HEALTH MONITORING AND NEED BASED SUPPORTING SYSTEM FOR PARTIALLY PARALYZED PATIENTS USING ESP-8266

A PROJECT REPORT

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BONAFIDE CERTIFICATE

Certified that this Mini-Project report **"HEALTH MONITORING AND NEED BASED SUPPORTING SYSTEM FOR PARTIALLY PARALYZED PATIENTS USING ESP-8266"** is the bonafide work of **"Abdul Ajees A (212220020001), GAJAPATHY B (212220020017), KAMESH B (212220020020), KEVIN SAMRAJ W (212220020023)"** who carried out the project work under my supervision.

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INTERNAL EXAMINER EXTERNAL EXAMINER

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ABSTRACT

The most common causes of paralysis are serious accidents or severe head injury or spinal cord injury. In most cases, people who are affected by paralysis are not able to convey their needs to their guardians or family members due to a loss of motor control by their brain. In this way, the supporting system of partially paralyzed patients truly automates the caretaking ability of the patient which ensures timely attention to the patient and the good health of the patient. This system is designed to convey the basic needs of partially paralyzed patients to their guardians through the message to their phone numbers based on the hand gesture of the patients which is measured with the help of MPU-6050 (micro accelerometer and gyro sensor). This system is also designed to monitor the patients' vital health parameters such as heart rate and oxygen saturation (SPO_2) with the help of MAX-30100(pulse oximeter sensor).

KEYWORDS: partial paralysis, heart rate, oxygen saturation, nodemcu, IoT, neurological disorders, MPU-6050, MAX-30100.

சுருக்கம்

பக்கவாதத்திற்கு மிகவும் பொதுவான காரணங்கள் கடுமையான விபத்துக்கள் அல்லது கடுமையான தலை காயம் அல்லது முதுகெலும்பு காயம் ஆகும். பெரும்பாலான சந்தர்ப்பங்களில், பக்கவாதத்தால் பாதிக்கப்பட்டவர்கள் தங்கள் தேவைகளை தங்கள் பாதுகாவலர் அல்லது குடும்ப உறுப்பினர்களிடம் தெரிவிக்க முடியாது, ஏனெனில் அவர்களின் மூளையின் மோட்டார் கட்டுப்பாட்டை இழக்கிறது. இந்த வழியில், பகுதியளவு முடங்கிய நோயாளிகளின் துணை அமைப்பு நோயாளியின் கவனிப்பு திறனை உண்மையிலேயே தானியங்குபடுத்துகிறது, இது நோயாளிக்கு சரியான நேரத்தில் கவனம் செலுத்துவதையும் நோயாளியின் நல்ல ஆரோக்கியத்தையும் உறுதி செய்கிறது. MPU-6050 (மைக்ரோ ஆக்சிலரோமீட்டர் மற்றும் கைரோ சென்சார்) உதவியுடன் அளவிடப்படும் நோயாளிகளின் கை சைகையின் அடிப்படையில், பகுதியளவு முடங்கிய நோயாளிகளின் அடிப்படைத் தேவைகளை அவர்களின் பாதுகாவலர்களுக்கு அவர்களின் தொலைபேசி எண்களுக்கு செய்தி மூலம் தெரிவிக்க இந்த அமைப்பு வடிவமைக்கப்பட்டுள்ளது. MAX-30100 (துடிப்பு ஆக்சிமீட்டர் சென்சார்) உதவியுடன் இதயத் துடிப்பு மற்றும் ஆக்ஸிஜன் செறிவு (SPO2) போன்ற நோயாளிகளின் முக்கிய சுகாதார அளவுருக்களைக் கண்காணிக்கவும் இந்த அமைப்பு வடிவமைக்கப்பட்டுள்ளது.

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ABBREVATIONS

IOT	INTERNET OF THINGS
I2C(IIC)	INTER-INTEGRATED CIRCUIT
UART	UNIVERSAL ASYNCHRONOUS RECEIVER-TRANSMITTER
SPI	SERIAL PERIPHERAL INTERFACE
SCL	SERIAL CLOCK
SDA	SERIAL DATA
MEMS	MICRO ELECTRO MECHANICAL SYSTEMS
IDE	INTEGRATED DEVELOPMENT ENVIRONMENT
NodeMCU	N*ODE* M*ICRO*C*ONTROLLER* U*NIT*
DOF	DEGREES OF FREEDOM
FIFO	FIRST IN FIRST OUT
GPIO	GENERAL PURPOSE INPUT/OUTPUT
SRAM	STATIC RANDOM ACCESS MEMORY

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

Recent years have seen a rising in wearable sensors and today several devices are commercially available for personal health care and activity awareness. A recent health care system should give better health care services to people at any time anywhere in affordable and patient friendly way. Currently, the health care system going to change from a traditional approach to a modernized patients centered approach. In the traditional way the doctors play the major role. For necessary diagnosis and advising they need to visit the doctor. There are two basic problems related to this approach. Firstly, the health care professionals must be in place of the patient all the time, the patient remains admitted in the hospital, wired to bedside biomedical instruments, for a long period. In order to solve these two problems, the patient-oriented approach has been received.

Now, Internet of Things (IOT) has become one of the most powerful communication paradigms of the 21st century. In the IOT environment, all objects in our daily life become part of the internet due to their communication and computing capabilities. Heart rate is one of the fundamental physiological limits, essential for monitoring and diagnosis of patients. To keep people effective and healthy, a readily accessible modern health care system is proving to be effective in saving costs, reducing illness and prolonging life.

Paralysis is the inability to move muscles on your own and with purpose.It can be temporary or permanent. The most common causes are stroke, spinal cord injury, and multiple sclerosis. Paralysis can be a complete loss of movement known as plegia, or a significant weakness called paresis. Paralysis is most often caused by damage in the nervous system, especially the spinal cord. Other major causes are stroke, trauma with nerve injury, poliomyelitis, cerebral palsy, peripheral neuropathy, Parkinson's disease, ALS, botulism, spina bifida, multiple sclerosis, and Guillain–Barré syndrome.

For example, monoplegia/monoparesis is complete loss of movement or weakness of one limb. Hemiplegia/hemiparesis is complete loss of movement or weakness of arm and leg on same side of the body. Paraplegia/paraparesis is complete loss or weakening of both legs. Tetraplegia/tetraparesisor otherwise called as quadriplegia/quadriparesis is complete loss or weakness of both arms and both legs. Paralysis is caused by injury or disease affecting the central nervous system (brain and spinal cord) which means that the nerve signals sent to the muscles is interrupted. Paralysis can also cause a number of associated secondary conditions, such as urinary incontinence and bowel incontinence.

