Chapter 1: Introduction

Tracking of human body parameters has attracted significant interest in recent years due to its wide-ranging applications such as rehabilitation, virtual reality, sports science, medical science, surveillance, in recent times, wireless sensors and sensor networks have become a great interest to research, scientific and technological community. Though sensor networks have been in place for more than a few decades now, the wireless domain has opened up a whole new application space of sensors. Wireless sensors and sensor networks are different from traditional wireless networks as well computer networks and, therefore, pose more challenges to solve such as limited energy, restricted life time, etc.

The objective is to allow the person to be monitored in a natural environment. For monitoring outside the laboratory, a wearable system must not only display the parameters but also record the data; the proposed approach uses the wireless sensor network concept with all the sensor nodes communicated to the coordinator wirelessly using Wi-Fi network protocol. The coordinator acts as a router which makes connectivity between sensor nodes and end device via internet, end device may be computer or mobile. Each sensor node is may equipped with accelerometer, temperature sensor, pulse oximeter SpO2 & heart-rate sensor and galvanic skin response sensor. The sensor nodes are attached to the human body and operate completely untethered. They are powered by battery. The small form factor and lightweight feature of the sensor nodes allow easy attachment to the body.

Many new research is focused at improving quality of human life in terms of health by designing and fabricating sensors which are either in direct contact with the human body (invasive) or indirectly (noninvasive). One of the reasons for more development in this area is the global population and rise in ageing population, one statistic provided by the U.S. Department of Health that by 2050 over 20% of the world's population will be above 65 years of age. This results in a requirement for medical care, which is expensive for long-term monitoring and long waiting lists for consultations with health professionals. The cost of hospitalization is ever increasing, So is the cost of rehabilitation after a major illness or surgery. Hospitals are looking at sending people back as soon as possible to recoup at home. During this recovery physiological parameters need to be continuously measured. Hence, telemedicine and remote monitoring of patients at home are gaining added importance and urgency.

Patients are being monitored using a network of wireless sensors. Many elderly people dread the idea of being forced to live with their adult children, or in a rest home or in other sheltered living arrangement. They want to live independently and keep control of their own lives. Yet at the same time they know there is a high risk of injury or even death because of a fall or stroke. Such people need to be monitored continuously and sprovided with immediate medical help and attention when required. We seek to come up with solutions, which help to remove anxiety. As a result, there is a need for an accurate, flexible, noninvasive, comfortable, unit reliable, and low-cost monitoring that unites all demands.

A Zigbee-Based Wearable Physiological Parameters Monitoring System can be used to monitor physiological parameters, such as temperature and heart rate, of a human subject. The system consists of an electronic device which is worn on the wrist and finger, by an at-risk person. Using several sensors to measure different vital signs, the person is wirelessly monitored within his own home. An impact sensor has been used to detect falls. The device detects if a person is medically distressed and sends an alarm to a receiver unit that is connected to a computer. This sets off an alarm, allowing help to be provided to the user.

The increased use of mobile technologies and smart devices in the health zone has brought on extraordinary effect on the worlds critical care. Health specialist and doctors are using these technologies to create critical change in medicinal services during clinical settings. Likewise, many users are being served from the upsides of the M-Health application and E-Health to enhance, help and assist their well-beimg.

1.1 Motivation

The increased use of mobile technologies and smart devices in the health zone has brought on extraordinary effect on the worlds critical care. Health specialist and doctors are using these technologies to create critical change in medicinal services during clinical settings. Likewise, many users are being served from the upsides of the M-Health (Mobile Health) applications and E-Health (social insurance upheld by ICT) to enhance, help and assist their well-being. The internet of things is progressively permitting to coordinate gadgets fit for associating with the internet and give data on the condition of health of patients and give data continuously to specialist who help. The main aim of this “Patient Monitoring System” is to build up a system fit for observing vital body signs, for example, body temperature, heart rate, pulse oximetry.

The System is additionally equipped for fall detection and sleep pattern analysis. To accomplish this, the system involves many sensors to screen fundamental signs that can be interfaced to the doctors mobile or the web. The gadget will exchange the reading from sensors to cloud remotely and the information gathered will be accessible for analysis progressively.it has the capacity of reading and transmitting emergency signs to the cloud and then to Doctor’s Smartphone. These reading can be utilized recognize the health state of the patient and as alert system against the emergency health condition.

1.2 Objectives

The objective is to allow the patient to be monitored in a natural environment. For monitoring outside the clinical laboratory, a wearable system must not only record data, but also proficiently process data on-board based on the analysis report is report any critical condition is proposed. The proposed approach uses the wireless sensor network concept with all the sensor nodes communicated to the coordinator wirelessly using TCP/UDP network protocol. The small form factor and lightweight feature of e sensor nodes also allow easy attachment to the body. This technology also used in sports technology, in this field we know about the player’s behavior. In this project the MEMS sensors and FLEX sensors will be introduced in to medical and sports applications. The wireless feature enables the unrestrained motion of the human body as opposed to a wired monitoring device and makes the system truly portable.

Chapter 2: Literature Survey

An important component of ubiquitous healthcare is wireless sensor network (WSN). WSNs are an emerging technology that is poised to transform healthcare. The WSNs promise to make life more comfortable by significantly improving and expanding the quality of care across a wide variety of settings and segments of the population. This paper provides a brief introduction on applications of wireless sensor networks in healthcare[1] . This paper reviews the various types of wireless technologies used for medical applications such as WLAN, WPAN, WIMAX and WBAN and states their frequency, range standard etc.,

These wireless technologies are compared based on the factors such as energy consumption, security, routing protocols in order to increase the efficiency and effectiveness of the monitoring system[2] . In parallel to WSNs, the idea of internet of things (IoT) is developed where IoT can be defined as an interconnection between identifiable devices within the internet connection in sensing and monitoring processes[3] . Measurement of Elder Health Parameters and the Gadget Designs for Continuous Monitoring Improving the quality of life for the elderly persons and giving them the proper care at the right time is the responsibility of the younger generation a simple, compact and user-friendly electronic gadget for continuous monitoring of elder health parameters is the need of the hour.

Day by day the menace of weakening health and chances of skin related problems, bed sores etc are becoming critical in case of bed ridden patients. This paper analyses the old age diseases and the parameters to be monitored[4].A Zigbee-Based Wearable Physiological Parameters Monitoring System can be used to monitor physiological parameters, such as temperature and heart rate, of a human subject. The system consists of an electronic device which is worn on the wrist and finger, by an at-risk person. Using several sensors to measure different vital signs, the person is wirelessly monitored within his own home. An impact sensor has been used to detect falls. The device detects if a person is medically distressed and sends an alarm to a receiver unit that is connected to a computer.

This sets off an alarm, allowing help to be provided to the user[5] . Technology which is well into existence and reduces cost of electrical wiring and uses the already available power line wires known as the power line communication. The intent of this work is to send the biomedical parameters like the heart rate, respiration rate and body temperature through PLC system[6] Some of the elder care systems as mentioned in [7] monitor activities of the elders in their home. They embed a video system in the living environment of elders and continuously monitor their activities at home.

However, this system doesn't measure any of the vital parameters of the elderly patient. Measuring the vital parameters is inevitable if the elder person suffers from any sort of heart ailments, which are very common in individuals aged above 60 [8]. In mobile devices like Calyx (Complete Ambient Assisted Living Experiment) which can measure vital signs like ECG, pulse, Blood pressure, Movement and Fall detection. However, the design we have proposed can monitor vital parameters and fall detection along with tilt monitoring for the bed-ridden patients to monitor any case of bedsore. Some devices as in[9] monitor only fall detection for the elderly patients based on the sensor readings from accelerometers and microphones attached to the body of the patients.

The system proposed in[10] is applicable to patients. And elders for activity monitoring and fall detection and also sports athletes exercise measurement and pattern analysis.[11] A wearable wireless sensor network using accelerometers has been developed in this paper to determine the arm motion in the sagittal plane. The system provides unrestrained movements and improves its usability. The lightweight and compact size of the developed sensor node makes its attachment to the limb easy. Experimental results have shown that the system has good accuracy and response rate when compared with a goniometer.

Chapter 3: System

3.1 Analysis

Generally, human health state is defined by variety of physiological body parameters, which usually are self- interdependent. Not all of them are equally informative and important. Besides, not all of those parameters could be easily and precisely controlled, since measurement of them requires special conditions, expensive medical equipment and materials. While designing the overall monitoring system, it is necessary to assess not only importance of measured parameters but also techniques of their measurement and potentiality of implication into practical systems. Medical investigations have proven that the most important parameters are those that specify the work of heart and respiratory system. They best describe the human heath state. In addition to this, body's temperature, Blood Oxygen level, skin resistance, body movement, posture is also important parameters to improve human life activities in medical, sports, exercise, rehabilitation, virtual reality and surveillance.

3.1.1 System

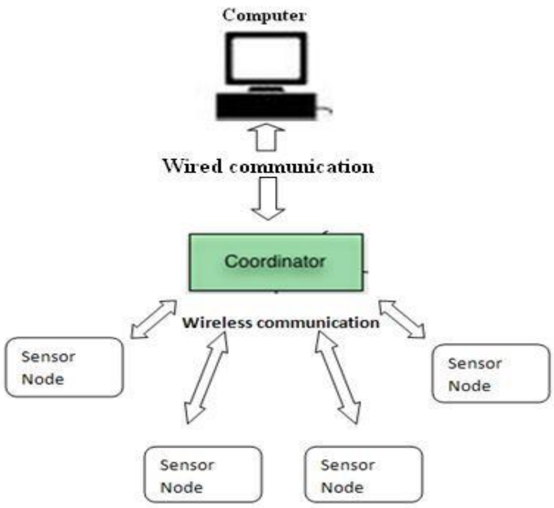


Fig.3.1.1 General configuration of the System

Fig. 4.1 shows the configuration of the system. It is observed that the system consists of a number of sensor nodes that wirelessly communicate to a central coordinator in a star network topology. Wireless sensor network is a promising field that integrates sensor technologies, embedded system and wireless communication together to produce small, low cost, low power and reliable system capable of monitoring specific events. For this system, wireless protocol suite used because it provides end-to-end connectivity. The coordinator acts as a router which makes connectivity between sensor nodes and end device via internet, end device may be computer or mobile. Each s

ensor node is may equipped with accelerometer, temperature sensor, pulse oximeter SpO2 & heart-rate sensor and galvanic skin response sensor. The sensor nodes are attached to the human body and operate completely untethered. They are powered by battery

3.1.2 SENSORS AND THEIR POSITIONING AT HUMAN BODY:

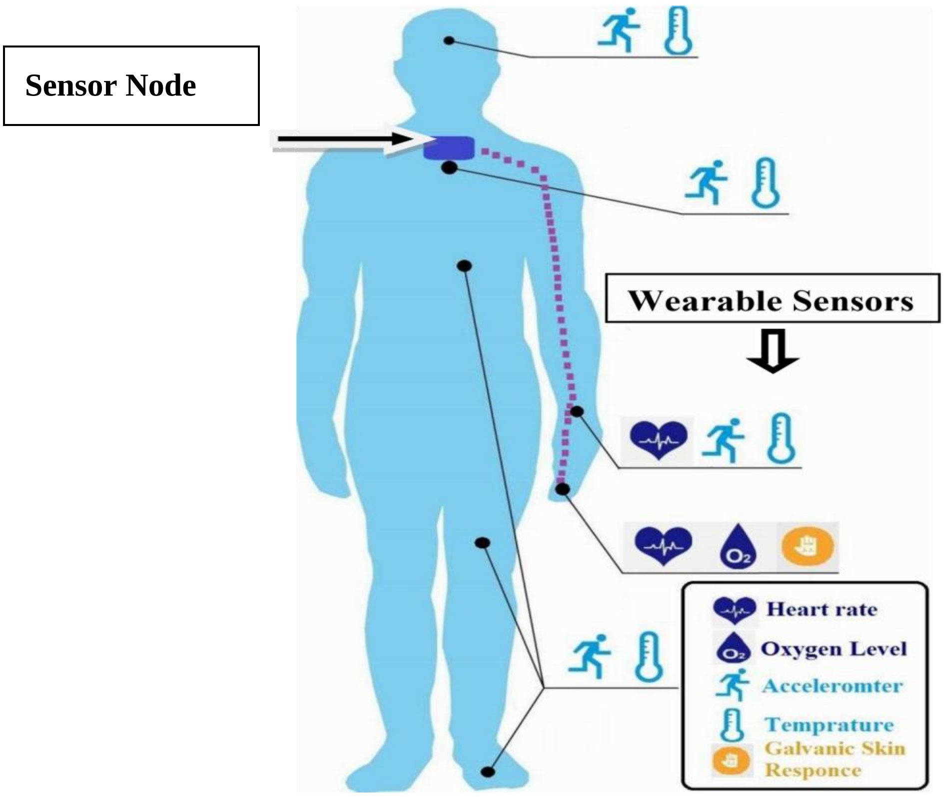


Figure 3.1.2: Various sensors and their placement on human body

Above figure shows that the Placement of sensor node and wearable sensors like Accelerometer, Temperature, Pulse Oximeter SpO2 & Hart rate, Galvanic Skin Response on Human body.

3.2 PARAMETERS TO BE MONITORED:

The system monitor numbers of body parameters at a time matters a lot while designing it.

Body Temperature

Body temperature is a basic parameter, which has to be monitored in any individual. Body temperature sensor fixed at a particular location of body measures the temperature and transmits the value to the main coordinator.

