IOT BASED HYBRID HEALTH MONITORING DEVICE

A Minor Project Report

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For

The Partial Fulfillment of Degree

of

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in

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By

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Session: 2021 - 2022

DECLARATION BY THE CANDIDATE

We the undersigned solemnly declare that the Minor project report entitled **"IOT BASED HYBRID HEALTH MONITORING DEVICE"** is based our own work carried out during the course of our study under the supervision of ***Dr. J P Patra.***

We assert that the statements made and conclusions drawn are an outcome of the project work. We further declare that to the best of our knowledge and belief that the report does not contain any part of any work which has been submitted for the award of any other degree/diploma/certificate in this University/Deemed university of India or any other country.

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CERTIFICATE BY THE SUPERVISOR

This is to certify that the Minor project report entitled **"IOT BASED HYBRID HEALTH MONITORING DEVICE"** is a record of project work carried out under my guidance and supervision for the fulfillment of the award of degree of Bachelor of Technology in the faculty of Computer Science & Engineering of Chhattisgarh Swami Vivekananda Technical University, Bhilai (C.G.) India.

To the best of my knowledge and belief the report

i) Embodies the work of the candidate himself

ii) Has duly been completed

iii) Fulfills the partial requirement of the ordinance relating to the B. Tech degree of the University

iv) Is up to the desired standard both in respect of contents and language for being referred to the examiners.

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CERTIFICATE BY THE EXAMINERS

The project report entitled **“IOT BASED HYBRID HEALTH MONITORING DEVICE** “has been examined by the undersigned as a part of the examination of Bachelor of Technology in the faculty of Computer Science & Engineering of Chhattisgarh Swami Vivekanand Technical University, Bhilai.

Internal Examiner	**External Examiner**
Date:	**Date:**

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LIST OF ABBREVIATIONS

IOT	Internet of Things
LIB	Lithium Ion Battery
NiCad	Nickel Cadmium Battery
RPM	Remote Patient Monitoring
M2M	Machine to Machine
WBAN	Wireless Body Area Network
ECG	Electrocardiography
SoC	System-on-a-Chip
WHO	World Health Organization
ICT	Information and Communications Technology
IDE	Integrated Development Environment
HIIT	High Intensity Interval Training
BPM	Beat Per Minute

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CHAPTER 1

ABSTRACT

1.1 Abstract:

IoT technology spread its wings to the medical sector to save many lives. The aim of developing this project is to monitor the health condition of a person anywhere and send the information to a specialized doctor to check up. Using this frequency of visiting doctor decreases. We developed a project using Wearable sensors with solar harvesting low energy transmission that creates a wireless body area network (WBAN). Using this project, you can detect the heartbeat, Blood pressure, temperature, etc., All these reports can be used for analyzing a person’s health. -Health has prime importance in our day-to-day life. Sound health is necessary to do the daily work properly. This project aims at developing a system which gives body temperature and heart rate using LM35 and pulse sensor respectively. These sensors are interfaced with controller Node MCU board. Wireless data transmission done by Node MCU through Wi-Fi module ESP8266 is used for wireless data transmission on IoT platform i.e. thing speak. Data visualization is done on Blynk App. So that record of data can be stored over period of time. Even the interaction between technology and healthcare has a long history, the embracing of e-health is slow because of limited infrastructural arrangements, capacity and political willingness. Internet of Things (IoT) is expected to usher in the biggest and fastest spread of technology in history, therefore together with e-health will completely modify person-to-person, human-to-machine and machine-to-machine (M2M) communications for the benefit of society in general. It is anticipated that the IoT-based e-health solutions will revolutionize the healthcare industry like nothing else before it. The rapid growth of IoT, Cloud computing and Big data, as well as the proliferation and widespread adoption of new technologies and miniature sensing device, have brought forth new opportunities to change the way patients and their healthcare providers manage health conditions, thus improving human health and well-being. The integration of IoT into the healthcare system brings numerous advantages, such as the availability and accessibility, the ability to provide a more “personalized” system, and high-quality cost-effective healthcare delivery. Still, the success of the IoT-based e-health systems will depend on barriers needed to overcome in order to achieve large-scale adoption of e-health applications. A large number of significant technological improvements in both hardware and software components are required to develop consistent, safe, effective, timely, flexible, patient-centered, power-efficient and ubiquitous healthcare systems. However, trust, privacy and security concerns, as well as regulation issues, identification, and semantic interoperability are pivotal in the widespread adoption of IoT and e-health together. Therefore, developing a climate of trust is one of the most important tasks that must be accomplished for successful e-health implementations.

CHAPTER 2
INTRODUCTION

2.1 Overview:

In the recent years wireless technology has increasing for the need of upholding various sectors. In these recent years IoT grasped the most of industrial area specially automation and control. Biomedical is one of recent trend to provide better health care. Not only in hospitals but also the personal health caring facilities are opened by the IoT technology. So, having a smart system various parameter are observed that consumes power, cost and increase efficiency. In according to this smart system, this paper is reviewed. In traditional method, doctors play an important role in health checkup. For this process requires a lot of time for registration, appointment and then checkup. Also reports are generated later. Due to this lengthy process working people tend to ignore the checkups or postpone it. This modern approach reduces time consumption in the process. In the recent years use of wireless technology is increasing for the need of upholding various sectors. In these recent years IoT groped the most of industrial area specially automation and control. Biomedical is one of recent trends to provide better health care. Not only in hospitals but also the personal health care facilities are opened by the IoT technology. So, having a smart system, various parameters are observed that consume power, cost and increase efficiency. In accordance with this smart system, this paper is reviewed. [1] Medical scientists are trying in the field of innovation and research since many decades to get better health services and happiness in human lives. Their contribution in medical area is very important to us and cannot be neglected. Today's automotive structures have the root ideas coming from yesterday's basics. Also, Early detection of chronic diseases can be easy with these technologies. [2] The body temperature, heart rate, blood pressure, respiration rate are prime parameters to diagnose the disease. This project gives temperature and heart rate values using IoT. In rural hospitals, the facilities for health caring are limited. The poor quality of health management enables issues in health care system Everyone should get the knowledge of own health as easy and early as possible. Also, it should be worth for each. Latest report of The India Spend analysis of data says that the 500,000 doctor's shortage in India. WHO defines the doctor patient ratio will be 1:1000 which has been failed in India. In developing countries there is lack of resources and management to reach out the problems of individuals. A common man cannot afford the expensive and daily checkup for his health. For this purpose, various systems which give easy and assured caring unit has been developed. Theses system reduces time with safely handled equipment.

2.1.1 Application:

Continuous care and monitoring of many medical conditions and chronic illnesses is critical to helping patients manage a health issue, maintain optimal wellness and avoid complications. Close and routine monitoring enables physicians to understand the progression of an illness and quickly identify worrying symptoms, behavioral trends, and biometric readings that require follow-up.

Generally, a patient’s care team provides monitoring and support through scheduled follow-up visits and check-ins. However, as the coronavirus pandemic continues and health facilities minimize inpatient visits, chronic illness patients and those undergoing drug therapy find themselves isolated and compelled to monitor their conditions on their own. Remote patient monitoring (RPM) is a solution that can fill care gaps for chronic illness and drug therapy patients who are unable to make in-clinic visits. RPM enables care providers to manage and monitor patients with many conditions remotely via virtual channels—phone, email, video consults, remote methods of specimen collection, portable medical devices, home health kits—while patients remain safely at home.

Patients can be provided wireless home medical devices, such as a weighing scale or a blood pressure monitor and a mobile phone or other device for data collection. The medical data or measurements are automatically sent to the mobile device and transmitted to the hospital’s data server for analysis. These systems send alerts to the doctor and the patient if the measurements are out of normal range. Remote patient monitoring allows physicians to:

- Adjust medication dosing or treatment regularly to improve outcomes
- Automate and respond to alerts while identifying worrisome trends or readings
- Minimize associated hospitalizations by performing timely interventions as soon as message alerts indicate a problem
- Monitor a patient’s progress and adherence to the treatment program
- Prioritize attention and resources on patients that need more support
- Provide a holistic and comprehensive outlook of an individual’s health
- Reduce manual data collection and data entry, providing more for data analysis to improve clinical decisions
- Understand a patient’s biometrics relative to lifestyle behavior and prescriptions

The primary goal of RPM is to ensure that care delivery for patients undergoing long term therapy or managing a chronic illness is effective and affordable, even if access has shifted from an in-clinic care model to a remote care model. RPM can keep people who don’t require acute care out of clinics, thus reducing the risk of spreading or catching COVID-19, or other contagions.

CHAPTER 3
LITERATURE REVIEW

3.1 IOT Concept:

The IoT is the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators and connectivity which enables these things to connect and exchange data. The term “Thing” in “Internet of Things” is used quite broadly. For example, a thing within the IoT could be a person with a heart monitor implant, a pet with a biochip transponder, a vehicle that has built-in sensors to alert the driver when tire pressure is low — or any other natural or man-made object that an IP address can be assigned to, thus gaining the ability to transfer data over a network. As a result, it is becoming increasingly easy to create opportunities to directly integrate the physical world into computer-based systems which results in improvements, efficiency, economic benefits and reduced human exertion.

The definition of the IoT has evolved due to a convergence of multiple technologies such as wireless technology, machine learning, automation, micro-electromechanical systems, and the internet. This convergence has facilitated the bridging of the gap between operational technology and information technology, allowing unstructured machine-generated data to be analyzed for insights that will drive innovation. The concept of a network of smart devices has been around since 1982. A modified Coke machine at Carnegie Mellon University became the first internet-connected appliance. The Coke Machine was able to report its inventory and whether newly loaded drinks were cold. The contemporary vision that we have of the IoT today, is in large part due to the efforts of Mark Weiser’s paper, “The Computer of the 21st Century.” His paper talked about ubiquitous computing, and how eventually technology would become so intertwined with our lives to the point where we couldn’t even imagine how life would be otherwise. In his book “Emerging Technologies for Learning,” David Becta describes ubiquitous computing as “a vision of computing power ‘invisibly’ embedded in the world around us and accessed through intelligent interfaces: ‘Its highest ideal is to make a computer so embedded, so fitting, so natural, that we use it without even thinking about it.’ This is about a shift to human-centered computing, where technology is no longer a barrier, but works for us, adapting to our needs and preferences and remaining in the background until required. This implies a change in our relationship with ICT [Information and Communications Technology] to a much more natural way of interacting and using the power of networked computing systems which will be connected not just to the internet or other computers, but to places, people, everyday objects and things in the world around us.”

3.2 Node MCU:

The NodeMCU (Node Microcontroller Unit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266.The NodeMCU ESP8266 development board comes with the ESP-12E module containing the ESP8266 chip having Tensilica Xtensa 32-bit LX106 RISC microprocessor. This microprocessor supports RTOS and operates at 80MHz to 160 MHz adjustable clock frequency. NodeMCU has 128 KB RAM and 4MB of Flash memory to store data and programs. The ESP8266, designed and manufactured by Espressif Systems. Its high processing power with in-built Wi-Fi / Bluetooth and Deep Sleep Operating features make it ideal for IoT projects.

NodeMCU can be powered using a Micro USB jack and VIN pin (External Supply Pin). It supports UART, SPI, and I2C interface. The NodeMCU Development Board can be easily programmed with Arduino IDE since it is easy to use. Programming NodeMCU with the Arduino IDE will hardly take 5-10 minutes. All you need is the Arduino IDE, a USB cable and the NodeMCU board itself.

The NodeMCU programming model is similar to that of Node.js, only in Lua. It is asynchronous and event-driven. Many functions, therefore, have parameters for callback functions.

The NodeMCU is available in various package styles. Common to all the designs is the base ESP8266 core. Designs based on the architecture have maintained the standard 30-pin layout. Some designs use the more common narrow (0.9″) footprint, while others use a wide (1.1″) footprint – an important consideration to be aware of.

The most common models of the NodeMCU are the Amica (based on the standard narrow pin-spacing) and the LoLin which has the wider pin spacing and larger board. The open-source design of the base ESP8266 enables the market to design new variants of the NodeMCU continually.

However, as a chip, the ESP8266 is also hard to access and use. You must solder wires, with the appropriate analog voltage, to its pins for the simplest tasks such as powering it on or sending a keystroke to the “computer” on the chip. You also have to program it in low-level machine instructions that can be interpreted by the chip hardware. This level of integration is not a problem using the ESP8266 as an embedded controller chip in mass-produced electronics. It is a huge burden for hobbyists, hackers, or students who want to experiment with it in their own IoT projects.

