# A Modern Healthcare System based on IoT using a Network of Body Sensors

A PROJECT REPORT

submitted by


**Adithya Vadlamani - 13BCE0193**

**Ajit Kumar Neelam - 13BCE0480**

**K. J Sai Krishna - 13BCE0199**


*in partial fulfillment for the award*

of the

**B. Tech**

degree in

**Computer Science and Engineering**

**School of Computer Science and Engineering**

**May 2017**

# School of Computer Science and Engineering

## DECLARATION

We hereby declare that the project entitled **"A Modern Healthcare Monitoring System based on IoT using a network of Body Sensors"** submitted by us to the School of Computer Science and Engineering, VIT University, Vellore-14 in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology in Computer Science and Engineering** is a record of bonafide work carried out by us under the supervision of **Prof. Anbarasi M., Assistant Professor (Senior), SCOPE.** We further declare that the work reported in this project has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma of this institute or of any other institute or university.

**Adithya Vadlamani (13BCE0193)**

**Ajit Kumar Neelam (13BCE0480)**

**K.J. Sai Krishna (13BCE0199)**

# School of Computer Science and Engineering

## CERTIFICATE

The project report entitled "**A Modern Healthcare Monitoring System based on IoT using a network of Body Sensors**" is prepared and submitted by **Adithya Vadlamani (13BCE0193), Ajit Kumar Neelam (13BCE0480) and K.J. Sai Krishna (13BCE0199).** It has been found satisfactory in terms of scope, quality and presentation as partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology in Computer Science and Engineering** in VIT University, India.

**Guide**
**(Name & Signature)**

**Internal Examiner**
**(Name & Signature)**

**External Examiner**
**(Name & Signature)**

# ACKNOWLEDGEMENT

We, Adithya Vadlamani (13BCE0193), Ajit Kumar Neelam (13BCE0480) and K.J Sai Krishna (13BCE0199) are highly grateful to our final year project guide Prof. Anbarasi M., Sr. Assistant Professor for her constant motivation, guidance, and lessons during our whole period of the project. She has been a constant support throughout. Her lessons and teachings have helped us improve our basic knowledge about missing data. We would not have been able to produce an efficient report for our project if it was not under his guidance. We are highly obliged to have undertaken a project under such knowledgeable mentors. Without the support and cooperation of Dr. Senthil Kumar R. (Head of Department), this in-house project would not have been possible. We would like to extend our gratitude to Prof. Arun Kumar T. (Dean, SCOPE) for allowing us to do this project. We would also like to thank VIT University, Vellore for giving us such a platform to undergo this final year project. Our experience was highly knowledgeable, beneficial and interesting and We look forward to more opportunities of such kind.

Place : Vellore

Date :

# CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

# LIST OF ABBREVIATIONS

| Abbreviation | Expansion |
|---|---|
| IoT | Internet of Things |
| RAM | Random Access Memory |
| LCD | Liquid Crystal Display |
| LED | Light Emitting Diode |
| DC | Direct Current |
| PHP | Hypertext Preprocessor |

# ABSTRACT

This project presents the usage of IoT technologies, brings convenience of physicians and patients since they are applied to various medical areas such as real-time monitoring, patient information management, and healthcare management. The body sensor network technology is one of the core technologies of IoT developments in healthcare system, where a patient can be monitored using a collection of tiny-powered and lightweight wireless sensor nodes.

Advances in information and communication technologies have led to the emergence of Internet of Things (IoT). In the modern health care environment, the usage of IoT technologies brings convenience of physicians and patients since they are applied to various medical areas (such as real-time monitoring, patient information management, and healthcare management). The body sensor network technology is one of the core technologies of IoT developments in healthcare system, where a patient can be monitored using a collection of tiny-powered and lightweight wireless sensor nodes. However, development of this new technology in healthcare applications without considering security makes patient privacy vulnerable. In this project, we design an IoT based healthcare system using BSN, which can efficiently accomplish those requirements.

Body Sensor Network (BSN) allows the integration of intelligent, miniaturized low-power sensor nodes in, on or around human body to monitor body functions and the surrounding environment. It has great potential to revolutionize the future of healthcare technology and attained several researchers both from the academia and industry in the past few years.

# 1. INTRODUCTION

## 1.1 THEORITICAL BACKGROUND

Advances in information and communication technologies have led to the emergence of Internet of Things (IoT). In the modern health care environment, the usage of IoT technologies brings convenience of physicians and patients, since they are applied to various medical areas (such as real-time monitoring, patient information management, and healthcare management). The body sensor network (BSN) technology is one of the core technologies of IoT developments in healthcare system, where a patient can be monitored using a collection of tiny-powered and lightweight wireless sensor nodes. However, the development of this new technology in healthcare applications without considering security makes patient privacy vulnerable. In this paper, at first, we highlight the major security requirements in BSN-based modern healthcare system. Subsequently, we propose a secure IoT-based healthcare system using BSN, called BSN-Care, which can efficiently accomplish those requirements.

## 1.2 MOTIVATION

The motivation behind proposing this system is the existing system having many drawbacks which can only be solved by developing an efficient system for combating the issues/drawbacks found in the existing system. The existing system involves no Self Healthcare monitoring and management system and also the method for taking time to hospitals is energy and time consuming. Besides, there is no RFID technology is used in healthcare systems

The various drawbacks involve issues such as the efficiency of the system in producing proper results required for the patient and for the doctor to examine them properly such as increase of manual work which again increases the man power and also a very time consuming process.

## 1.3 OBJECTIVE OF THE PROPOSED WORK

The main objective this project is to monitor the state of health of patients and provide information in real time to doctors who assist for security purpose. Similarly, also the readings that do permanently to patients reports, doctors recommend also workout routines that allow them to improve the quality of life and overcome such diseases. The internet of things applied to the care and monitoring of patients is increasingly common in the health sector, seeking to improve the quality of life of people.

## 1.4 AIM OF THE PROPOSED WORK

In Today's modern world, People in Rural areas and in remote places like Hilly areas etc. do not have access to high-level sophisticated modern healthcare equipment. Most highly-qualified Doctors and Physicians are looking to work and settle in High-tech Metro cities like Mumbai, Chennai, Delhi, Hyderabad etc. This makes for the people in Rural and remote areas, very difficult to access them in case of any emergency.

So, using different modern technological developments like IoT, Sensors, Mobile transmission etc. we are developing a modern healthcare monitoring system through which any patient can be monitored remotely by physicians or Doctors without actually physically being present near the patient.

# 2. LITERATURE REVIEW

With the intention of achieving a broad standpoint, we explored widely in internet sources. The databases sheltered are:

- ACM Digital Library (<portal.acm.org>)
- IEEE eXplore (<ieeexplore.ieee.org>)
- Springer LNCS (<www.springer.com/Incs>)
- Google Scholar
- Inspec (<www.theiet.org/publishing/inspec/>)

These databases shelter the most pertinent journals and conference & workshop proceedings.

## 2.1 SURVEY OF THE EXISTING MODELS

In [1], the Body Sensor Network has been introduced and explained. Also, the potential use of it in Medical Healthcare system has also been mentioned.

In [2], a design of Fuzzy Logic controller has been discussed to read such data received from sensors which is imprecise or crisp. The FLC system receives context information from sensor as input (which is in crisp form) and the fuzzification module converts input into fuzzy linguistic variable and output is sent to Patient / Doctor which can be easily understood by common person.

The paper [3] presents a remote measuring and monitoring system for ECG, lung functioning (spirometer), heart rate and temperature signals. Use of ZigBee, radio frequency (RF) trans-receiver circuits for Healthcare is discussed.

In [4], an adaptive load control algorithm for ZigBee-based WBAN/WiFi coexistence environments has been proposed, with the aim of guaranteeing that the delay experienced by ZigBee sensors does not exceed a maximally tolerable period of time.

In [5], A critical evaluation of the existing literature, which discusses the effective ways to deploy IoT in the field of medical and smart health care has been done. Also, a model providing a platform for accessing patients' health data using smart phones has been proposed.

In [6], CodeBlue, a wireless infrastructure intended for deployment in emergency medical care, integrating low-power, wireless vital sign sensors, PDAs, and PC-class systems was introduced. It will enhance first responders' ability to assess patients on scene, ensure seamless transfer of data among caregivers, and facilitate efficient allocation of hospital resources. We use this technology's architecture as a reference in our project as this infrastructure will support reliable, data delivery, a flexible naming and discovery scheme, and a decentralized security model.

In [7], it has been envisioned that a common protocol and software framework could integrate devices such as wearable vital sign sensors, handheld computers, and location tracking tags into disaster response scenarios. Thr CodeBlue architecture is being proposed as the suitable one for achieving the above stated objective in Medical field.

The aim of the paper [8] is to address issues related to using wearable or implantable sensors for distributed mobile monitoring. A ubiquitous monitoring system is presented for continuous monitoring of patients under their natural physiological states. It provides the architecture for collecting, gathering and analyzing data from several biosensors.

In [9], they have introduced MEDiSN, a wireless sensor network for monitoring patients' physiological data in hospitals and during disaster events.

In paper [10] a lightweight, secure, and an expeditious authentication scheme has been proposed, which can preserve the user anonymity using low-cost cryptographic primitives such as one-way hash functions and EXCLUSIVE-OR operations, which are most suitable for battery-powered mobile devices.

## 2.2 GAPS IDENTIFIED IN THE SURVEY

### 2.2.1 EXISTING SYSTEM

An existing system a wireless health monitoring system using zigBee technology. It has the capability to monitor vital signals from multiple biosensors. Biomedical signals are collected and processed using 2-tiered subsystems. The first stage is the mobile device carried on the body that runs a number of biosensors (internal subsystem). At the second stage, further processing is performed by a local base station (external subsystem) using the raw data transmitted on-request by the mobile device. The raw data is also stored at this base station. The processed data as well as the analysis results are then monitored and diagnosed through a human-machine interface.

### 2.2.2 DISADVANTAGES

- In existing system, security issues were a major drawback.

- Due to this lack of security, some patient's vital information is lost.
- It leads to the vulnerability of the patient privacy.
- To overcome these problems, some proposed techniques are handled to maintain the data security.