Even though, there are innovative approaches for curing or treating paralysis patients, but the aim of treatment is to help a person adapt to life with paralysis by making them as independent as possible. Where we see a problem with these types of devices that are being developed is that they are very large and expensive machines. They seem to be only available in hospitals and not able to be used at the patients home or at their convenience. Our goal is to make a device that will be able to retrain a patient’s motion but have them be able to use the device themselves and have it been cheap enough for them to afford without much debt.

1.2 PROBLEM STATEMENT

Neurological diseases are frequent in older adults affecting between 5% and 55% of people aged 65 and older. They are associated with a high risk of adverse health outcomes, including morality, disability.

Patients who have the partial Paralysis. These people in most cases are not able to convey their needs as they are neither able to speak properly due to loss of motor function.

1.3BACKGROUND

1.3.1 PARALYSIS

Paralysis is the loss of the ability to move some or all of your body. It can have lots of different causes, some of which can be serious. Depending on the cause, it may be temporary or permanent.

Symptoms of paralysis

The main symptom of paralysis is the inability to move part of your body, or not being able to move at all.

It can start suddenly or gradually. Sometimes it comes and goes.

Paralysis can affect any part of the body, including:

- the face
- the hands
- one arm or leg (monoplegia)
- one side of the body (hemiplegia)
- both legs (paraplegia)
- both arms and legs (tetraplegia or quadriplegia)

causes

Some of the main causes of paralysis are:

- sudden weakness on one side of the face, with arm weakness or slurred speech – a stroke or transient ischemic attack (TIA or "mini-stroke")
- sudden weakness on one side of the face, with earache or face pain – Bell's palsy
- temporary paralysis when waking up or falling asleep – sleep paralysis
- paralysis after a serious accident or injury – a severe head injury or spinal cord (back) injury
- weakness in the face, arms or legs that comes and goes – multiple sclerosis or, less commonly, myasthenia gravis or **hypokalemia** periodic paralysis

Treatment and support for paralysis

Paralysis can have a big impact on your life, but support is available to help you live as independently as you can and have the best possible quality of life.The help you need will largely depend on what's causing your paralysis. Some of the things that can help people who are paralysed include:

- mobility equipment – such as wheelchairs and limb support (braces)
- physiotherapy to help you maintain as much strength and muscle mass as you can
- occupational therapy to help adapt your home so everyday tasks like dressing and cooking are easier
- medicines to relieve problems such as pain, stiffness and muscle spasms

Location

Localized paralysis affects a small area of the body, such as the face, hands, or feet.

Generalized paralysis affects a larger area, including multiple parts of the body.

Types of paralysis include:

- **Monoplegia:** This affects one area, such as one arm or leg.
- **Hemiplegia:** This affects one arm and one leg on the same side of the body.
- **Paraplegia:** Also called lower body paralysis, this affects both legs and sometimes the hips and organs in the lower abdomen.
- **Quadriplegia:** This affects both arms and legs, and sometimes muscles in the trunk, the functions of internal organs, or both.

Damage to the spinal cord is the most common cause of paraplegia.

Muscle tension

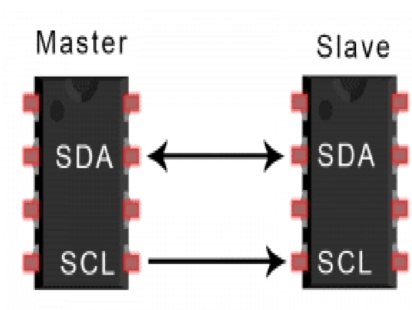
Flaccid paralysis damages the lower motor neurons that stimulate skeletal muscle movement. Over time, the muscles shrink or deteriorate. It is a common complication of polio, according to the Centers for Disease Control and Prevention (CDC)Trusted Source.

Spastic paralysis causes muscle stiffness, involuntary spasms, and muscle weakness. This form of paralysis can result from spinal cord injuries, amyotrophic lateral sclerosis (ALS), stroke, or hereditary spastic paraplegia. Other causes include inflammation of the spinal cord, also called **myelitis**, and **Guillain-Barré syndrome**, a rare Trusted Source autoimmune disorder in which the immune system attacks the PNS.

1.3.2 I2C(IIC) COMMUNICATION PROTOCOL

I2C combines the best features of SPI and UARTs. With I2C, you can connect multiple slaves to a single master (like SPI) and you can have multiple masters controlling single, or multiple slaves. This is really useful when you want to have more than one microcontroller logging data to a single memory card or displaying text to a single LCD.

Like UART communication, I2C only uses two wires to transmit data between devices



Wires Used	2
Maximum Speed	Standard mode= 100 kbps
	Fast mode= 400 kbps
	High speed mode= 3.4 Mbps
	Ultra fast mode= 5 Mbps
Synchronous or Asynchronous?	Synchronous
Serial or Parallel?	Serial
Max # of Masters	Unlimited
Max # of Slaves	1008

Figure 1.1 I2C INTERFACE **Figure 1.2 I2C PROTOCOL SPECIFICATIONS**

Source: https://www.circuitbasics.com/wp-content/uploads/2016/02/Basics-of-the-I2C-Communication-Protocol-Specifications-Table.png

SDA– The line for the master and slave to send and receive data.

SCL – The line that carries the clock signal.

I2C is a serial communication protocol, so data is transferred bit by bit along a single wire (the SDA line). Like SPI, I2C is synchronous, so the output of bits is synchronized to the sampling of bits by a clock signal shared between the master and the slave. The clock signal is always controlled by the master.