Uses of NodeMCU:

- Prototyping of IoT devices
- Low power battery operated applications
- Network projects
- Projects requiring multiple I/O interfaces with Wi-Fi and Bluetooth functionalities

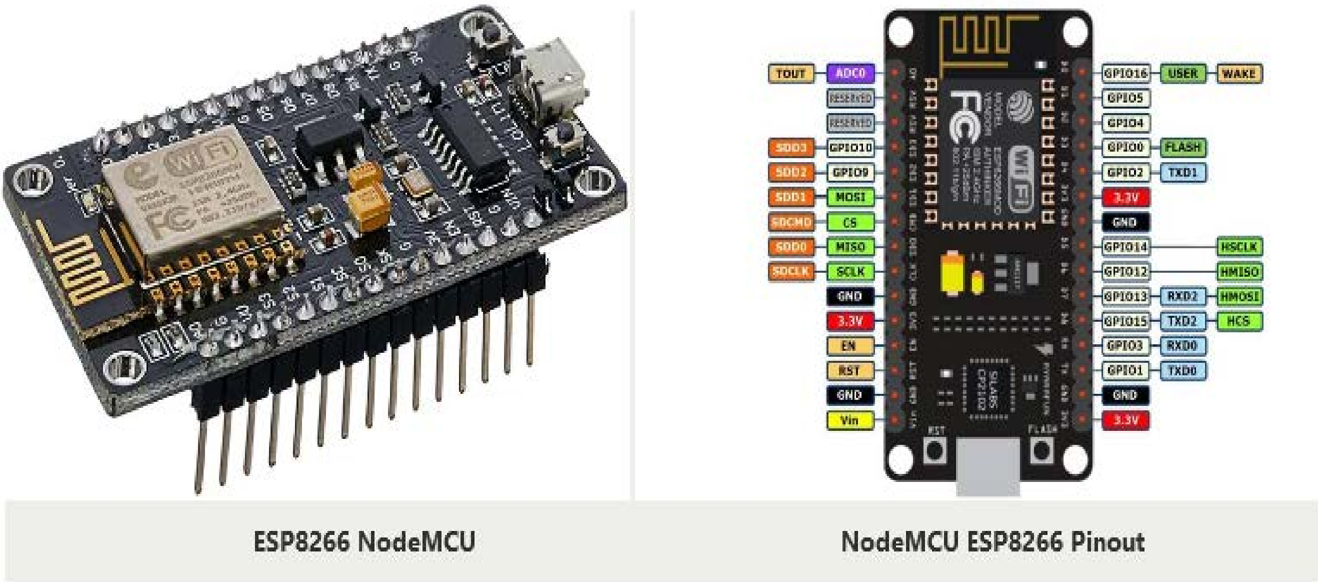


Fig 3.1 NodeMCU ESP8266

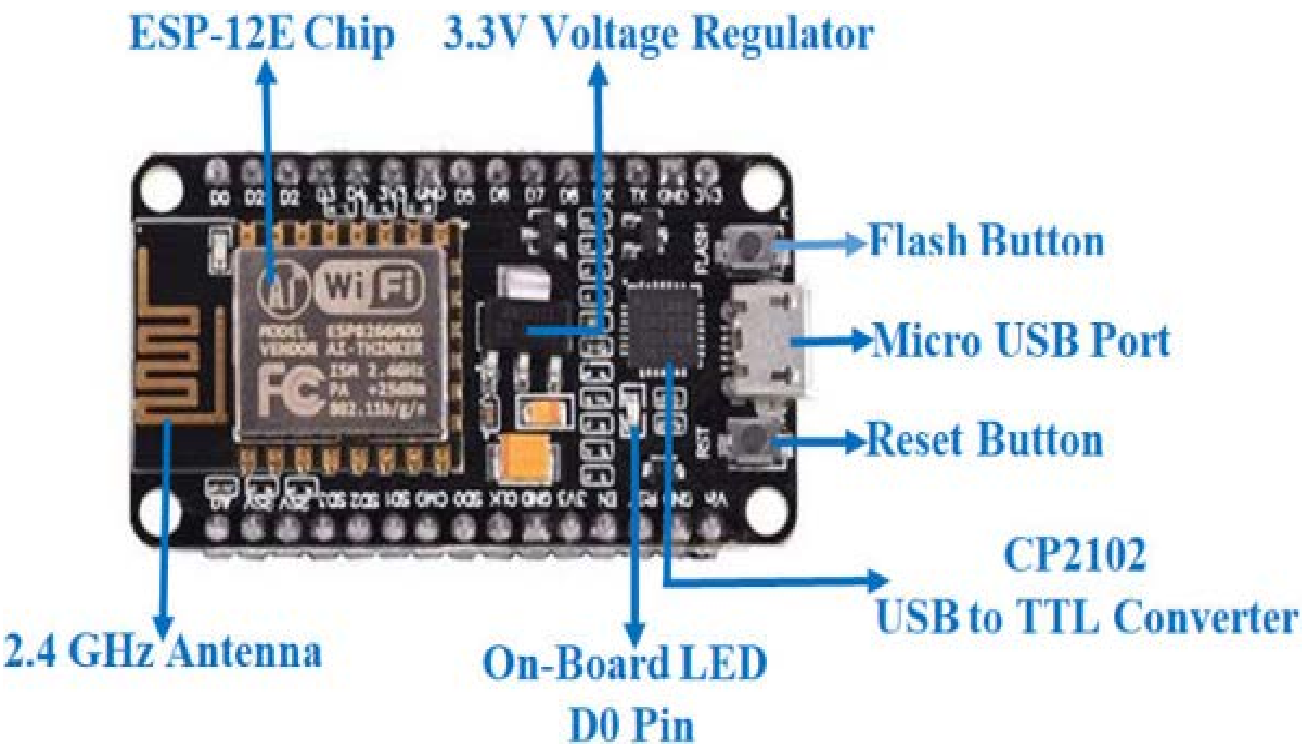


Fig 3.1.2 Detailed NodeMCU

NodeMCU Development Board Pinout Configuration

Pin Category	**Name**	**Description**
Power	Micro-USB, 3.3V, GND, Vin	**Micro-USB:** NodeMCU can be powered through the USB port **3.3V:** Regulated 3.3V can be supplied to this pin to power the board **GND:** Ground pins **Vin:** External Power Supply
Control Pins	**EN, RST**	The pin and the button resets the microcontroller
Analog Pin	A0	Used to measure analog voltage in the range of 0-3.3V
GPIO Pins	GPIO1 to GPIO16	NodeMCU has 16 general purpose input-output pins on its board
SPI Pins	SD1, CMD, SD0, CLK	NodeMCU has four pins available for SPI communication.
UART Pins	TXD0, RXD0, TXD2, RXD2	NodeMCU has two UART interfaces, UART0 (RXD0 & TXD0) and UART1 (RXD1 & TXD1). UART1 is used to upload the firmware/program.
I2C Pins		NodeMCU has I2C functionality support but due to the internal functionality of these pins, you have to find which pin is I2C.

Table 3.1 Pin Configuration of NodeMCU

3.3 Blynk:

Blynk is a full suite of software required to prototype, deploy, and remotely manage connected electronic devices at any scale: from personal IoT projects to millions of commercial connected products.
With Blynk anyone can connect their hardware to the cloud and build a no-code iOS, Android, and web applications to analyze real-time and historical data coming from devices, control them remotely from anywhere in the world, receive important notifications, and much more… Blynk is a multi-tenant solution. You can configure how users get access to the data by setting roles and configuring permissions.
Applications made with Blynk are ready for the end-users. Whether it is your family member, an employee, or someone who has purchased your product, they will be able to download the app, connect the device and start using it. Blynk also offers a white-label solution (part of the Business Plan), which means that you can add your company logo, app icon, choose the theme, colors, and publish the app to App Store and Google Play under your company name. These apps will work with your devices.

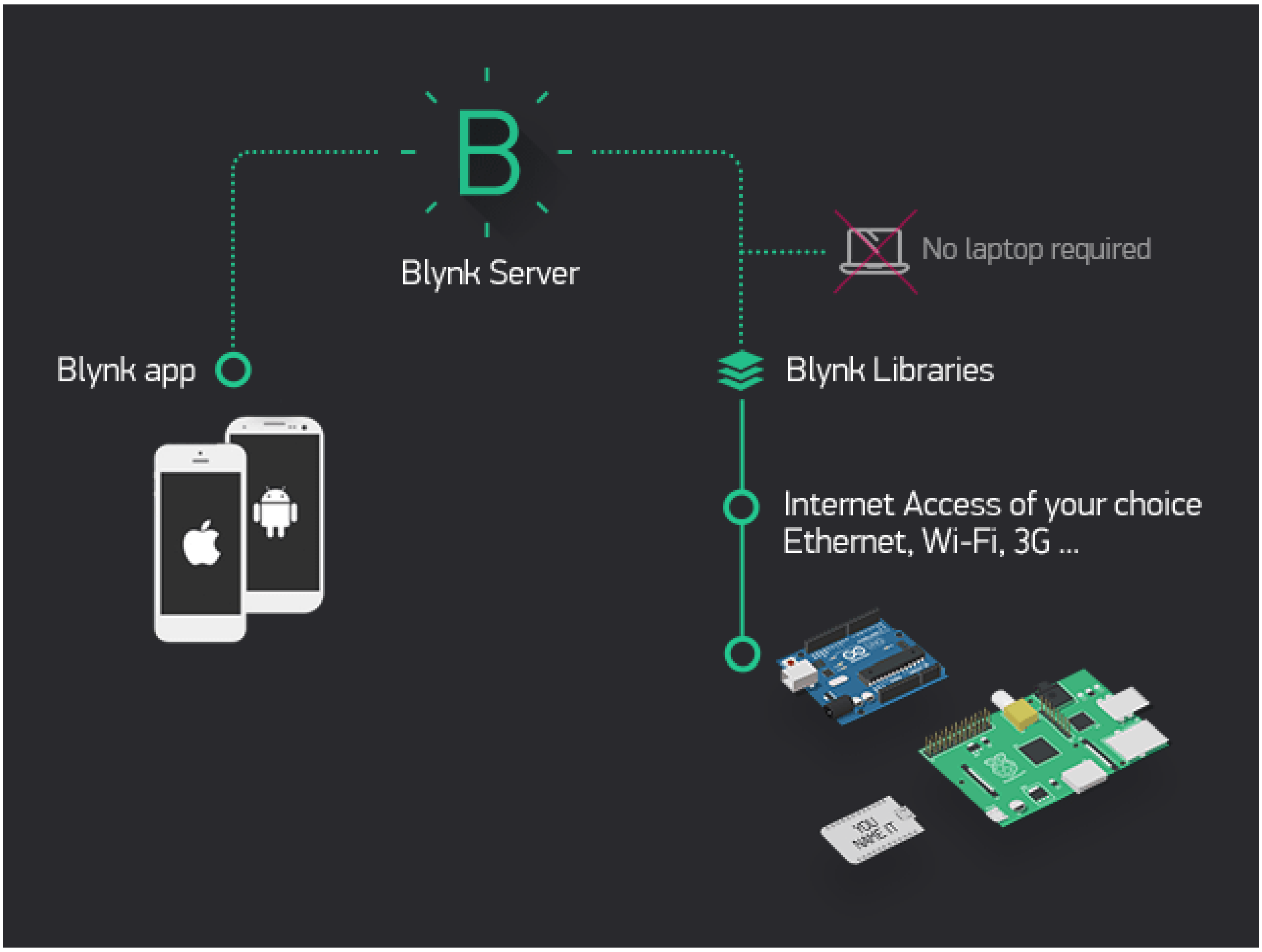


Fig 3.2 Blynk Architecture

Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, vizualize it and do many other cool things.
There are three major components in the platform:

- Blynk App - allows to you create amazing interfaces for your projects using various widgets we provide.
- Blynk Server - responsible for all the communications between the smartphone and hardware. You can use our Blynk Cloud or run your private Blynk server locally. It’s open-source, could easily handle thousands of devices and can even be launched on a Raspberry Pi.
- Blynk Libraries - for all the popular hardware platforms - enable communication with the server and process all the incoming and outcoming commands.

Features:

- Set of easy-to-use Widgets
- Direct pin manipulation with no code writing
- Easy to integrate and add new functionality using virtual pins
- History data monitoring via SuperChart widget
- Device-to-Device communication using Bridge Widget
- Sending emails, tweets, push notifications, etc.

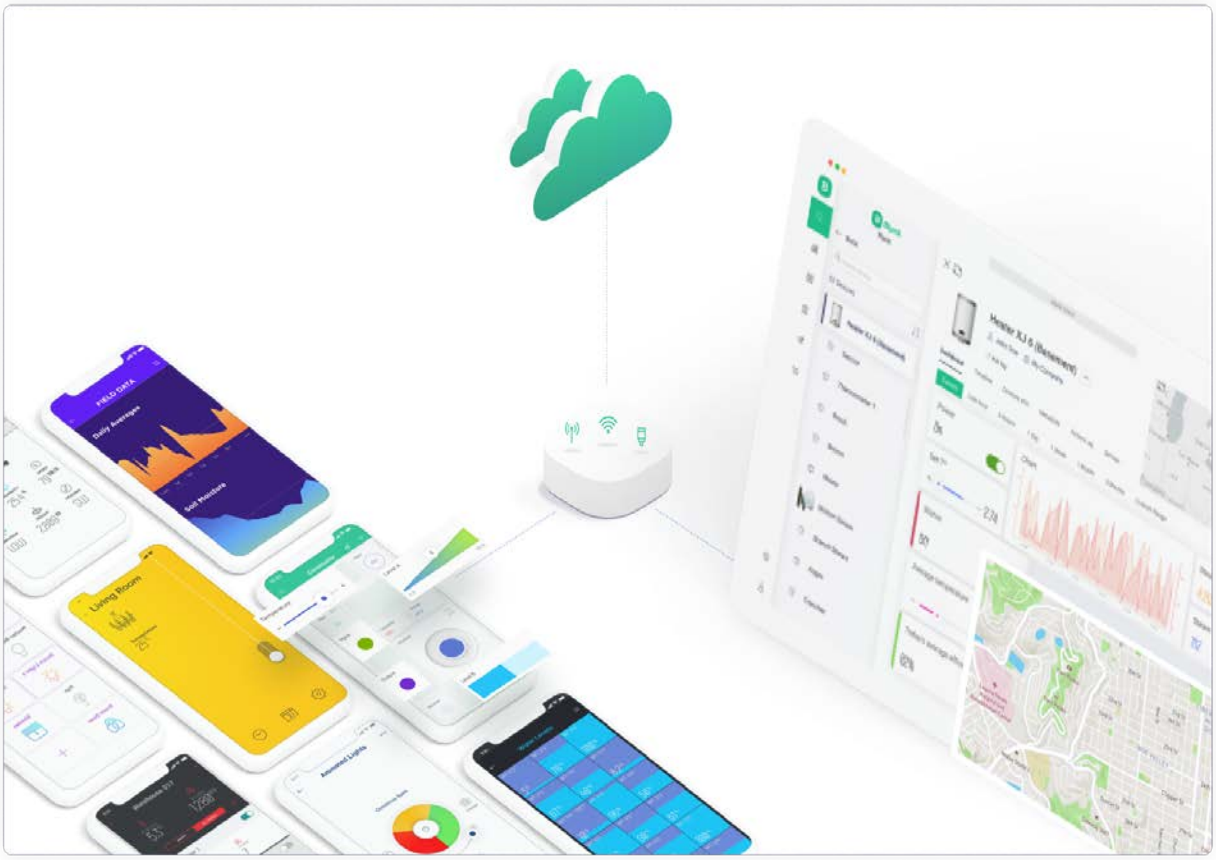


Fig 3.3 Blynk Connectivity

3.4 Battery:

A battery can be defined as an electrochemical device (consisting of one or more electrochemical cells) which can be charged with an electric current and discharged whenever required. Batteries are usually devices that are made up of multiple electrochemical cells that are connected to external inputs and outputs. Batteries are widely employed in order to power small electric devices such as mobile phones, remotes, and flashlights. Historically, the 'term' battery has always been used in order to refer to the combination of two or more electrochemical cells. However, the modern definition of the term 'battery' is believed to accommodate devices that only feature a single cell. Batteries are broadly classified into two categories, namely primary batteries and secondary batteries. Primary batteries can only be charged once. When these batteries are completely discharged, they become useless and must be discarded. The most common reason why primary batteries cannot be recharged is that the electrochemical reaction that takes place inside of them is irreversible in nature. It is important to note that primary batteries are also referred to as use-and-throw batteries. On the other hand, secondary batteries are the batteries than can be charged and reused for many charging-discharging cycles. The electrochemical reactions that take place inside these batteries are usually reversible in nature. Therefore, secondary batteries are also known as rechargeable batteries. When discharging, the reactants combine to form products, resulting in the flow of electricity. When charging, the flow of electrons into the battery facilitates the reverse reaction, in which the products react to form the reactants.