During exercise, the body temperature is not only one of the most important physiological indicators, but indicators can also be used to determine the signs of heat and heat stroke. If the body temperature reaches 40 °C, heat stroke may occur, so that monitoring of body temperature is essential during exercise.

Variety of accidents caused by physical stress due to a lack of thermo regulation. Nowadays, due to globalization, athletes repeatedly demand maximum performances from their body under sometimes extreme climatic circumstances. Although in sports science it is already for a long time known that body temperature is an important factor during the training and competition process Humans, as homeothermic (warm-blooded) beings, have a constant operating temperature in a tolerance range of 37 °C} 0.5 °C in the core body.

Body Postural & Movements

Monitoring the movements of the human body is of great importance in various application fields including medicine, physical exercise and sport.

It is important to monitors activity and movement for physical therapists to understand the detect motion with inertial sensors for balance and gait assessment and treatment in rehabilitation.

By combining multiple types of A 3-axis accelerometer can be used together to create a convenient device for use in outdoor activities such as adventure sports.

Another serious issue related to Elders is fall detection. Falls can be markers of poor health and declining function, and they are often associated with significant morbidity. More than 90 percentages of hip fractures occur as a result of falls, with most of these fractures occurring in persons over 70 years of age. Monitoring of bed ridden elders thus becomes very crucial issue in maintaining proper health condition.

Thus it requires that the caretaker to monitor the elder at regular intervals. If the caretaker fails to keep track of the elder posture it could lead to a case of bedsore. Thus a system is necessary to keep track of the elder posture continuously and assist the caretaker in taking timely action in order to avoid the cases of bedsores.

Heart rate and Blood Oxygen level

Hart rate is another basic important parameter of a human. High blood pressure, or hypertension, is commonly linked to conditions such as heart attacks and stroke

In Sports heart-rate monitors have been widely used by professional trainers as well as club-level athletes and enthusiasts in cardiovascular sports such as running, swimming, and cycling help to improve sport performance.

Blood oxygen saturation is a measure commonly used by healthcare professionals to check for conditions such as anemia or correct operation of the heart. A poorly pumping heart is major issue in elderly community. The overall activeness of heart reduces since all the nerves and arteries get weaker. More than 83% of the people who die of heart disease are older than 65 years. So, it is compulsory required to include the heart rate monitoring.

Galvanic Skin Response

The GSR sensor measures changes in the surface resistance of the skin by releasing a current to the human body whereas the skin resistance (G) depends on the skin humidity, vasoconstriction and relaxation, the thickness of the stratum corneum, and chemical substances. So, when a person’s mood changes or they feel discomfort, then the skin resistance value decreases. Therefore, we can use the rate of change of GSR as the evaluation index for heat stroke.

3.2.1 WIRELESS SENSOR NETWORK :

WNS is a promising field that integrates sensor technologies, embedded system and wireless communication together to produce small, low cost, low power and reliable system capable of monitoring specific events. The IEEE standard 802.15.4 is developed targeting specifically for this application domain. It is generally applied in monitoring applications with non-critical data, where longer latency is not a critical issue. Such applications usually do not need high data throughput but emphasize on power saving to maximize battery life. It has been used in a variety of applications including commercial and industrial monitoring, home automation and networking, consumer electronics, personal computer peripherals, home security, personal healthcare, toys and games, automotive sensing, agriculture etc

Table 3.2.1 lists the data transfer rate and latency requirement of a few applications from the table; it can be observed that higher data transfer rate is required in entertainment and gaming applications. For personal health care and automation, lower data rate and higher data latency are acceptable.

Applications	Maximum data rate required (kb/s)	Maximum acceptable latency (ms)
Consumer Electronics	3	16.7
PC Peripherals	115.2	16.7
Home Automation	10	100
Personal Health Care	10	30
Toys and Games	115.2	16.7-100

Table 3.2.1: Data transfer rate and latency requirements

Selection of Network:

Communication between the Sensor Node and the Coordinator unit is wireless. The data from the sensor node is monitor on IoT platform at the internet accessed host computer by building a network between the sensor node and the coordinator unit, for the communication Wi-Fi wireless network technology is used. in our system design Wi-Fi Technology take into account because it is commonly used for the wireless local area networking (WLAN) of devices which is based around the IEEE 802.11 family of standards Wi-Fi uses multiple parts of the IEEE 802 protocol family and is designed to seamlessly interwork with its wired sister protocol Ethernet

Devices that can use Wi-Fi technologies include desktops and laptops, smart phones and tablets. Compatible devices can connect to each other over Wi-Fi through a wireless access point as well as to connected Ethernet devices and may use it to access the Internet. Such an access point (or hotspot) has a range of about 100 meter greater range, high data rate up to 55Mbps and having node per network connectivity up to 30 node. Table 3.2.2 shows that the Comparison of Wireless Technologies,

Wireless Parameters	**Blue tooth**	**Home RF**	**802.11 Wireless LAN**	**ZigBee**	**Wi-Fi**
IEEE Connection Type	802.15.1	Alternative Of IEEE 802.11	802.15.1	802.15.4	802.11.a/b/c
Frequency Spectrum	2.4 GHz	2.4 GHz	2.4 GHz	868/915Mhz,2.4GHz	2.4Ghz-5GHz
Data Rate	1Mbps	1Mbps,2Mbps	1Mbps, ,2Mbps	250Kbps	54Mbps
Node Per Network	7,8	127		64K	30
Rang	10 Meter	Typical home	100Meter	10 - 100Meter	100Meter
Network Topology	Ad-hoc, Small network		Ad-hoc, Peer to Peer	Ad-hoc, Peer to Peer, Star Or Mesh	Point to Hub
N/W joint time	>3Sec	Variable	>30ms	>30ms	Variable, 1Sec Typically
Application	Wireless device Connection	High Quality Vice Channel	Small inhome networks to large school, campus, office building etc	Industrial Control & Monitoring sensor N/W, Bulinding Automation, Toys & Game	Wire Less LAN, Internet access

Table 3.2.2: Comparison of Wireless Technologies

3.3 DESIGN

3.3.1 SYSTEM DESIGN CONFIGURATION:

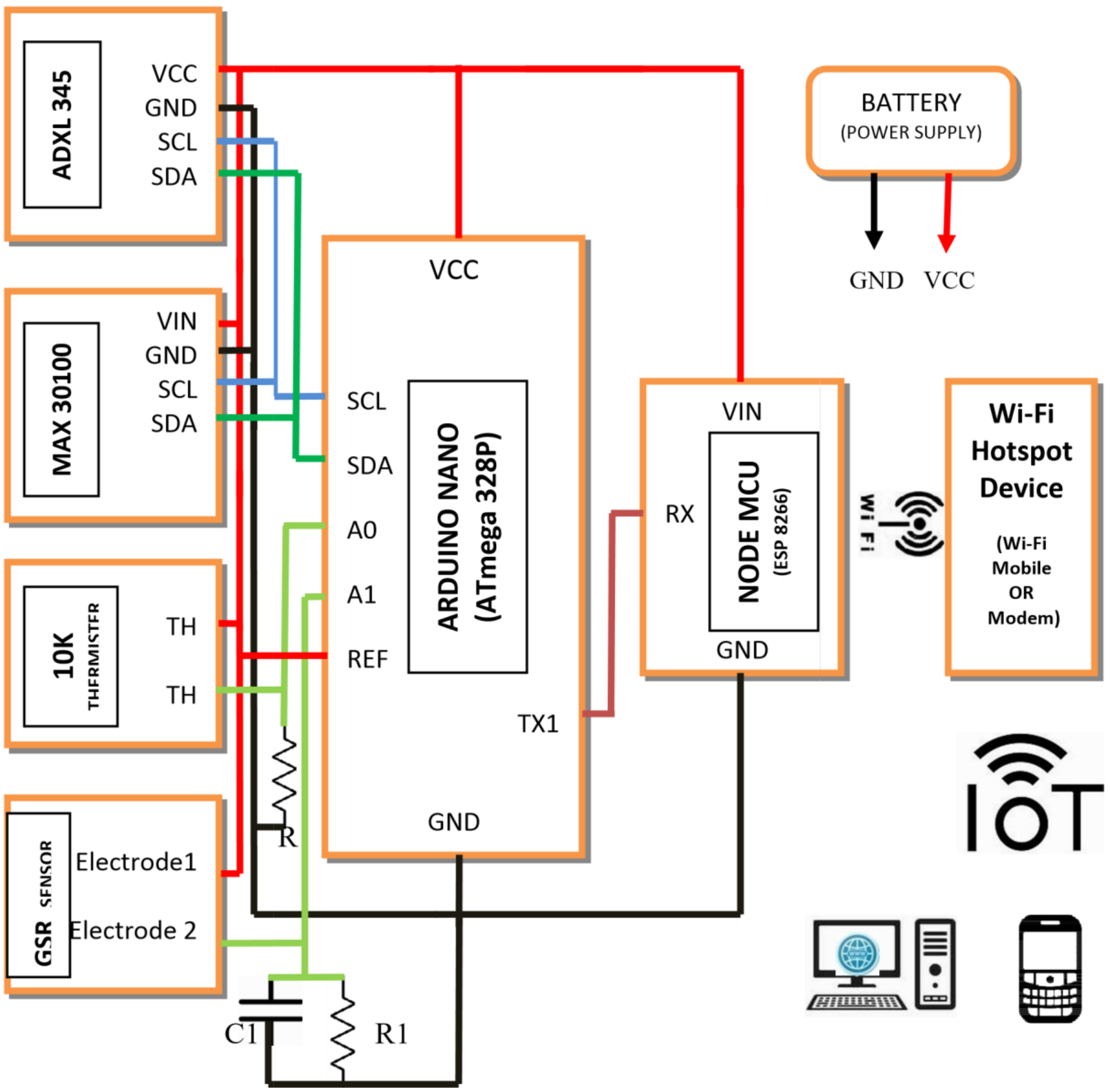


Figure 3.3.1: Configuration of the system (Circuit Configuration of Sensor Node)

The configuration of the system shown in the Fig. 4.4, it is observed that the system consists of number of sensors that are Accelerometer ADXL 345 for detection of postural & motion of body in terms of tilt angle of up to three axes, SPO2 MAX30100 for detection of hart rate & blood oxygen level, 10K thermistor for temperature detection and GSR for skin resistance measure. All these sensors communicate to arduino nano board with two to four wire connections. The aduino nano board module contains ATmega328 Microcontroller, out of the sensors in the system the accelerometer ADXL345 and SPO2 MAX 30100 sensor module are digital sensors, so that ADXL345 & MAX 30100 sensor module communicate with microcontroller by Inter Integrated Circuit(I2C: SCL, SDA) logic. Whereas thermister and GSR sensor is the analog sensor therefore they communicate through analog inputs (A0 & A1) lines of the microcontroller.

The microcontroller ATmega 328 processes received data from the various sensors and transmit processed data serially to the Node MCU ESP8266 Wi-Fi Module with the help of Tx & Rx line. The Node MCU Wi-Fi connectivity feature allow to made connection with Wi-Fi modem or Mobile phone i.e. Coordinator device of the system. With the help of coordinator node McUESP8266 send all the data to the end device via internet and finally Thinger.io an IoT platform allows monitoring of human body parameters from various sensor nodes on the end device i.e. computer or mobile. The sensor node may use a 5-V rechargeable alkaline battery.

3.3.2 ABOUT ARDUINO NANO:

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 microcontroller (Arduino Nano 3.0). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one. The Nano was designed and is being produced by Gravitech.

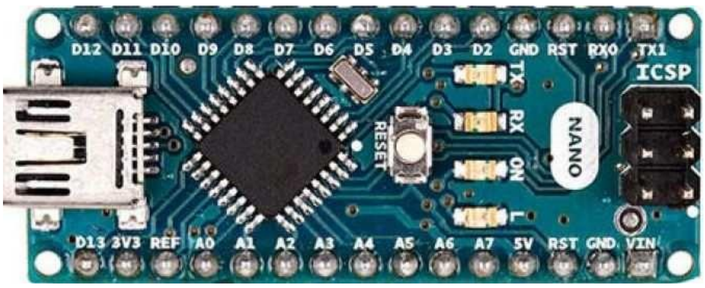
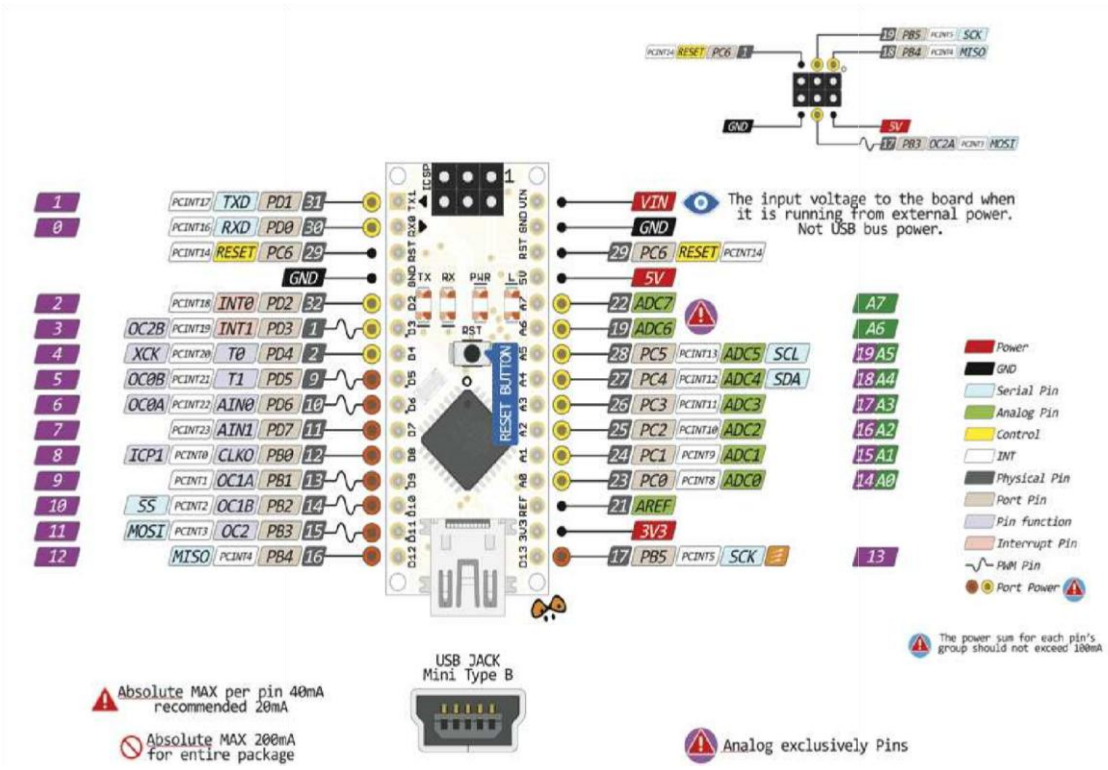


