the chair from the phone itself easily as if it's like controlling a vehicle in a video game!

In such a pandemic situation where people cannot step out from their houses, it's really difficult for people who rely on housemaids or house servants. This chair will give their freedom back and will also keep the user safe through the health monitoring system.

If the user is an older citizen and his/her children live abroad for work related stuff, then this chair will definitely help their parents. They'll be able to keep a track on the user's health even from another city or country. So, if an emergency occurs the user can immediately be taken to the hospital and treated. This will increase the chances of saving the patient by a greater number.

There are many wheelchairs available in the Indian market but they are either not smart or do not offer any health care features and on the other hand our Smart Wheelchair does both the job. It is easy to handle and operate with, the user doesn't need any prerequisites regarding the wheelchair. It's fairly easy to cope with the controls. Keeping every section in mind we used the least costly products possible so that the overall price looks good and anyone can afford it. We really hope our idea gets recognized because many of my knowns use wheelchairs and they need extra help which gets irritating sometimes. So this smart wheelchair can help many people around India and the world.

9. Acknowledgement

The authors deeply acknowledge the support from the department of ECE & CSE, Bengal Institute of Technology (A unit of Techno India Group).We also want to thank all our team members who gave their tremendous support and successfully completed the project all possible features and ideas.

10. Reference

1. A D-Band SPDT Switch Utilizing Reverse-Saturated SiGe HBTs for Dicke-Radiometers. https://ieeexplore.ieee.org/document/8335025
2. A. Khanna and Ranjan, "Solar-powred Android based Speed Control of DC motors through Secure Bluetooth", Communication systems and network technologies CSNT 2015 international conference (IEEE Publication), pp. 1244-1249. https://ieeexplore.ieee.org/document/8945907/references#references
3. B.-H. Yang, S. Rhee and H. Asada, "A Twenty-Four Hour Tele Nursing System Using a Ring Sensor", Proc. of 1998 IEEE International Conference on Robotics and Automation, May 1998.
https://ieeexplore.ieee.org/abstract/document/7033986/references#references
4.M. J Drinnan, J. Allen, and A. Murray (2001). "Relation between heart rate and pulse transit time during paced respiration", Physiol. Meas. vol. 22, pp425–432.
5. J. J. Baviskar, A. Y. Mulla, A. J. Baviskar, N. B. Panchal and R. P. Makwana, "Implementation of 802.15.4 for designing of home automation and power monitoring system", Electrical Electronics and Computer Science(SCEECS) 2014 IEEE Students' Conference, pp. 1-5. https://ieeexplore.ieee.org/document/7939237.
6. P.A. Hughes and A.D.P. Green, "MySQL Database for Storage of Fingerprint Data ", Proc. 2nd Int. Conf. Neural Network, pp. 79-81, 1991.https://ieeexplore.ieee.org/document/5754229
7. NodeMCU is an open source Lua based firmware for the ESP8266 WiFi SOC from Espressif and uses an on-module flash-based SPIFFS file system.
http://www.nodemcu.com/index_en.html
8. Open-source electronic prototyping platform enabling users to create interactive electronic objects. https://en.wikipedia.org/wiki/Arduino_Uno
9. D. Sinyukov, R. Desmond, M. Dickerman, J. Fleming, J. Schaufeld and T. Padir, "Multi-modal control framework for a semi-autonomous wheelchair using modular sensor designs", Intelligent Service Robotics, vol. 7, no. 3, pp. 145-155, April 2014. https://ieeexplore.ieee.org/document/8734264
10. R. S. Sutton and A. G. Barto. Reinforcement Learning: An Introduction. The MIT Press, Cambridge, Massachusetts, 1998.
11. L. P. Reis, B. M. Faria, S. Vasconcelos, and N. Lau. Invited paper: Multimodal interface for an intell. wheelchair. volume 325 of Lecture Notes in Elect. Eng., pages 1–34. Springer Int. Publishing, 2015.
12. R. C. Simpson, D. Poirot and F. Baxter, "The Hephaestus Smart Wheel chair System", IEEE Trans. Neural Syst. Rehabil. Eng, vol. 10, no. 2, 2002.
https://ieeexplore.ieee.org/document/7947914
13. A. Brandt, S. Iwarsson and A. Stahle, "Older people's use of powered wheelchairs for activity and participation", J. Rehabil. Med., no. 36, pp. 70-77, 2004. https://ieeexplore.ieee.org/document/7849501
14. [144] A. Widyotriatmo, Suprijanto, and S. Andronicus. A collaborative control of brain computer interface and robotic wheelchair. In 2015 10th Asian Control Conf., pages 1–6, May 2015.