3.4.1 Lead-Acid Battery:

The lead-acid battery is believed to have been invented by the French physicist and inventor Gaston Planté in the year 1859. It is known to be one of the earliest rechargeable batteries. Despite the fact that the lead-acid battery has a very high energy-to-volume ratio and also a very low energy-to-weight ratio, the electrochemical cells in this battery are known to have a fairly large power-to-weight ratio. This can be attributed to their ability to produce strong surge currents. These features of the lead-acid battery, along with its relatively low cost, makes it highly desirable for use in motor vehicles and automobiles in order to provide the high current required to start the engine.

Some key characteristics of the lead-acid battery are:

- It has the ability to hold an electric charge for up to 3 years.
- It is ideal for use as an emergency power backup.
- It is one of the most inexpensive batteries in its output range.

3.4.2 Nickel-Cadmium Battery (also known as the NiCad Battery):

The nickel-cadmium battery (sometimes referred to as the 'NiCad' battery) is a type of rechargeable battery that employs metallic cadmium and nickel oxide hydroxide as the electrodes o the battery. The NiCad battery is known to offer varying discharge rates that are dependent on the size of the battery itself. For example, the discharge rate (maximum) for a typical AA sized cell is approximately equal to 1.8 amperes. On the other hand, the discharge rate for a D size battery can be as high as 3.5 amperes.

The key features of the NiCad battery are listed below.

- The nickel-cadmium battery features a very fast and even discharge of electrical energy.
- This type of battery is widely available and is also known to be relatively inexpensive.
- The NiCad battery can most commonly be found in certain toys and small electronic devices such as TV remotes.

3.4.3 Lithium-Ion Battery (also known as the LIB Battery):

The lithium-ion battery, often abbreviated to LIB, is a type of secondary battery which is rechargeable. LIBs are known to have many applications in powering electric vehicles and is also known to be used extensively in the aerospace industry. Within the batteries, during the discharging process, lithium ions are known to pass from the negative electrode to the positive electrode (through an electrolyte). These lithium ions are also known to travel back when charging. Lithium-ion batteries usually employ an intercalated lithium compound in the positive electrode and usually graphite in the negative electrode as the fuel. Lithium-ion batteries are highly desirable due to their high energy capacity, no memory effect (with the exception of LFP cells), and low self-discharge.

Some key characteristics of LIBs are listed below.

- The lithium-ion battery is regarded to be one of the most stable and safe batteries. This battery is also known to have a very high energy capacity.
- LIBs are widely used in mobile phones and portable computers (such as laptops and tablets).
- This battery has a very slow self-discharge. Furthermore, it is known to have twice the energy capacity of the NiCad battery.

F.V/Time	5min	10min	15min	30min	1h	2h	3h	4h	5h	6h	10h	20h
1.80V/cell	2.664	1.965	1.574	0.981	0.598	0.383	0.240	0.196	0.161	0.148	0.090	0.050
1.75V/cell	2.985	2.110	1.668	1.008	0.606	0.392	0.242	0.200	0.163	0.150	0.091	0.051
1.70V/cell	3.301	2.254	1.762	1.031	0.617	0.396	0.244	0.202	0.164	0.153	0.092	0.052
1.67V/cell	3.493	2.325	1.801	1.039	0.621	0.398	0.246	0.203	0.166	0.153	0.094	0.053
1.60V/cell	3.731	2.493	1.918	1.055	0.625	0.400	0.248	0.204	0.167	0.154	0.096	0.053

Table 3.2 Constant Current Discharge Sealed Lead Acid Batteries

F.V/Time	5min	10min	15min	30min	1h	2h	3h	4h	5h	6h	10h	20h
1.80V/cell	5.062	3.734	2.991	1.863	1.136	0.728	0.455	0.372	0.307	0.280	0.170	0.095
1.75V/cell	5.671	4.008	3.170	1.915	1.151	0.744	0.459	0.380	0.309	0.285	0.173	0.097
1.70V/cell	6.272	4.283	3.348	1.960	1.173	0.752	0.463	0.383	0.311	0.290	0.175	0.098
1.67V/cell	6.636	4.417	3.422	1.974	1.180	0.756	0.467	0.386	0.314	0.290	0.179	0.100
1.60V/cell	7.089	4.736	3.645	2.004	1.188	0.760	0.471	0.388	0.317	0.292	0.182	0.101

Table 3.3 Constant Power Discharge Sealed Lead Acid Batteries

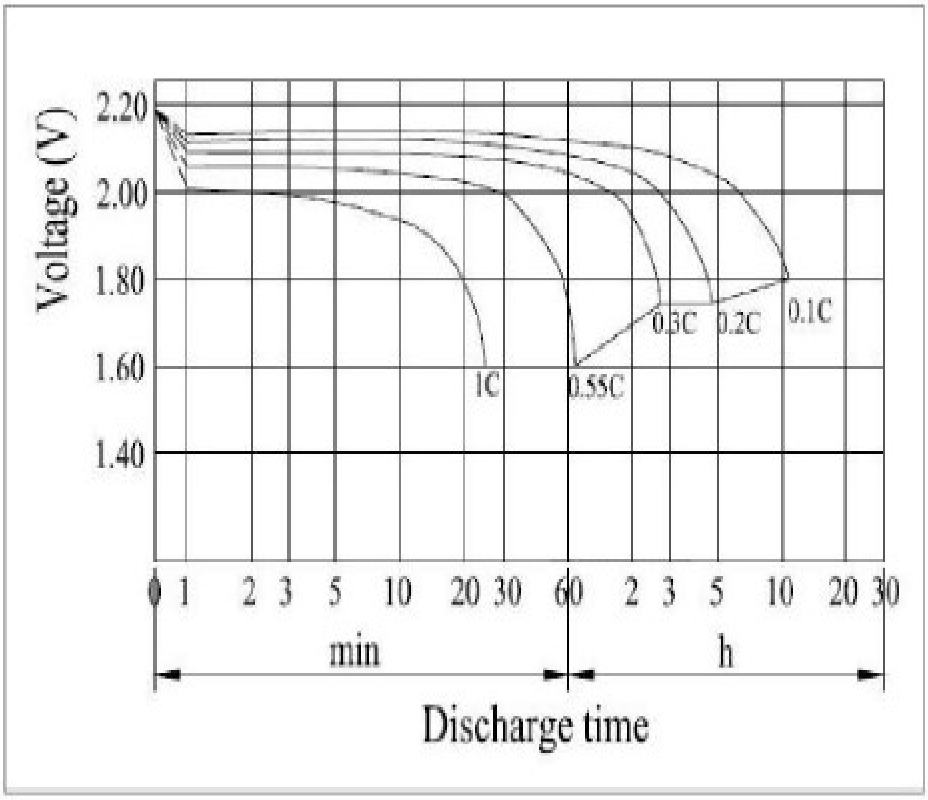


Fig 3.4 Discharge Characteristics

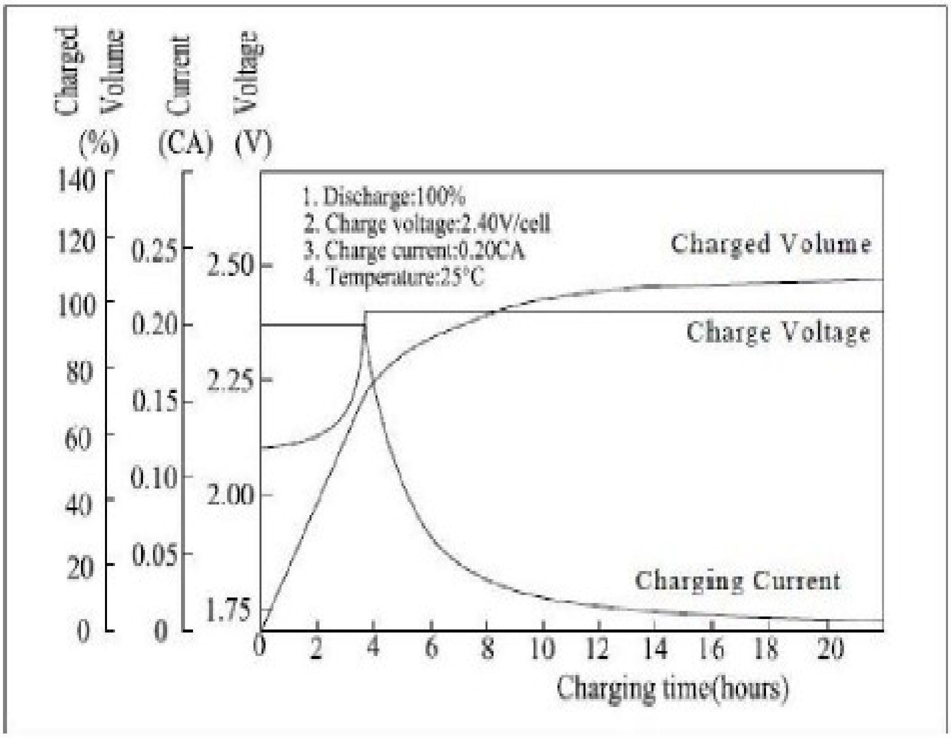


Fig 3.5 Float Charging Characteristics

3.5 Wearable Sensors:

Among home health monitoring technologies, wearable sensors are useful when continuous physiological monitoring is required [3]. For example, continuous assessment of heart rate enables one to diagnose cardiac arrhythmias and assess heart rate variability (HRV), an indicator of cardiovascular and psychophysiological state [4]. In rehabilitation health care, wearable sensors allow caregivers to monitor physiological changes like fall detection etc., sense heartbeat to detect heart attack, wherein all these disorders can be monitored remotely [5] [6]. Other wearable sensors like skin temperature play an important role in sensing activity, energy expenditure, and potential medical emergencies. For example, an acute stroke could be assessed by increase in body temperature and fall detection, and skin temperature play an important role in diagnosis [7]. When combined with wireless transmission, the implementation of these sensors will help in monitoring medical emergencies remotely [8]. There are several other emerging applications of wearable sensors. A few examples: clinicians use motion sensors to monitor neonatal lung development by recording the number of breathing cycles; by golfers to monitor improper swings; and by divers to detect harmful chemicals underwater which are a threat to human and aquatic life [9]. The most popular use is in the fitness market, where athletes and coaches track motion, energy expenditure, cardiovascular state, and other conditions using wearable sensors. A decade earlier, wearable sensors were not feasible because technology could not meet the size and power constraints required for wearable devices. However, recent advances in microsensors, radio communication ICs, open software, low power microcontrollers, and 3 smartphone technology has led to breakthrough advancements in developing wearable sensors. This technology advancement has also helped researchers in various other ways to implement wearable sensors. Wearable sensors are a combination of software and hardware, these sensors are designed to help us detect various emerging medical conditions prior to serious symptoms. The sensor technology consists of important building blocks:

1) displays for visualization,
2) software and hardware required for sensing,
3) communication protocols like GSM, Zigbee,
4)Bluetooth for remote monitoring,
5) information technology for analyzing the data according to the requirement.

After collecting and analyzing the raw data, the next important step is to communicate of the filtered data to the Android application. As human life expectancy and chronic disease increases, healthcare costs have also increased [10]. Wearable sensors can potentially help mitigate issues such as cost, size, efficiency, accuracy, and power consumption.

3.5.1 Heart Rate Monitoring Technologies:

Heart rate is a universal physiological parameter, which responds to both physical and psychological load. The heart responds to increases in physical activity, and also to emotions such as fear, stress, and anxiety. Increases and decreases in heart rate are controlled by the central nervous system [11], which includes the sympathetic and parasympathetic nervous system. The sympathetic nervous system controls the ‘flight or fight’ response, generally increases heart rate, while the parasympathetic nervous system brings the heart rate and blood pressure down during moments of relaxation. Continuous heart rate monitors (CHRM) can document these regular changes in heart rate, and therefore important play an important role in diagnosing physical and psychological load. A popular device used for continuous heart rate monitoring is the Holter monitor (Figure1.1), a portable electrocardiography (ECG) unit with electrodes attached to the chest area, and a recording device attached to the patient’s waist. The Holter monitor records continuous ECG waveforms, which can identify irregularities in heart function, including arrhythmias, palpitations, and others. Due to the size and bulk of the device, it is prescribed only on a short-term basis, such as weekly or monthly, before they are returned to the doctor for data analysis. Holter monitors are prescribed to diagnose atrial fibrillation, multi focal atrial, palpitation, fainting etc. [12] [13].

3.5.2 Heart Rate Target Zones:

In the consumer fitness market, one of the popular uses of heart rate monitoring is to help athletes maintain target heart rates during training. There are several predefined target zones, and a wearable heart rate monitor can help the athlete remain in one or more target zones to reach a specific training goal. The zones are defined as a percentage of maximum heart rate, which is age dependent. There are several algorithms available to calculate maximum heart rate (HRmax), but the simplest is HRmax = 220 – age in years. The fat burning or the fat loss zone, also called the recovery zone, accounts to a heart rate of 60% to 70%. The aerobic training zone, in the 70-80% of HRMax, helps an athlete to become stronger and fitter by developing the cardiovascular system endurance. The anaerobic zone, falling within 80-90% of HRMax, builds the lactic acid system which in turn helps burning the glycogen in lactic acid. The red line zone, between 90% to 100% of HRMax, is used for high intensity Interval training (HIIT) or other high-level fitness training [14]. The recommended target zones are a general guideline, and individuals are recommended to consult with physician, and proceed with a stress test, to determine his or her exercise program.