Fig:3.3.2 Monitoring of Human Body Parameters using Wearable Wireless Sensor Network



3.3.3: Arduino Nano 3.0 Board Pin Configuration Detail

ATmega328 Microcontroller features:

High Performance, Low Power AVR, Advanced RISC Architecture

- 131 Powerful Instructions – Most Single Clock Cycle Execution
- 32 x 8 General Purpose Working Registers
- Up to 20 MIPS Throughput at 20 MHz
- On-chip 2-cycle Multiplier

High Endurance Non-volatile Memory Segments

32K Bytes of In-System Self-Programmable Flash program memory

1K Bytes EEPROM

2K Bytes Internal SRAM

Write/Erase Cycles: 10,000 Flash/100,000 EEPROM

Data retention: 20 years at 85°C/100 years at 25°C

Optional Boot Code Section with Independent Lock Bits

- In-System Programming by On-chip Boot Program
- True Read-While-Write Operation

Peripheral Features

- Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode
- One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
- Real Time Counter with Separate Oscillator
- Six PWM Channels
- 8-channel 10-bit ADC in TQFP and QFN/MLF package
- Temperature Measurement
- 6-channel 10-bit ADC in PDIP Package
- Programmable Serial USART
- Master/Slave SPI Serial Interface
- Byte-oriented 2-wire Serial Interface (Philips I2 C compatible)
- Programmable Watchdog Timer with Separate On-chip Oscillator
- On-chip Analog Comparator
- Interrupt and Wake-up on Pin Change

Special Microcontroller Features

- Power-on Reset and Programmable Brown-out Detection
- Internal Calibrated Oscillator
- External and Internal Interrupt Sources
- Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby

I/O and Packages

- 23 Programmable I/O Lines
- 32-lead TQFP, 32-pad QFN/MLF

Each of the 14 digital pins on the Nano can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead()_functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the FTDI USB-to-TTL Serial chip.

External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.

PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite()

function.

SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.

LED: 13 there is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Nano has 8 analog inputs, each of which provides 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the analog Reference () function. Additionally, some pins have specialized functionality:

I2C: 4 (SDA) and 5 (SCL). Support I2C (TWI) communication using the Wire library

There are a couple of other pins on the board:

AREF: Reference voltage for the analog inputs. Used with analogReference(). ***Reset.*** Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

Operating Voltage:

- 1.8 - 5.5V

Temperature Range:

- -40°C to 85°C

Speed Grade:

- 0 - 20 MHz @ 4.5 - 5.5V

Power: The Arduino Nano can be powered via the Mini-B USB connection, 6-20V unregulated external power supply (pin 30), or 5V regulated external power supply (pin 27). The power source is automatically selected to the highest voltage source.

The FTDI FT232RL chip on the Nano is only powered if the board is being powered over USB. As a result, when running on external (non-USB) power, the 3.3V output (which is supplied by the FTDI chip) is not available and the RX and TX LEDs will flicker if digital pins 0 or 1 are high.

Communication:

The Arduino Nano has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provide UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and

1 (TX). An FTDI FT232RL on the board channels this serial communication over USB and the FTDI drivers (included with the Arduino software) provide a virtual com port to software on the computer. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the FTDI chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the nano's digital pins.

The ATmega328 also support I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus, The Serial

Peripheral Interface (SPI) IN PINS 7,8,13,14 AND 15

Serial Peripheral Interface (SPI) is a synchronous serial data protocol used by microcontrollers for communicating with one or more peripheral devices quickly over short distances. It can also be used for communication between two microcontrollers. With an SPI connection there is always one master device (usually a microcontroller) which controls the peripheral devices. Typically, there are three lines common to all the devices:

- MISO (Master In Slave Out) - The Slave line for sending data to the master,
- MOSI (Master Out Slave In) - The Master line for sending data to the peripherals,
- SCK (Serial Clock) - The clock pulses which synchronize data transmission generated by the master and one-line specific for every device:
- SS (Slave Select) - the pin on each device that the master can use to enable and disable specific devices. When a device's Slave Select pin is low, it communicates

with the master. When it's high, it ignores the master. This allows you to have multiple SPI devices sharing the same MISO, MOSI, and CLK lines.

Programming:

The Arduino Nano can be programmed with the Arduino software (download). Select "Arduino Diecimila, Duemilanove, or Nano ATmega328" from the **Tools > Board** menu (according to the microcontroller on our board).

The ATmega328 on the Arduino Nano comes preburned with a boot loader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files). You can also bypass the boot loader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header.

Automatic (software) reset:

Rather than requiring a physical press of the reset button before an upload, the Arduino Nano is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the FT232RL is connected to the reset line of the ATmega328 via a 100 nano farad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip.

The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the boot loader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload.

This setup has other implications. When the Nano is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the boot loader is running on the Nano. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data.

3.3.3 DETAIL DESIGN

DETAILS OF THE SENSING SYSTEM:

The current version of the system consists of four sensors: an Accelerometer, Pulse Oximeter SpO2 and Heart-Rate Sensor, Temperature sensor and Galvanic Skin Response Sensor. Accelerometer & SpO2 sensor are the Digital sensors as far as Temperature & GSR sensor are Analog sensors their circuitry used in the design generates analog voltage which is fed to the ADC (Analog-to-Digital) inputs of the micro-controller. The ADC input is time-multiplexed and sampled at different rates. The description of individual sensors follows.

Accelerometer ADXL345 Module:

The ADXL345 is a low-power, 3-axis MEMS accelerometer modules with both I2C and SPI interfaces. The Sunrom Breakout boards for these modules feature on-board 3.3v voltage regulation and level shifting which makes them simple to interface with 5v microcontrollers such as the Arduino. The sensor has three axes of measurements, X Y Z, and pins that can be used either as I2C or SPI digital interfacing. You can set the sensitivity level to either +-2g, +-4g, +-8g or +-16g. The lower range gives more resolution for slow movements, the higher range is good for high speed tracking. The ADXL345 is the latest and greatest from Analog Devices, known for their exceptional quality MEMS devices.

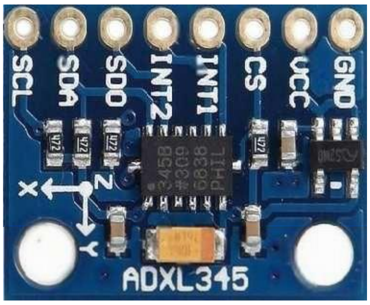


Figure : ADXL345 Sensor Module

Features:

- Main Chipset: ADXL345
- Communication: IIC/SPI Communication Protocol
- Measuring Ranging: ±2g±16g
- Digital Output: SPI/IIC

- 3-axis, ±2g/±4g/±8g/±16g
- Compact Accelemotor/Inclinometer
- Working Voltage: 3V to 5V
- Working Temperature: -40° to 85°
- Working Current: 30uA
- Low Power Consumption

Theory of Operation:

The ADXL345 is a complete 3-axis acceleration measurement system with a selectable measurement range of ±2 g, ±4 g, ±8 g, or ±16 g. It measures both dynamic acceleration resulting from motion or shock and static acceleration, such as gravity, that allows the device to be used as a tilt sensor. The sensor is a polysilicon surfacemicromachined structure built on top of a silicon wafer. Polysilicon springs suspend the structure over the surface of the wafer and provide a resistance against forces due to applied acceleration. Deflection of the structure is measured using differential capacitors that consist of independent fixed plates and plates attached to the moving mass. Acceleration deflects the proof mass and unbalances the differential capacitor, resulting in a sensor output whose amplitude is proportional to acceleration. Phasesensitive demodulation is used to determine the magnitude and polarity of the acceleration.

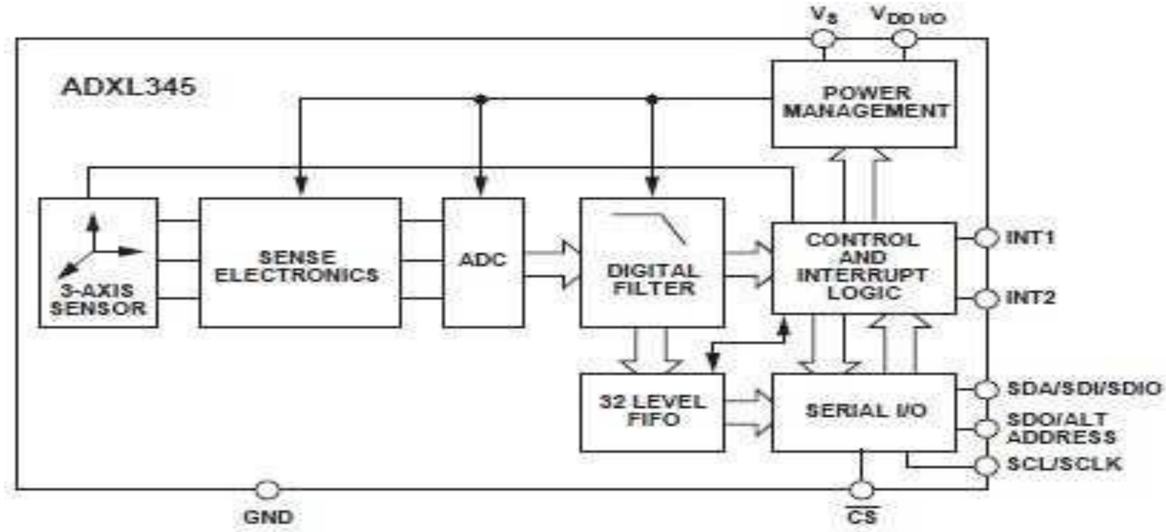


Figure : Functional diagram of ADXL 345

Offset Calibration:

Accelerometers are mechanical structures containing elements that are free to move. These moving parts can be very sensitive to mechanical stresses, much more so than solid-state electronics. The 0 g bias or offset is an important accelerometer metric because it defines the baseline for measuring acceleration. Additional stresses can be applied during assembly of a system containing an accelerometer. These stresses can come from, but are not limited to, component soldering, board stress during mounting, and application of any compounds on or over the component. If calibration is deemed necessary, it is recommended that calibration be performed after system assembly to compensate for these effects. A simple method of calibration is to measure the offset while assuming that the sensitivity of the ADXL345 is as specified in appendix Table A.2.

The offset can then be automatically accounted for by using the built-in offset registers. This results in the data acquired from the DATA registers already compensating for any offset. In a no-turn or single-point calibration scheme, the part is oriented such that one axis, typically the z-axis, is in the 1 g field of gravity and the remaining axes, typically the x- and y-axis, are in a 0 g field. The output is then measured by taking the average of a series of samples. The number of samples averaged is a choice of the system designer, but a recommended starting point is 0.1 sec worth of data for data rates of 100 Hz or greater. This corresponds to 10 samples at the 100 Hz data rate. For data rates less than 100 Hz, it is recommended that at least 10 samples be averaged together. These values are stored as X0g, Y0g, and Z+1g for the 0 g measurements on the x- and y-axis and the 1 g measurement on the z-axis, respectively. The values measured for X0g and Y0g correspond to the x- and y-axis offset, and compensation is done by subtracting those values from the output of the accelerometer to obtain the actual acceleration:

$$XACTUAL = XMEAS - X0g \quad YACTUAL = YMEAS - Y0g$$

Because the z-axis measurement was done in a +1 g field, a no-turn or singlepoint calibration scheme assumes an ideal sensitivity, SZ for the z-axis. This is subtracted from Z+1g to attain the z-axis offset, which is then subtracted from future measured values to obtain the actual value:

$$Z0g = Z{+}1g - SZ$$

$$ZACTUAL = ZMEAS - Z0g$$

The ADXL345 can automatically compensate the output for offset by using the offset registers (Register 0x1E, Register 0x1F, and Register 0x20). These registers contain an 8-bit, twos complement value that is automatically added to all measured acceleration values, and the result is then placed into the DATA registers. Because the value placed in an offset register is additive, a negative value is placed into the register to eliminate a positive offset and vice versa for a negative offset. The register has a scale factor of 15.6 mg/LSB and is independent of the selected g-range. As an example, assume that the ADXL345 is placed into full resolution mode with a sensitivity of typically 256 LSB/g. The part is oriented such that the z-axis is in the field of gravity and x-, y-, and z-axis outputs are measured as +10 LSB, −13 LSB, and +9 LSB, respectively. Using the previous equations, X0g is +10 LSB, Y0g is −13 LSB, and Z0g is +9 LSB. Each LSB of output in full-resolution is 3.9 mg or onequarter of an LSB of the offset register. Because the offset register is additive, the 0 g values are negated and rounded to the nearest LSB of the offset register:

$$XOFFSET = -Round(10/4) = -3 \text{ LSB}$$

$$YOFFSET = -Round(-13/4) = 3 \text{ LSB}$$

$$ZOFFSET = -Round(9/4) = -2 \text{ LSB}$$

These values are programmed into the OFSX, OFSY, and OFXZ registers, respectively, as 0xFD, 0x03 and 0xFE. As with all registers in the ADXL345, the offset registers do not retain the value written into them when power is removed from the part.