# 3. OVERVIEW OF PROPOSED SYSTEM

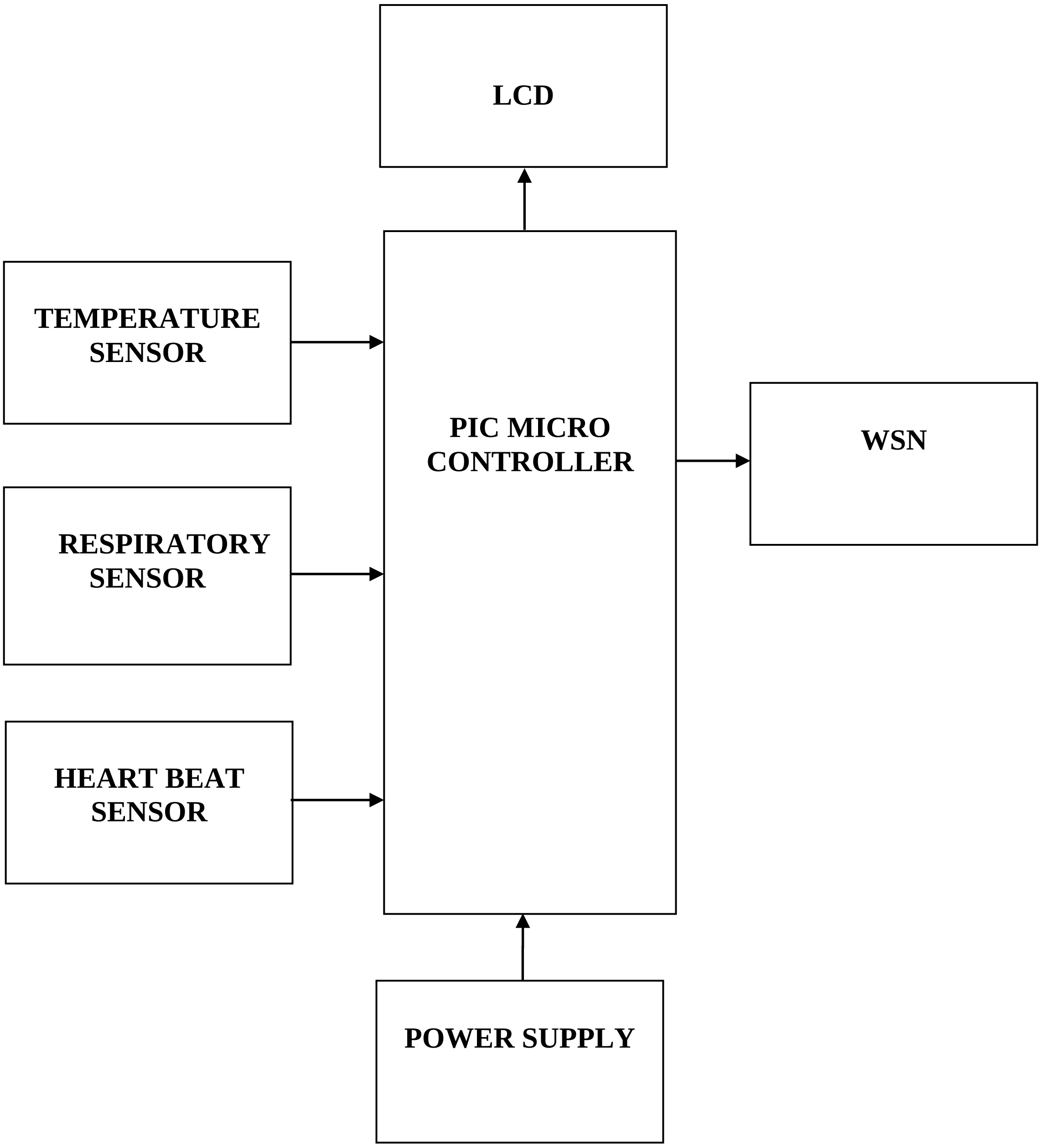
## 3.1 INTRODUCTION

The proposed system body sensor network (BSN) technology is one of the core technologies of IoT developments in healthcare system, where a patient can be monitored using a collection of tiny-powered and lightweight wireless sensor nodes. However, the development of this new technology in healthcare applications without considering security makes patient privacy vulnerable. In this paper, at first, we highlight the major security requirements in BSN-based modern healthcare system. The internet of things applied to the care and monitoring of patients is increasingly common in the health sector, seeking to improve the quality of life of people.

### 3.1.1 ADVANTAGES

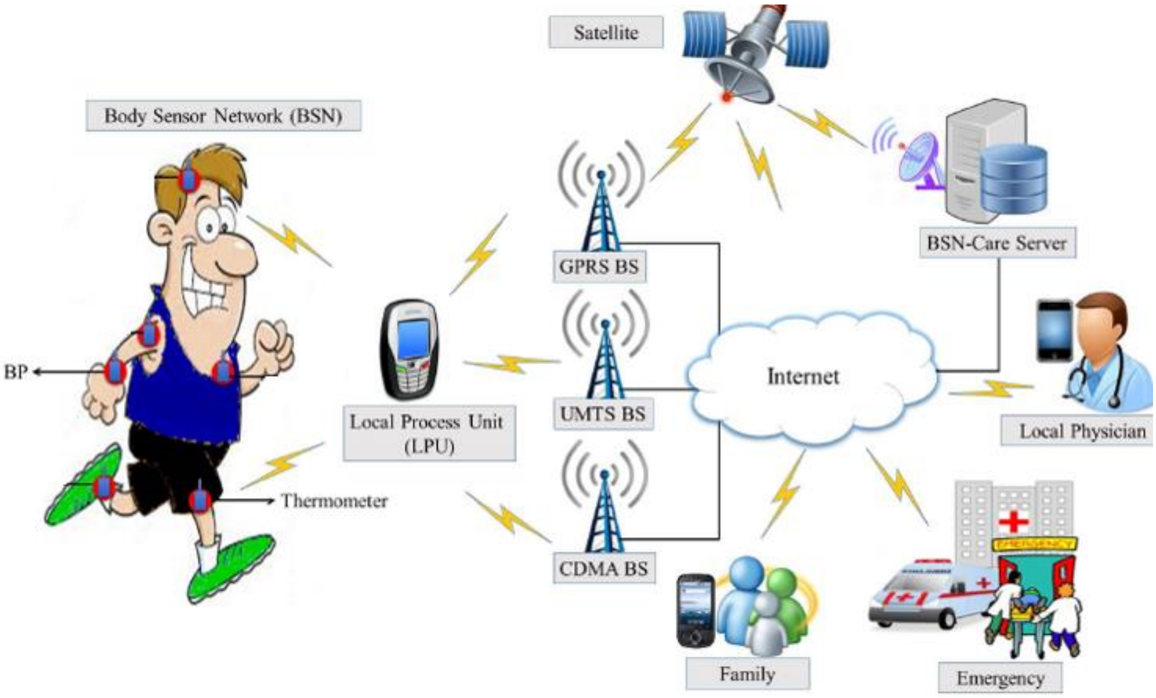
- The proposed system consists of major security requirements in BSN based modern healthcare system.
- A secure IoT based healthcare system using BSN, called BSN-Care, which can efficiently accomplish security requirements were proposed.
- The main advantage of this system is to protect the patient's records by maintaining the data integrity and authentication.

## 3.2 SYSTEM DESIGN




**Functional block diagram**

### 3.3 PROPOSED SYSTEM MODEL




**Framework Diagram, Modules of the Proposed System**

## 4. PROPOSED SYSTEM ANALYSIS AND DESIGN

### 4.1 Introduction

Requirements analysis is the method of determining the expectations of user for a new product. These features called requirements, must be assessable, relevant and detailed. In software engineering, such requirements are called functional specifications. Requirements analysis is a significant aspect of project management. Requirements analysis comprises frequent communication with the product users to determine specific feature expectations, resolution of conflict or ambiguity in requirements as required by the various users or groups of users

### 4.2 Requirement Analysis

### 4.2.1 Functional Requirements for the Project:

Functional requirements define the main function of the system or its components. A function is described as a set of inputs, behavior, and outputs.

Functional requirements could be data manipulation or processing or other specific functionality that state what a particular system is supposed to accomplish.

### 4.2.1.1 Product Perspective

The main objective this project is to monitor the state of health of patients and provide information in real time to doctors who assist for security purpose. Similar to the readings The main objective this project is to monitor the state of health of patients and provide information in real time to doctors who assist for security purpose. Similarly, also the readings that do permanently to patients reports, doctors recommend also workout routines that allow them to improve the quality of life and overcome such diseases. The internet of things applied to the care and monitoring of patients is increasingly common in the health sector, seeking to improve the quality of life of people that do permanently to patients reports, doctors recommend also workout routines that allow them to improve the quality of life and overcome such diseases. The internet of things applied to the care and monitoring of patients is increasingly common in the health sector, seeking to improve the quality of life of people.

### 4.2.1.2 Assumptions and Dependencies

**Assumptions**

- ❖ This device can detect the heart-beat of a particular person when connected.
- ❖ This can tell the blood pressure of the individual.
- ❖ The body temperature of an individual can be noted and verified.
- ❖ Required anti-biotics can be given for the particular when we know the particular disease is found out.

**Dependencies**

- ❖ The care taker of the patient of that patient need to perform those tests effectively in order for the doctor to provide the correct prescription.
- ❖ Any error in the values may lead to the improper medication.

### 4.2.1.3 Domain Requirements

(A) Hardware Requirements

- PIC16F877A
- Temperature Sensor
- Respiratory Sensor
- Heart Beat Sensor
- IOT Board
- ZIGBEE
- LCD

(B) Software Requirements

- MPLAB IDE
- EMBEDDED C
- VB

### 4.2.2 Non-Functional Requirements for the Project:

- **Usability:**

  The system developed can be accessed in ease which defines usability. The process involves the connecting of the available sensors to the body and the abnormality in the values is immediately notified by the device connected to the system.

- **Reliability:**

  Our system correctly delivers the services as expected by the user. The reliability of the system is good as it delivers the expected output by the users. Unexpected output may be produced in the cases of poor reliability. Our system acts according to the situation and can be modified according to the situation.

- **Availability:**

  The current developed system is available to be used at any time of requirement. Availability of a system is typically measured as a factor of its reliability. Both the factors are directly proportional to each other. The sensors in our system can always be connected to the patients and can be constantly monitored by the caretakers. So the system can be used whenever and wherever needed.

- **Security:**

  The system can be used only by the authorized personnel. The data of the patient is secured from unauthorized access. Also the data transferred is secured from corrupting and necessary steps are taken to back up the old data of the patient as the old medical records of a patient are very important.

- **Scalability:**

  Scalability refers to capability of a system to handle the work load of the system and work with varying amounts of users and data. The present system also works with any other sensors connected other than the mentioned ones and can handle the data from these sensors and safely transfers the data to the connected device.

- **Integrity:**

  The data of the patient is always backed up as the old records are very crucial for a patient. Even in case of the system failure, necessary precautions are taken for the information of the patient to be transferred and backed up. Integrity refers to the ability of the system to preserve important data and information in case of system failure.