HOW I2C WORKS

With I2C, data is transferred in *messages.* Messages are broken up into *frames* of data. Each message has an address frame that contains the binary address of the slave, and one or more data frames that contain the data being transmitted. The message also includes start and stop conditions, read/write bits, and ACK/NACK bits between each data frame:

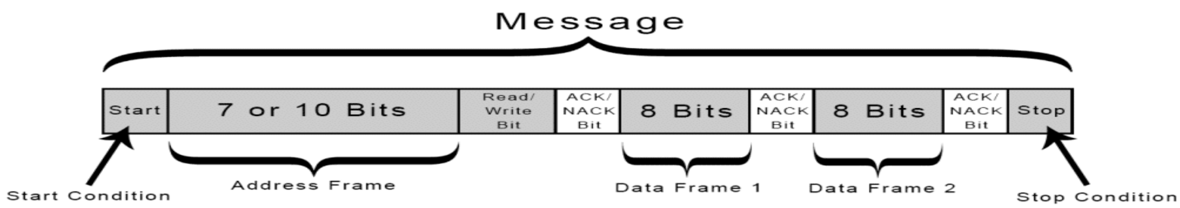


FIGURE 1.3 I2C DATA TRANSFERING METHOD

Source: https://www.circuitbasics.com/wp-content/uploads/2016/01/Introduction-to-I2C-Message-Frame-and-Bit-2.png

Start Condition: The SDA line switches from a high voltage level to a low voltage level *before* the SCL line switches from high to low.

Stop Condition: The SDA line switches from a low voltage level to a high voltage level *after* the SCL line switches from low to high.

Address Frame: A 7 or 10 bit sequence unique to each slave that identifies the slave when the master wants to talk to it.

Read/Write Bit: A single bit specifying whether the master is sending data to the slave (low voltage level) or requesting data from it (high voltage level).

ACK/NACK Bit: Each frame in a message is followed by an acknowledge/no-acknowledge bit. If an address frame or data frame was successfully received, an ACK bit is returned to the sender from the receiving device.

ADDRESSING

I2C doesn't have slave select lines like SPI, so it needs another way to let the slave know that data is being sent to it, and not another slave. It does this by *addressing*. The address frame is always the first frame after the start bit in a new message.

The master sends the address of the slave it wants to communicate with to every slave connected to it. Each slave then compares the address sent from the master to its own address. If the address matches, it sends a low voltage ACK bit back to the master. If the address doesn't match, the slave does nothing and the SDA line remains high.

READ/WRITE BIT

The address frame includes a single bit at the end that informs the slave whether the master wants to write data to it or receive data from it. If the master wants to send data to the slave, the read/write bit is a low voltage level. If the master is requesting data from the slave, the bit is a high voltage level.

THE DATA FRAME

After the master detects the ACK bit from the slave, the first data frame is ready to be sent.

The data frame is always 8 bits long, and sent with the most significant bit first. Each data frame is immediately followed by an ACK/NACK bit to verify that the frame has been received successfully. The ACK bit must be received by either the master or the slave (depending on who is sending the data) before the next data frame can be sent.

After all of the data frames have been sent, the master can send a stop condition to the slave to halt the transmission. The stop condition is a voltage transition from low to high on the SDA line after a low to high transition on the SCL line, with the SCL line remaining high.

ADVANTAGES

- Only uses two wires
- Supports multiple masters and multiple slaves
- ACK/NACK bit gives confirmation that each frame is transferred successfully

- Hardware is less complicated than with UARTs
- Well known and widely used protocol

DISADVANTAGES

- Slower data transfer rate than SPI
- The size of the data frame is limited to 8 bits
- More complicated hardware needed to implement than SPI

1.3.3 INTERNET OF THINGS

The Internet of Things (IoT) describes the network of physical objects— "things"—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. These devices range from ordinary household objects to sophisticated industrial tools. With more than 7 billion connected IoT devices today, experts are expecting this number to grow to 10 billion by 2020 and 22 billion by 2025. Oracle has a network of device partners.

IoT WORKING

An IoT ecosystem consists of web-enabled smart devices that use embedded systems, such as processors, sensors and communication hardware, to collect, send and act on data they acquire from their environments. IoT devices share the sensor data they collect by connecting to an IoT gateway or other edge device where data is either sent to the cloud to be analyzed or analyzed locally. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The devices do most of the work without human intervention, although people can interact with the devices -- for instance, to set them up, give them instructions or access the data.

benefits of IoT

The internet of things offers several benefits to organizations. Some benefits are industry-specific, and some are applicable across multiple industries. Some of the common benefits of IoT enable businesses to:

- monitor their overall business processes;
- improve the customer experience (CX);
- save time and money;
- enhance employee productivity;
- integrate and adapt business models;
- make better business decisions; and
- generate more revenue.

pros and cons of IoT

Some of the advantages of IoT include the following:

- ability to access information from anywhere at any time on any device;
- improved communication between connected electronic devices;
- transferring data packets over a connected network saving time and money; and
- automating tasks helping to improve the quality of a business's services and reducing the need for human intervention.

Some disadvantages of IoT include the following:

- As the number of connected devices increases and more information is shared between devices, the potential that a hacker could steal confidential information also increases.
- Enterprises may eventually have to deal with massive numbers -- maybe even millions -- of IoT devices, and collecting and managing the data from all those devices will be challenging.
- If there's a bug in the system, it's likely that every connected device will become corrupted.

CHAPTER 2

LITERATURE REVIEW

2.1MOTIVATION

- A research article titled as **SURVEY ON PARALYSIS PATIENTS IN THE CENTER FOR THE REHABILITATION OF THE PARALYZED** by Farhana Israt Jahan, Nazmul Hossain and Al Mamun Department of Pharmacy, Daffodil International University, Dhaka, Bangladesh
- They stated that 15.66% patients are suffered from partial paralysis among disabled patients and also, they identified spinal cord injury, cerebral palsy was common causes of paralysis.
- They also found that the paralyzed patients are finding the difficulties in conveying their needs to their guardian in day-to-day life and also, they need a person regularly to monitor their health status in order to overcome that problem.
- we had planned to design a supporting system for partially paralyzed patients with the WIFI module (ESP-8266) and pulse oximeter and gyro sensor.

2.2 OBJECTIVE

- To design an algorithm using Arduino IDE that determines the working of the system.
- To visualize the working model of the system using the CIRCUITO.IO software.
- To design the working model of the system using esp-8266, gyro sensor and pulse oximeter sensor.
- To implement the IOT technology using the BLYNK platform

CHAPTER 3

MATERIALS AND METHODS

3.1 PROPOSED METHOD

- To reduce the circuit complexity in this system, we will be using only one microcontroller which has inbuilt WIFI module and 2.4GHz antenna for transferring data that is designed to connected with patient and smartphone.
- We will be using a micro accelerometer \gyro sensor (GY-521 or MPU650) due to its cost-efficiency and accuracy.
- To monitor body vital parameters (heart rate, oxygen saturation) we will be using a pulse oximeter sensor (MAX30100).