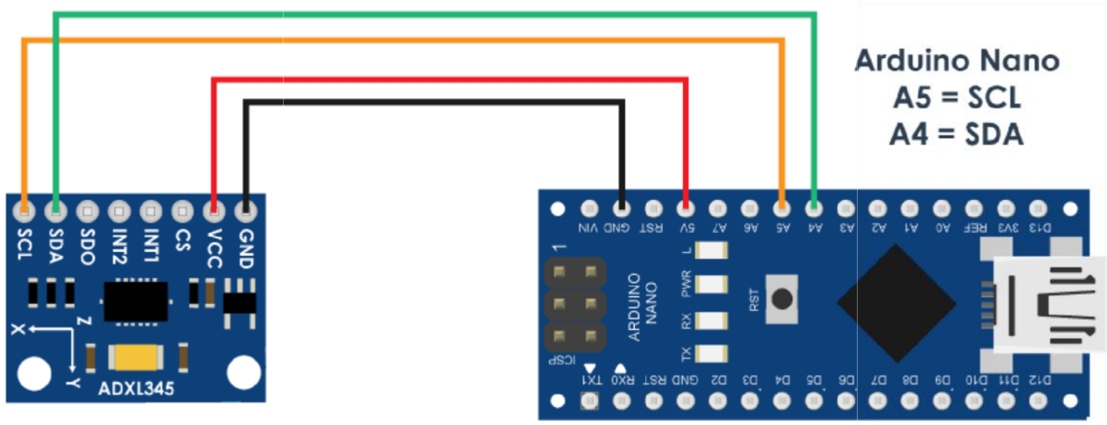


Figure 3.3.3.1 : I2C Interfacing of ADXL345 Module with Arduino Nano Board

MAX30100 Pulse Oximeter SpO2 and Heart-Rate Sensor Module:

The MAX30100 is an integrated pulse oximetry and heart rate monitor sensor solution. It combines two LEDs, a photo detector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart-rate signals. The MAX30100 breakout operates from 1.8V and 5.5V power supplies and can be powered down through software with negligible standby current, permitting the power supply to remain connected at all times.

Figure : SPO2 & Hart rate Sensor Module

Features:

- Working voltage: 1.8-5.5V
- Complete Pulse Oximeter and Heart-Rate Sensor Solution Simplifies Design
- Integrated LEDs, Photo Sensor, and High-Performance Analog Front -End
- Ultra-Low-Power Operation Increases Battery Life for Wearable Devices
- Programmable Sample Rate and LED Current for Power Savings Ultra-Low Shutdown Current (0.7µA

What is Pulse Oximeter:

A pulse oximeter is basically a device which can measure your pulse and oxygen saturation in your blood. Usually this sensor consists of two LEDs emitting light: one in Red spectrum (650nm) and the other one in Infrared (950nm). This sensor is placed on your finger or earlobe, essentially anywhere where the skin is not too thick so both light frequencies can easily penetrate the tissue. Once both of them are shined through your finger for example, the absorption is measure with a photodiode.

How Does Pulse Oximetry Work?

Within the Sp02 sensor, light emitting diodes shine red and infrared light through the tissue. Most sensors work on extremities such as a finger, toe or ear. The blood, tissue and bone at the application site absorb much of the light. However, some light passes through the extremity. A light-sensitive detector opposite the light source receives it.

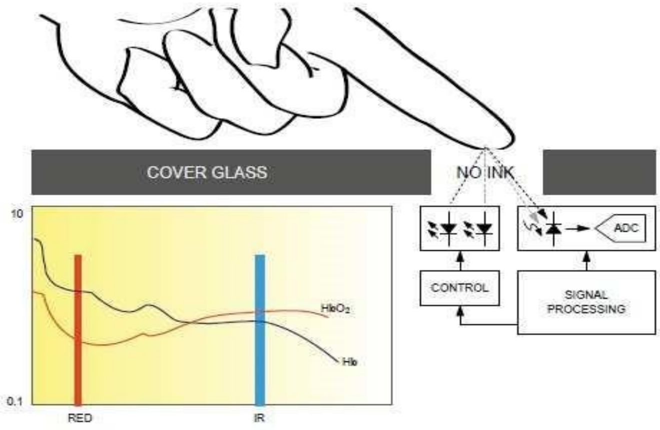


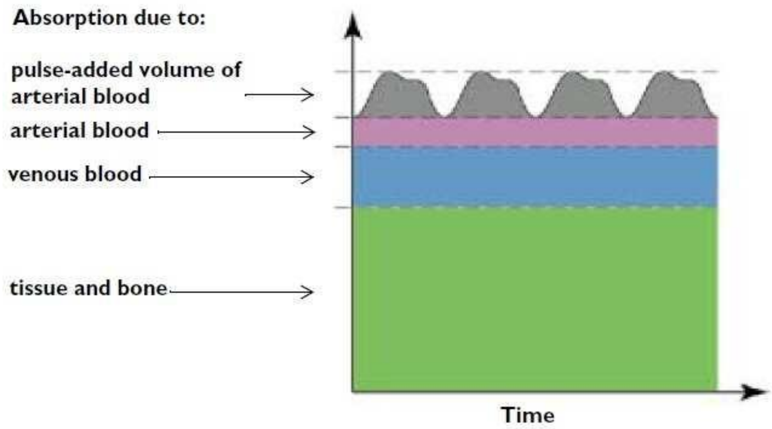
Figure : SPO2 & Hart rate System Block Diagram

SpO2 Sensors:

Most sensors work on extremities such as a finger, toe or ear. The sensor measures the amount of red and infrared light received by the detector and calculates the amount absorbed. Much of it is absorbed by tissue, bone and venous blood, but these amounts do not change dramatically over short periods of time. The amount of arterial blood does change over short periods of time due to pulsation (although there is some constant level of arterial blood). Because the arterial blood is usually the only light absorbing component which is changing over short periods of time, it can be isolated from the other components.

Absorption at the Sensor Site:

The amount of light received by the detector indicates the amount of oxygen bound to the hemoglobin in the blood. Oxygenated hemoglobin (oxyhemoglobin or HbO2) absorbs more infrared light than red light. Deoxygenated hemoglobin (Hb) absorbs more red light than infrared light. By comparing the amounts of red and infrared light received, the instrument can calculate the SpO2 reading.



Detailed Description of MAX30100:

The MAX30100 is a complete pulse oximetry and heart-rate sensor system solution designed for the demanding requirements of wearable devices. The MAX30100 provides very small total solution size without sacrificing optical or electrical performance. Minimal external hardware components are needed for integration into a wearable device.

The MAX30100 is fully configurable through software registers, and the digital output data is stored in a 16-deep FIFO within the device. The FIFO allows the MAX30100 to be connected to a microcontroller or microprocessor on a shared bus, where the data is not being read continuously from the device's registers.

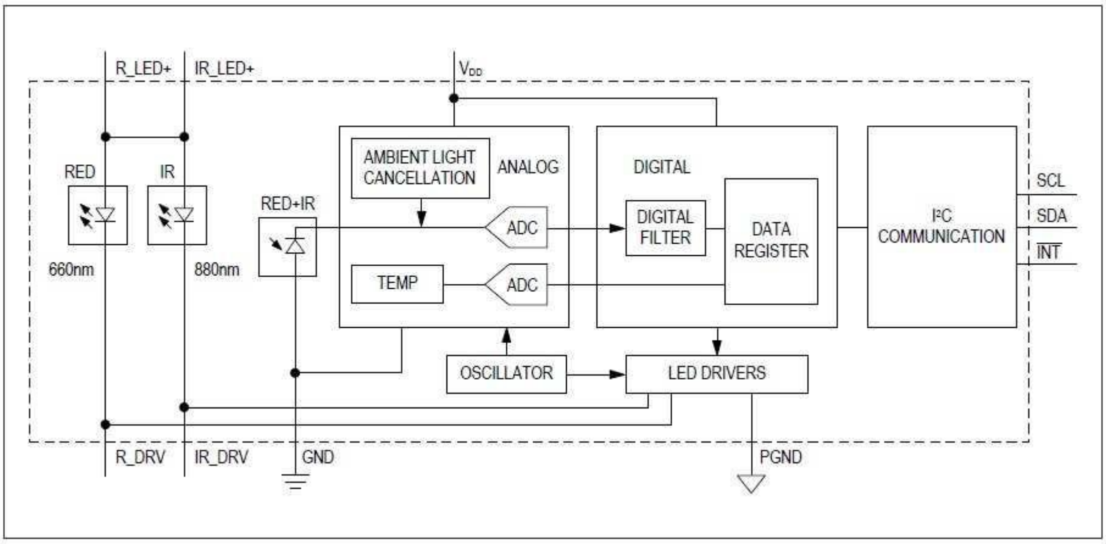


Figure : Functional Diagram of MAX30100

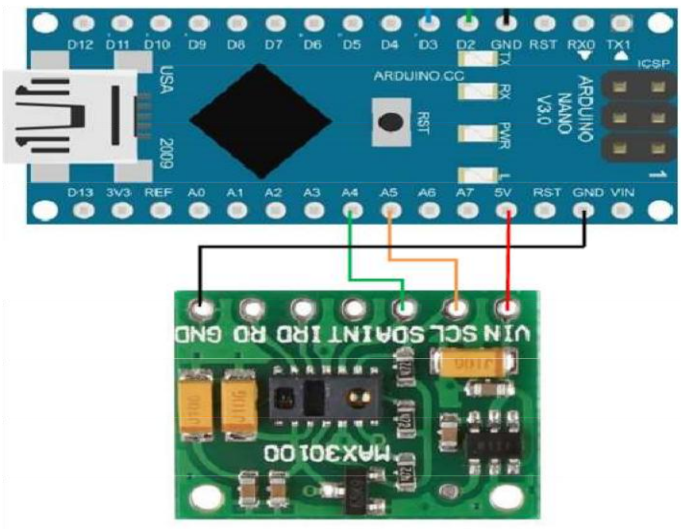
SpO2 Subsystem

The SpO2 subsystem in the MAX30100 is composed of ambient light cancellation (ALC), 16-bit sigma delta ADC, and proprietary discrete time filter.

The SpO2 ADC is a continuous time oversampling sigma delta converter with up to 16-bit resolution. The ADC output data rate can be programmed from 50Hz to 1 kHz. The MAX30100 includes a proprietary discrete time filter to reject 50Hz/60Hz interference and low-frequency residual ambient noise.

LED Driver

The MAX30100 integrates red and IR LED drivers to drive LED pulses for SpO2 and HR measurements. The LED current can be programmed from 0mA to 50mA (typical only) with proper supply voltage. The LED pulse width can be programmed from 200µs to 1.6ms to optimize measurement accuracy and power consumption based on use cases.



Interfacing of SPO2 MAX30100 Module with Arduino Nano Board:

Figure 4.14: I2C Interfacing of SPO2 MAX30100 Module with Arduino Nano Board

NTC Thermistor 10k:

Thermistor is an electronic component used to calculate the temperature. This is a type of resistor whose resistance varies with change in temperature. These NTC thermistors are made up from the combination of metal oxides which passed through sintering process which gives negative electrical resistance versus temperature (R/T) relationship to it. Due to having a large negative slope a small change in temperature cause a huge change in electrical resistance.

Figure : Thermistor 10K

Basically, there are two types of thermistor one is NTC (Negative Temperature Coefficient) and second one is PTC (Positive Temperature Coefficient). If the thermistor is NTC type then it decreases the resistance as increase in temperature and PTC behavior is just opposite to the NTC. A thermistor is connected with any electrical circuit to measure the temperature of the body or the substance. This thermistor’s operating temperature range is -55 °C to 125 °C, the range of the temperature is depend upon the base resistance.

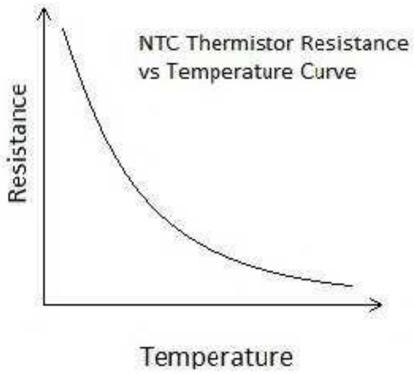


Figure : A Graph of thermistor relation between resistance & temperature

The graph shows the change in the resistance with respect to the temperature, the curve is for NTC type thermistor.

Features:

- Come with broad resistance range
- Thermistor cost is economical
- Provided with lacquer-coated thermistor disk
- Copper leads have coating of tin.