Age	Approximate Maximum Heart Rate (MHR)	Target heart rate for low to moderate intensity exercise (50-70% of maximum for MHR)
20	200 bpm	100 - 140 bpm
30	190 bpm	95 - 133 bpm
40	180 bpm	90 - 126 bpm
50	170 bpm	85 - 119 bpm
60	160 bpm	80 - 112 bpm
70	150 bpm	75 - 105 bpm
80	140 bpm	70 - 98 bpm
90	130 bpm	65 - 91 bpm

Table 3.4 Heart Rate Target Zone

3.6 Solar Cell:

Several organizations have started to use new solar technology to power their IoT fleets. It’s similar to using any other energy source, like a gas-powered generator, with the added benefit of being much more sustainable. A combination of solar technology like a rooftop panel array and storage solution can ensure the continuous delivery of power to a fleet of IoT sensors. This approach can be a great way for factories or other large, centralized industrial buildings to reduce their carbon footprint without the risk of intermittent power to essential IoT sensors. Existing IoT infrastructure can also support smart devices that track and optimize the function of newly installed solar panel arrays. New panels can be expensive, and businesses that need to power many IoT devices may need to invest in a significant array. Fortunately, most organizations should take advantage of the wide range of public and private incentives available for solar technology. These credits and subsidies can help organizations convince stakeholders and decision-makers that solar power is a worthwhile investment. The long-term benefits of a solar panel array can also help. For nonprofits, expenses like utility bills can be offset by the energy generated using solar arrays that power IoT devices. Developing new miniature solar panels for IoT devices. These panels may generate minimal amounts of power — as little as 1 watt, depending on solar panel size. As a result, they are small, lightweight, and cost-effective, making it practical to bundle them with many sensors. This approach is most effective when sensors are outdoors or distributed over a large area. It may be impractical or impossible to wire them all to a power source. Individual solar panels can provide consistent power even when a connection to the local grid isn’t feasible. Combined with a battery, they can ensure each sensor has an uninterrupted power source that generates a minimal amount of carbon emissions. Because most modern IoT sensors draw little power while in use, even smaller batteries can store enough energy to keep devices powered for days or weeks. One new solar-powered IoT asset tracker can operate for a month in darkness on a full charge. This long-lasting energy storage means that even if solar panels become less efficient over time — due to factors like the natural accumulation of dust — they should still provide enough power to keep an attached IoT device operational.

Exhaustible Energy Sources such as coal are decreasing at an alarming speed and the overreliance on them too is not stopping. That’s where Inexhaustible Energy like Solar and Wind Energy comes into action. Solar energy is an important inexhaustible source of energy that has been getting attention in the current time. Investment being done in Solar Industry for the hope of a less dependent future on fossil fuels. Fuels like natural gas, coal, oil are limited in quantity and not environmentally friendly. So, individually there has to be a collective response in the favor of renewable sources of energy. The life of fossil fuels is too small in comparison to the sun (billions of years left). Emissions from greenhouse gas are in significant because the technology does not need fuel combustion. Sun rays emitted throughout the planet Earth which allows all the countries of the world to utilize this abundance of energy. The scope of solar technology is not only at the highest level (national/international level) but also at the individual housing level hence making it self- reliant. The phenomena of converting light's energy into electrical energy are called the Photovoltaic effect. When semiconductor materials are displayed to light, some photons of light ray are sucked up by crystal (semiconductor) which causes a notable value of free electrons inside the crystal. Solar energy technology provides heat, light, electricity, for homes, businesses, and industries. IoT's attach all sensors, devices on a regular network. Smart IoT's along with automated controls to improve the efficiency of electricity production. Inexhaustible Energy resources can be strapped with maximum efficiency by these controls. The equipment is based on generating highest output. Real-time data generation is a major pro for IoT devices and helps in minimize wastage if any. IoT provides excellent tools for monitoring power consumption. Users may administer the functioning of the electrical devices through a desktop or mobile. Smart gadget sat homes or at office spaces that calculate the power absorbed by independent appliances and devices can be installed. It provides waste identification and helps in saving energy bills by monitoring real-time consumption. Sensors in IoT are attached to the transmission, generation, and distribution equipment. This IoT based monitoring system helps the user in monitoring and controlling the working of the equipment's remotely in real-time. This will lead to a reduction in operational costs and lowers our dependency on the already exhaustible fossil fuels. The implementation of IoT will help us efficiently utilize this solar energy. Hence, we can have a very successful partnership of IoT with Solar Energy.

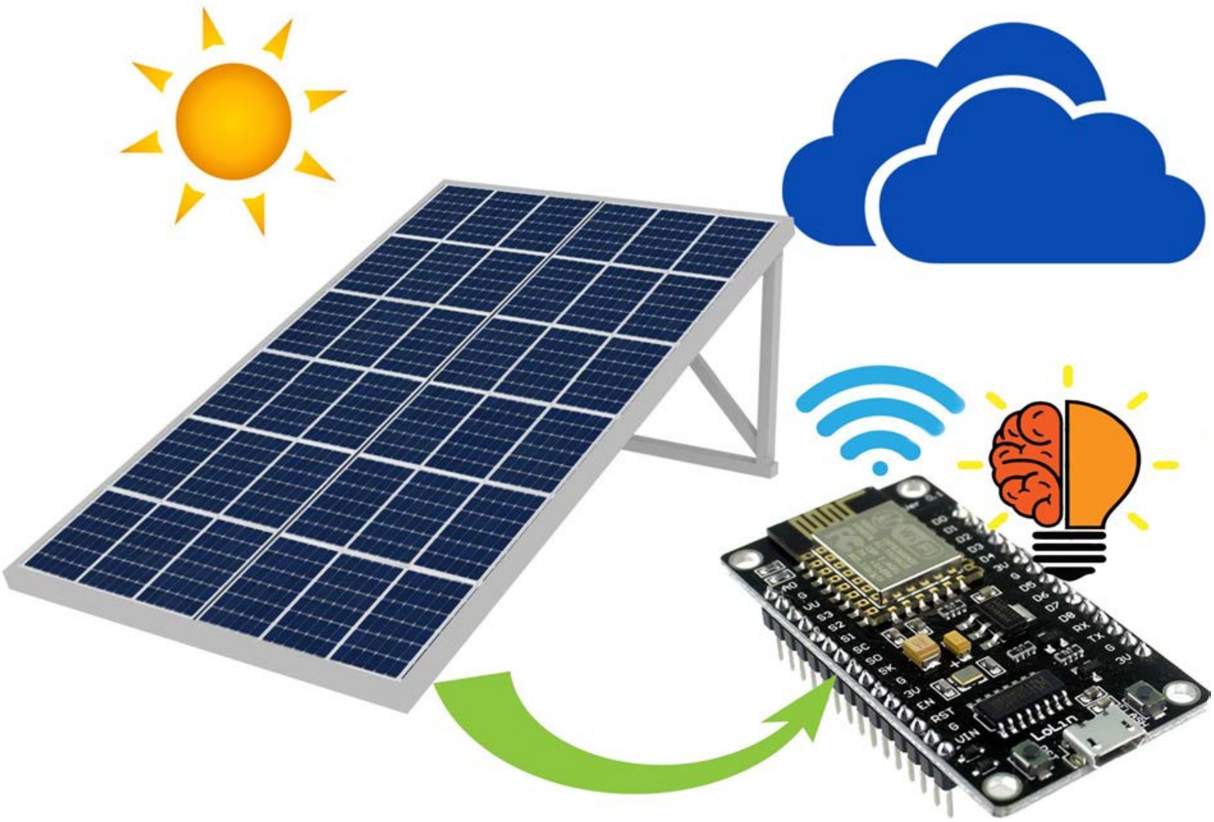


Fig 3.6 Solar Integrated IOT

3.7 DHT-11 Sensor:

The DHT11 humidity and temperature sensor measures relative humidity (RH) and temperature. This sensor includes a resistive element and a sense of wet NTC temperature measuring devices. 33 It has excellent quality, fast response, anti-interference ability and high cost performance advantages. Relative humidity is the ratio of water vapor in air vs. the saturation point of water vapor in air. Relative Humidity = (density of water vapor / density of water vapor at saturation) x 100% The DHT11 calculates relative humidity by measuring the electrical resistance between two electrodes. The humidity sensing component of the DHT11 is a moisture holding substrate (usually a salt or conductive plastic polymer) with the electrodes applied to the surface. When water vapor is absorbed by the substrate, ions are released by the substrate which increases the conductivity between the electrodes. The change in resistance between the two electrodes is proportional to the relative humidity. Higher relative humidity decreases the resistance between the electrodes while lower relative humidity increases the resistance between the electrodes. Inside the DHT11 you can see electrodes applied to a substrate on the front of the chip: The temperature readings from the DHT11 come from a surface mounted NTC temperature sensor (thermistor) built into the unit.

Specification:

- Operating Voltage: 3.5V to 5.5V
- Operating current: 0.3mA (measuring) 60uA (standby)
- Output: Serial data
- Temperature Range: 0°C to 50°C
- Humidity Range: 20
- Resolution: Temperature and Humidity both are 16-bit
- Accuracy: ±1°C and ±1z

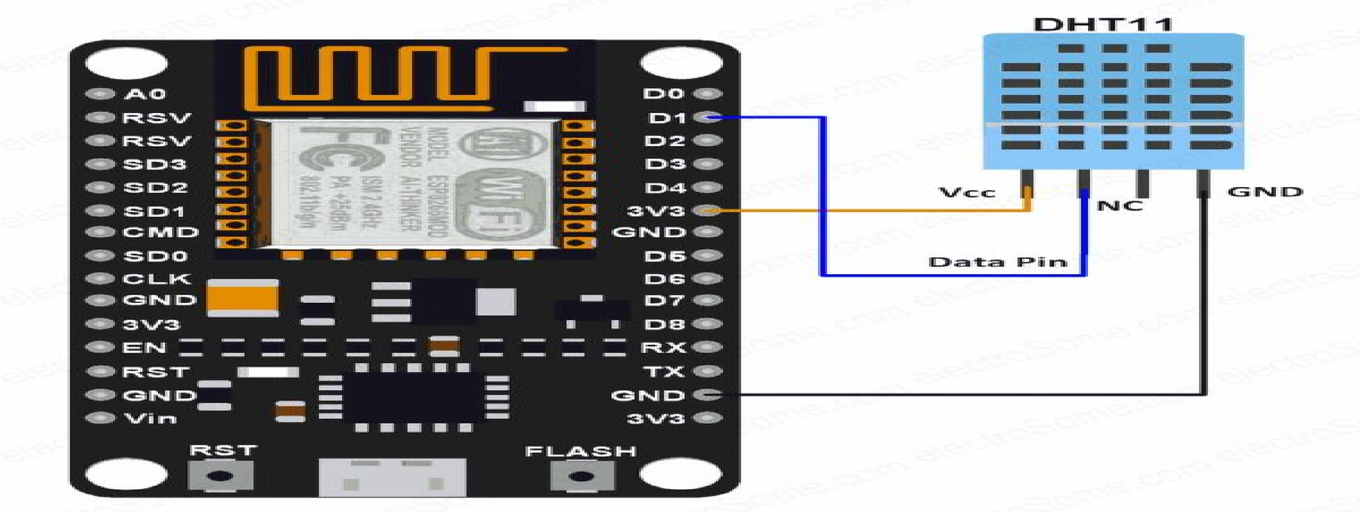


Fig 3.7 DHT-11 Connection

Temperature and humidity are perhaps the most monitored environmental variables as the two have shown significant impact in the almost all aspects, e.g. of optimal plant growth and development, the quality of food during production processing and storage, efficiency of many temperature and humidity-sensitive equipment among many others. The monitoring of temperature and humidity in laboratories, storages, halls, school and hospitals is important with respect to health and hygiene. Despite this, temperature and humidity measurement are among the most difficult problems in basic metrology. The difficulty to achieve accuracy due to the fragility and the requirement standards to maintain the preferred good quality instruments. Thus, much interests have been geared towards the improvement of existing instrument and come up with more innovative ones as done recently by the authors. This study was motivated by the dire need to provide a system capable of monitoring of temperature and humidity by one integrated system, having real time data logging, with an embedded alarming system that alerts the user when the desired temperature and humidity limits are exceeded recorded. The study utilized the Arduino, a low-cost, effective readily available open resource. The study was also to display the values of temperature and relative humidity as well as the time at which these values were recorded on the LCD screen. The language needed to program the microcontroller is user friendly since it uses a combination of C and C++. Its storage is almost space less since together with its components requires minimal space and can reduce the manpower of farming and reduce the number of greenhouse attendant and workload. But majority of times such an alerting humidity and temperature fluctuation could easily go unnoticed, the user or the person in charge is sleeping or in absentia due to some unavoidable circumstances in case, it is better to log the data in a storage medium in case of such an event so that he can keep a track of the data. The purpose of this Arduino microcontroller for the study were used in programing and running the circuit. The program (code) is generated using the Arduino IDE software and fed into the microcontroller. In interfacing the Arduino Nano in the circuit, it will run it to produce the required results.

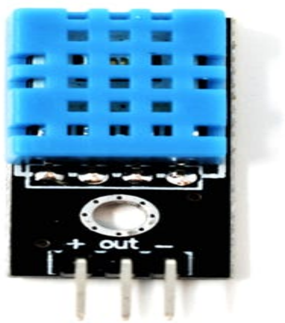


Fig 3.7.1 DHT-11

3.8 Chapter Summary:

- In this project, a system for 24×7 human health monitoring is designed and implemented.
- In this system, the Node Mcu is used for collecting and processing all data received from the sensors attached to the system (DHT11 and pulse rate).
- Different sensors are used for measuring different parameters.
- The sensors would be attached with a belt, and the belt would be attached to a body part during achieving the data from the subjected patient’s body.
- All this data is uploaded to blynk application for remote analysis.
- If the data achieved from the body by the sensors, exceed or subceed the critical limit, as implemented to the code for the application.
- An ESP8266 module is used for connecting the device to the internet connection.
- A solar power system is provided for powering all the sensors.
- The solar cell traps the energy and stores it in a battery. During the day time, the solar cell powers the system, and also stores energy to the battery. During night time, the battery with stored energy powers the system.