3.2 BLOCK DIAGRAM

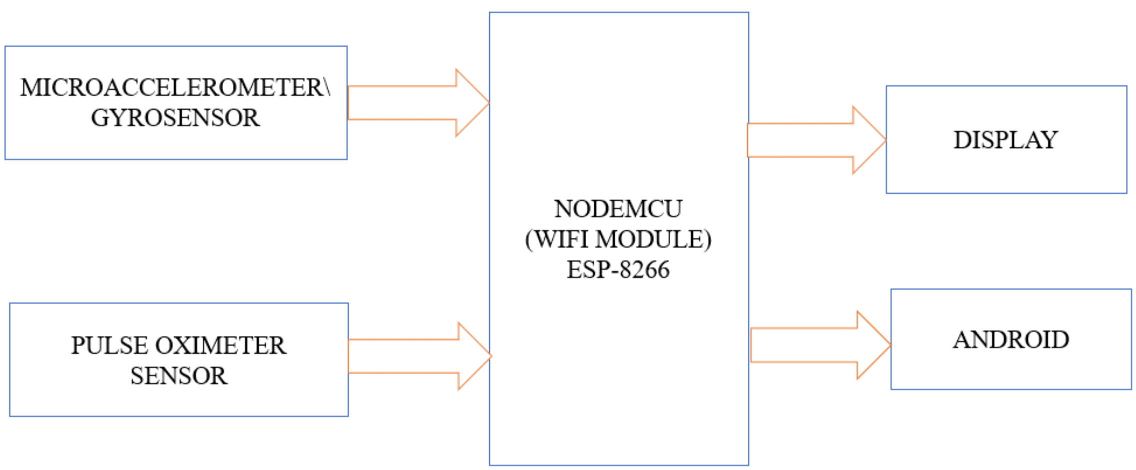


FIGURE 3.1 BLOCK DIAGRAM OF THE SYSTEM

3.3 HARDWARE DISCRIPTION

3.3.1 NODEMCU(ESP-8266)

OVERVIEW

The NodeMCU (***N***ode ***M***icro***c***ontroller ***U***nit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (WIFI), and even a modern operating system and SDK. That makes it an excellent choice for Internet of Things (IoT) projects of all kinds.

TYPES

There are two available versions of NodeMCU as version 0.9 & 1.0 where the version 0.9 contains **ESP-12** and version 1.0 contains **ESP-12E** where E stands for "Enhanced".

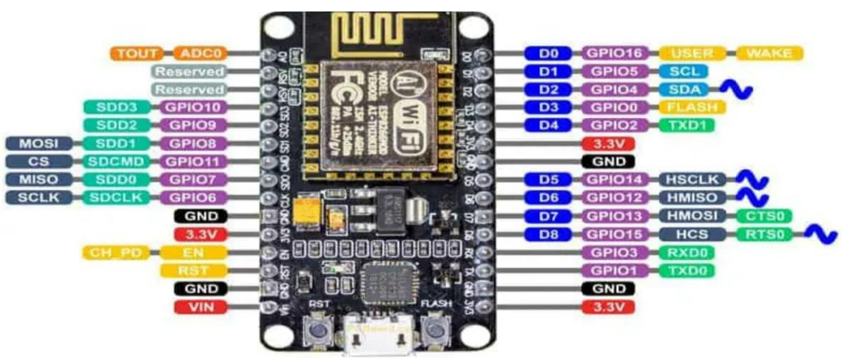


FIGURE 3.2 NODEMCU ESP-8266

Source: http://surl.li/dxxbk

TECHNICAL SPECFICATIONS

- Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106
- Operating Voltage: 3.3V
- Input Voltage: 7-12V
- Digital I/O Pins (DIO): 16
- Analog Input Pins (ADC): 1

- UARTs: 1
- SPIs: 1
- I2Cs: 1
- Flash Memory: 4 MB
- SRAM: 64 KB
- Clock Speed: 80 MHZ

PIN DISCRIPTION

POWER PINS

- **VIN** can be used to directly supply the NodeMCU/ESP8266 and its peripherals. Power delivered on
- **VIN** is regulated through the onboard regulator on the NodeMCU module – you can also supply 5V regulated to the **VIN** pin

  3.3V pins are the output of the onboard voltage regulator and can be used to supply power to external components.
- **GND** are the ground pins of NodeMCU/ESP8266

I2C PINS

- I2C pins are used to connect I2C sensors and peripherals. Both I2C Master and I2C Slave are supported. I2C interface functionality can be realized programmatically, and the clock frequency is 100 kHz at a maximum. It should be noted that I2C clock frequency should be higher than the slowest clock frequency of the slave device.

GPIO PINS

- NodeMCU/ESP8266 has 17 GPIO pins which can be assigned to functions such as I2C, I2S, UART, PWM, IR Remote Control, LED Light and Button programmatically. Each digital enabled GPIO can be configured to internal pull-up or pull-down, or set to high impedance. When configured as an input, it can also be set to edge-trigger or level-trigger to generate CPU interrupts.

ADC CHANNEL

- The NodeMCU is embedded with a 10-bit precision SAR ADC. The two functions can be implemented using ADC. Testing power supply voltage of VDD3P3 pin and testing input voltage of TOUT pin. However, they cannot be implemented at the same time.

UART PINS

- NodeMCU/ESP8266 has 2 UART interfaces (UART0 and UART1) which provide asynchronous communication (RS232 and RS485), and can communicate at up to 4.5 Mbps. UART0 (TXD0, RXD0, RST0 & CTS0 pins) can be used for communication. However, UART1 (TXD1 pin) features only data transmit signal so, it is usually used for printing log.

SPI PINS

- NodeMCU/ESP8266 features two SPIs (SPI and HSPI) in slave and master modes. These SPIs also support the following general-purpose SPI features:
    1. 4 timing modes of the SPI format transfer
    2. Up to 80 MHz and the divided clocks of 80 MHz
    3. Up to 64-Byte FIFO

PWM PINS

- The board has 4 channels of Pulse Width Modulation (PWM). The PWM output can be implemented programmatically and used for driving digital motors and LEDs. PWM frequency range is adjustable from 1000 μs to 10000 μs (100 Hz and 1 kHz).

CONTROL PINS

- Control pins are used to control the NodeMCU/ESP8266. These pins include Chip Enable pin (EN), Reset pin (RST) and WAKE pin.
    1. **EN:** The ESP8266 chip is enabled when EN pin is pulled HIGH. When pulled LOW the chip works at minimum power.
    2. **RST:** RST pin is used to reset the ESP8266 chip.
    3. **WAKE:** Wake pin is used to wake the chip from deep-sleep.