- Having lead spacing of 5.0 mm
- Component remarked with resistance and tolerance
- Good stability, durability in environment
- Provide high accuracy in resistance and B-constant
- Product is not containing lead
- Technical Specifications
- Resistance at 25 degrees C: 10K +- 1%
- B-value (material constant) = 3950+- 1%
- Dissipation factor (loss-rate of energy of a mode of oscillation) δ th = (in air)approx.7.5mW/K
- Thermal cooling time constant <= (in air) 20 seconds
- Thermistor temperature range -55 °C to 125 °C

Some Important Parameters

***1.* Zero-power Resistance of Thermistor: (R)**

The convenient reference point for thermistors provided by resistance is at 25 °C (substantially at room temperature).The formula by which the resistance of the thermistor is specified:

$$R=R0 \exp B (1/T-1/T0)$$

Where, R = Resistance in ambient temperature T (K)

R0 = Resistance in ambient temperature T0 (K)

B = Material constant

***2.* Material Constant: (B)**

Material constant B controls the slope of the RT characteristics as shown in figure. B value varies according to the temperature and defined between two temperature 25°C and 85°C by the formula:

$$B25/85 = \ln (R85/R25) / (1/T - 1/T0)$$

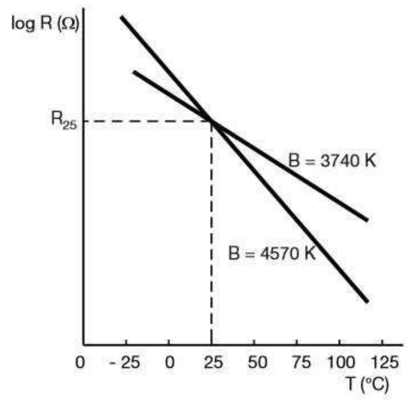


Figure : A Graph of Material constant

B25/85 is the value used to compare and characterize different ceramics. Tolerance on this value is caused by material composition.

2. **Temperature co-efficient of Resistance: (α)**

This value shows the sensitivity of a sensor according to temperature changes.

It defined as:

$$\alpha = \Delta B / T$$

The formula represents that the relative tolerance on α is equal to the relative tolerance on B-value.

3. **Thermal Time constant**

This is the time period in which the thermistor's temperature will rapidly change 63.2% of its temperature (T difference from ambient temperature (T1).

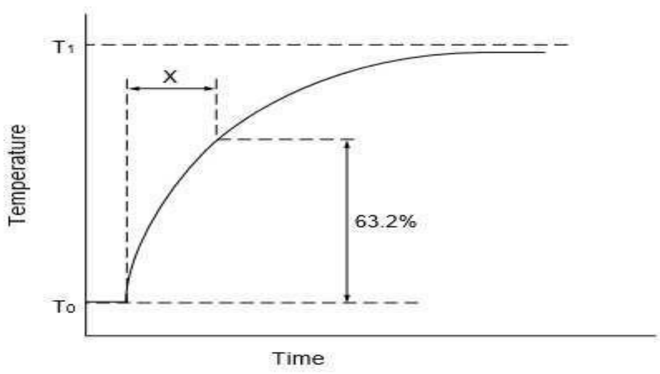


Figure : A graph of Thermal Time Constant

3. Thermal Dissipation Constant

The amount of electric power P (mW) consumed in T1 (ambient temperature) and T2 (rises thermistor temperature), there is a formula as follows:

P = C (T2-T1) Where, C is the thermal dissipation constant.

Interfacing of SPO2 MAX30100 Module with Arduino Nano Board:

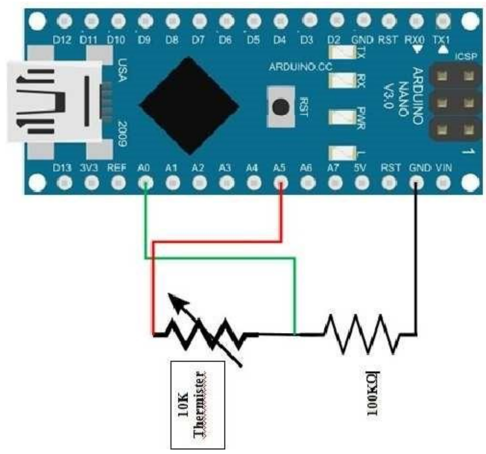
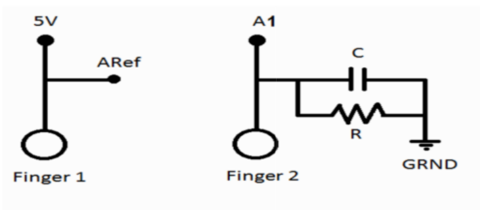


Figure : Interfacing of 10K thermister with Arduino Nano Board

Galvanic Skin Response (GSR):

The galvanic skin response is a method of measuring the Electrical conductance of skin, when people are anxious; they tend to sweat due to the activity of Sympathetic Nervous System. This is different from the typical sweating and it's highly reflected at palms and foot. Because of this sweating, it causes a difference in conductivity of the skin, by reducing the resistance. Hence, it is used as a measurement of anxiety, which in turns can be used in lie detection



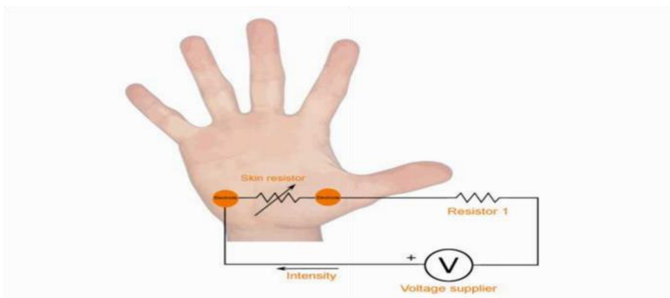


Figure : GSR Sensor

GSR, which falls under the umbrella term, of electro dermal activity, or EDA refers to changes in sweat gland activities that are reflective of the intensity of our emotional state, otherwise known as emotional arousal. Our level of emotional arousal changes in response to the environment we're in – if something is scary, threatening, joyful, or otherwise emotionally relevant, then the subsequent change in emotional response that we experience also increases echini sweat gland activity.

Chapter 4: IMPLEMENTATION

Working:

To measure electro dermal activity (EDA) using an Arduino board. A traditional theory of EDA states, that it varies with the skin changes of sweat glands, thus altering the electrical resistance. EDA is modulated as outcome of cognitive processes, emotions, and general human behavior. The techniques to measure EDA is straight forward:

By inducing voltages through one electrode, an electrical output is measured using a second electrode. The higher the measured value is, the higher the EDA is. This can be easily achieved using an Arduino. By using the 5V power to induce voltages, a second electrode is used to read the remaining voltages. Connect one cable from the 5V output of the Arduino to a sensor. To construct a sensor, connect an electrode cable to a piece of wrapped aluminum foil. Wrap it around the Velcro tape, which will serve as a retainer for the fingers. Construct a second sensor, which is connected pull down 100k ohm resistors. Finally, connect a electrode cable to A1 on the Arduino board. While one sensor induces electrical voltages, the other one measures the remaining arriving electrical potential.

Interfacing of Galvanic Skin Response sensor with Arduino Nano Bord:

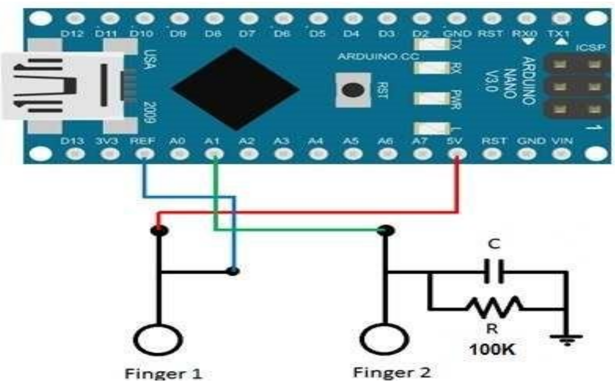


Figure : Interfacing of GSR sensor with Arduino Nano Board

4.1 DETAILS OF NODE MCU ESP8266 ESP-12E WIFI BOARD:

NodeMCU is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module. The term “NodeMCU” by default refers to the firmware rather than the DevKit. The firmware uses the Lua scripting language. It is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as lua-cjson, and spiffs.

Figure : Node MCU ESP8266 ESP-12E WiFi Development Board

ESP8266EX (simply referred to as ESP8266) is a system-on-chip (SoC) which integrates a 32-bit Tensilica microcontroller; standard digital peripheral interfaces, antenna switches, RF balun, power amplifier, and low noise receive amplifier, filters and power management modules into a small package. It provides capabilities for 2.4 GHz Wi-Fi (802.11 b/g/n, supporting WPA/WPA2), general-purpose input/output (16

GPIO), Inter-Integrated Circuit (I²C), analog-to-digital conversion (10-bit ADC), ESP8266.net — The Internet of Things with ESP8266 UART (on dedicated pins, plus a transmit-only UART can be enabled on GPIO2), and pulse-width modulation (PWM). The processor core, called "L106" by Espressif, is based on Tensilica's Diamond Standard 106 Micro 32-bit processor controller core and runs at 80 MHz (or overclocked to 160 MHz). It has a 64 KiB boot ROM, 32 KiB instruction RAM, and 80 KiB user data RAM. (Also, 32 KiB instruction cache RAM and 16 KiB ETS system data RAM.) External flash memory can be accessed through SPI. The silicon chip itself is housed within a 5 mm × 5 mm Quad Flat No-Leads package with 33 connection pads — 8 pads along each side and one large thermal/ground pad in the center.

Features:

- Version : DevKit v1.0
- Breadboard Friendly
- Light Weight and small size.
- 3.3V operated, can be USB powered.
- Uses wireless protocol 802.11b/g/n.
- Built-in wireless connectivity capabilities.

- Built-in PCB antenna on the ESP-12E chip.
- Capable of PWM, I2C, SPI, UART, 1-wire, 1 analog pin.
- Uses CP2102 USB Serial Communication interface module.
- Arduino IDE compatible (extension board manager required).
- Supports Lua (alike node.js) and Arduino C programming language.

Pin out Diagram:

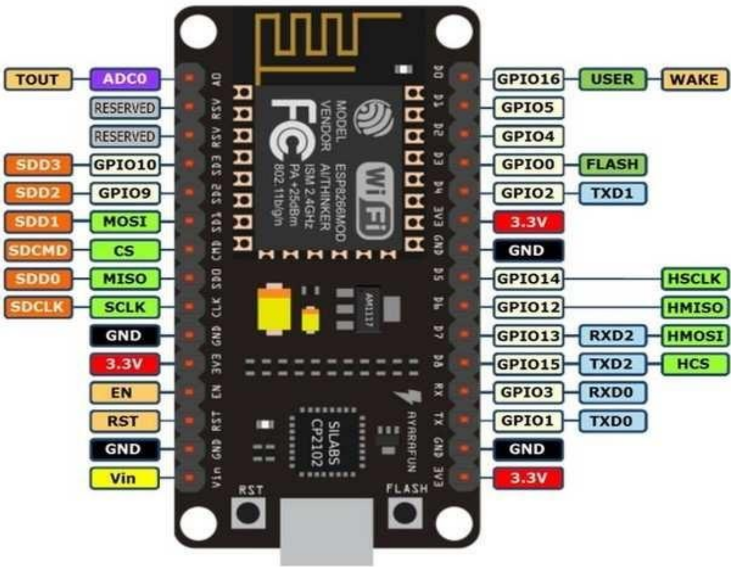


Figure 4.23: Pin out Diagram of MCU ESP8266 ESP-12E WiFi Development Board

Specifications of ESP-12E WiFi Module:

- IO Capability -UART, I2C, PWM, GPIO, 1 ADC
- Electrical Characteristic-3.3 V Operated, 15 mA output current per GPIO pin,

  Less than 200 uA standby current, 12 - 200 mA working current
- Operating Temperature--40 to +125 ºC
- Serial Transmission-110 - 921600 bps, TCP Client 5,
- Wireless Form- On-board PCB Antenna
-

4.7 INTERNET OF THINGS (IOT):

The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

A thing in the internet of things can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low or any other natural or man-made object that can be assigned an IP address and is able to transfer data over a network. Increasingly, organizations in a variety of industries are using IoT to operate more efficiently, better understand customers to deliver enhanced customer service, improve decision-making and increase the value of the business.

How Its Works

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

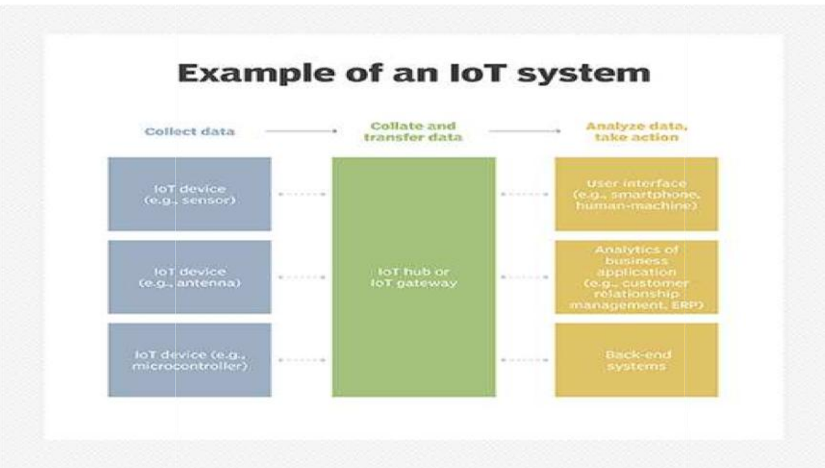


Figure 4.24: Example of Internet of Things

Consumer and enterprise IoT applications

There are numerous real-world applications of the internet of things, ranging from consumer IoT and enterprise IoT to manufacturing and industrial IoT (IIoT). IoT applications span numerous verticals, including automotive, telco, energy and more. In the consumer segment, for example, smart homes that are equipped with smart thermostats, smart appliances and connected heating, lighting and electronic devices can be controlled remotely via computers, smart phones or other mobile devices.

