VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM

PROJECT REPORT

on

"IOT BASED SMART PATIENT HEALTH MONITORING BAND"

Submitted in partial fulfilment of the requirements for the award of

BACHELOR OF ENGINEERING

IN

ELECTRICAL AND ELECTRONICS ENGINEERING

For the academic year 2019-2020

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CERTIFICATE

This is to certify the Project work entitled "IOT BASED SMART PATIENT HEALTH MONITORING BAND", carried by the following bonafide students of **CMR Institute of Technology, Bengaluru** in partial fulfillment of the requirements for the award of **Bachelor of Engineering in** Electrical and Electronics **Engineering** of the V**isvesvaraya Technological University, Belagavi-590018** during the academic year 2019-20. This is certified that all the corrections and suggestions indicated for Internal Assessment have been incorporated in the report deposited in the departmental library. The Project report has been approved as it satisfies the academic requirements prescribed for the said degree.

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ABSTRACT

THE PROBLEM STATEMENT

Health monitoring is the major problem in today's world. Due to lack of proper health monitoring, patient suffer from serious health issues. There are lots of IoT devices now days to monitor the health of patient over internet. Health experts are also taking advantage of these smart devices to keep an eye on their patients. With tons of new healthcare technology start-ups, IoT is rapidly revolutionizing the healthcare industry.The problem is focused mainly by to reduce the gap between patient and doctor where the patient is at a distant place and the doctor needs to monitor the patient's health.

THE PROPOSED SOLUTION

In this project, we are monitoring various parameters of the patient using the internet of things. In the patient monitoring system based on the Internet of things project, the real-time parameters of a patient's health are sent to the cloud using Internet connectivity. These parameters are sent to a remote Internet location so that user can view these details from anywhere in the world.

There is a major difference between SMS based patient health monitoring and IOT based patient monitoring system. In IOT based system, details of the patient health can be seen by many users. The reason behind this is that the data needs to be monitored by visiting a website or URL. Whereas, in data based patient monitoring, the health parameters are sent using data via SMS.

TECHNICAL DETAILS

IOT patient monitoring has 3 sensors. The first one is a temperature sensor, the second is the Heartbeat sensor and the third one is humidity sensor. This project is very useful since the doctor can monitor patient health parameters just by visiting a website or URL. And nowadays many IOT apps are also being developed. So now the doctor or family members can monitor or track the patient's health through the Android apps.

This system shows patients temperature and heartbeat tracked live data with timestamps over the Internet network. Thus Patient health monitoring system based on IoT uses internet to effectively monitor patient health and helps the user monitoring their loved ones from work and saves lives.Here we use aurdino lilypad and wifi module with other sensors to analyse the patient health and share it to the cloud in real time.

CHAPTER 1

INTRODUCTION

Health care, health-care, or healthcare is the maintenance or improvement of health via the prevention, diagnosis, and treatment of disease, illness, injury, and other physical and mental impairments in people. Health care is delivered by health professionals in allied health fields.
Physicians and physician associates are a part of these health professionals. Dentistry, midwifery,nursing, medicine, optometry, audiology, pharmacy, psychology, occupational therapy, physical therapy and other health professions are all part of health care. It includes work done in providing primary care, secondary care, and tertiary care, as well as in public health.

Access to health care may vary across countries, communities, and individuals, largely influenced by social and economic conditions as well as health policies. Providing health care services means "the timely use of personal health services to achieve the best possible health outcomes".[1] Factors to consider in terms of healthcare access include financial limitations (such as insurance coverage), geographic barriers (such as additional transportation costs, possibility to take paid time off of work to use such services), and personal limitations (lack of ability to communicate with healthcare providers, poor health literacy, low income).[2] Limitations to health care services affects negatively the use of medical services, efficacy of treatments, and overall outcome (well-being, mortality rates).

Health monitoring systems are gaining their significance as the Fast-growing universal elderly population increases demands for caretaking. In ICU there is needed to continuous monitoring their health conditions. In so many cases patients released from the hospital still they are strongly advised to be under rest and observation some period time then these cases the system is very much helpful. Chronic diseases such as cardiovascular illnesses, cancers, chronic respiratory sicknesses, and diabetes, are the primarily causes of death in the world. The mortality rate of these chronic diseases is of about 68% of the world's population [3]. When people suffer a chronic disease, they need a constant monitoring of their vital signals. These biomedical signals provide information about the health patient status, allowing the patient to have a better treatment.