3.3.2 MPU-6050 3-AXIS GYRO & ACCELEROMETER MODULE

OVERVIEW

The **MPU6050 module** is a Micro Electro-Mechanical Systems (**MEMS**) which consists of a 3-axis Accelerometer and 3-axis Gyroscope inside it. This helps us to measure acceleration, velocity, orientation, displacement and many other motions related parameter of a system or object.

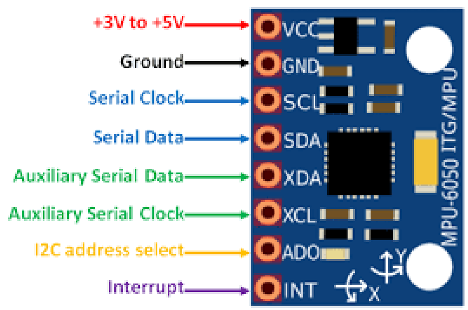


FIGURE 3.3 MPU-6050 PIN DIAGRAM

MPU6050 Pinout Configuration

Pin Number	Pin Name	Description
1	Vcc	Provides power for the module, can be +3V to +5V. Typically +5V is used
2	Ground	Connected to Ground of system
3	Serial Clock (SCL)	Used for providing clock pulse for I2C Communication
4	Serial Data (SDA)	Used for transferring Data through I2C communication
5	Auxiliary Serial Data (XDA)	Can be used to interface other I2C modules with MPU6050. It is optional
6	Auxiliary Serial Clock (XCL)	Can be used to interface other I2C modules with MPU6050. It is optional

7	AD0	If more than one MPU6050 is used a single MCU, then this pin can be used to vary the address
8	Interrupt (INT)	Interrupt pin to indicate that data is available for MCU to read.

MPU6050 Features

- Supply voltage: 2.3–3.4 V
- Consumption: 3.9 mA max.
- Accelerometer:
    - Measuring ranges: ±2 g ±4 g ±8 g ±16 g
    - Calibration tolerance: ±3%
- Gyroscope:
    - Measuring ranges: ±250/500/1000/2000 °
    - Calibration tolerance: ±3%
- I2C interface.

MPU-6050 WORKING

The MPU6050 is a Micro-Electro-Mechanical Systems (MEMS) that consists of a 3-axis Accelerometer and 3-axis Gyroscope inside it. This helps us to measure acceleration, velocity, orientation, displacement and many other motion-related parameters of a system or object. This module also has a (DMP) Digital Motion Processor inside it which is powerful enough to perform complex calculations and thus free up the work for Microcontroller.

MEMS ACCELEROMETER WORKING

MEMS accelerometers are used wherever there is a need to measure linear motion, either movement, shock, or vibration but without a fixed reference. They measure the linear acceleration of whatever they are attached to. All accelerometers work on the principle of a mass on a spring, when the thing they are attached to accelerates, then the mass wants to remain stationary due to its inertia and therefore the spring is stretched or compressed, creating a force which is detected and corresponds to the applied acceleration.

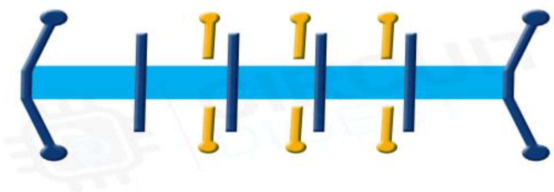


FIGURE 3.4 MEMS ACCELEROMETER

Source: https://circuitdigest.com/sites/default/files/other/MEMS-Accelerometer-Working.gif

In MEMS accelerometer, precise linear acceleration detection in two orthogonal axes is achieved by a pair of silicon MEMS detectors formed by spring ‘proof’ masses. Each mass provides the moving plate of a variable capacitance formed by an array of interlaced finger loke structures. When the sensor is subjected to a linear acceleration along its sensitive axis, the proof mass tends to resist motion due to its inertia, therefore the mass and its fingers become displaced concerning the fixed electrode fingers. The gas between the fingers provides a damping effect. This displacement induces a differential capacitance between the moving and fixed silicon fingers which is proportional to the applied acceleration. This change in capacitance is measured with a high-resolution ADC and then the acceleration is calculated from the rate of change in capacitance. In MPU6050 this is then converted into readable value and then it’s transferred to the I2C master device.

MEMS GYROSCOPE WORKING

The MEMS Gyroscope working is based on the Coriolis Effect. The Coriolis Effect states that when a mass moves in a particular direction with velocity and an external angular motion is applied to it, a force is generated and that causes a perpendicular displacement of the mass. The force that is generated is called the Coriolis Force and this phenomenon is known as the Coriolis Effect. The rate of displacement will be directly related to the angular motion applied.

The MEMS Gyroscope contains a set of four proof mass and is kept in a continuous oscillating movement. When an angular motion is applied, the Coriolis Effect causes a change in capacitance between the masses depending on the axis of the angular movement. This change in capacitance is sensed and then converted into a reading. Here is a small animation showing the movement of these proof masses on the application of an angular movement for different axis.

FIGURE 3.5 MEMS GYROSCOPE

Source: https://circuitdigest.com/sites/default/files/other/MEMS-Gyroscope-Working.gif

There are three modes depending on the axis along which the angular rotation is applied.

Roll Mode:

When an angular rate is applied along the X-axis, M1 and M3 will move up and down out of the plane due to the coriolis effect. This causes a change in the roll angle, hence the name Roll Mode.

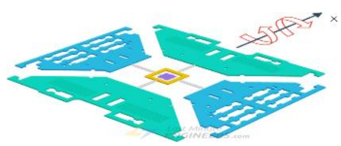


FIGURE 3.5 ROLL MODE

Source: https://lastminuteengineers.b-cdn.net/wp-content/uploads/arduino/MPU6050-Accel-Gyro-Working-Roll-Mode-Output.gif

Pitch Mode:

When an angular rate is applied along the Y-axis, M2 and M4 will move up and down out of the plane. This causes a change in the pitch angle, hence the name Pitch Mode.

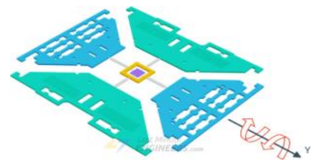


FIGURE 3.6 PITCH MODE

Source: https://lastminuteengineers.b-cdn.net/wp-content/uploads/arduino/MPU6050-Accel-Gyro-Working-Pitch-Mode-Output.gif

Yaw Mode:

When an angular rate is applied along the Z-axis, M2 and M4 will move horizontally in opposite directions. This causes a change in the yaw angle, hence the name Yaw Mode.