Figure 4.25: Applications of Internet of Things

Wearable devices with sensors and software can collect and analyze user data, sending messages to other technologies about the users with the aim of making users' lives easier and more comfortable. Wearable devices are also used for public safety -- for example, improving first responders' response times during emergencies by providing optimized routes to a location or by tracking construction workers' or firefighters' vital signs at life-threatening sites.

In healthcare, IoT offers many benefits, including the ability to monitor patients more closely to use the data that's generated and analyze it. Hospitals often use IoT systems to complete tasks such as inventory management, for both pharmaceuticals and medical instruments.

Smart buildings can, for instance, reduce energy costs using sensors that detect how many occupants are in a room. The temperature can adjust automatically -- for example, turning the air conditioner on if sensors detect a conference room is full or turning the heat down if everyone in the office has gone home.

In agriculture, IoT-based smart farming systems can help monitor, for instance, light, temperature, humidity and soil moisture of crop fields using connected sensors. IoT is also instrumental in automating irrigation systems.

In a smart city, IoT sensors and deployments, such as smart streetlights and smart meters, can help alleviate traffic, conserve energy, monitor and address environmental concerns, and improve sanitation.

4.8 THINGER.IO – AN OPEN SOURCE INTERNET OF THINGS:

Overview

This documentation is related with the Arduino client library version of the Thinger.io platform. With this library you will be able to connect almost any Arduino board using Ethernet, Wifi, GSM, or other supported boards like ESP8266, NodeMCU, and TI CC3200. The client library allows connecting your IoT devices to the Thinger.io cloud platform. This is a library specifically designed for the Arduino IDE, so you can easily program your devices and connect them within minutes.

It supports multiple network interfaces and boards, like Ethernet Shield, Wifi Shield, and GSM. It also supports other boards like ESP8266 (or NodeMCU), Texas Instruments CC3200 Launchpad, and Adafruit CC3000 board. It requires a modern Arduino IDE version, starting at 1.6.3.

Installation

The first step to start building thinger.io devices is to install the required libraries in the Arduino IDE to support exposing device resources like sensor values, lights, relays, and so on. If you do not have the Arduino IDE installed yet, then it is a good moment to start, here are also some advices to choose the right version.

Arduino IDE

It is required a modern version of Arduino supporting Library Manager and some other features. Please install a version starting form 1.6.3 from the official Arduino download page. This step is not required if you already have a modern version.

There are two ways of installing the library. The preferred way is by using the Arduino Library Manager, which simplifies searching and installing new libraries. It also supports updating libraries when new versions are released. So use this method when possible. The other way to install the library is by using the traditional method of download and import the zip library.

Library Manager

The easiest way to install new libraries is by using the Library Manager available in the Arduino IDE. For installing the thinger.io library please follow the following steps:

Open the Library Manager Search and install the thinger.io library now the library should be available with some default examples.

Supported Hardware

The thinger.io platform is designed to support almost any microcontroller or device with communication capabilities. No matter if it has Ethernet, Wifi, GSM, or the chip is from some vendor or not. Almost any device can be integrated in the cloud. So you can choose the hardware you want to connect, as this platform does not force you to purchase some compatible vendor hardware. This is a crucial when designing your IoT projects. Here you are free to choose the hardware you want.

In the following sections there are some of the devices that are compatible trough the Arduino IDE.

ESP8266 / NODEMCU

The ESP8266 chip from Espressif was the new generation of low-cost WiFi chips after the TI CC3000/CC3200. This small chip not only integrates the whole WiFi features, but also a powerful programmable MCU. Depending on the board layout (ESP-01, ESP-03, ESP-07, ESP12, etc) it is attached to a programmable flash, ranging from 512K to 4M. This increases the available user code space, and makes possible other cool features like a small file system, or OTA updates. This device can be directly programmed from the Arduino IDE. You can follow the following steps if you did not program these boards with the Arduino IDE. The only requirement is to install the board via the Arduino Boards Manager.

For this step, just put http://arduino.esp8266.com/stable/package_esp8266com_index.json into Additional Board Manager URLs field in the Arduino v1.6.4+ preferences. If this URL is not working,maybe you may need to check the Github project that supports the library: ESP8266 Github In the Arduino preferences, enter

http://arduino.esp8266.com/stable/package_esp8266com_index.json in Additional Boards Manager URLs. Next, go to the Boards manager to install the ESP8266 package. Search for the esp8266 and install the package esp8266 by ESP8266 Community Tools > Boards > Board manager… Then search and install the esp8266 package.

Now you can program almost any ESP8266 directly from the Arduino IDE. From the Tools > Boards you should see now the new ESP8266 boards installed. Select your board to be able to compile code for the ESP8266. Select the ESP8266 based board you will program from Tools > Boards

You can find additional information for the ESP8266 package in the ESP8266 Github Repository. The easiest board to program is the Node MCU, which does not require pressing Flash + Reset buttons for uploading the sketch. For other boards you will need to use a USB to Serial converter (3v3) and flash the sketch by setting some GPIOs to GND. Please search in Google for this step if you are not sure how to make it for your board. For our example we will be using the NodeMCU that already converts the 5v from USB to 3v3, and provides the USB to Serial embedded in the board.

The following example will allow connecting your device to the cloud platform in a few lines. Just replace the sketch username, deviceId, and deviceCredential with your own credentials, and the WiFi_SSID, WiFi_Password with the WiFi credentials.

```
harshathingliot §
#include <EEPROM.h>
#include <ESP8266WiFi.h>
#include <ThingerESP8266.h>

#define USERNAME "healtiot"
#define DEVICE_ID "ESP8266SensorNode2"
#define DEVICE_CREDENTIAL "12345678@2"

#define SSID "harshalprojme"
#define SSID_PASSWORD "harshalnode"

ThingerESP8266 thing(USERNAME, DEVICE_ID, DEVICE_CREDENTIAL);
```

Screen-shots : Initialization of thinger.io login user name, device ID & Credential, and Wi-Fi Coordinator Wi-Fi SSID & Password in a code

4.9 SOFTWARE DEVELOPMENT:

Writing a Source Code:

The program is written in ‘C’ language. It is compiled and can programmed (upload) into the target device/board using Arduino integrated development environment (IDE). Arduino IDE is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards.

In our system design software two source code i.e sketches in term of Arduino need to develop one is for the main Microcontroller unit that is Arduino nano board and other is for Wi-Fi module is called Node McU.

Writing of source code for the Arduino nano board (Microcontroller- ATmega 328) which includes flowing steps:

1) Initialization of digital sensor modules and ADC for read the data from digital sensor & analog sensors also initialization of I2C and UART for communication with digital sensor and Wi-Fi Node McU module.
2) Read/acquire data from sensors.
3) Process data received from sensors.
4) Processing data serially send to Wi-Fi IoT Device (NodeMcU).

Figure 4.26 shows the program flow chart of the Ardunio board (Microcontroller Atmega 328).

Similarly the second source code written for NodMcU Wi-Fi development board, which include flowing steps:

1) Initialization of the ESP2866 Wi-Fi for connect ESP8266 module to Wi-Fi network, ESP2866 to allow connecting your IoT devices to the Thinger.io cloud and UART for serial communication.
2) Define IoT device(ESP8266) user name, device Id, device credential which is already define in Thinger.io an IoT Cloud platform to access sensor node at thinger.io website.

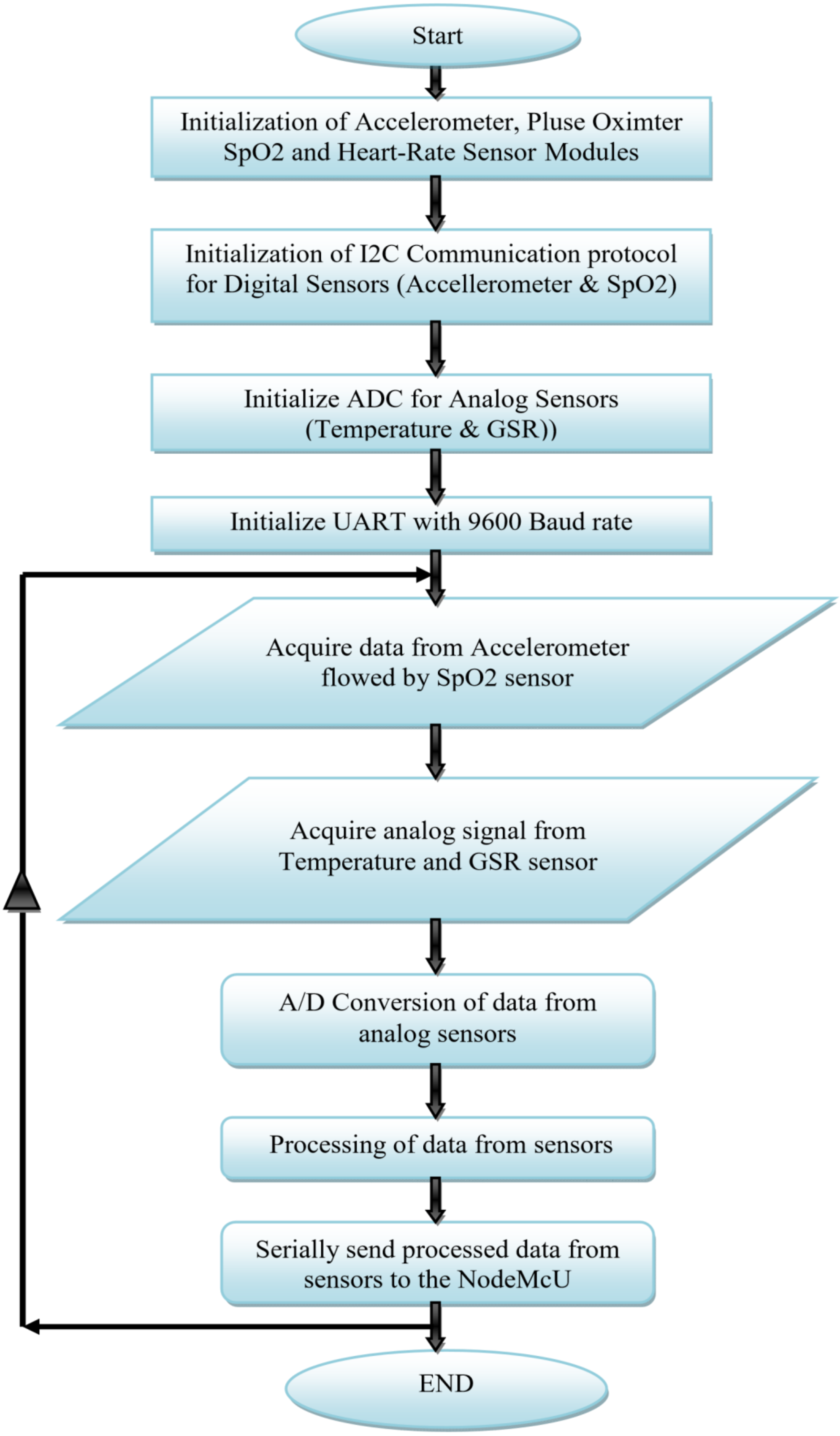


Figure 4.26: Program Flow chart for Arduino Nano (μC-ATmega328)