Unfortunately, commercial vital signals monitors are expensive and skilled personnel is required. Making the monitor difficult to acquire and to interpret. In addition, some patients are restricted to bed and wired to large machines. These machines do not allow patients to perform their normal daily activities. A portable and ambulatory device is going to be helpful to solve this factor.

In recent years, several works have approached this issue, designing monitoring systems based on microcontrollers and small screens. Smartphones and PDAs (personal digital assistant) have been used as monitors too. A BSN (Body Sensor Network) is a special purpose network designed to operate autonomously to connect to various medical sensors and implants located inside and outside of the human body. Introducing it in medical monitoring will offer flexibility of operation and cost saving options to both healthcare professionals and patients. They reduce user discomfort and enhance mobility. Applications in this category include monitoring of the human physiological data, tracking and monitoring of the patients inside a hospital, drug administration in hospitals etc [4]. Vitals signs are used to measure body's basic functions which can be helpful for monitoring general health of a person.

Health care systems are organizations established to meet the health needs of targeted populations. According to the World Health Organization (WHO), a well-functioning health care system requires a financing mechanism, a well-trained and adequately paid workforce, reliable information on which to base decisions and policies, and well maintained health facilities to deliver quality medicines and technologies. An efficient health care system can contribute to a significant part of a country's economy, development and industrialization. Health care is conventionally regarded as an important determinant in promoting the general physical and mental health and well-being of people around the world. Health information technology (HIT) is "the application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of health care information, data, and knowledge for communication and decision making."

In this project, we have designed the **IoT Based Patient Health Monitoring System using Arduino**. The IoT platform used in this project is ThingSpeak. ThingSpeak is an open-source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network. This IoT device could read the pulse rate and measure the surrounding temperature. It continuously monitors the pulse rate and surrounding temperature and updates them to an IoT platform.

APPLICATIONS OF HEALTH MONITORING SYSTEM

The applications of the automatic wireless health monitoring system mainly include the following.

- ✓ The wireless health monitoring system is used to transfer the data from the TX section to RX section wirelessly.
- ✓ The systems mainly focus on the situation where the doctors and patients are at the distant location and it is very important to give the entire details about the heartbeat and the temperature of the patient to the doctor.
- ✓ Besides this if made particular changes in this project, it can also be applicable for acknowledging the students with the fastest mode of information about certain notices.

ADVANTAGES OF HEALTH MONITORING SYSTEM

The advantages of the automatic wireless health monitoring system mainly include the following.

- ✓ Associating the gap between the patients and the doctor.
- ✓ Best to be used in rural areas for multipurpose. So that all the conditions are simply measured.
- ✓ Operation of the device is very simple.
- ✓ The device is cheap, fast and small.
- ✓ Since it is used in real time, future complications can be minimized.
- ✓ Convenient for illiterates .
- ✓ Doctors can be prepared for the upcoming patient and inform the nearby hospitals.
- ✓ Doctors can prescribe first aid and some drugs in case of emergency to the required people.
- ✓ Doctors can also advise do's and don's for the care takers.
- ✓ Better access to healthcare
- ✓ Improved quality of care
- ✓ Peace of mind and daily assurance
- ✓ Improved support, education and feedback

PROS AND CONS OF UNIVERSAL HEALTH CARE

PROS OF UNIVERSAL HEALTHCARE

Equal Access to Healthcare

- ✓ The main advantage of this type of healthcare is that it gives people that can't afford healthcare the services they need. This system provides basic services for all citizens and it doesn't discriminate against anyone. It helps those that aren't employed or have other difficulties getting healthcare when they need it the most.

Improve Public Health

- ✓ The entire population spreads around the cost of healthcare, so everyone can at least get the basic care that they need.
- ✓ This type of healthcare will help to improve the health of the general population, since every member of society has equal access to medical care. Hence, it will lead to a reduction in the amount of illness suffered by the general population, create healthier people, and increase productivity.

Less Paperwork

- ✓ It's easier to have everyone under one system with universal healthcare. Doctors can concentrate on patients and not problems with insurance and other factors. With universal healthcare in place, doctors and other healthcare professionals can finally concentrate on treating the patient without worrying themselves with paperwork from the patients' insurance companies and other necessary paperwork.

Boost Economy

- ✓ Without a doubt, people work more when they live healthier lives, which allow them to contribute as much as they can to the nation's economy. Universal healthcare will raise the standard of living of every individual in society, which will lead to more economic productivity.