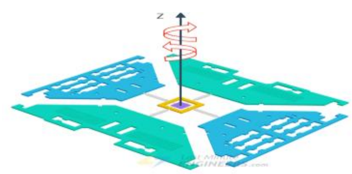


FIGURE 3.7 YAW MODE

Source: https://lastminuteengineers.b-cdn.net/wp-content/uploads/arduino/MPU6050-Accel-Gyro-Working-Yaw-Mode-Output.gif

I2C Interface

The module communicates with the Arduino via the I2C interface. It supports two different I2C addresses: $0x68_{HEX}$ and $0x69_{HEX}$. This allows two MPU6050s to be used on the same bus or to avoid address conflicts with other devices on the bus.

The ADO pin determines the I2C address of the module. This pin is pulled down with a 4.7K resistor. Therefore, when you leave the ADO pin unconnected, the default I2C address is $0x68_{HEX}$; when you connect it to 3.3V, the line is pulled HIGH, and the I2C address becomes $0x69_{HEX}$.

3.3.3 MAX 30100 PULSE OXIMETER

OVERVIEW

The MAX30100 is an integrated pulse oximetry and heartrate monitor sensor solution. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart-rate signals. The MAX30100 operates from 1.8V and 3.3V power supplies and can be powered down through software with negligible standby current, permitting the power supply to remain connected at all times.

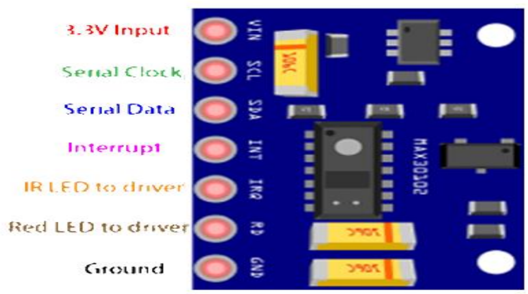


FIGURE 3.8 MAX 30100 PIN DIAGRAM

APPLICATIONS

- Wearable Devices
- Fitness Assistant Devices
- Medical Monitoring Devices

MAX30100 Sensor specifications

- Input power: 1.7 to 2.0 V
- Temperature range: -40 to +85 °C
- LED Current: 1mA to 50mA
- LED pulse width: 200µs to 1.6ms
- I2C interface

WORKING

The MAX30100, or any optical pulse oximeter and heart-rate sensor for that matter, consists of a pair of high-intensity LEDs (RED and IR, both of different wavelengths) and a photodetector. The wavelengths of these LEDs are 660nm and 880nm, respectively.

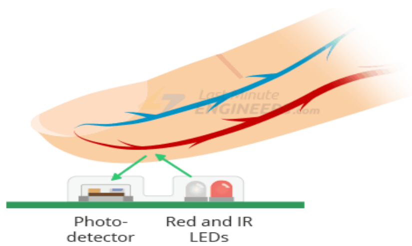


FIGURE 3.9 MAX 30100 WORKING

Source: https://lastminuteengineers.b-cdn.net/wp-content/uploads/arduino/MAX30100-Pulse-Detection-Photoplethysmogram.png

The MAX30100 works by shining both lights onto the finger or earlobe (or essentially anywhere where the skin isn’t too thick, so both lights can easily penetrate the tissue) and measuring the amount of reflected light using a photodetector. This method of pulse detection through light is called Photoplethysmogram.

The working of MAX30100 can be divided into two parts: Heart Rate Measurement and Pulse Oximetry (measuring the oxygen level of the blood).

Heart Rate Measurement

The oxygenated hemoglobin (HbO2) in the arterial blood has the characteristic of absorbing IR light. The redder the blood (the higher the hemoglobin), the more IR light is absorbed. When the heart pumps blood, there is an increase in oxygenated blood as a result of having more blood. As the heart relaxes, the volume of oxygenated blood also decreases. Ultimately, by knowing the time between the increase and decrease of oxygen-rich blood, the device calculates the pulse rate.

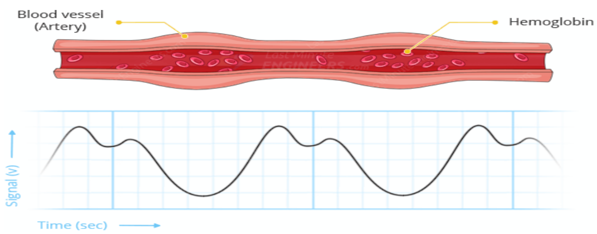


FIGURE 3.10 HEART RATE MEASUREMENT

Source: https://lastminuteengineers.b-cdn.net/wp-content/uploads/arduino/Pulse-Detection-Heart-Rate-Sensor-Working-Photoplethysmogram.png

Pulse Oximetry

Pulse oximetry is based on the principle that the amount of RED and IR light absorbed varies depending on the amount of oxygen in your blood. The following graph is the absorption-spectrum of oxygenated hemoglobin (HbO2) and deoxygenated hemoglobin (Hb).

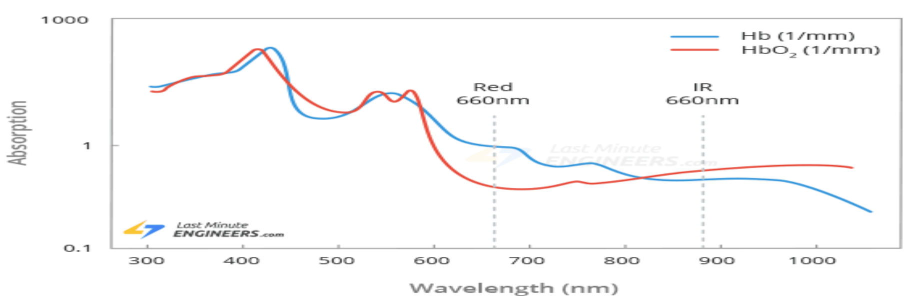


FIGURE 3.11 PULSE OXIMETER GRAPH

Source: https://lastminuteengineers.b-cdn.net/wp-content/uploads/arduino/Absorption-Spectrum-of-Hb-and-HbO2.png

As you can see from the graph, deoxygenated blood absorbs more RED light (660nm), while oxygenated blood absorbs more IR light (880nm). By measuring the ratio of IR and RED light received by the photodetector, the oxygen level (SpO2) in the blood is calculated.