CHAPTER 4
SOFTWARE REQUIREMENT

4.1 Software Requirement:

4.1.1 Software's Versions:

- Blynk App (2.27.32)
- Arduino IDE (1.8.12)
- Window (8/10/11)

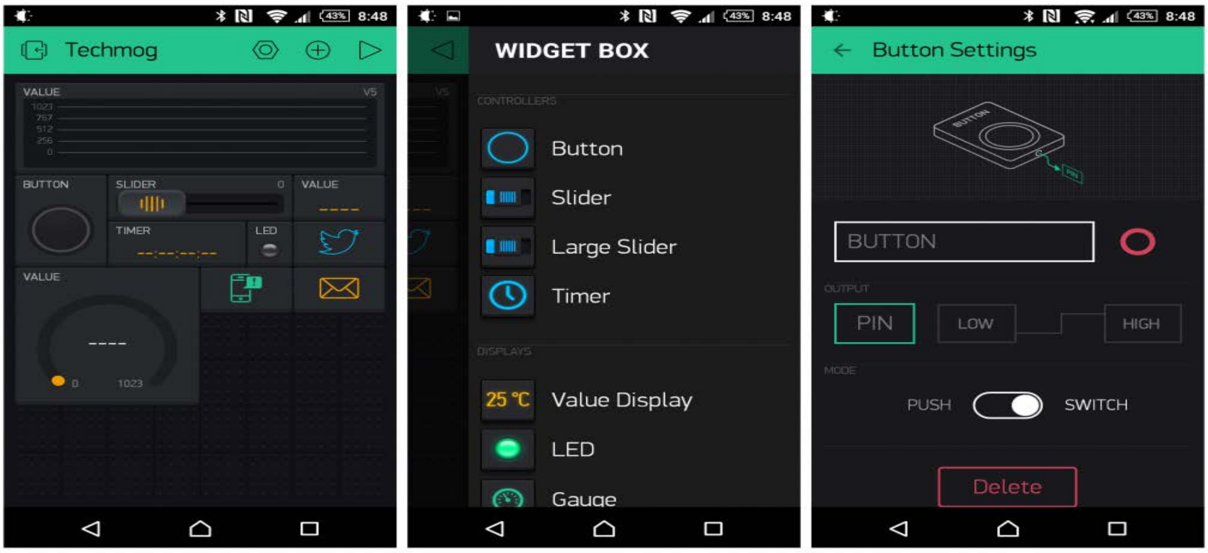


Fig 4.1 Blynk for mobile application

4.1.2 Developers Requirement:

- IDE (Arduino)
- Libraries for Sensor

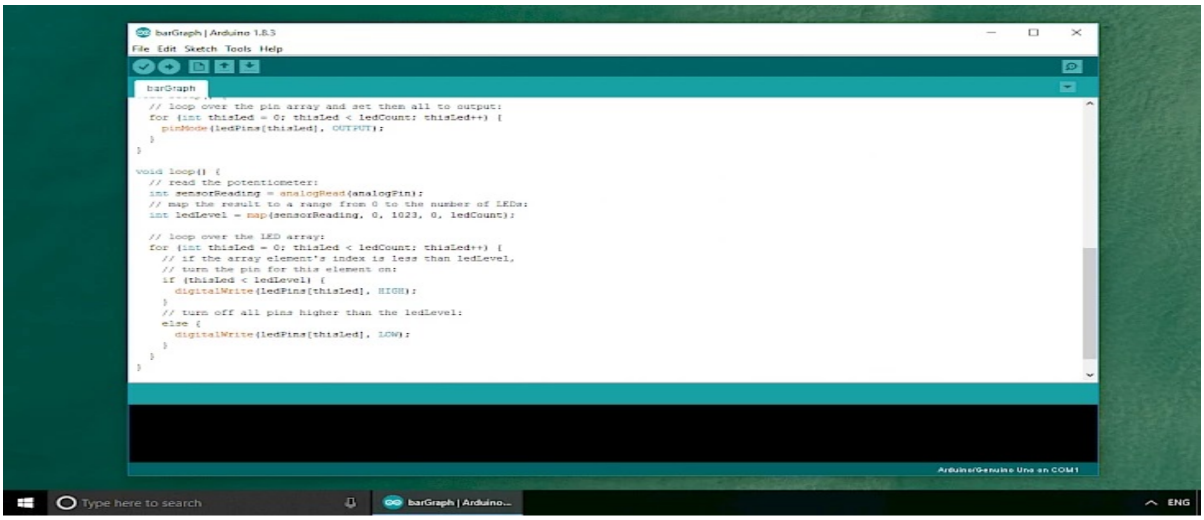


Fig 4.2 Arduino IDE

CHAPTER 5
HARDWARE REQUIREMENT

5.1 Hardware Requirement:

5.1.1 Developers Requirement:

- NodeMCU ESP8266
- DHT-11 Sensor
- Solar Panel
- Smartphone
- Battery (Sealed Lead-Acid)
- Heart Rate Pulse Sensor
- Connection Wire

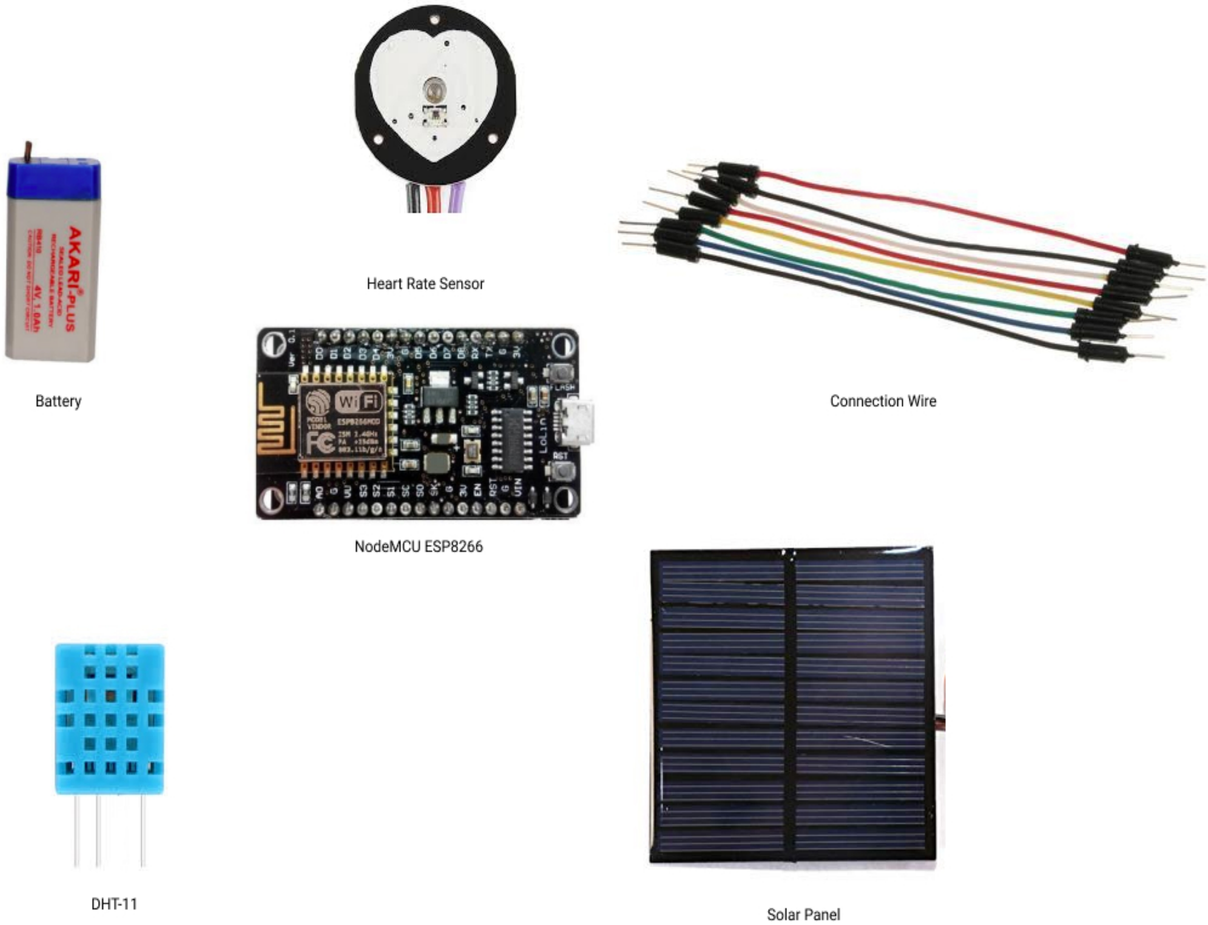


Fig 5.1 Hardware Components

5.1.2 End User Requirement:

- Smart phone (for its application to run- Blynk app)
- The device (IoT based hybrid health monitoring device)