- **Usefulness:**

  The system is used for a patient who needs to be constantly monitored. Even in cases of emergency, the patients abnormal condition will be intimidated to the doctors.

- **Performance:**

  The performance of the system can be tested with measuring the response time, speed and throughput. An efficient system would have short response time, high throughput which indicates more speed. Our desired system would be quick in processing the data and transfer it to the device. The rate of processing is very high which indicates a good performance of our system.

- **Efficiency:**

  The efficiency of the developed system is high as there is minimal effort in gathering and transferring data to the device. The data of the patient transferred would be accurate and exact.

- **Configuration:**

  The present developed system is convenient in connecting to another device and transferring the patient information to that device. The sensors of the system can be modified and new sensors could be connected. The hardware and the software components of the system could be modified at any time without disturbing the systems performance and efficiency.

- **Portability:**

  Portability is a key factor for developing cost reduction. The current developed system has the ability to connect to different devices based on which the required information is transferred. Any platform can be used to connect to the system and the data from the sensors can be transferred.

- **Maintainability:**

  When the system is being used, new health issues may emerge. Our system is changeable to accommodate these new requirements and to add other type of sensors for maintaining the usefulness of the system. There is no need for developing another system even with new requirements emerging as the current developed system is maintainable.

- **Supportability:**

  Supportability refers to the ability of user to configure and monitor the system defects if any and to debug and restore the system to normal. Our system maintains the pursuit of maintaining supportability and this helps in maintaining more efficiency and reducing of operational costs.

### 4.2.3 Engineering Standard Requirements

Being an engineer, it is our responsibility to contribute to the society. Instead of just taking from the environment, we should return the same adding something extra to it. So, our product follows all the engineering standard requirements which a product should have and should be verified before its launch.

- **Economic**

The components like the sensors, microcontroller etc. cost low. Also, the softwares used in this project are all open-source. Ultimately, the implementation of this project will reduce the expenditure of the user.

- **Environmental**

The project is very ecofriendly. It aims at improving medical outreach to remote and rural areas. This will improve the quality of life and life expectancy of people and thus will benefit the environment in a better way.

- **Social**

As mentioned earlier, we understand our responsibility and for the same cause, our product also follows all the socio-economic norms that every product should agree with. We are trying to make our society a better place to live in by providing solution to the common problems. We are aware of and trying to bring changes across the globe.

- **Political**

As mentioned earlier, our product can be used by the government by installing our system at places to inspect for suitable conditions. This makes our system totally available for the public use allotted by the government.

- **Ethical**

It follows all the ethical norms and none of the human values are violated by the product. Being an IoT product, it serves the purpose of following the dream of smart cities in India. Once our product reaches mass production, it will surely solve many issues.

- **Health and Safety**

Since we are not using any explosive or faulty hardware, product is totally safe and risk-free to use. Similarly, the software is also risk-free and hardly ever faces any attack. Whereas, it will be adding its remarkable value to the world of health and safety.

- **Sustainability**

Since the system is robust and scalable also, it is by itself sustainable. It will always have scope of improvement which makes it even more sustainable. The module provides very user-friendly interface and does not need extra training for usage.

- **Legality**

No illegal work is done in the making of the product and the usage too is purely legal. So, it follows the legality engineering standard requirement.

- **Inspect-ability**

The product is inspect-able as it does not involve any difficult features. The database is also very easy to maintain and the hardware too is very easy to detect. The software code embedded in it is also low in complexity, making it easy to debug and detect faults.

## 4.2.4 SYSTEM REQUIREMENTS

### 4.2.4.1 HARDWARE REQUIREMENTS

- PIC16F877A
- TEMPERATURE SENSOR
- RESPIRATORY SENSOR
- HEART BEAT SENSOR
- IOT BOARD
- LCD

### 4.2.4.2 SOFTWARE REQUIREMENTS

- MPLAB IDE
- EMBEDDED C
- VB

## MICROCONTROLLER

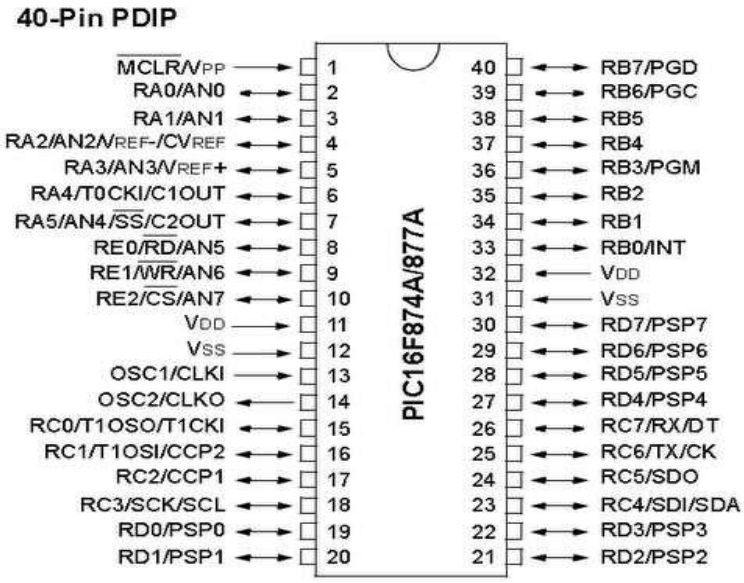
PIC 16F877A is one of the most advanced microcontroller from Microchip. This controller is widely used for experimental and modern applications because of its low price, wide range of applications, high quality, and ease of availability. It is ideal for applications such as machine control applications, measurement devices, study purpose, and so on. The PIC 16F877A features all the components which modern microcontrollers normally have. The figure of a PIC16F877A chip is shown below.

**PIC 16F877A**

The PIC16FXX series has more advanced and developed features when compared to its previous series. The important features of PIC16F877A series is given below.

## FEATURES

- High performance RISC CPU, only 35 simple word instructions.
- All single cycle instructions except for program branches which are two cycles.
- Operating speed: clock input (200MHz), instruction cycle (200nS).
- Up to 368×8bit of RAM (data memory), 256×8 of EEPROM (data memory), 8k×14 of flash memory.
- Pin out compatible to PIC 16C74B, PIC 16C76, PIC 16C77.
- Interrupt capability (up to 14 sources).
- Different types of addressing modes (direct, Indirect, relative addressing modes.




**PIN DIAGRAM**

PIC16F877A chip is available in different types of packages. As per the type of applications and usage, these packages are differentiated. The pin diagram of a PIC16F877A chip in different packages is shown in the figure above.

## INPUT/ OUTPUT PORT

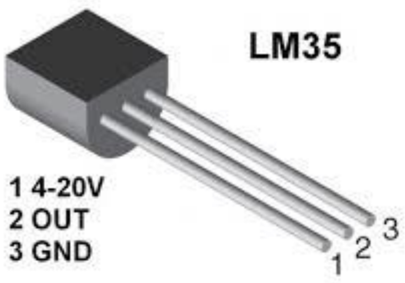
PIC16F877A has 5 basic input/output ports. They are usually denoted by PORT A (RA), PORT B (RB), PORT C (RC), PORT D (RD), and PORT E (RE). These ports are used for input/ output interfacing. In this controller, “PORT A” is only 6 bits wide (RA-0 to RA-7), “PORT B”, “PORT C”, “PORT D” are only 8 bits wide (RB-0 to RB-7, RC-0 to RC-7, RD-0 to RD-7), “PORT E” has only 3 bit wide (RE-0 to RE-7). All these ports are bi-directional. The direction of the port is controlled by using TRIS(X) registers (TRIS A used to set the direction of PORT-A, TRIS B used to set the direction for PORT-B, etc.).

| | | |
|---|---|---|
| PORT A | RA-0 to RA-5 | 6 Bit wide |
| PORT B | RB-0 to RB-7 | 8Bit wide |
| PORT C | RC-0 to RC-7 | 8 Bit wide |
| PORT D | RD-0 to RD-7 | 8 Bit wide |
| PORT E | RE-0 to RE-7 | 3 Bit wide |

**Input/output Port**

## TEMPERATURE SENSOR

A temperature sensor is a device, typically, a thermocouple or RTD, that provides for temperature measurement through an electrical signal. A thermocouple (T/C) is made from two dissimilar metals that generate electrical voltage in direct proportion to changes in temperature.




**LM35 Temperature sensor**

A thermocouple is made from two dissimilar metal wires. The wires are joined together at one end to form a measuring (hot) junction. The other end, known as the reference (cold) junction, is connected across an electronic measurement device (controller or digital indicator). A thermocouple will generate a measurement signal not in response to actual temperature, but in response to a difference in temperature between the measuring and reference junctions. A small ambient temperature sensor is built into the electronic measuring device near the point where the reference junction is attached. The ambient temperature is then added to the thermocouple differential temperature by the measuring device to determine and display the actual measured temperature.

Only two wires are necessary to connect a thermocouple to an electrical circuit; however, these connecting wires must be made from the same metals as the thermocouple itself. Adding wire made from other materials (such as common copper wire) will create new measuring junctions that will result in incorrect readings.

## THERMOCOUPLE

These sensors depend on differences in charge mobility in two dissimilar metals to produce a potential difference. The developed potentials are small, but measurable. Thermocouples are rugged, and tolerate a wide range of temperatures, but they have many drawbacks, including low signal levels, long-term stability, and noise. Their response time tends to be very slow, but this often results from the packaging more than the device physics.

The measurement is in fact temperature difference, not an absolute temperature level, so a supplementary measurement is required to establish the reference temperature. The resulting temperature correction is called cold junction compensation. Despite their limitations, thermocouples are used with success

Thermocouple Example Thermocouple Calibration Cold Junction Compensation in a variety of applications. You can obtain moderate accuracy using standard device curves with no calibration. Careful calibration can improve accuracy to within a degree C or so.