I2C Interface

The module uses a simple two-wire I2C interface for communication with the microcontroller. It has a fixed I2C address: $0xAE_{HEX}$ (for write operation) and $0xAF_{HEX}$ (for read operation).

FIFO Buffer

The MAX30100 embeds a FIFO buffer for storing data samples. The FIFO has a 16-sample memory bank, which means it can hold up to 16 SpO2 and heart rate samples. The FIFO buffer can offload the microcontroller from reading each new data sample from the sensor, thereby saving system power.

Interrupts

The MAX30100 can be programmed to generate an interrupt, allowing the host microcontroller to perform other tasks while the data is collected by the sensor. The interrupt can be enabled for 5 different sources:

- Power Ready : triggers on power-up or after a brownout condition.
- SpO2 Data Ready : triggers after every SpO2 data sample is collected.
- Heart Rate Data Ready : triggers after every heart rate data sample is collected.
- Temperature Ready : triggers when an internal die temperature conversion is finished.
- FIFO Almost Full: triggers when the FIFO becomes full and future data is about to lost.

3.4 SOFTWARE DISCRIPTION

3.4.1 ARDUINO IDE

Arduino IDE is an open-source software, designed by Arduino.cc and mainly used for writing, compiling & uploading code to almost all Arduino Modules. Arduino is an open-source hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices. Its hardware products are licensed under a CC BY-SA license, while software is licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially from the official website or through authorized distributors.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards ('shields') or breadboards (for prototyping) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs. The microcontrollers can be programmed using the C and C++ programming languages, using a standard API which is also known as the Arduino language, inspired by the Processing language and used with a modified version of the Processing IDE. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) and a command line tool developed in Go.

Sketch

A sketch is a program written with the Arduino IDE. Sketches are saved on the development computer as text files with the file extension **.ino**. Arduino Software (IDE) pre-1.0 saved sketches with the extension **.pde**.

A minimal Arduino C/C++ program consists of only two functions:

- `setup()`: This function is called once when a sketch starts after power-up or reset. It is used to initialize variables, input and output pin modes, and other libraries needed in the sketch. It is analogous to the function `main()`.
- `loop()`: After `setup()` function exits (ends), the `loop()` function is executed repeatedly in the main program. It controls the board until the board is powered off or is reset. It is analogous to the function `while(1)`

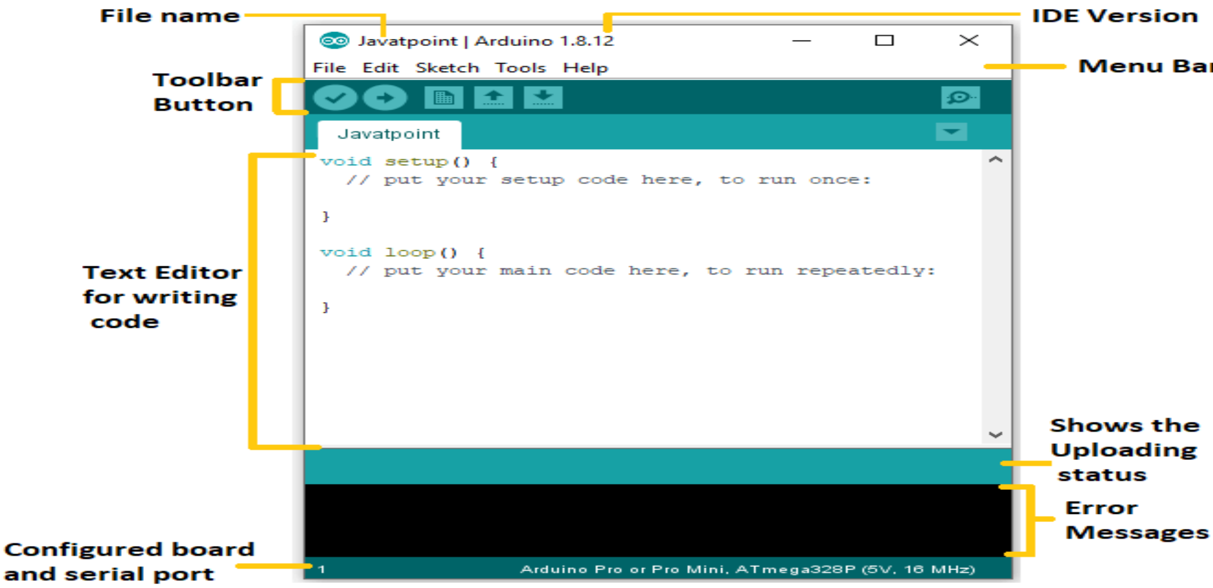


FIGURE 3.12 ARDUINO IDE USER INTERFACE

Source: https://static.javatpoint.com/tutorial/arduino/images/arduino-ide.png

3.4.2 CIRCUIT.IO

Circuito.io is an online tool for designing complete electronic circuits. The Circuito app generates instant and accurate schematics and code for your electronic circuit. You select the major building blocks, and it computes all the electrical requirements for your selection.

It has a fantastic interface that allows you to drag and drop different parts together. It also has three different sections that one needs to work on before testing, and the first is the Bill of Materials (BoM) called design**.**

Here, you check out all the materials available and you then select your preferred options. You choose the components you want, or you think you need and move on to the next section. The next section being the wiring tool which will process, add all necessary additional items required and in return give a well-labeled wiring diagram. Another exciting aspect about circuito.io is that it has an interface that allows you to step through each building component, guiding you through the creation of the circuit; This simply means that you are not working with a static diagram rather one that can move in different directions.