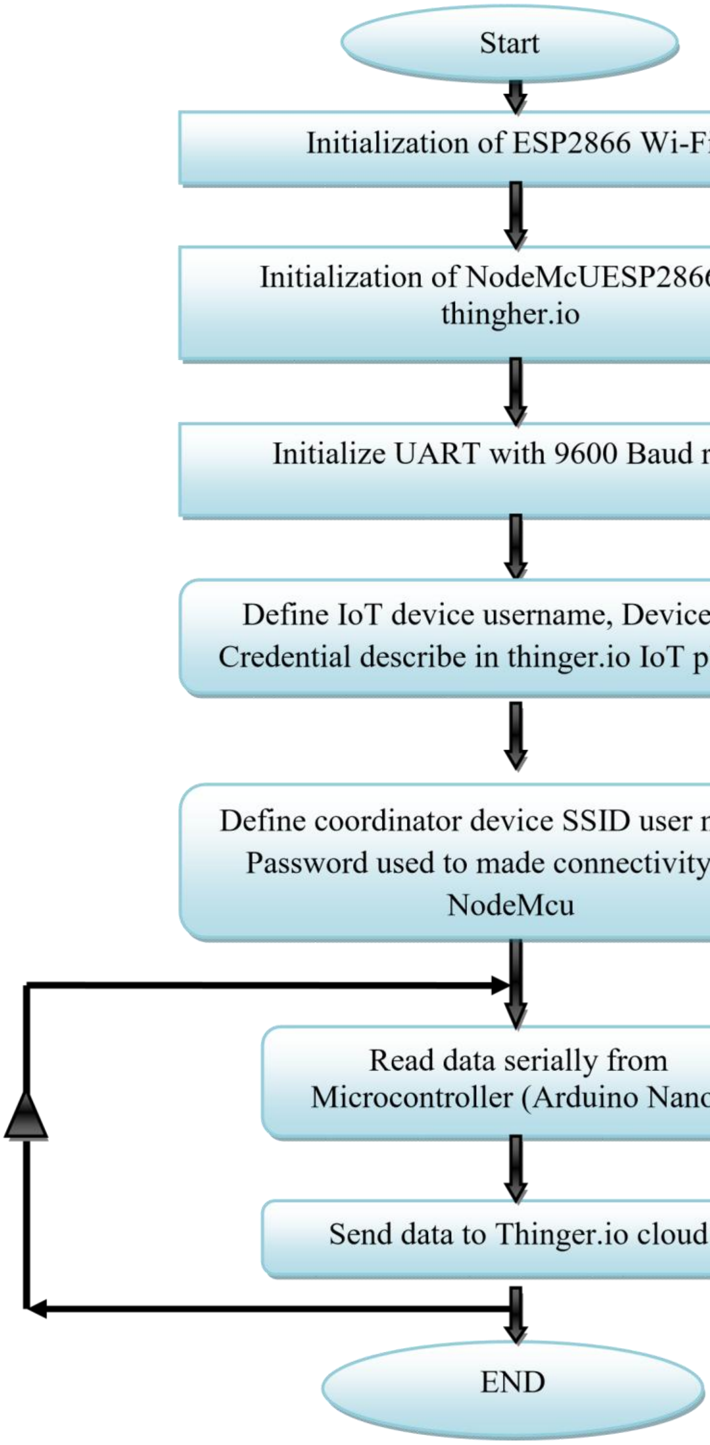


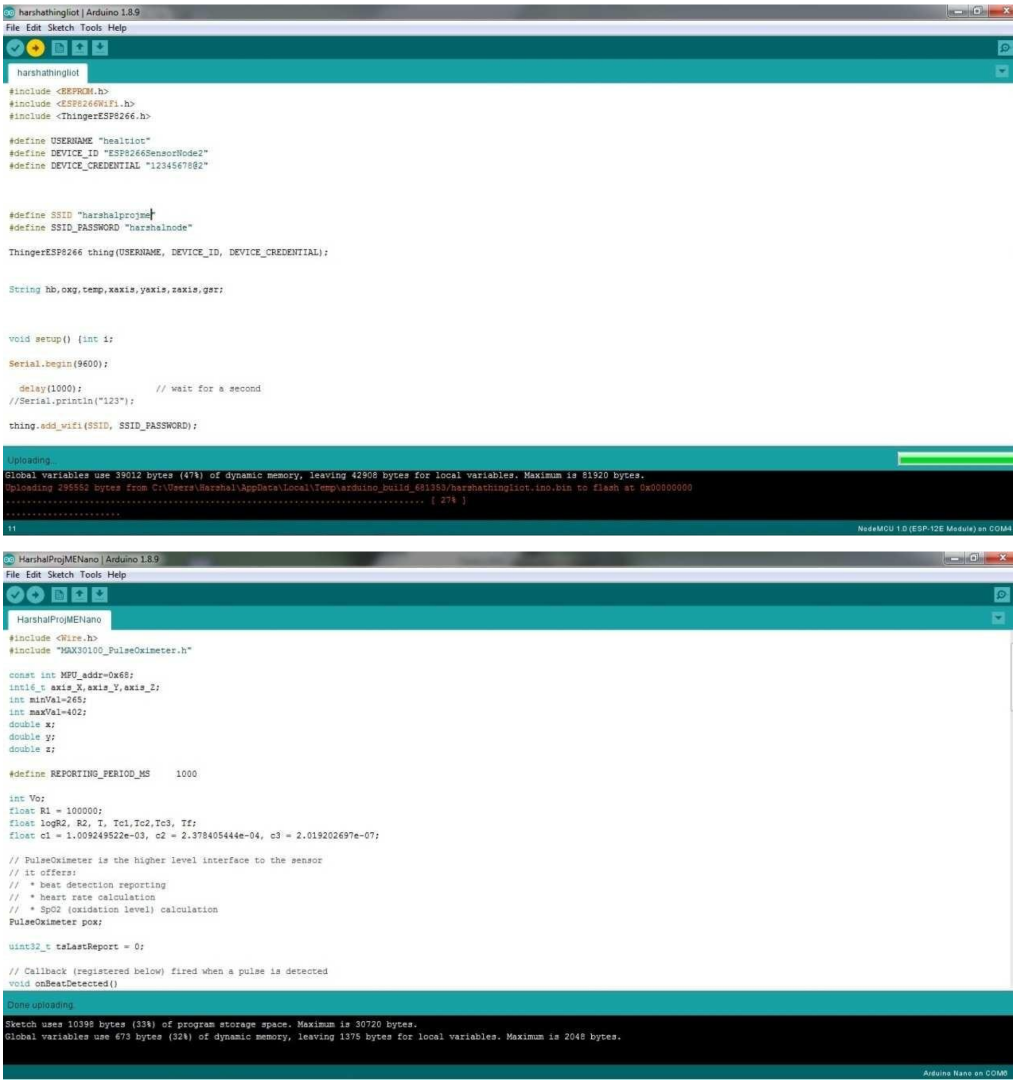
Figure 4.9.1: Program Flow chart for NodeMcU Wi-Fi Dev. board

Compilation and Uploading:

While compiling of source code (sketch) some important library must need to install (for example MAX30100, Thinger.io) from library manager tool.

Uploading a source code to the target board tools must be specify, that are Board type, upload speed, CPU frequency, Flash Size, Com port and programmer. Board can be added or install from board manager tool as similar as library manager.

During Programming/uploading source code of NodeMcU WiFi Module> board: NodeMcU 1.0 (EsSP-12E module) and Programmer: AVRISP mkII where as for Microcontroller > board: Arduino nano, Processor: ATmega328P and Programmer: arduinoISP are taken into account.



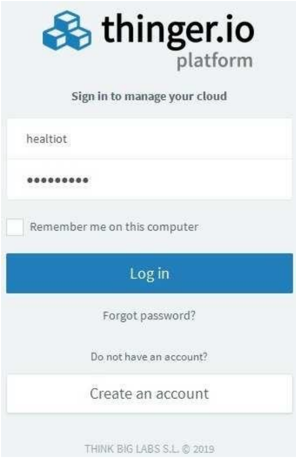
Screen-shots 4.9: A snapshot of sketch compilation & uploading to the target board.

CHAPTER 5 RESULT

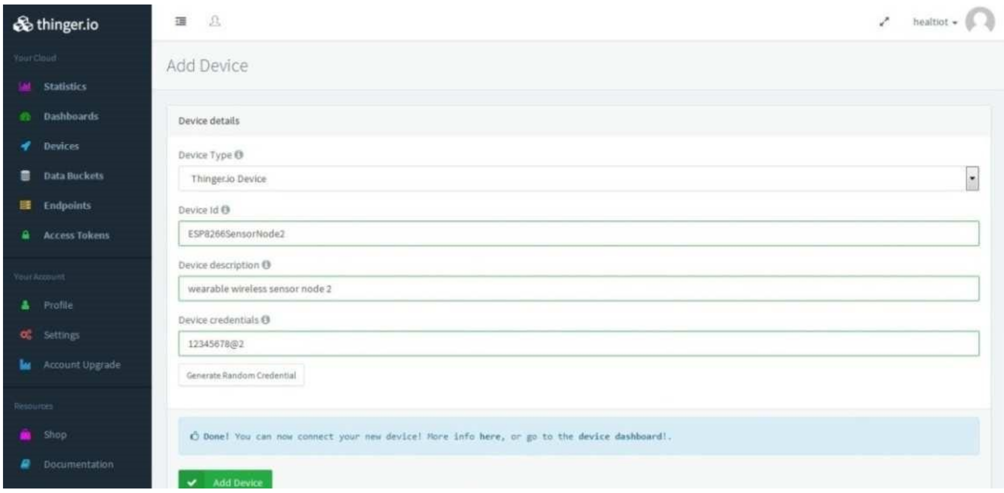
Brief Introduction of Thinger.io IoT Platform:

To see the result, that is monitoring of human body parameters from wearable wireless sensor nodes we have to visit http://thinger.io website, first create a Login account and do following steps:

1.Create device: - The first step to start an IoT project in Thinger.io is by creating devices, which will grant access to connect your devices to your account. To register a new device, once you have been logged in your console dashboard, please go to the Devices section that appears in the left menu. Click on Add Device that will open a form in which you can introduce the device credentials as shown in Screen-shots 5.2.

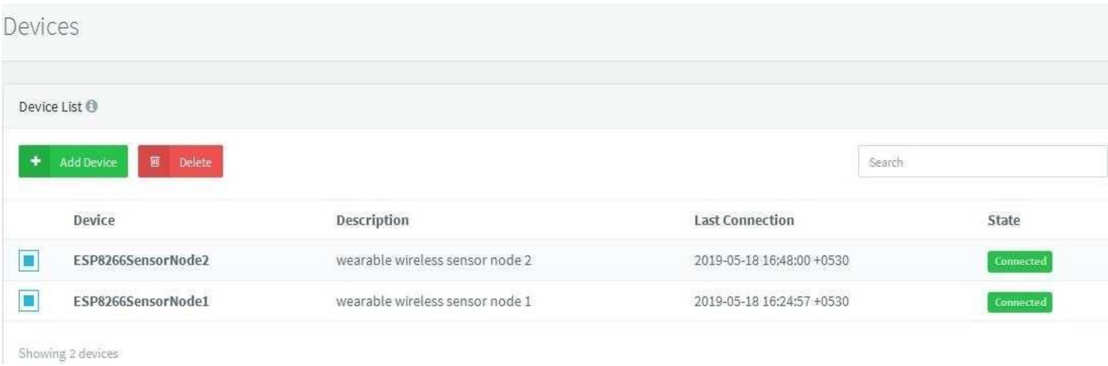


Screen-shots 5.1: Account login & Statistics section on thinger.io



Screen-shots 5.2: Device credentials detail in thinger.io

Add here the device identifier (unique within your devices), a device description that may help you to identify your device, and the device credentials as mention in Node McU ESP8266 code (software). If all goes fine, you should see some success message. Now, you can o back to your devices list, and your device should appear similar to the following picture.



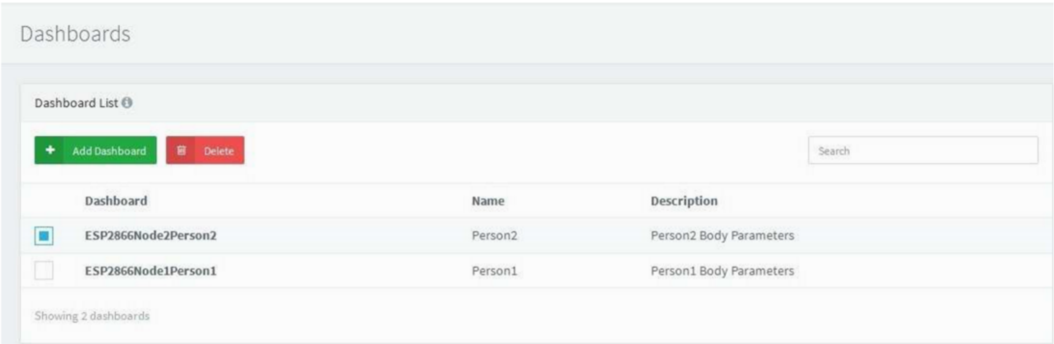
Screen-shots 5.3: List of created device in thinger.io

Create Dashboards: A dashboard is a graphical user interface that allows displaying information in different figures and charts. Here we can configure the dashboards with different widgets; configure its layout, dimension, color, and data sources to generate valuable information for our project. The dashboards can display information in real-time from our sensor node devices.

To manage all our dashboards, it is necessary to access to the dashboards section, then click on the Add Dashboard button that will open a new interface for entering the dashboard details, like in the following screenshot:

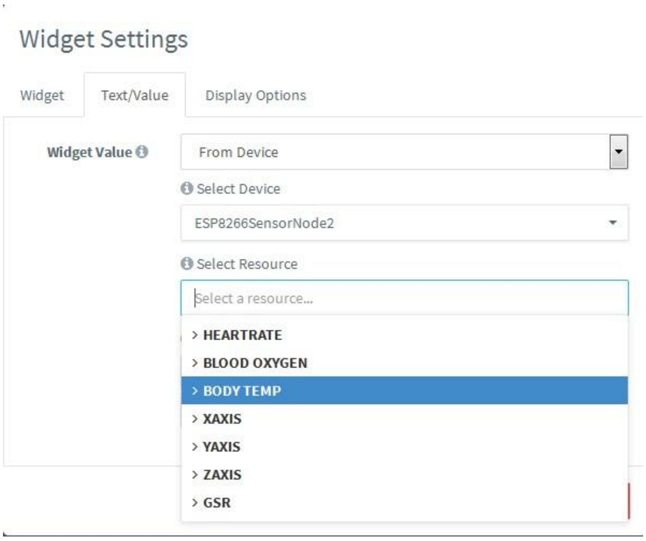
Screen-shots 5.4: Addition of dashboard in thinger.io

After this process, it is possible to access to the new dashboard that will appear like in following screenshot.