## RESPIRATORY SENSOR

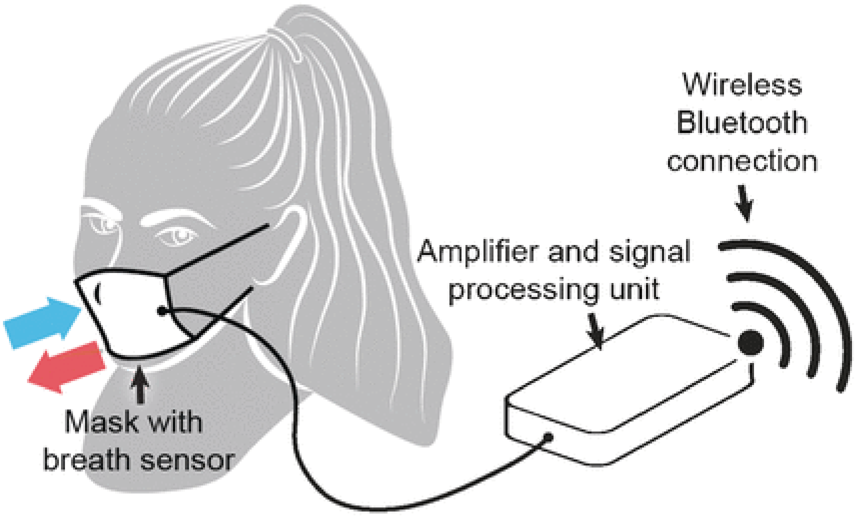
Breathing (which in organisms with lungs is called ventilation and includes inhalation and exhalation) is a part of respiration. The rate at which breaths occur, usually measured in breaths per minute, is called the ventilation rate, or, by long-standing convention, the respiratory rate. Monitoring a patient's respiratory status usually takes place in a hospital setting and may be the primary purpose for a patient being observed or admitted to a medical setting.

The physical signs of respiratory distress may present as a patient appearing short of breath, having an increased work of breathing, use of their accessory muscles, and changes in skin color, general pallor, or partial or complete loss of consciousness.

When the initial efforts of respiratory monitoring show evidence of a patient's inability to adequately oxygenate their blood, the patient may require mechanical ventilation.

## MEASUREMENT

Human respiration rate is measured when a person is at rest and involves counting the number of breaths for one minute by counting how many times the chest rises. An optical breath rate sensor can be used for monitoring patients during a magnetic resonance imaging scan.[1] Respiration rates may increase with fever, illness, or other medical conditions. When checking respiration, it is important to also note whether a person has any difficulty breathing




## Respiratory sensor

Inaccuracies in respiratory measurement have been reported in the literature. One study compared respiratory rate counted using a 90-second count period, to a full minute, and found significant differences in the rates. Another study found that rapid respiratory rates in babies, counted using a stethoscope, were 60–80% higher[11]. than those counted from beside the cot without the aid of the stethoscope. Similar results are seen with animals when they are being handled and not being handled the invasiveness of touch apparently is enough to make significant changes in breathing.

Various other methods to measure respiratory rate are commonly used, including impedance pneumographic, and capnography which are commonly implemented in patient monitoring. In addition, novel techniques for automatically monitoring respiratory rate using wearable sensors are in development.

## NORMAL RANGE

The typical respiratory rate for a healthy adult at rest is 12–20 breaths per minute.

Average resting respiratory rates by age are:

- birth to 6 weeks: 30–40 breaths per minute
- 6 months: 25–40 breaths per minute
- 3 years: 20–30 breaths per minute
- 6 years: 18–25 breaths per minute
- 10 years: 17–23 breaths per minute
- Adults: 12-18-breaths per minute
- Elderly ≥ 65 years old: 12-28 breaths per minute.
- Elderly ≥ 80 years old: 10-30 breaths per minute.

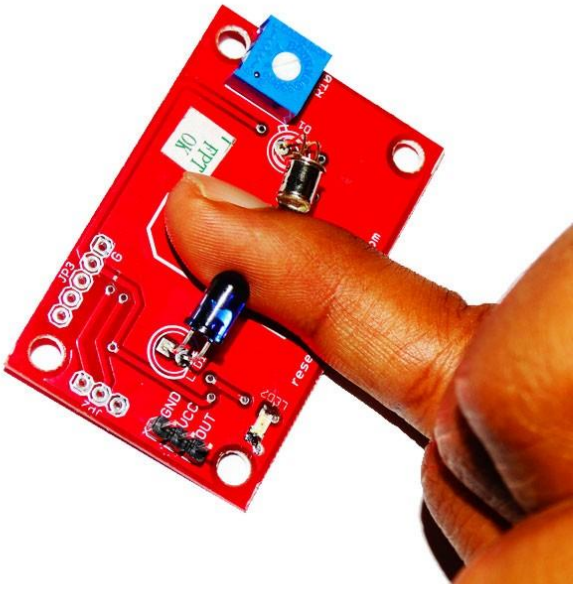
## DIAGNOSTIC VALUE

The value of respiratory rate as an indicator of potential respiratory dysfunction has been investigated but findings suggest it is of limited value. One study found that only 33% of people presenting to an emergency department with an oxygen saturation below 90% had an increased respiratory rate. An evaluation of respiratory rate for the differentiation of the severity of illness in babies under 6 months found it not to be very useful. Approximately half of the babies had a respiratory rate above 50 breaths per minute, thereby questioning the value of having a "cut-off" at 50 breaths per minute as the indicator of serious respiratory illness.

It has also been reported that factors such as crying, sleeping, agitation and age have a significant influence on the respiratory rate. Because of these and similar studies the value of respiratory rate as an indicator of serious illness is limited.

## HEART BEAT SENSOR

The heartbeat sensor is based on the principle of photo plethysmography. It measures the change in volume of blood through any organ of the body which causes a change in the light intensity through that organ (a vascular region). In case of applications where heart pulse rate is to be monitored, the timing of the pulses is more important. The flow of blood volume is decided by the rate of heart pulses and since light is absorbed by blood, the signal pulses are equivalent to the heart beat pulses.




**Heart Beat Sensor**

The heart is one of the most vital organs within the human body. It acts as a pump that circulates oxygen and nutrient carrying blood around the body to keep it functioning. The circulated blood also removes waste products generated from the body to the kidneys. When the body is exerted the rate at which the heart beats will vary proportional to the amount of effort being exerted. By detecting the voltage created by the beating of the heart, its rate can be easily observed and used for several health purposes.

An electrocardiogram (ECG) is a graphical trace of the voltage produced by the heart. A sample trace of a typical ECG output for a single beat is shown below. There are 5 identifiable features in an ECG trace which corresponds to different polarization stages that makes up a heartbeat. These deflections are denoted by the letters P, Q, R, S and T.

By detecting the R peaks and measuring the time between them the heart rate can be calculated and then displayed. A person's heart rate before, during and after exercise is the main indicator of their fitness. Measuring this manually requires a person to stop the activity they are doing to count the number of heart beats over a period. Measuring the heart rate using an electrical circuit can be done much quicker and more accurately.

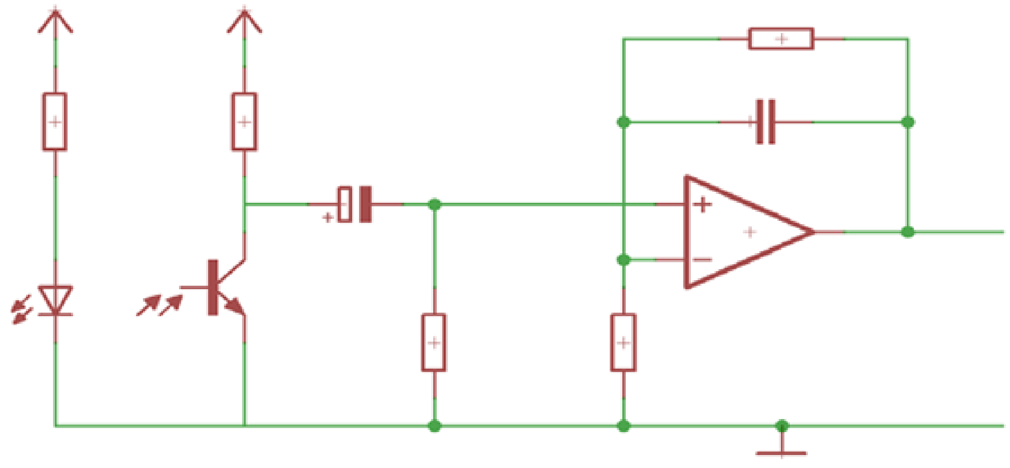
There are two types of photo-plethysmography:

**Transmission**: Light emitted from the light emitting device is transmitted through any vascular region of the body like earlobe and received by the detector.

**Reflection**: Light emitted from the light emitting device is reflected by the regions.

## WORKING

The basic heartbeat sensor consists of a light emitting diode and a detector like a light detecting resistor or a photodiode. The heart beat pulses cause a variation in the flow of blood to different regions of the body. When a tissue is illuminated with the light source, i.e. light emitted by the led, it either reflects (a finger tissue) or transmits the light (earlobe). Some of the light is absorbed by the blood and the transmitted or the reflected light is received by the light detector. The amount of light absorbed depends on the blood volume in that tissue. The detector output is in form of electrical signal and is proportional to the heart beat rate. This signal is in fact a DC signal relating to the tissues and the blood volume and the AC component synchronous with the heart beat and caused by pulsatile changes in arterial blood volume is superimposed on the DC signal. Thus, the major requirement is to isolate that AC component as it is of prime importance.



**Circuit Diagram**

To achieve the task of getting the AC signal, the output from the detector is first filtered using a 2 stage HP-LP circuit and is then converted to digital pulses using a comparator circuit or using simple ADC. The digital pulses are given to a microcontroller for calculating the heat beat rate, given by the formula-

BPM (Beats per minute) = 60*f

## FEATURES

- Microcontroller based SMD design
- Heat beat indication by LED
- Instant output digital signal for directly connecting to microcontroller
- Compact Size
- Working Voltage +5V D
- Low power consumption
- Wide power supply range: DC 3~5V
- work current 6~7mA

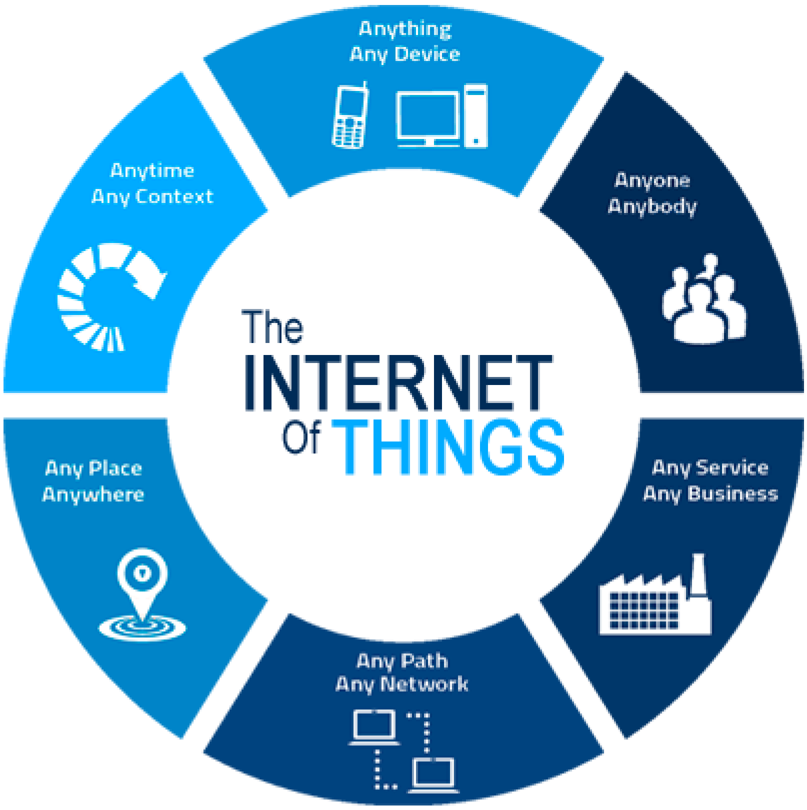
- Easy to use
- High sensitivity
- Length of ear clip wire:120 CM

## APPLICATIONS

- Digital Heart Rate monitor
- Patient Monitoring System
- Bio-Feedback control of robotics and applications

## INTERNET OF THING (IoT)

The Internet of Things (IoT) is the network of physical objects—devices, vehicles, buildings and other items embedded with electronics, software, sensors, and network connectivity that enables these objects to collect and exchange data.