CONS OF UNIVERSAL HEALTHCARE

Long Wait Times

- ✓ This type of healthcare system often results in long wait times for patients, and not everyone will receive the type of care that they need. Since this type of system is run by the government, there can be a lot of red tape and bureaucracy that can result in poor care, especially if the country is already poor and doesn't have a lot of revenue to spend on the care of its citizens.

Takes Time to Get There

- ✓ Universal healthcare often has a lot of rules and regulations that people have to follow, and there is going to be a learning curve and probably trial and error, or even some technical difficulties, just like when Obamacare first launched.

No Competition. No Innovation

- ✓ Universal healthcare eliminates the free market for healthcare, where prices may be lower.
- ✓ There is no incentive to create better medications or pursue better medical services.

Medical Abuse Leads to Rationing

- ✓ People may abuse the system and seek care for conditions which don't require a visit to the hospital, and these people can tax the system and cause unnecessary burdens on the system.

In the next chapter, literature survey is discussed on different research papers, which lead to the background key feature of the project.

MOTIVATION

In today's competitive environment, healthcare concerns have grown tremendously. There are big expectations for the potential of Smart Health Technologies to support healthcare. This type of technology is still in its infancy, but Smart Health Technologies are expected to be commonplace in the future. There are many opportunities for companies to develop Smart Health Technology solutions that will support the healthcare sector, e.g. within telemedicine and early detection.

However, there are also definite barriers, e.g. the infrastructure and competencies needed to incorporate Smart Health Technologies in daily operations. The motivation to undertake this project is to hone professional skills in software development and integration with hardware. With the improvement in mass media and various forms of communication, it is now possible to monitor and control the user's heartbeat rate and body temperature. However, so far, the technologies used are passive in nature, i.e., the monitoring systems only help in detecting the symptoms for the cause but do not actively participate in providing the precautions and measures in order to achieve ideal normalized body parameters.

During the project work, we could explore individual technical skills, knowledge, creativity and practical application of theoretical studies. It gave opportunity to learn from the best engineers, in encouraging working environment. The successful design and development of the project has fulfilled desired motivational objective for the team members. The existing conventional healthcare system can be easily replaced by a Smart healthcare system where the user can access their vital results in an instant and also keep a track of them. The main motivation behind this project arose because of the current failing healthcare system with numerous flaws that are left un-managed. Keeping all the above circumstances in mind, an efficient Smart Healthcare System as to be implemented, that can smartly take decisions on its own based on the vital levels of the user and also because of the flaws in the current healthcare system, the process is automated, wherein an external supervisor is not required to man the system.

As a learning value, over view of component and systems functioning and its design process was provided including physical demonstration of each sub part. It was allowed to interact with engineers working on these systems and components, and see various facilities, used for design, development, integration and testing purpose. It has provided opportunities to explore technical interest and develop professional skills and competencies for the individual. It has provided opportunity to learn balance between college study and social life, thus capability to handle more responsibilities.

During the project work, we could apply academic knowledge and concepts in to real life professional environment. Overall, this project work, provided necessary technical skills and professional experience, which is essential for a successful engineer and career development. The project has helped, learn resolving practical problems encountered during applicability of academic knowledge in real technical world to design, develop, integrate, fabricate and assess its functionality. The experience as helped us a lot in digging up more complicated real-time problems;

which drives us on finding alternate efficient solutions. The motive is to bring changes in the existing healthcare system, and to provide a better and efficient healthcare system to the users via uprising cutting edge technologies.

Smart Health Technologies are influenced by the mega trends of democratization, urbanization, change in healthcare burden and individualization, amongst others, while the

trends of acceleration and technological advances enable Smart Health Technology solutions, along with Data Analytics. In relation to the burning platform created by the megatrend demographic shifts, the advances of technology have already been adopted to assist in providing care and wellbeing for persons in need for several decades. The demographic shifts are expected to be a driver for the development of Smart Health Technologies. The types of Smart Health solutions will depend on the needs presented by this change. The true relevance of Smart Health Technologies also depends on the future capabilities of the technologies.

It's clear that the introduction of Smart Health Technology will foster a change in the system which requires not only that we adopt a new way for managing citizens with diseases and special needs, but also a new way and more agile way for healthcare personnel to work with technological devices. While the use of technological devices in the healthcare system is vast, the advances in especially Smart Health Technology will speed up the process of using telemedicine to remotely monitor as well as treat patients.