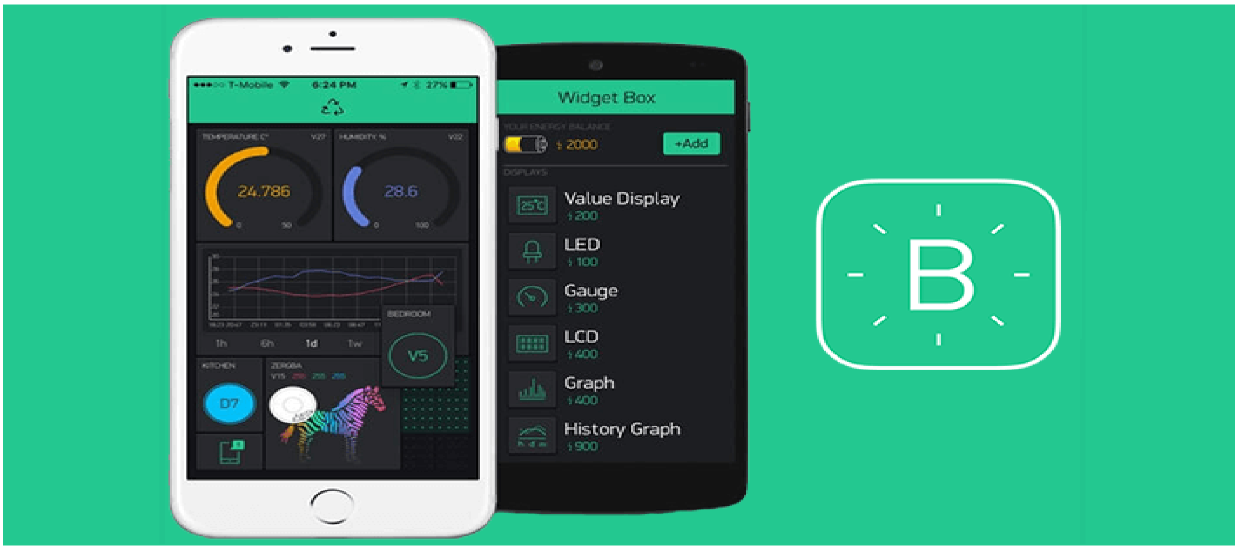


Fig 5.2 Installed Apps & widgets

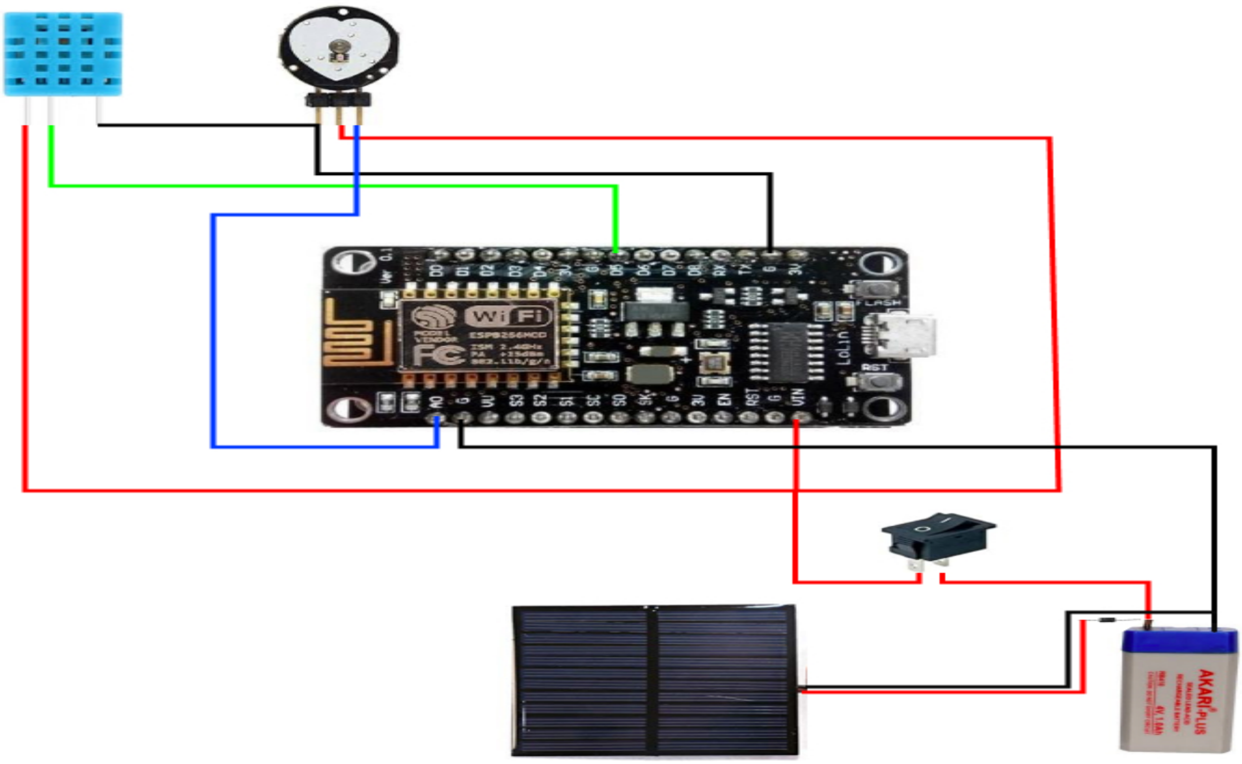
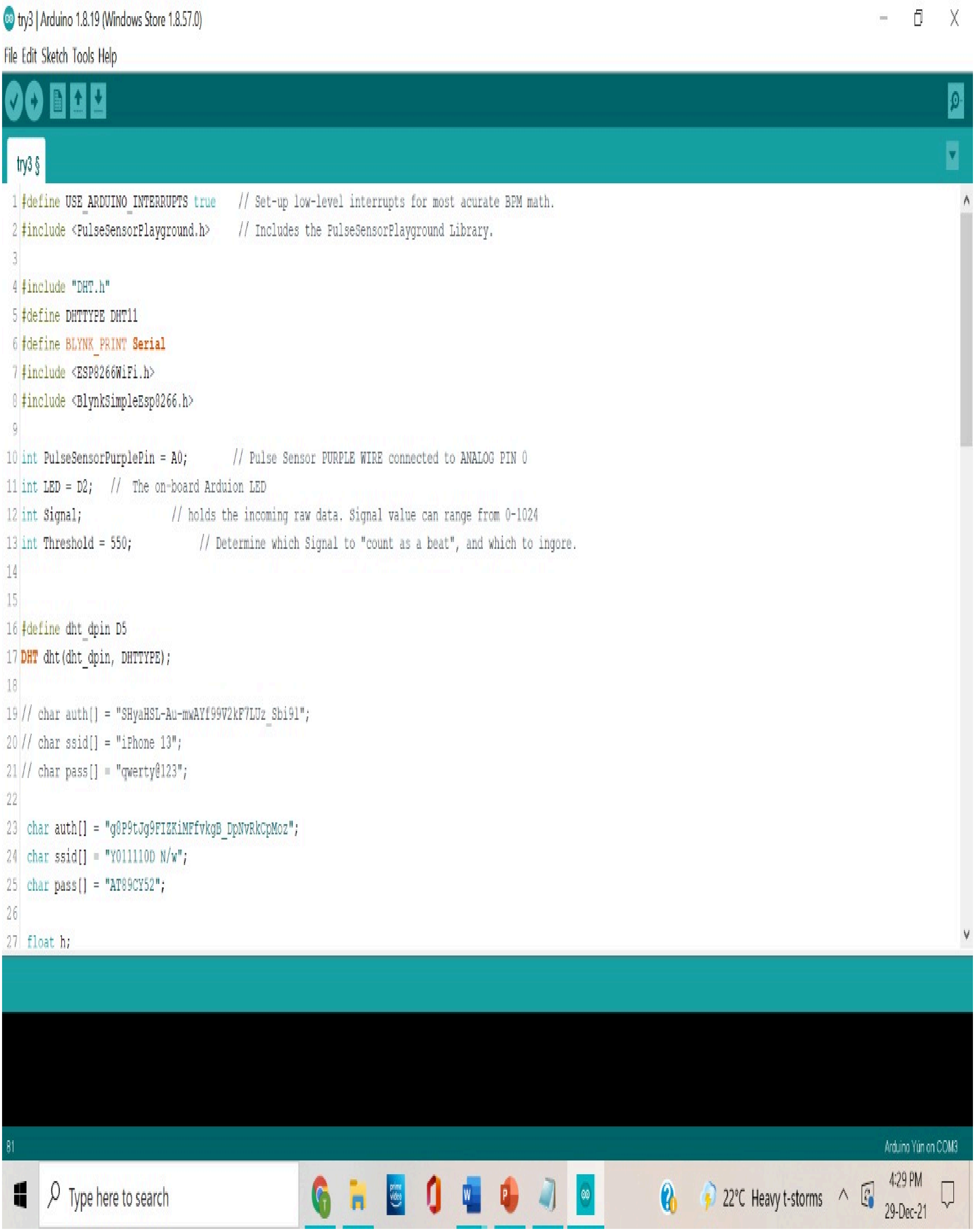
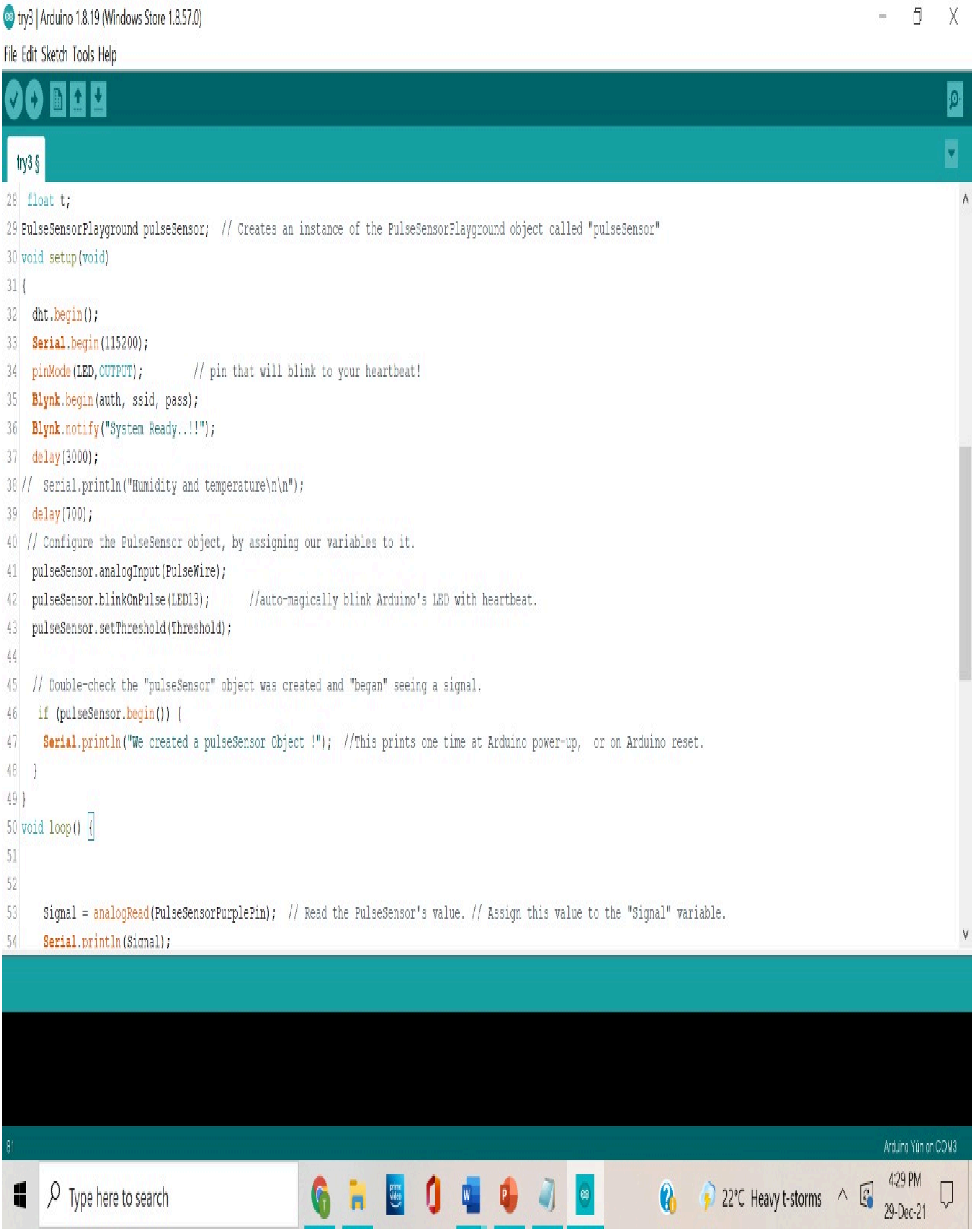


Fig 5.3 Health Monitoring Device

CHAPTER 6
SNAP SHOTS


try3 | Arduino 1.8.19 (Windows Store 1.8.57.0)
File Edit Sketch Tools Help
try3 §
#define USE_ARDUINO_INTERRUPTS true   // Set-up low-level interrupts for most acurate BPM math.
#include <PulseSensorPlayground.h>   // Includes the PulseSensorPlayground Library.
#include "DHT.h"
#define DHTTYPE DHT11
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
int PulseSensorPurplePin = A0;   // Pulse Sensor PURPLE WIRE connected to ANALOG PIN 0
int LED = D2;   // The on-board Arduion LED
int Signal;   // holds the incoming raw data. Signal value can range from 0-1024
int Threshold = 550;   // Determine which Signal to "count as a beat", and which to ingore.
#define dht_dpin D5
DHT dht(dht_dpin, DHTTYPE);
// char auth[] = "SHyaHSL-Au-mwAYf99V2kF7LUz_Sbi9l";
// char ssid[] = "iPhone 13";
// char pass[] = "qwerty@123";
char auth[] = "g0P9tJg9FIZKiMFfvkgB_DpNvRkCpMoz";
char ssid[] = "Y011110D N/w";
char pass[] = "AT89CY52";
float h;
81
Arduino Yún on COM3
Type here to search
22°C Heavy t-storms
4:29 PM
29-Dec-21



try3 | Arduino 1.8.19 (Windows Store 1.8.57.0)

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try3 §

```
 float t;
PulseSensorPlayground pulseSensor;  // Creates an instance of the PulseSensorPlayground object called "pulseSensor"
void setup(void)
{
  dht.begin();
  Serial.begin(115200);
  pinMode(LED,OUTPUT);         // pin that will blink to your heartbeat!
  Blynk.begin(auth, ssid, pass);
  Blynk.notify("System Ready..!!");
  delay(3000);
//  Serial.println("Humidity and temperature\n\n");
  delay(700);
 // Configure the PulseSensor object, by assigning our variables to it.
  pulseSensor.analogInput(PulseWire);
  pulseSensor.blinkOnPulse(LED13);       //auto-magically blink Arduino's LED with heartbeat.
  pulseSensor.setThreshold(Threshold);

  // Double-check the "pulseSensor" object was created and "began" seeing a signal.
   if (pulseSensor.begin()) {
    Serial.println("We created a pulseSensor Object !");  //This prints one time at Arduino power-up,  or on Arduino reset.
  }
}
void loop() {


    Signal = analogRead(PulseSensorPurplePin);  // Read the PulseSensor's value. // Assign this value to the "Signal" variable.
    Serial.println(Signal);
```

81 Arduino Yún on COM3

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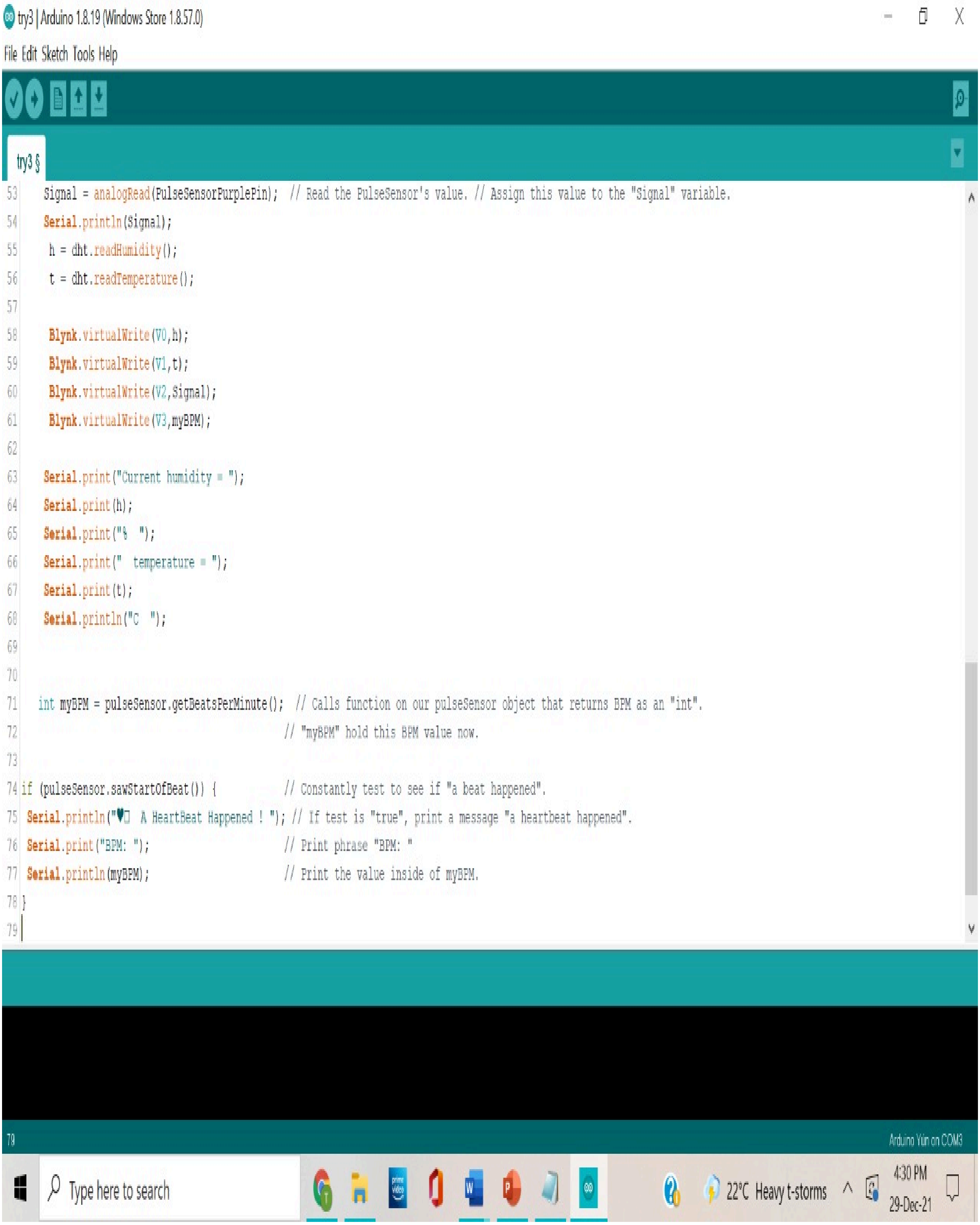
try3 | Arduino 1.8.19 (Windows Store 1.8.57.0)
File Edit Sketch Tools Help
try3 §
Signal = analogRead(PulseSensorPurplePin); // Read the PulseSensor's value. // Assign this value to the "Signal" variable.
Serial.println(Signal);
h = dht.readHumidity();
t = dht.readTemperature();
Blynk.virtualWrite(V0,h);
Blynk.virtualWrite(V1,t);
Blynk.virtualWrite(V2,Signal);
Blynk.virtualWrite(V3,myBPM);
Serial.print("Current humidity = ");
Serial.print(h);
Serial.print("% ");
Serial.print(" temperature = ");
Serial.print(t);
Serial.println("C ");
int myBPM = pulseSensor.getBeatsPerMinute(); // Calls function on our pulseSensor object that returns BPM as an "int".
// "myBPM" hold this BPM value now.
if (pulseSensor.sawStartOfBeat()) { // Constantly test to see if "a beat happened".
Serial.println("♥ A HeartBeat Happened ! "); // If test is "true", print a message "a heartbeat happened".
Serial.print("BPM: "); // Print phrase "BPM: "
Serial.println(myBPM); // Print the value inside of myBPM.
}
Arduino Yún on COM3
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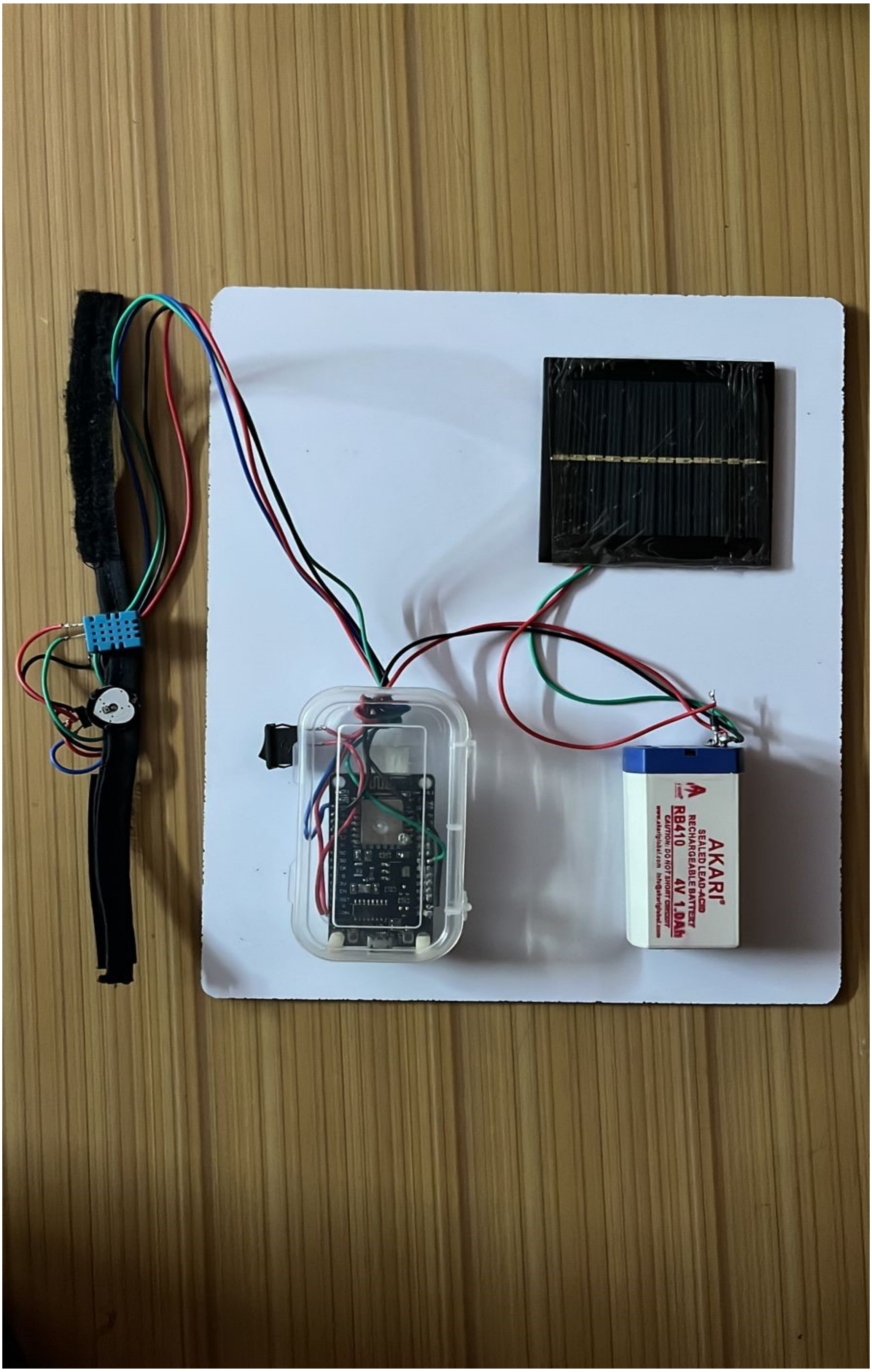
22°C Heavy t-storms
4:30 PM
29-Dec-21