**IoT Concept**

"Things" in the IoT sense, can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, electric clams in coastal waters, automobiles with built-in sensors, DNA analysis devices for environmental/food/pathogen monitoring or field operation devices that assist fire fighters in search and rescue operations. Legal scholars suggest to look at "Things" as an "inextricable mixture of hardware, software, data and service". These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices. Current market examples include home automation (also known as smart home devices) such as the control and automation of lighting, heating (like smart thermostat), ventilation, air conditioning (HVAC) systems, and appliances such as washer/dryers, robotic vacuums, air purifiers, ovens or refrigerators/freezers that use Wi-Fi for remote monitoring.

## APPLICATIONS

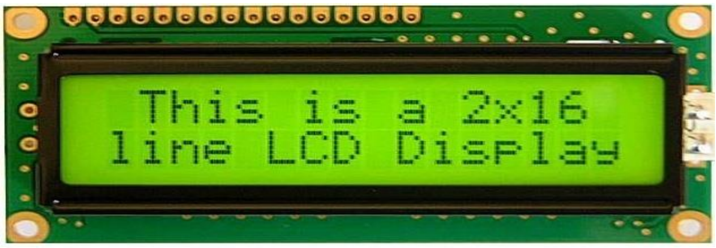
- Internet Of Things (IoT) Applications For Connected/Smart Home
- Internet Of Things (IoT) Applications For Wearables
- Internet Of Things (IoT) Applications In Retail
- Internet Of Things (IoT) Applications For Smart Cities
- Internet Of Things (IoT) Applications In Healthcare
- Internet Of Things (IoT) Applications In Agriculture
- Internet of Things (IoT) Applications in Automotive/Transportation
- Internet Of Things (IoT) Applications For Industrial Automation
- Internet Of Things (IoT) Applications Energy Management

## LCD [LIQIUD CRYSTAL DISPLAY]

It is one of the most common dot-matrix liquid crystal display (LCD) display controllers available. Hitachi developed the microcontroller specifically to drive alphanumeric LCD display with a simple interface that could be connected to a general-purpose microcontroller or microprocessor. Many manufacturers of displays integrated the controller with their product making it the informal standard for this type of display. The device can display ASCII characters, Japanese Kana characters, and some symbols in two 28 character lines. Using an extension driver, the device can display up to 80 characters. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD, each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD.

When a voltage is applied across the electrodes, a torque acts to align the liquid crystal molecules parallel to the electric field, distorting the helical structure (this is resisted by elastic forces since the molecules are constrained at the surfaces). This reduces the rotation of the polarization of the incident light, and the device appears gray. If the applied voltage is large enough, the liquid crystal molecules in the center of the layer are almost completely untwisted and the polarization of the incident light is not rotated as it passes through the liquid crystal layer. This light will then be mainly polarized perpendicular to the second filter, and thus be blocked and the pixel will appear black. By controlling the voltage applied across the liquid crystal layer in each pixel, light can be allowed to pass through in varying amounts thus constituting different levels of gray.




LCD DISPLAY

**FEATURES**

- High contrast lcd supertwist display.
- Ea. dip162-dnled: yellow/green with led backlight.
- Ea. dip162-dn3lw and dip162j-dn3lw with white led b/l., low power.
- Incl. hd 44780 or compatible controller.
- Interface for 4- and 8-bit data bus.
- Power supply +5v or ±2.7v or ±3.3v.
- Led backlight y/g max. 150ma@+25°c.
- Led backlight white max. 45ma@+25°c.
- Some more modules with same mechanic and same pin out.
- Dot-matrix 1x8, 4x20.
- Graphic 122x32.

### 4.2.4.2 SOFTWARE REQUIREMENTS

- MPLAB IDE
- Embedded C
- PC with .NET and PHP

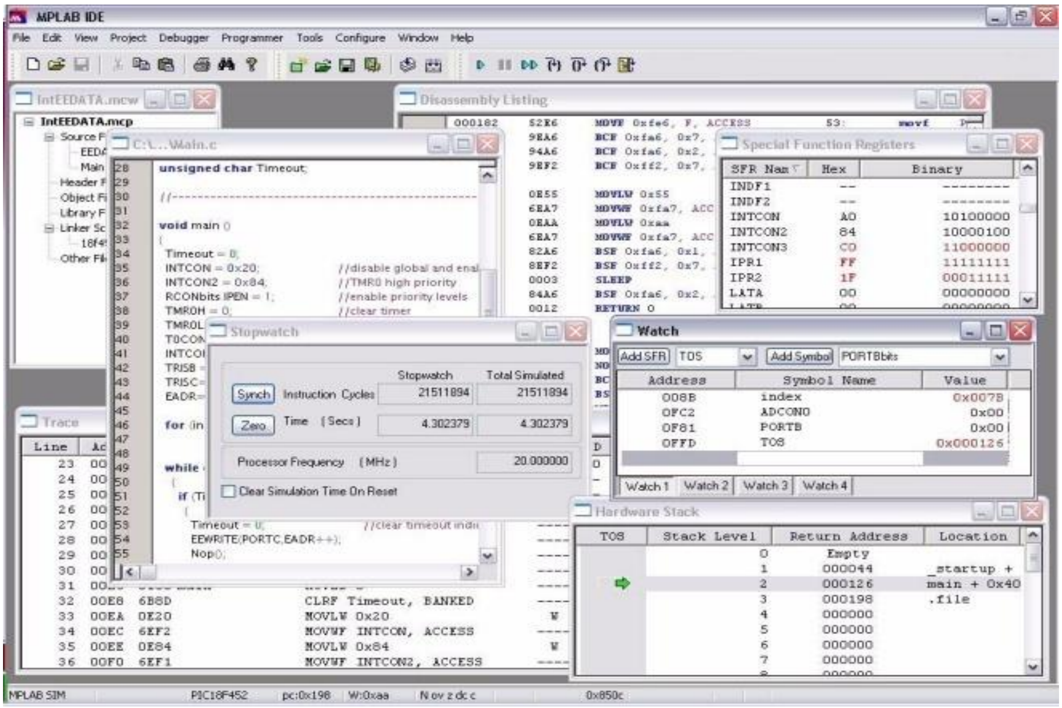
**MPLAB IDE**

The current version of MPLAB IDE is version X. MPLAB IDE v8.92 which was released in June 2017 was the last MPLAB 8 version that contains new device support. It is a 32-bit application on Microsoft Windows and includes several free software components for application development, hardware emulation and debugging. MPLAB IDE also serves as a single, unified graphical user interface for additional Microchip and third-party software and hardware development tools. Both Assembly and C programming languages can be used with MPLAB IDE v8. Others may be supported using third-party programs. Support for MPLAB IDE, along with sample code, tutorials, and drivers can be found on Microchip's website. MPLAB IDE v8 does not support Linux, UNIX or Macintosh operating systems.

## MPLAB X IDE

MPLAB Integrated Development Environment (IDE) is a free, integrated toolset for the development of embedded applications employing Microchip's PIC® and dsPIC® microcontrollers. MPLAB IDE runs as a 32-bit application on MS Windows®, is easy to use and includes a host of free software components for fast application development and super-charged debugging. MPLAB IDE also serves as a single, unified graphical user interface for additional Microchip and third party software and hardware development tools. Moving between tools is a snap, and upgrading from the free software simulator to hardware debug and programming tools is done in a flash because MPLAB IDE has the same user interface for all tools.

Download MPLAB IDE and use the tutorial in the MPLAB IDE User's Guide at the bottom of this page to explore how easy it is to create an application. Write assembly code, build and assemble your project with MPLAB's wizards, then test your code with the built-in simulator and debugger. When you are ready to test your own application, select one of our low-cost debugger/programmers to program a device and analyze your hardware.



**MPLAB IDE**

Choose MPLAB C Compilers, the highly optimized compilers for the PIC18 series microcontrollers, high performance PIC24 MCUs, dsPIC digital signal controllers and PIC32MX MCUs. Or, use one of the many products from third party language tools vendors. Most integrate into MPLAB IDE to function transparently from the MPLAB project manager, editor and debugger.

## Embedded C:

Embedded C is a set of language extensions for the C Programming language by the C Committee which works on the standards based to check for the commonality issues that may be present in between the extensions of C language for the various different embedded systems. Satirically, embedded C programming language needs non-standard augmentations to the language C in a way to backing the peculiar values such as the fixed-point arithmetic, and basic Input output operations.

## PHP:

PHP is a scripting language but also used as a programming language.

**.NET:**

.NET provides user interaction, access to the data, connection to the database, cryptanalysis, pertinence evolution, numerical logics and networking of inter-communications Programmers produce software by combining their own code with .NET Framework and other various libraries. Microsoft also produces an IDE largely for .NET software called Visual Studio.