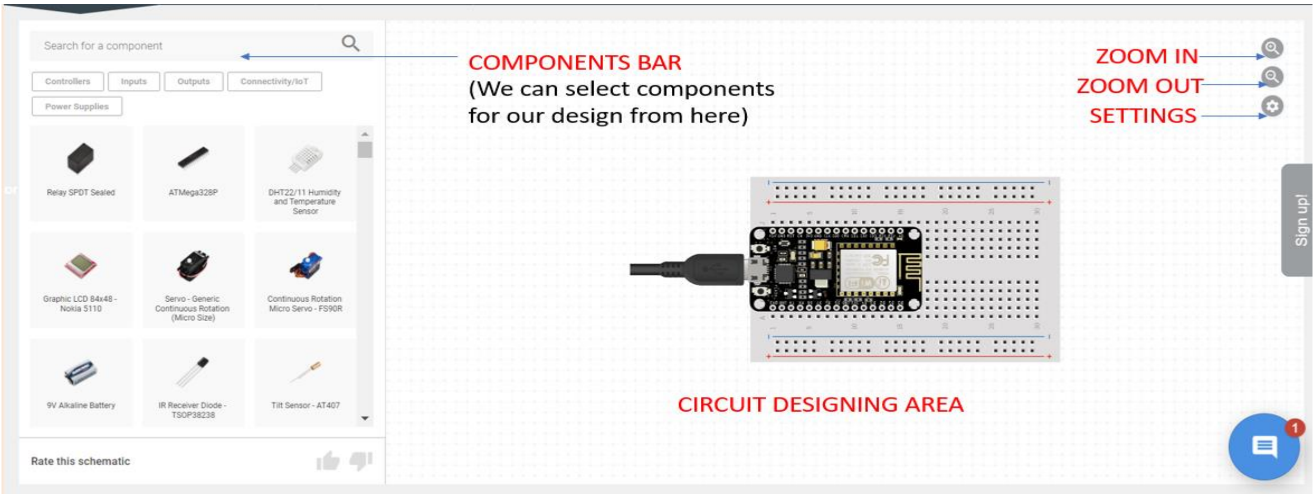


FIGURE 3.13 CIRCUITO.IO USER INTERFACE

3.5 CIRCUIT DIAGRAM

DESIGNED USING CIRCUIT.IO

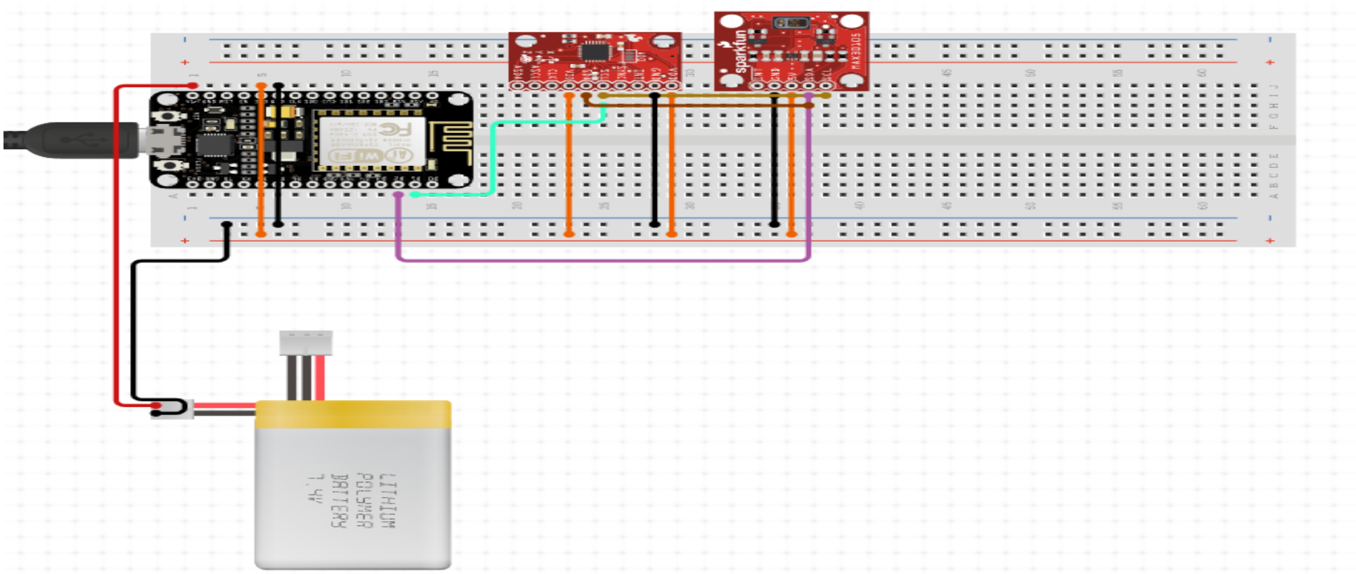


FIGURE 3.14 CIRCUIT DIAGRAM OF THE SYSTEM

CHAPTER 4

RESULT AND DISCUSSION

4.1 RESULTS AND DISCUSSION

```
♥ Beat!
Heart rate:81.25bpm / SpO2:99%
i need water

♥ Beat!
Heart rate:52.18bpm / SpO2:98%
i need water

Heart rate:52.18bpm / SpO2:98%
i need water
```

```
♥ Beat!
Heart rate:87.48bpm / SpO2:99%
I FEEL HUNGRY

♥ Beat!
♥ Beat!
Heart rate:88.44bpm / SpO2:99%

♥ Beat!
Heart rate:88.47bpm / SpO2:99%
I FEEL HUNGRY
```

```
♥ Beat!
Heart rate:76.24bpm / SpO2:96%
RESTROOM

♥ Beat!
Heart rate:65.33bpm / SpO2:96%
RESTROOM

♥ Beat!
Heart rate:61.08bpm / SpO2:96%
RESTROOM
```

FIGURE 4.1: OUTPUT OF THE SYSTEM

```
♥ Beat!
♥ Beat!
♥ Beat!
♥ Beat!
Heart rate:278.90bpm / SpO2:94%
malfunction
```

FIGURE 4.2: SYSTEM OUTPUT WHEN THERE IS AN ERROR

Thus, we had successfully designed a system to convey the needs (“water”,” food”,” restroom”,” health issues”) of partially paralysed patients and also to monitor the body vital parameter (heartbeat, spo_2) that is shown at the above figure4.1. And also, the system will itself indicate when there is an error in the system that is shown in the above figure 4.2.

CHAPTER 5

CONCLUSION

5.1 FUTURE SCOPE

- This system can be updated to detect the falls of partial paralysis patient and elderly people those who are suffered from neurological disorders.
- And also the system can be designed with an SD card module along with the cloud storage(if the cloud server fails SD card module can storage the data) so that we can store and analyze the health status of the patient when we need.

5.2 CONCLUSION

- By taking a overall survey, it can be found that there are many problems existing for the paralyzed people such as paralysis in their leg, hand, vocal tract and also in other body parts.
- There are systems existing for their comforts individually. But, this system will help to monitor the needs of paralytic patients when needed. This system helps pateint overcome barriers to convey their needs without putting efforts.
- Moreover this can be modified to be used for several purposes where persons mobility is affected.

CHAPTER 6

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