AKARI
SEALED LEAD-ACID
RECHARGEABLE BATTERY
RB410 4V 1.0Ah
CAUTION: DO NOT SHORT CIRCUIT


health monitoring
PULSE
TEMPERATURE
Live
1h
6h
1d
1w
1M
3M
HUMIDITY
TEMPERATURE (°C)
39
0
100
27.6
0
200
PULSE
843
0
1023

CHAPTER 7
RESULT & ANALYSIS

7.1 Experiment:

The body temperature, humidity and pulse rate sensors are monitored and initially displayed. The values from the sensors especially the body temperature sensor and the pulse rate sensor are stored in the database. For body temperature, the range is defined as in Table II. The membership function of the temperature range can be explained as:

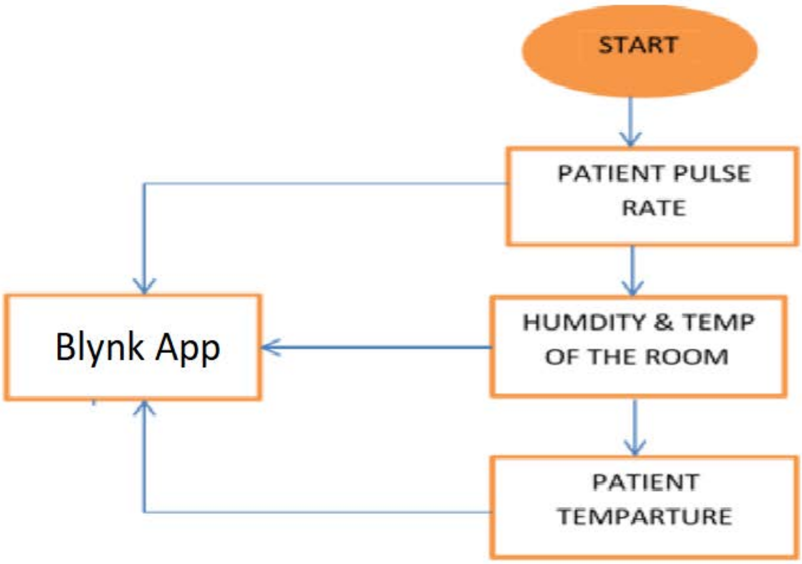


Fig 7.1 Sensors Monitor

$$\text{Low} = \begin{cases} 1, & x < 36°C \\ 0, & x > 36°C \end{cases}$$

$$\text{Normal} = \begin{cases} 1, & 36.0°C \leq x \leq 37.5°C \\ 0, & x > 37.5°C \text{ and } x < 36°C \end{cases}$$

$$\text{High} = \begin{cases} 1, & x > 37.5°C \\ 0, & x < 37.5°C \end{cases}$$

Body Temperature	State
36.0 –37.5 °C	Normal
>37.5 °C	High
<36.0 °C	Low

Table 7.1 Body Temperature

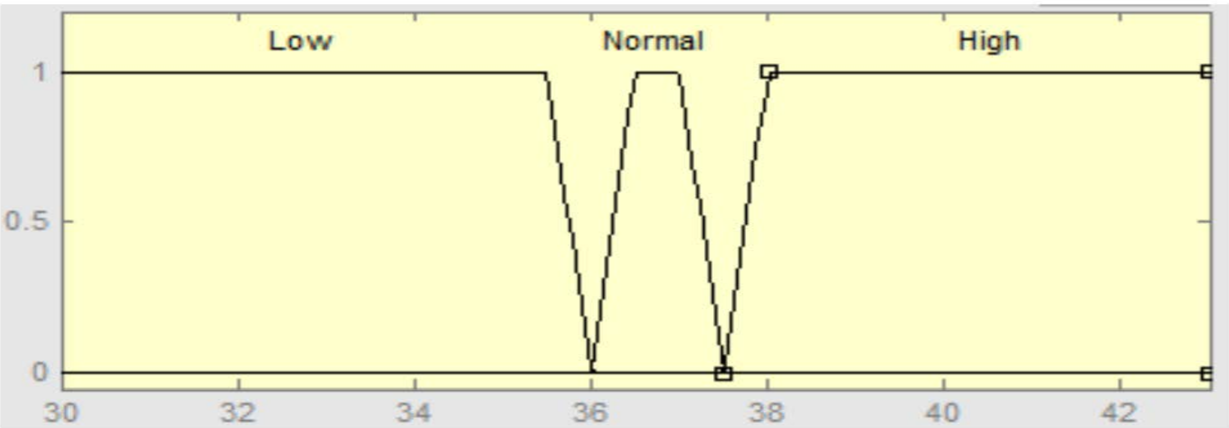


Fig 7.2 Body Temperature Membership Function

Similarly, to determine the health state of the patient, different range of pulse rate reading is also considered. The membership function of the pulse rate as given below:

$$\text{Low} = \begin{cases} 1, x<60 \text{ BPM} \\ 0, x>60 \text{ BPM} \end{cases}$$

$$\text{Normal} = \begin{cases} 1, 60 \text{ BPM} \leq x \leq 100 \text{ BPM} \\ 0, x > 100 \text{ BPM and } x < 60 \text{ BPM} \end{cases}$$

$$\text{High} = \begin{cases} 1, x > 100 \text{ BPM} \\ 0, x < 100 \text{ BPM} \end{cases}$$

Pulse rate	State
60 BPM - 100 BPM	Normal
>100 BPM	High
<60 BPM	Low

Table 7.2 Pulse Rate

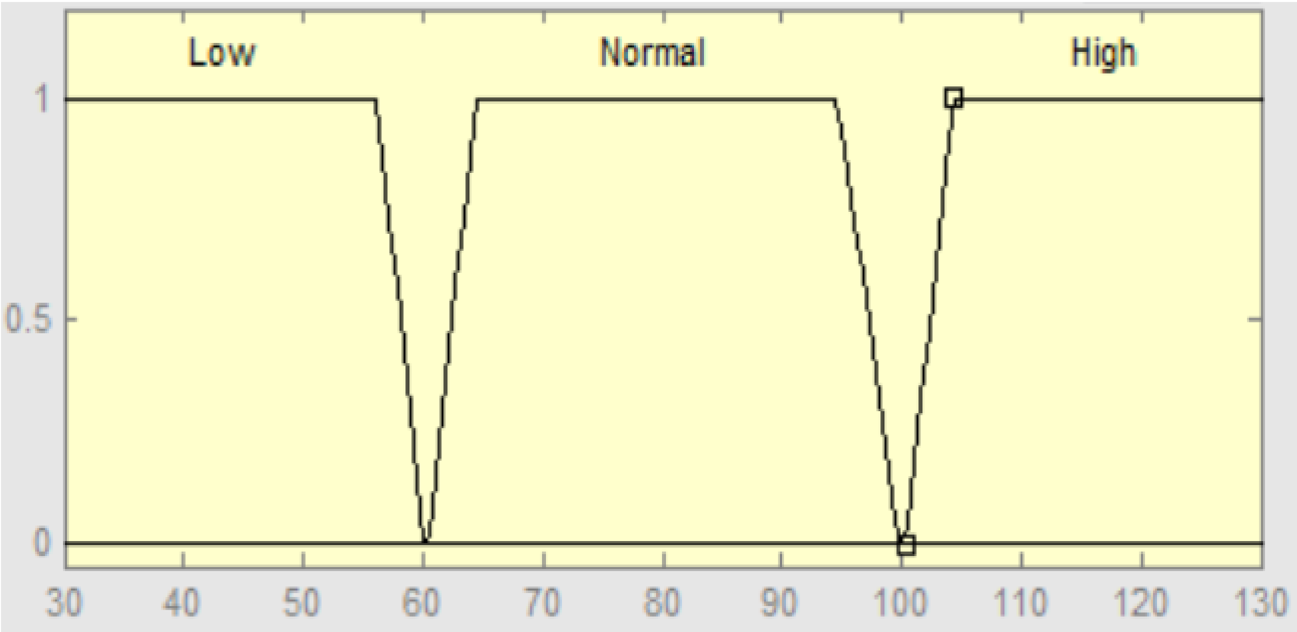


Fig 7.3 Pulse Rate Membership Function

Based on these different range values, the rules for diagnosing the disease of the patient is performed. The output health state is diagnosed with the following membership function: Healthy, Unwell, Hypothermia, Fever and Needs a detailed health checkup as shown. The membership function of the output health state is defined as given below:

$$\text{Checkup} = \begin{cases} 1, & x < 20 \\ 0, & x > 20 \end{cases}$$

$$\text{Unwell} = \begin{cases} 1, & 20 \leq x \leq 40 \\ 0, & x > 40 \text{ and } x < 20 \end{cases}$$

$$\text{Hypothermia} = \begin{cases} 1, & 40 \leq x \leq 60 \\ 0, & x > 60 \text{ and } x < 40 \end{cases}$$

$$\text{Healthy} = \begin{cases} 1, & x > 80 \\ 0, & x < 80 \end{cases}$$

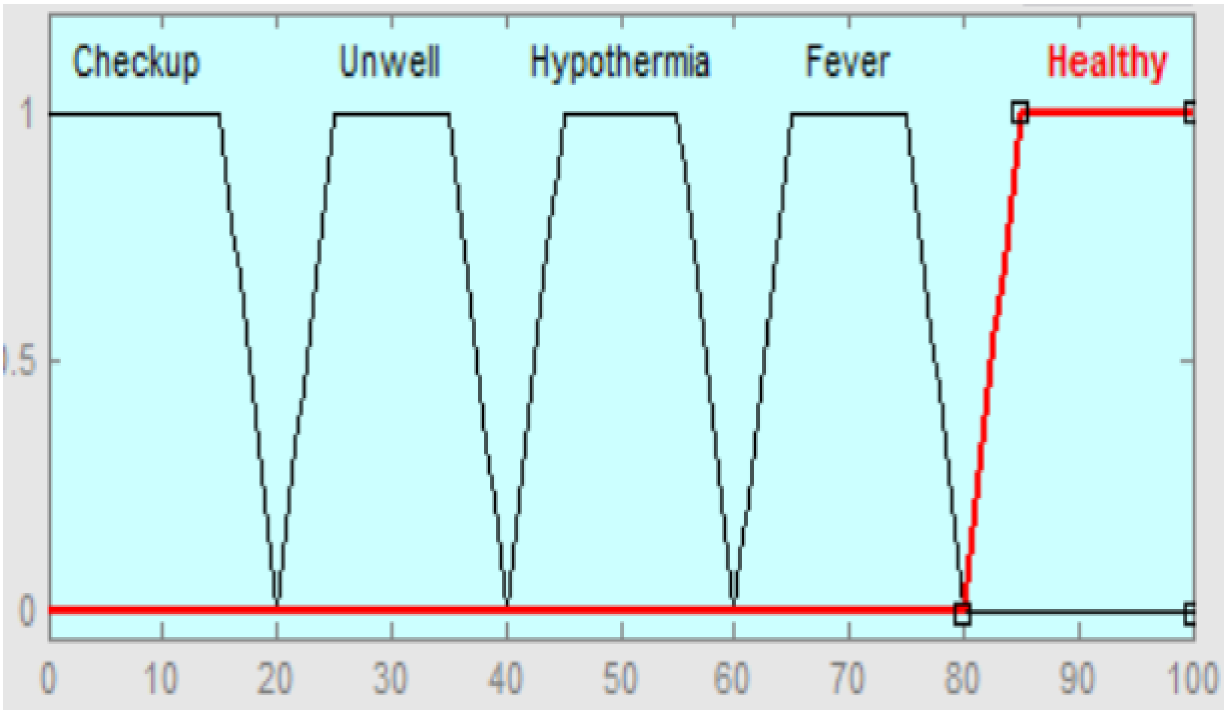


Fig 7.4 Output Health State membership Function

The rules for diagnosing the output health condition are as given:

Pulse rate	Body Temperature		
	Low	Normal	High
Low	Health Checkup	Unwell	Health Checkup
Normal	Hypothermia	Healthy	Fever
High	Health Checkup	Unwell	Health Checkup

Table 7.3 Rules For Diagnosing Disease

These rules for diagnosis can be summarized by considering all the combinations of membership functions of the body temperature and the pulse rate as given below:

If the pulse rate and body temperature are (Low & Low) OR (Low & High) OR (High & Low) OR (High & High)

- Then the patient has to immediately go for a detailed Health Checkup.
- If the pulse rate and body temperature are (Low & normal) OR (High & Normal), then the patient is considered to be unwell.
- If the pulse rate and body temperature are (Normal & Low) then the patient is considered to be in a hypothermia state.
- If the pulse rate and body temperature are (Normal & High) then the patient is considered to be having fever.
- If the pulse rate and body temperature are (Normal & Normal) then the patient is considered to be healthy.

7.2 Result:

The main objective of the experiment was successfully achieved. All the individual modules like Heartbeat detection module, fall detection module etc. and remote viewing module gave out the intended results. The designed system modules can further be optimized and produced to a final single circuit. More important fact that came up during project design is that all the circuit components used in the remote health detection system are available easily. With the development in the integrated circuit industry, Micro Electro Mechanical Systems (MEMs) and microcontrollers have become affordable, have increased processing speeds, miniaturized and power efficient. This has led to increased development of embedded systems that the healthcare specialists are adopting. These embedded systems have also been adopted in the Smartphone technology. And with increased internet penetration in most developing countries through mobile phones, and with use of Internet of things (IoT) will become adopted at a faster rate. The Remote Health Care system utilizes these concepts to come up with a system for better quality of life for people in society. From an engineering perspective, the project has seen concepts acquired through the computer science and embedded study period being practically applied. The Electric circuit analysis knowledge was used during design and fabrication of the individual modules. Electromagnetic fields analysis used in the wireless transmission between microcontrollers and Software programming used during programming of the microcontrollers to come up with a final finished circuit system.

CHAPTER 8
FUNCTIONALITY

8.1 Project Flow Diagram:

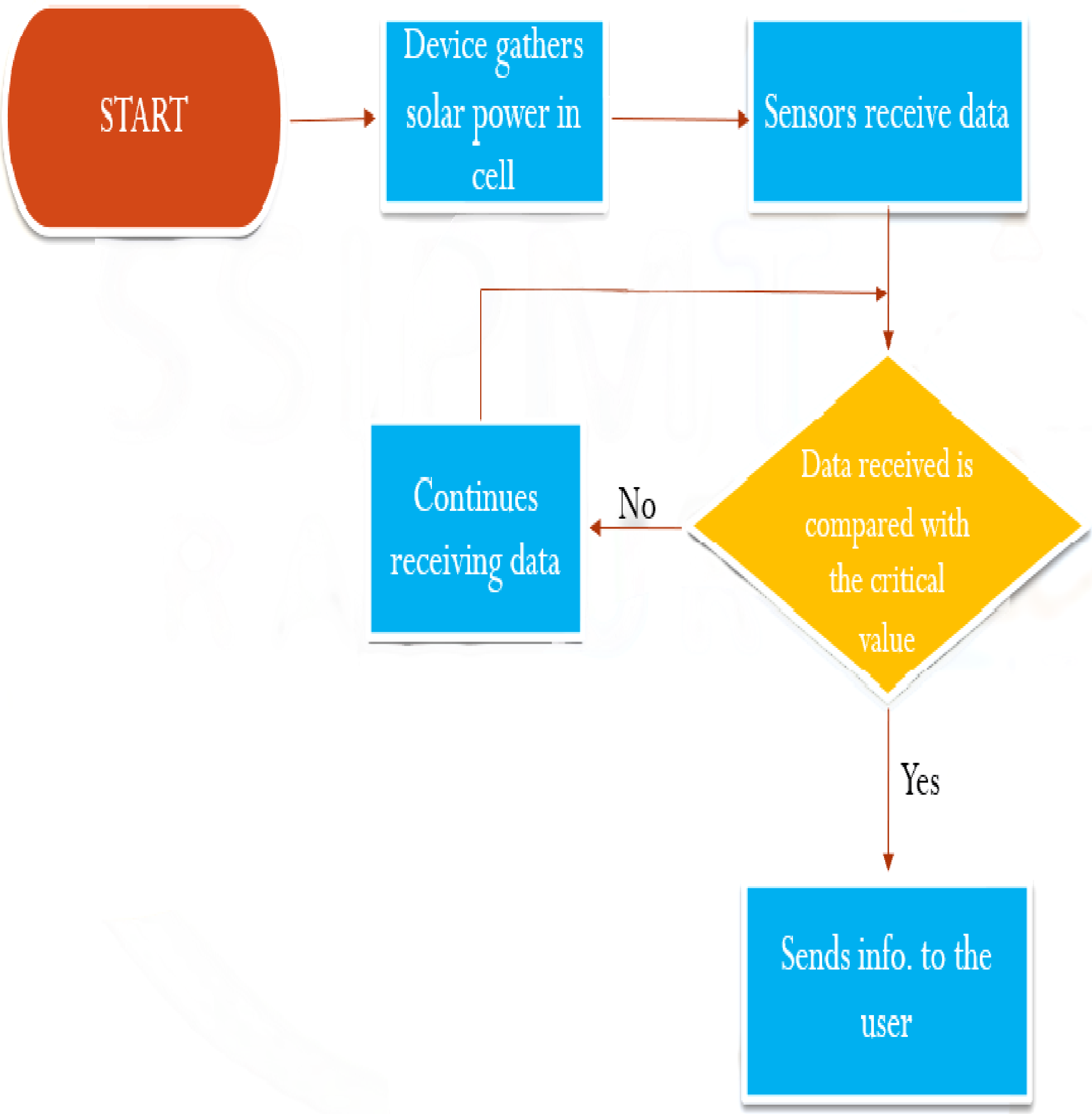


Fig 8.1 Project Flow Diagram

8.2 Data flow diagram:

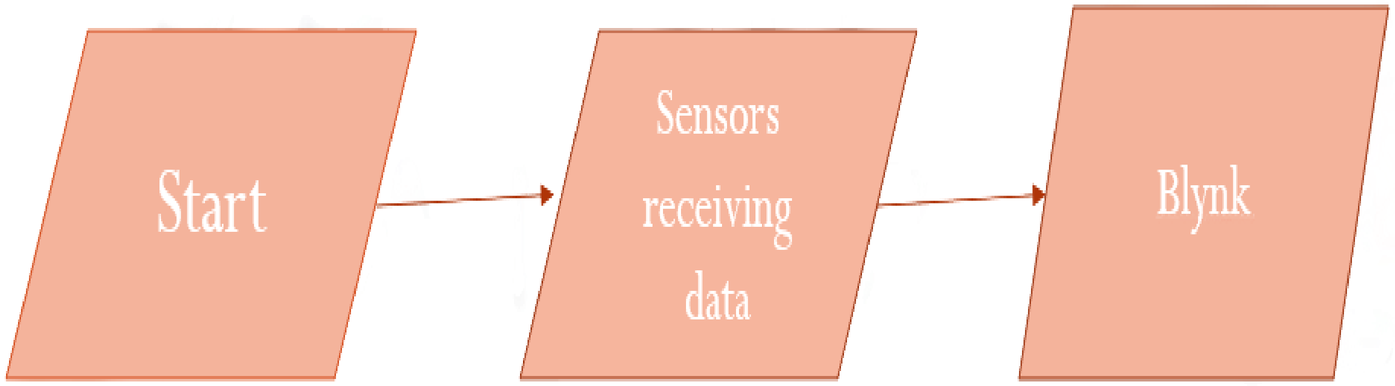


Fig 8.2 DFD

8.3 Process explanation:

- In this project, a system for 24×7 human health monitoring is designed and implemented.
- In this system, the Node Mcu is used for collecting and processing all data received from the sensors attached to the system (DHT11 and pulse rate).
- Different sensors are used for measuring different parameters.
- The sensors would be attached with a belt, and the belt would be attached to a body part during achieving the data from the subjected patient’s body.
- All this data is uploaded to blynk application for remote analysis.
- If the data achieved from the body by the sensors, exceed or subceed the critical limit, as implemented to the code for the application.
- An ESP8266 module is used for connecting the device to the internet connection.
- A solar power system is provided for powering all the sensors.
- The solar cell traps the energy and stores it in a battery. During the day time, the solar cell powers the system, and also stores energy to the battery. During night time, the battery with stored energy powers the system.
- The connections are as follows:
    - Solar cell is connected with the battery via a diode (so as to avoid reverse flow of energy).
    - The battery is connected with Node MCU via a switch with Gnd pin and Vin.
    - Pulse rate sensor is connected with three Vin pin, Gnd and analog pin A0.
    - The DHT11 sensor is connected with the digital pin D5.

CHAPTER 9
LIMITATIONS & FUTURE IMPROVEMENTS

9.1 Limitations:

Every emerging technology have some Limitations. IoT based Healthcare Monitoring also have some bottlenecks and challenges too. Some of them are as follows: A. Security & Privacy Issues Healthcare devices and applications captures private healthcare information and these devices are connected to internet for anytime, anywhere access. So, it may attract hacker to steal private information. Private health information must be used after patient authorization. According to the official breach reports from 2009 to mid-April 2013 presents 51% of total the security risks is theft of laptop or medical device for healthcare. Data security in healthcare should address the following challenges: •Physical security of health devices •Providing secure routing for data communication •Providing data transparency in cloud computing environment. • Maximum security with minimum resource consumption In IoT Based healthcare patient health information is collected from various medical sensors and wearable devices. medical devices have to connect to other devices and multiple users for data gathering. There are thousands of vendors who manufacture devices without following any standard rules and regulations for compatible interfaces and protocols for inter device communication. So, data captured by these devices are not visible to other devices. This cause interoperability issues. Because of lack of interoperability, data from different IoT devices may remain locked in each individual system and lose its potential value and increase system integration cost. B. Device Designing issue IoT devices used in healthcare are tiny sensors those have low computing power processors, low storage capacity and limited battery power. IoT devices are mobile in nature too and internet connected. Wearable devices have to connect different networks to provide health information to caregivers. Developing a IoT devices that have higher computing power, more storage capacity, high battery power and mobility complaint security is still a research challenge. C. Scalability In coming days improved medical device will came into market. Billions of IoT devices will connected to the network that will produce large amount of health data. The amount of data that have to be store and processed will also increase exponentially. This will cause a big data problem for healthcare. The system which stores and analyses this information from the IoT devices needs to be scalable. Data collected from connected IoT devices needs big data analytics to making better treatment plan and cloud storage for storing for future. As number of IoT devices is increasing, it is becoming difficult to generate knowledge and insights from this data. D. Trust Information generated and delivered by medical devices are prone to security attacks. information might appear to be correct but it could be infected or corrupted by virus malware during data transmission. hackers may use this information to harm individual because on the basis of information generated by these sensors, caregiver take decision and makes treatment plan. So, this corrupted information can cause life and death decisions. How then we can trust the treatment based on medical sensors data? This is a big challenge in IoT based health monitoring.

9.2 Future Improvements:

a) Physiological data collection
   1. Home Ultrasound
   2. Brain signal monitoring

b) Remote viewing of data
   1. Problems associated with having data online. Tackle Distributed denial of service.
   2. DDOS, and Data privacy/security especially of medical systems.

c) IoT based Remote Patient Monitoring System can be enhanced to detect and collect data of several anomalies for monitoring purpose such as home ultrasound, Brain signal monitoring, Tumor detection etc.

d) More research on problems associated with having data online, data privacy as IoT is managed and run by multiple technologies and multiple vendors are involved in it. Security algorithms and certain precautions by the users will help avoid any security related threats in IoT network.

e) The interface can be designed to control which sensors can be used by consumers according to their needs.

f) Web UI can be enhanced to perform several activities which include controlling the hardware, real-time graphs, history and analysis graphs to observe anomalies etc.

CHAPTER 10
CONCLUSION

10.1 Conclusion:

Internet of things technology is in its starting face but it has potential to impact human healthcare and associated market at a massive scale. Due to high speed internet access and advanced sensor technology it is possible to track human and other objects. Researcher have start to discover many technological solutions to improve healthcare system. This paper offers deeper insights of Internet of things-based healthcare applications, enabling technologies, current challenges and issues of healthcare.

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