# 5. RESULTS AND DISCUSSIONS

## 5.1 Pseudo Code

```
#include <main.h>
#include <lcd.h>

#byte TXSTA=0X98
#byte RCSTA=0X18
#byte SPBRG=0X99
#byte TXREG=0X19
#bit  TXIF=0x0c.4

void clk();
void lcd_input(unsigned char input,int i);
void lcd_init();
void string(char *g);
void lcd_str(unsigned char str);
void lcd_putc(char value);

unsigned long int t;
unsigned long int t1;
unsigned long int r;
unsigned long int h;
```

```
char lh[4];


char ch[4];
char ch1[4];
char ch2[4];

int i;

int x=0;
int y=0;

int h1=60;
int h2=68;
int h3=69;
int h4=70;
int h5=75;
int h6=80;
int h7=85;
int h8=90;
int h9=95;
int h0=00;


char h11[3];
char h22[3];
char h33[3];
char h44[3];
char h55[3];
char h66[3];
char h77[3];
```

```
char h88[3];
char h99[3];
char h00[3];


void main()
{
     t_lcd=0;
     t_rs=0;
     t_en=0;
     t_rw=0;

       TXSTA=0X20;
       RCSTA=0X90;
       SPBRG=15;

       lcd_init();

      setup_adc(adc_clock_internal);
      setup_adc_ports(AN0_AN1_AN2_AN3_AN4);

     lcd_input(0x83,0);
     printf(lcd_putc,"%s","INTERNET");
     lcd_input(0xc2,0);
     printf(lcd_putc,"%s","OF THINGS");

     delay_ms(1000);

     lcd_input(0x01,0);

     lcd_input(0x82,0);
```

```
  printf(lcd_putc,"%s","HEALTH CARE");
  lcd_input(0xc5,0);
  printf(lcd_putc,"%s","SYSTEM");
  delay_ms(1000);

  lcd_input(0x01,0);

  lcd_input(0x80,0);
  printf(lcd_putc,"%s","TEMP");

  lcd_input(0x89,0);
  printf(lcd_putc,"%s","H.B");

  lcd_input(0xc0,0);
  printf(lcd_putc,"%s","RES.");

while(TRUE)
{

 st:

    y=0; x=0;

     set_adc_channel(0);
     t=read_adc();
     t1=t/3;
     sprintf(ch,"%02lu",t1);



     TXREG='T';
     while(TXIF==0);
```

```
delay_ms(100);
TXIF=0;

lcd_input(0x85,0);
for(i=0; i<2; i++)
 {
   TXREG=ch[i];
   while(TXIF==0);
   lcd_putc(ch[i]);
   delay_ms(500);
   TXIF=0;

 }



 delay_ms(1000);
////////////////////////////////////////////////////////////////////////////////

set_adc_channel(1);
r=read_adc();
sprintf(ch1,"%04lu",r);

TXREG='R';
while(TXIF==0);
delay_ms(100);
TXIF=0;



lcd_input(0xc5,0);

for(i=0; i<4; i++)
```

```
    {

      TXREG=ch1[i];
      while(TXIF==0);
      delay_ms(500);
      lcd_putc(ch1[i]);
      TXIF=0;
    }



   delay_ms(1000);
////////////////////////////////////////////////////////////////////////////////

  TXREG='H';
  while(TXIF==0);
  delay_ms(100);
  TXIF=0;

 lcd_input(0x8d,0);
 printf(lcd_putc,"%s","ST");
 delay_ms(1000);
 do{
  set_adc_channel(2);
  h=read_adc();
  sprintf(lh,"%04lu",h);
   if(h<=680)
     {
       y++;
     }
    x++;
   delay_ms(350);
```

```
}while(x<=20);

 lcd_input(0x8d,0);
 printf(lcd_putc,"%s","CD");
 delay_ms(1000);



lcd_input(0x8d,0);

if(y>=0 && y<=2)
   {
     sprintf(h00,"%02d",h0);
     for(i=0; i<2; i++)
       {
         TXREG=h00[i];
         while(TXIF==0);
         lcd_putc(h00[i]);
         delay_ms(100);
         TXIF=0;
       }
   }

if(y<=7 && y>=3)
{
   sprintf(h11,"%02d",h1);
   for(i=0; i<2; i++)
     {
       TXREG=h11[i];
       while(TXIF==0);
       lcd_putc(h11[i]);
```

```
          delay_ms(100);
          TXIF=0;
        }

      delay_ms(1000);

   }

 if(y==8)
   {
       sprintf(h11,"%02d",h1);
       for(i=0; i<2; i++)
        {
          TXREG=h11[i];
          while(TXIF==0);
          lcd_putc(h11[i]);
          delay_ms(100);
          TXIF=0;
        }
      delay_ms(1000);
   }



   if(y==9)
   {
       sprintf(h22,"%02d",h2);
       for(i=0; i<2; i++)
        {
          TXREG=h22[i];
          while(TXIF==0);
          lcd_putc(h22[i]);
```

```
        delay_ms(100);
        TXIF=0;
      }
    delay_ms(1000);
 }


if(y==10)
 {
     sprintf(h33,"%02d",h3);
     for(i=0; i<2; i++)
      {
        TXREG=h33[i];
        while(TXIF==0);
        lcd_putc(h33[i]);
        delay_ms(100);
        TXIF=0;
      }
    delay_ms(1000);
 }

if(y==11)
 {
     sprintf(h44,"%02d",h4);
     for(i=0; i<2; i++)
      {
        TXREG=h44[i];
        while(TXIF==0);
        lcd_putc(h44[i]);
        delay_ms(100);
        TXIF=0;
```

```
    }
  delay_ms(1000);
}

 if(y==12)
{
   sprintf(h55,"%02d",h5);
   for(i=0; i<2; i++)
    {
      TXREG=h55[i];
      while(TXIF==0);
      lcd_putc(h55[i]);
      delay_ms(100);
      TXIF=0;
    }
  delay_ms(1000);
}

 if(y==13)
{
   sprintf(h66,"%02d",h6);
   for(i=0; i<2; i++)
    {
      TXREG=h66[i];
      while(TXIF==0);
      lcd_putc(h66[i]);
      delay_ms(100);
      TXIF=0;
    }
  delay_ms(1000);
}
```

```
if(y==14)
 {
     sprintf(h77,"%02d",h7);
     for(i=0; i<2; i++)
      {
        TXREG=h77[i];
        while(TXIF==0);
        lcd_putc(h77[i]);
        delay_ms(100);
        TXIF=0;
      }
    delay_ms(1000);
 }

if(y==15)
 {
     sprintf(h88,"%02d",h8);
     for(i=0; i<2; i++)
      {
        TXREG=h88[i];
        while(TXIF==0);
        lcd_putc(h88[i]);
        delay_ms(100);
        TXIF=0;
      }
    delay_ms(1000);
 }

  if(y==16)
 {
```

```
    sprintf(h99,"%02d",h9);
    for(i=0; i<2; i++)
     {
       TXREG=h99[i];
       while(TXIF==0);
       lcd_putc(h99[i]);
       delay_ms(100);
       TXIF=0;
     }
   delay_ms(1000);
 }


if(y>=17)
  {

   sprintf(h99,"%02d",h9);
    for(i=0; i<2; i++)
     {
       TXREG=h99[i];
       while(TXIF==0);
       lcd_putc(h99[i]);
       delay_ms(100);
       TXIF=0;
     }

    delay_ms(1000);
  }



   TXREG=0X0a;
```

```
        while(TXIF==0);
        delay_ms(100);
        TXIF=0;

        TXREG=0X0D;
        while(TXIF==0);
        delay_ms(100);
        TXIF=0;
////////////////////////////////////////////////////////////////////////////////////


  }


}
```

## 5.2 Sample Test Cases

| | |
|---|---|
| Test Case ID | 1 |
| Test Engineer | Adithya Vadlamani |
| Product Module | Sensors |
| Testing Date | 27th April |
| Status | Working Correctly. |

Table 1.

| | |
|---|---|
| Sl. No. | 1 |
| Purpose | Testing of Temperature sensor with respect to the surroundings during day |
| Assumption | Device connected. No obstacle in the way. |
| Preconditions | Controller and Display are working properly. |
| Steps to reproduce | 1.Check the temperature using digital apparatus.<br>2.Check the display for temperature. |
| Expected Results | Room Temperature during day($32^0$C) |
| Actual Outcome | Room Temperature during day($32^0$C) |

Table 1.1

| | |
|---|---|
| Sl. No. | 2 |
| Purpose | Testing of Temperature sensor with respect to the surroundings during night |
| Assumption | Device connected. No obstacle in the way. |
| Preconditions | Controller and Display are working properly. |
| Steps to reproduce | 1.Check the temperature using digital apparatus.<br>2.Check the display for temperature. |
| Expected Results | Room Temperature during night($27^0$C) |
| Actual Outcome | Room Temperature during night($27^0$C) |

Table 1.2

| | |
|---|---|
| Sl. No. | 3 |
| Purpose | Testing of Temperature sensor with respect to body temperature |
| Assumption | Device connected. No obstacle in the way. |
| Preconditions | Controller and Display are working properly. |
| Steps to reproduce | 1.Check the temperature using digital apparatus.<br>2.Check the display for temperature. |
| Expected Results | $37^0$C |
| Actual Outcome | $37^0$C |

Table 1.3

| | |
|---|---|
| Sl. No. | 4 |
| Purpose | Testing of Temperature sensor with respect to fire from lighter |
| Assumption | Device connected. No obstacle in the way. |
| Preconditions | Controller and Display are working properly. |
| Steps to reproduce | 1.Check the temperature using digital apparatus.<br>2.Check the display for temperature. |
| Expected Results | $200^0$C – $300^0$C |
| Actual Outcome | Temperature constantly increases. |

Table 1.4

| | |
|---|---|
| Sl. No. | 5 |
| Purpose | Testing of Temperature sensor with respect to ice |
| Assumption | Device connected. No obstacle in the way. |
| Preconditions | Controller and Display are working properly. |
| Steps to reproduce | 1.Check the temperature using digital apparatus.<br>2.Check the display for temperature. |
| Expected Results | $-1^0$C |
| Actual Outcome | Temperature decreases |

Table 1.5

| | |
|---|---|
| Sl. No. | 6 |
| Purpose | Testing of Temperature sensor with respect to hot air blown |
| Assumption | Device connected. No obstacle in the way. |
| Preconditions | Controller and Display are working properly. |

| | |
|---|---|
| Steps to reproduce | 1.Check the temperature using digital apparatus.<br>2.Check the display for temperature. |
| Expected Results | $45^0C$ |
| Actual Outcome | Temperature increases steadily. |

Table 1.6

| | |
|---|---|
| Sl. No. | 7 |
| Purpose | Testing of Temperature sensor with respect to cold air blown |
| Assumption | Device connected. No obstacle in the way. |
| Preconditions | Controller and Display are working properly. |
| Steps to reproduce | 1.Check the temperature using digital apparatus.<br>2.Check the display for temperature. |
| Expected Results | $18^0C$ |
| Actual Outcome | Temperature decreased steadily |