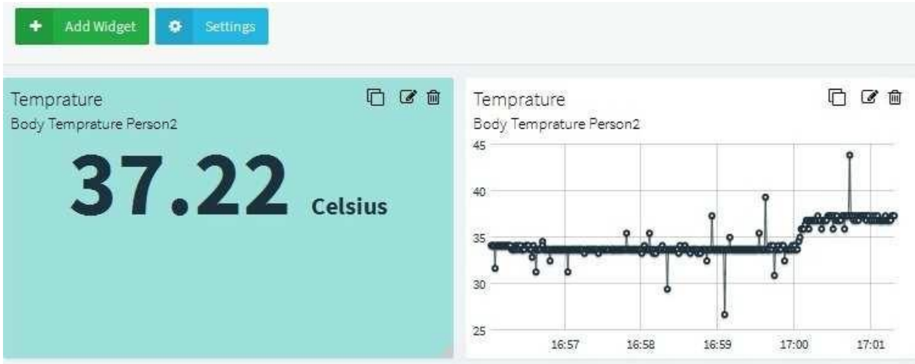
Screen-shots 5.5: List of created dashboard in thinger.io

1. Add a Display Widget: When the edit mode is enabled in the dashboard, a new button called Add Widget will appear. Clicking on it will show a popup where it is possible to select the widget type to add in the dashboard. There are different widgets both for displaying information, or control connected devices, just like in the following picture:



Screen-shots 5.6: Addition of widget in dashboard on thinger.io

After adding display widget and widget setting the widget display for Temperature as shown in below picture



Screen-shots 5.7: Widget for temperature in Dashboard

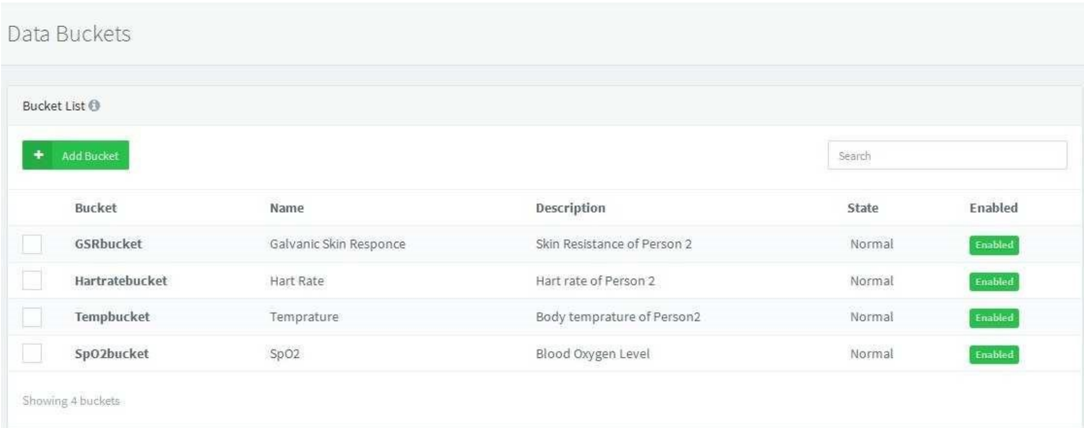
Similarly add display widget for sensor node devices (ESP8266 Sensor Node1 & node 2) and resources/parameters (Hart rate, SpO2, GSR, Accelerometer).

2.Create Data Bucket: A data bucket is some kind of virtual storage where you can keep time series information over time. This information can be used to plot information in dashboards, or can be exported in different formats for offline processing.

To create a data bucket, you need to access the Data Buckets feature just press in the Add Bucket button, which will show the following screen:

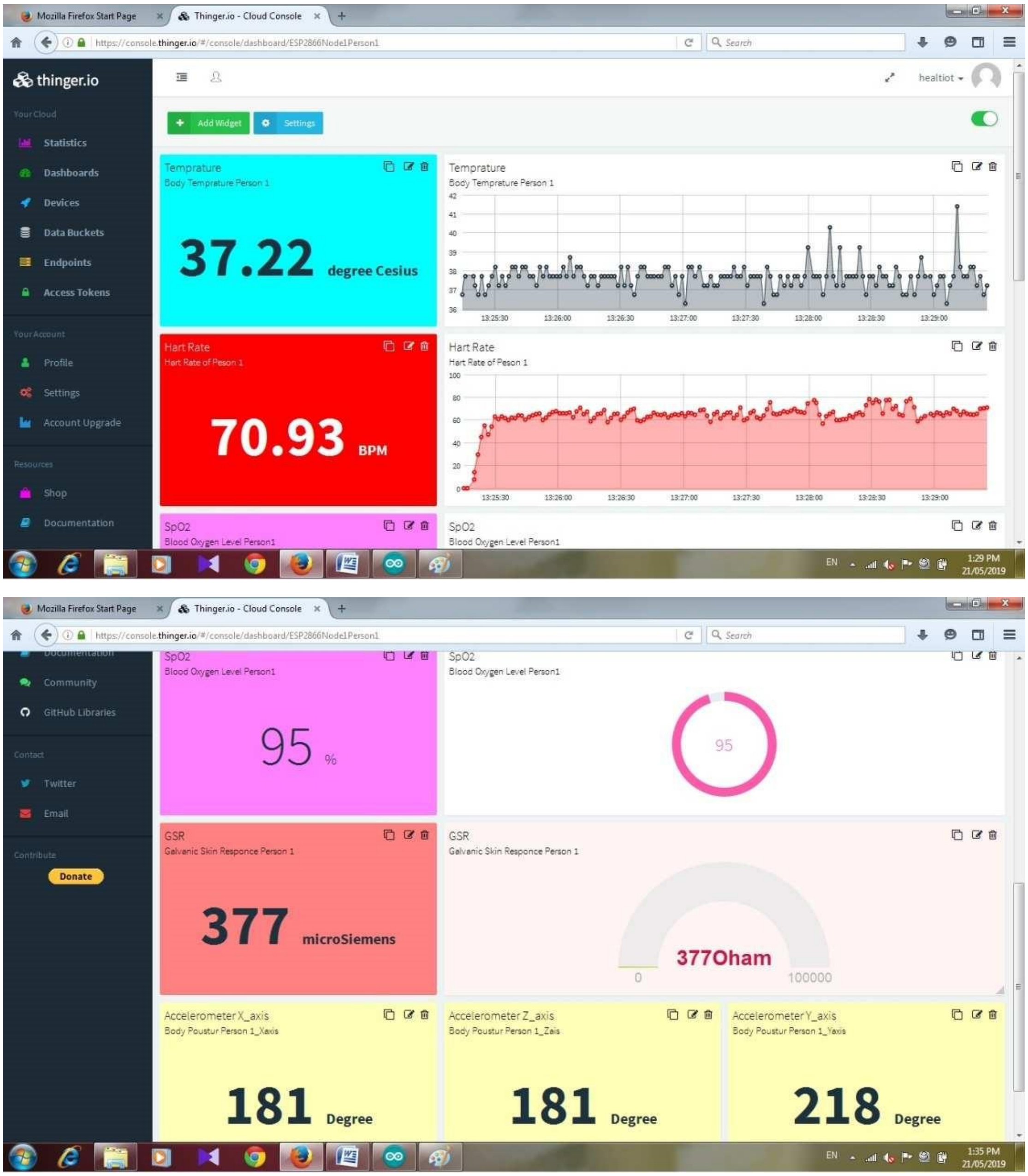
Screen-shots 5.8: Creating a data bucket for resources

And necessary to configure different parameters mention in bucket detail. After creating data buckets for our resources (Sensor Parameters) the data buckets will appear like in following screenshot.

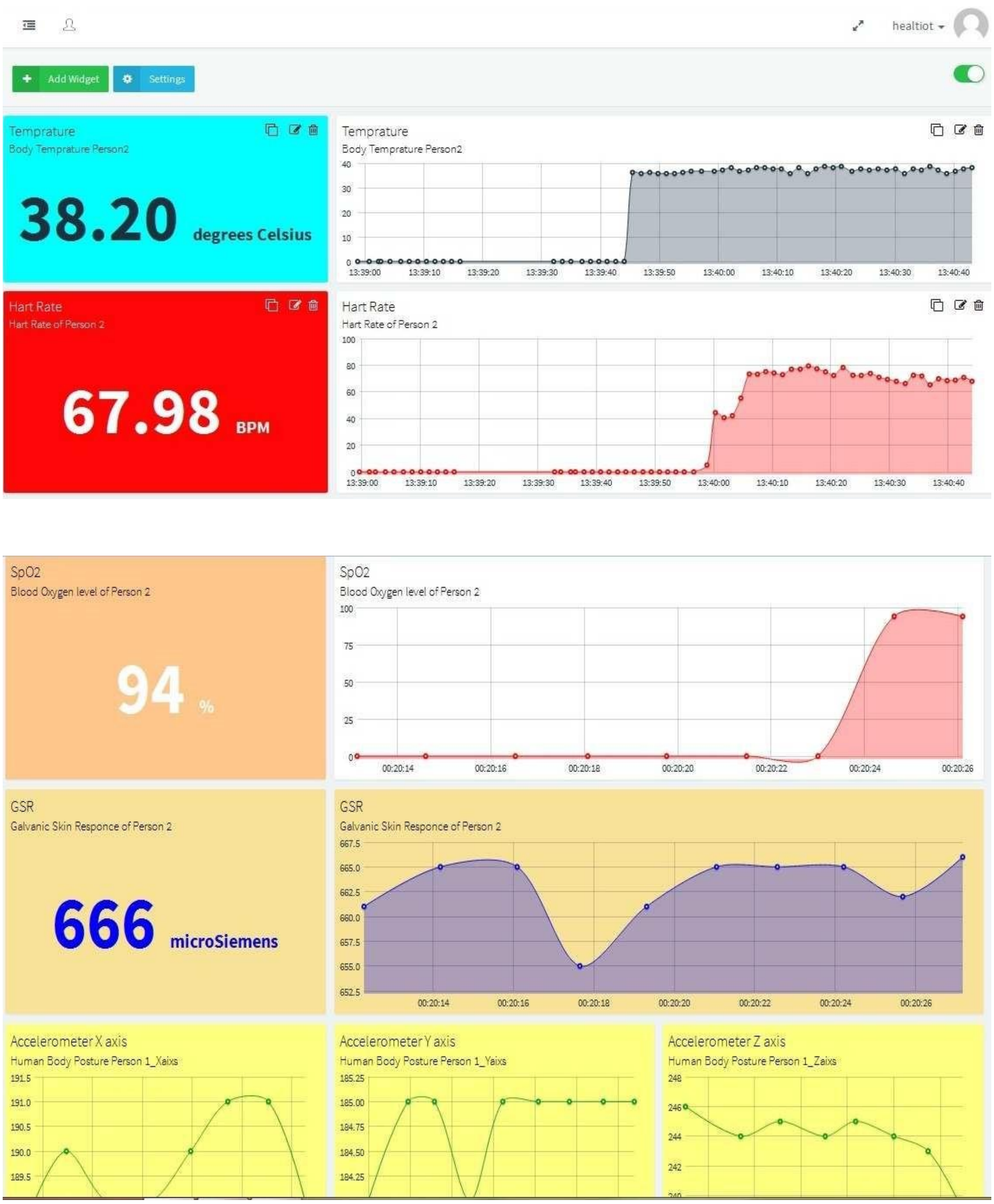


Screen-shots 5.9: Created data buckets for our resources

Now finally it is time to see our project result from sensor nodes that are ESP8266Sensor Node1 and ESP8266Sensor Node2, monitoring of human body parameters such as Temperature, Hart rate, Blood Oxygen level, Skin Resistance and Body posture. Here are the different screen shots of result which displays body parameters in the form of text values and graphical format.



Screen-shots 5.10: Various body parameters from sensor Node 1, Person 1



Screen-shots 5.11: Various body parameters from sensor Node 2, Person 2

CHAPTER 6 APPLICATIONS:

Medical science :

Patient monitoring undergoing physiotherapy and patient surveillance. As we need of proper counseling for health. And this need must be satisfied, because this entire database stored in one place which can be used for further patient's recovery as early as possible. So it provides the most medical help to patient and doctor as well as to the family members of patient.

Sports science :

- For analysis of sport rehabilitation exercises.
- Recognition of physical activities and their intensities

It is also applicable for player monitoring. Starting with the national game "HOCKEY" we are lacking in this day by day if we use our project for this then we easily monitor the player and according to that we increase the efficiency of player as well as game. By this we know how to kick the ball, how to make goal and stop that (for opponent), means we know all the defense criteria.

For Military :

Military the most important for nation development, here we can also use this project for monitoring the soldier to know the day to day routine of them and this database use for the improvement of soldier and health therefore increase efficiency of nation's military.

And other :

- Human motion capture and analysis.
- For interactive dance performance.
- Human motion tracking for rehabilitation

Chapter 7: Future Scope

In our Project "Monitoring of Human Body Parameters using wearable wireless sensor network", the hardware part of system design is the sensor node which include digital & analog sensors, arduino nano board and node McU Wi-Fi modules, it is an important aspect of the design was miniaturization, so that the system was as nonintrusive as possible to the wearer. This was achieved by the use of wearable sensors module and nano boards with ultra low power operating devices which increases battery life for wearable sensor node.

With some modification, the system can be made available commercially. Future improvements will focus on the use of embedded board which include microcontroller with Wi-Fi device on a single board instead of Arduino nano and nodeMcU boards. Again addition of more wearable sensors such as ECG, EEG, EMG, pressure, airflow in the system which improves the performance of the system. Depending on the applications such as sports, medical, physical exercise where system going to be used a provision of selection of sensors can be made, would allow the system to be more advance and more comfortable for the wearer.

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Chapter 8: Conclusion

A new approach for remote measurement and monitoring of the human body parameters based on a wearable wireless sensor network has been presented. The proposed design will be able to effectively measure and monitor human body parameters collectively.

The system uses wearable sensors, Wi-Fi standard wireless communication protocol for data transfer between the sensors node and coordinator. The coordinator allows transfer of data from sensor nodes to the IoT cloud environment, which will allow monitoring of all human body parameters on IoT platform effectively.

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