Table 1.7

| | |
|---|---|
| Sl. No. | 8 |
| Purpose | Testing of Heart Beat sensor |
| Assumption | Device connected. No obstacle in the way. |
| Preconditions | Controller and Display are working properly. |
| Steps to reproduce | 1.Place the finger between the IR transmitter and LED.<br>2.Check the display for Heart Beat reading. |
| Expected Results | Heart Beat reading should be displayed. |
| Actual Outcome | Heart Beat reading is displayed as normal 80. |

Table 1.8

| | |
|---|---|
| Sl. No. | 9 |
| Purpose | Testing of Respiratory sensor in Room conditions |
| Assumption | Device connected. No obstacle in the way. |
| Preconditions | Controller and Display are working properly. |
| Steps to reproduce | 1.Place the respiratory sensor on a table in a room.<br>2.Check the display for analog reading. |
| Expected Results | Analog reading should be displayed. |
| Actual Outcome | Analog reading is displayed as 200. |

Table 1.9

| | |
|---|---|
| Sl. No. | 10 |
| Purpose | Testing of Respiratory sensor by placing on Nose |
| Assumption | Device connected. No obstacle in the way. |
| Preconditions | Controller and Display are working properly. |
| Steps to reproduce | 1.Place the respiratory sensor on nose.<br>2.Check the display for analog reading. |
| Expected Results | Analog reading should be displayed. |
| Actual Outcome | Analog reading is displayed as normal 208. |

Table 1.10

| | |
|---|---|
| Test Case ID | 2 |
| Test Engineer | Ajit Kumar Neelam |
| Product Module | Controller and Power Unit |
| Testing Date | 29th April |
| Status | Working Correctly. |

Table 2

| | |
|---|---|
| Sl. No. | 1 |
| Purpose | Testing of PIC Controller |
| Assumption | Hardware is working as desired. |
| Preconditions | Registers set to zero. |
| Steps to reproduce | 1.Checking whether LEDs are working.<br>2.Checking resistors, capacitors and other hardware. |
| Expected Results | Hardware should be fully functional. |
| Actual Outcome | Hardware is working as desired. |

Table 2.1

| | |
|---|---|
| Sl. No. | 2 |
| Purpose | Testing of PIC Controller |
| Assumption | No software flaw. |
| Preconditions | Registers set to zero. |
| Steps to reproduce | Test the Controller with Switch on. |
| Expected Results | Blinking of LED. |
| Actual Outcome | Result obtained as expected. |

Table 2.2

| | |
|---|---|
| Sl. No. | 3 |
| Purpose | Testing of Power Unit |
| Assumption | Connected properly to power supply. |
| Preconditions | It is connected properly without any obstacles. |
| Steps to reproduce | 1.Connect the power unit to voltage meter.<br>2.Check if the voltage is 5V. |
| Expected Results | Flow of current. |
| Actual Outcome | Current is flowing as expected. |

Table 2.3

| | |
|---|---|
| Test Case ID | 3 |
| Test Engineer | K.J. Sai Krishna |
| Product Module | Communication and Monitoring. |
| Testing Date | 28th April |
| Status | Working Correctly. |

Table 3

| | |
|---|---|
| Sl. No. | 1 |
| Purpose | IOT Testing |
| Assumption | Device connected via IoT. No obstacle in the way |
| Preconditions | Sensors should be working properly. |
| Steps to reproduce | 1.Analyse the health parameters.<br>2.The readings are sent to concerned doctor |
| Expected Results | reading is communicated to doctor. |
| Actual Outcome | reading is sent to the concerned doctor. |

Table 3.1

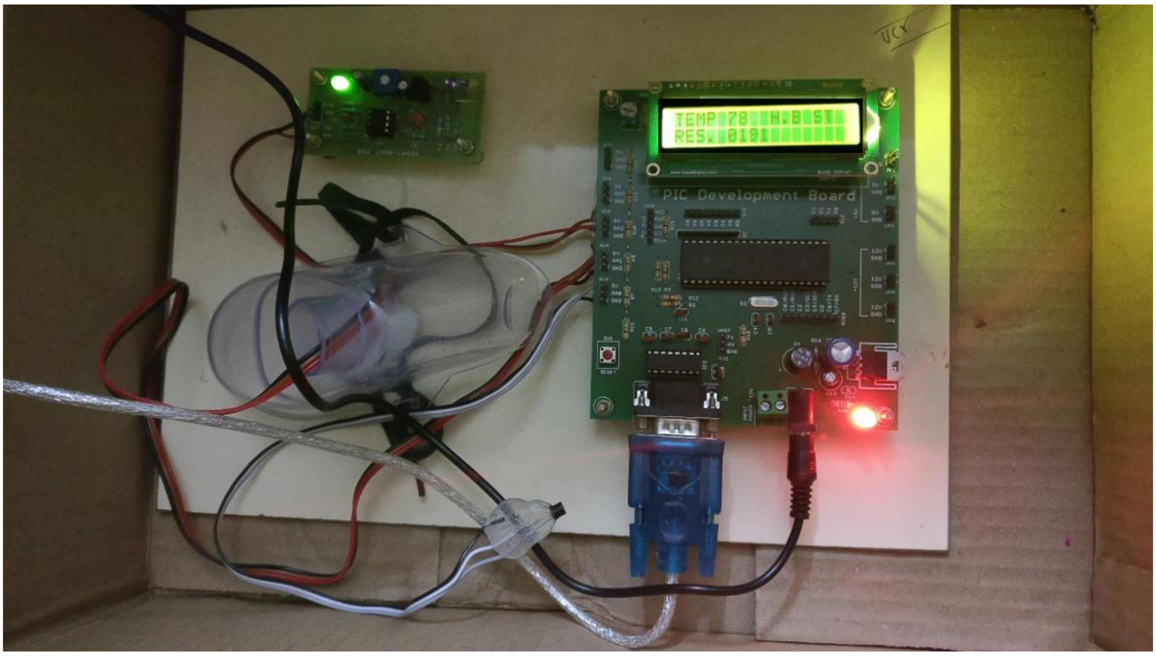
| | |
|---|---|
| Sl. No. | 2 |
| Purpose | Testing of Monitoring Unit |
| Assumption | Device connected. No obstacle in the way. |
| Preconditions | Circuit is set up. |
| Steps to reproduce | Check whether LCD displays the values taken by sensors. |
| Expected Results | LCD should print value for Heart Beat, respiration levels and temperature of patient. |
| Actual Outcome | LCD is working as expected. |

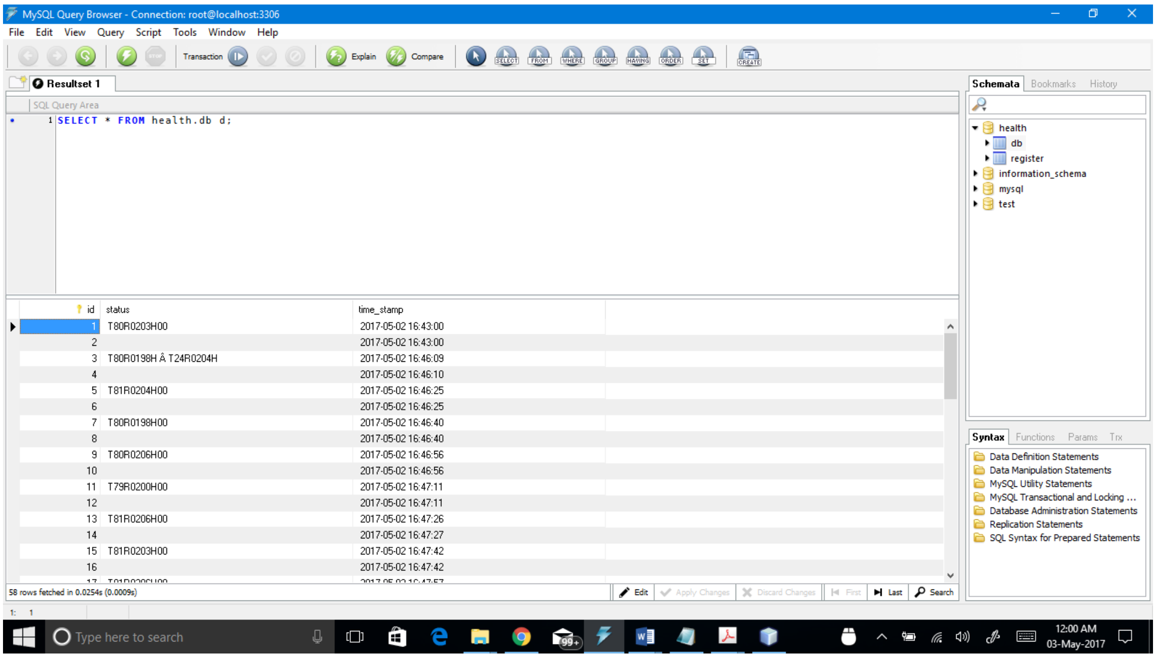
Table 3.2

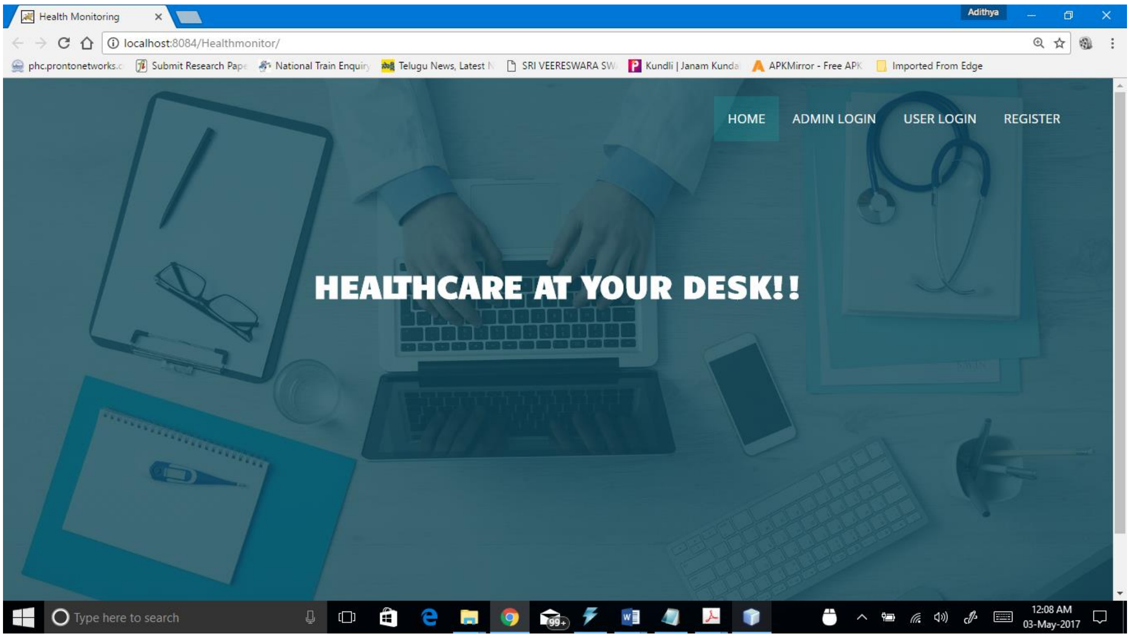
| | |
|---|---|
| Sl. No. | 3 |
| Purpose | Testing of LCD |
| Assumption | Device connected |
| Preconditions | Display is working properly. |
| Steps to reproduce | 1.Put the thermometer on the palm.<br>2.Check the display for temperature reading. |
| Expected Results | displaying body temperature. |
| Actual Outcome | displaying body temperature. |

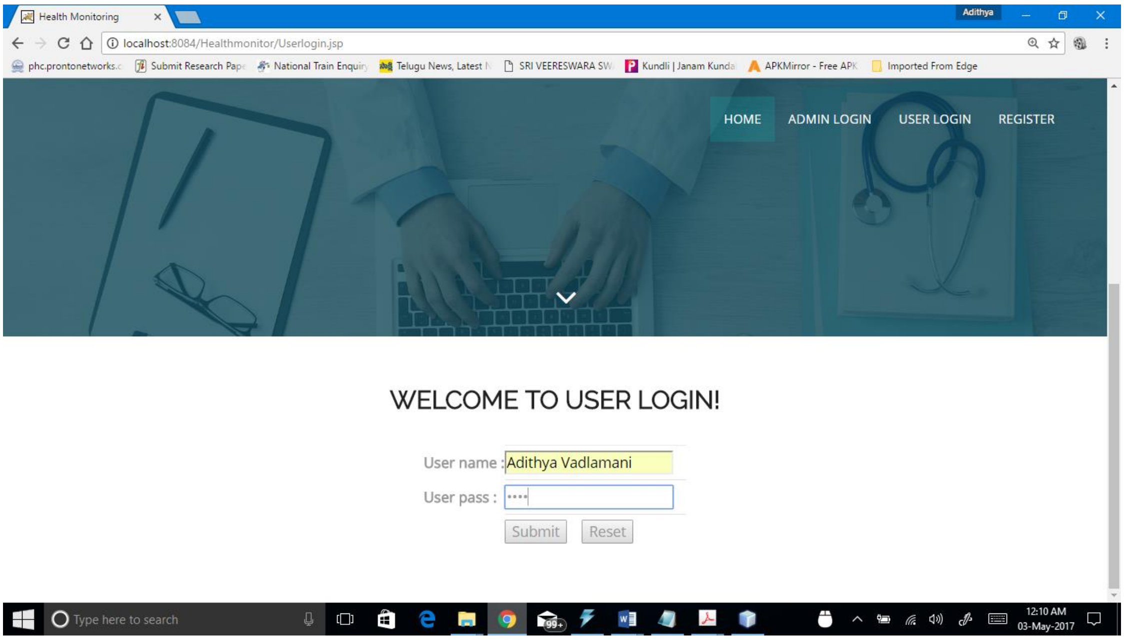
Table 3.3

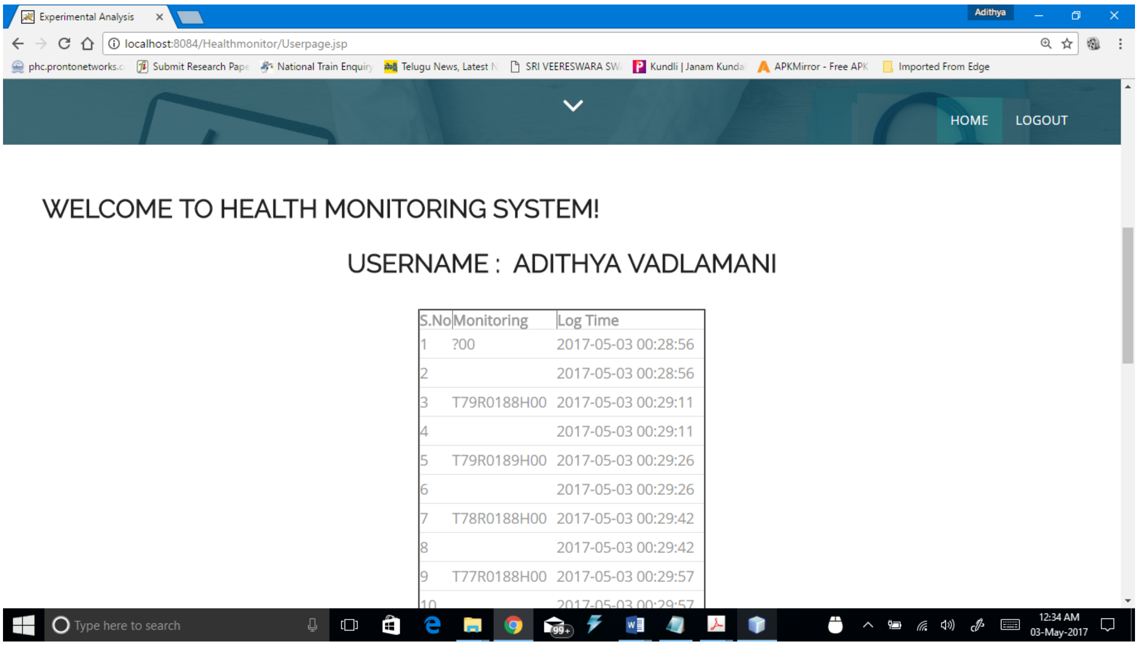
## 5.3 Screen Shots :-




Health Monitoring
localhost:8084/Healthmonitor/
HOME
ADMIN LOGIN
USER LOGIN
REGISTER
HEALTHCARE AT YOUR DESK!!
Type here to search
12:08 AM
03-May-2017


Health Monitoring
localhost:8084/Healthmonitor/Userlogin.jsp
HOME
ADMIN LOGIN
USER LOGIN
REGISTER
WELCOME TO USER LOGIN!
User name :
Adithya Vadlamani
User pass :
Submit
Reset
Type here to search
12:10 AM
03-May-2017


Experimental Analysis
localhost:8084/Healthmonitor/Userpage.jsp
HOME
LOGOUT
WELCOME TO HEALTH MONITORING SYSTEM!
USERNAME : ADITHYA VADLAMANI
S.No Monitoring Log Time
1 ?00 2017-05-03 00:28:56
2 2017-05-03 00:28:56
3 T79R0188H00 2017-05-03 00:29:11
4 2017-05-03 00:29:11
5 T79R0189H00 2017-05-03 00:29:26
6 2017-05-03 00:29:26
7 T78R0188H00 2017-05-03 00:29:42
8 2017-05-03 00:29:42
9 T77R0188H00 2017-05-03 00:29:57
Type here to search
12:34 AM
03-May-2017

## 5.4. Summary of the test cases results

The results obtained from the above performed tests on the project have given correct results and have successfully passed all the test cases of every module. Hence, all the modules – controller, sensors, monitoring, communication, power; all the modules mentioned above have successfully passed all the test cases done on them taking all the extreme cases.

# 6. CONCLUSION AND SCOPE FOR FUTURE ENHANCEMENT

In this project, at first we have described the issues in healthcare applications using body sensor network (BSN). Subsequently, we found that even though most of the popular BSN based research projects acknowledge the issues, but they fail to embed strong services that could serve patients remotely. Finally, we proposed an IoT based healthcare system using BSN, called BSN-Care, which can efficiently accomplish various requirements of the BSN based healthcare system.

The system can carry out a long-term monitoring on patient's condition and is equipped with an emergency rescue mechanism using SMS. This system can be enhanced by acquiring other health parameter from the patient's body.

# 7. REFERENCES

Journal(s):

1. Body Sensor Network – A Wireless Sensor Platform for Pervasive Healthcare Monitoring [Benny P.L. Lo, SurapaThiemjarus, Rachel King and Guang-Zhong Yang] 2015.
2. Fuzzy Logic based Health Care System using Wireless Body Area Network [PrakashgoudPatil, SaminaMohsin, Karnataka, India] 2014.
3. A Unique Health Care Monitoring System Using Sensors and Zig Bee Technology [EktaMadhyan Mahesh Kadam, Department of Electronics & Telecommunications, Mumbai University, India] 2013

4. Coexistence of zigbee-based WBAN and WiFi for Health Telemonitoring Systems [Yena Kim, Student Member, seungseob Lee, Student Member, and sukyoung Lee, Member,] 2013
5. Effective Ways to Use Internet of Things in the Field of Medical and Smart Health Care. [KaleemUllah, Munam Ali Shah, Sijing Zhang, Department of Computer Science, University of Bedfordshire, Luton, UK] 2015.
6. D. Malan, T. F. Jones, M. Welsh,S. Moulton, "CodeBlue: An Ad-Hoc Sensor Network Infrastructure for Emergency Medical Care," Proceedings of the MobiSys 2004 Workshop on Applications of Mobile Embedded Systems (WAMES 2004); Boston, MA, USA. 6–9 June 2004.
7. K. Lorincz, D. J. Malan, T. R. F. Fulford-Jones, A. Nawoj, A. Clavel, V. Shayder, G. Mainland, M. Welsh, "Sensor Networks for Emergency Response: Challenges and Opportunities", Pervas. Comput. vol.3, pp.16–23, 2004.
8. J.W.P. Ng, B.P.L Lo, O. Wells, M. Sloman, N. Peters, A. Darzi, C. Toumazou, G. Yang, "Ubiquitous Monitoring Environment for Wearable and Implantable Sensors (UbiMon)," Proceedings of 6th International Conference on Ubiquitous Computing (UbiComp'04); Nottingham, UK. 7–14 September 2004.
9. J. Ko, J. H. Lim, Y. Chen, R. Musaloiu-E, A. Terzis, G. M. Masson, "Median: Medical Emergency Detection in Sensor Networks," ACM Trans. Embed. Comput. Syst. vol. 10, pp. 1–29, 2010.
10. P. Gope, T. Hwang, "Lightweight and Energy Efficient Mutual Authentication and Key Agreement Scheme with User Anonymity for Secure Communication in Global Mobility Networks," IEEE Systems Journal, DOI: 10.1109/JSYST.2015.2416396, 2015.

Book(s):

1. Michael J. McGrath and Cliodhna Ni Scanaill-Sensor Technology, Healthcare, Wellness and Environmental Applications-Press Open Media, LLC, 2014.