In the next chapter, the objective of the project is discussed. Chapter 4 aims to distinguish the qualities and features that the existing system is lacking. Also, the impact of our project on the society is also discussed in page 6.

Thanks to this continuous, instantaneous connection between people and their caregivers, RPM also provides patients with **expanded levels of education, support and feedback**, as compared to traditional models of healthcare.

"If the RPM model is comprehensive enough that you're not only collecting data but you're automatically providing information back, over time those patients are getting a lot of education," Julie adds. "**They're getting a lot of support.**"

"Whether it's presenting a number that represents their vital sign, or a graph of trends over time, or just a friendly paragraph that summarizes" their daily care outlook, explains Karissa Price in the video, "RPM programs allow that patient to get that daily information, that daily support, that daily help, **that can make all the difference in the world in terms of their health outcomes**."

Important as patient comfort and engagement are, the benefits of remote patient monitoring go beyond that, offering patients invaluable **assurance that someone is watching out for their health and well-being** on a daily basis.

OBJECTIVE

Healthcare system has two basic functions. The first is to allow people to gain a live view of points of interest on their health. The other main function is to allow the user to access vital recordings to review significant events and provide evidence as needed with ideal precautions and measures to normalize the vital levels. This is where a smart healthcare system comes in handy. The objective of the project is to design and develop a smart healthcare system with remote monitoring, so as to enhance the efficiency of the healthcare operations.

Smart Technology is an umbrella term covering all forms of technologies which have
1. Physical sensors with which to register data from its surroundings
2. Computational capacity with which to store and analyse the data
3. The means to deliver either actionable advice tailored to the end-user or automated actions, based on the data input.

Smart Health Technology adheres to the above definition, with the clause that it is used with the purpose of, or within the domain of health. The primary objectives of any health delivery system are to enable all citizens to receive health care services whenever needed, and to deliver health services that are cost-effective and meet pre-established standards of quality. The motto of the project is providing an effective application for Real Time Health Monitoring and Tracking. The system will track, trace, monitor patients and facilitate taking care of their health; so efficient medical services could be provided at appropriate time. By Using specific sensors, the data will be captured and compared with a configurable threshold via microcontroller which is defined by a specialized doctor who follows the patient; in any case of emergency a short message service (SMS) will be sent to the Doctor's mobile number along with the measured values through data module. One of the most important qualities for any professional endeavor is a secure and efficient healthcare system.

The use of sensors in self-monitoring has long been the cornerstone of the notion of Quantified Self. The combination of recording personal health and the possibilities within Data Analytics enable Smart Health Technologies to provide engaging and personalized output. In the future, machine learning may enable Smart Health solutions to provide users with predictive recommendations based on their lifestyle recorded through different data sources. More advanced solutions will be developed in the near future, as the advances in mobile data-sharing rise with the advances of 5G data transfer. This will enable data transfer rates faster than 1Gbps, allowing for virtually instantaneously responses to citizens.

Values:-

EARLY DETECTION AND PREVENTION: Central to the value of Smart Health Technology is the continuous monitoring of the health and well-being of citizens. At the very least, this enables users with information on their current health and notice to seek medical consultation or emergency attention. It is likely that we will see an overall increase in timely treatment as the time between detection of symptoms and treatments are administered is shortened. For chronic illnesses it is possible that treatment can be administered automatically on the go. This would add value to both their immediate medical state as well as provide them with, and their parents, with peace of mind in knowing that the aspect of the condition is managed reliably.

Risks:-

CONTINUOUS MONITORING AND INSTANT ACCESS: With patients and citizens monitoring themselves and being in control of the data being recorded it is likely that some users will engage and analyze their data independently. As the Smart Health Technology develops into more reliable systems and the abilities of Data Analytics and advanced, users will either be informed of serious diagnosis by an automated system or be withheld from that type of data until medical staff can analyze and inform the citizen. In addition, there will likely be a growing desire from patients to be able to seek medical consultations at all times. With the development of increasingly more personalized treatments, the jobs of the Healthcare staff will change. This change is compounded by the overall change in the Healthcare system to adapt to prevention rather than reaction, and will require Healthcare staff to train in the operation of different types of Telemedicine, as well as other forms of Smart Health Technology. In the next chapter, the Methodology of the project is discussed. A detailed explanation on the proposed model is shown.

CHAPTER 2

PROJECT METHODOLOGY

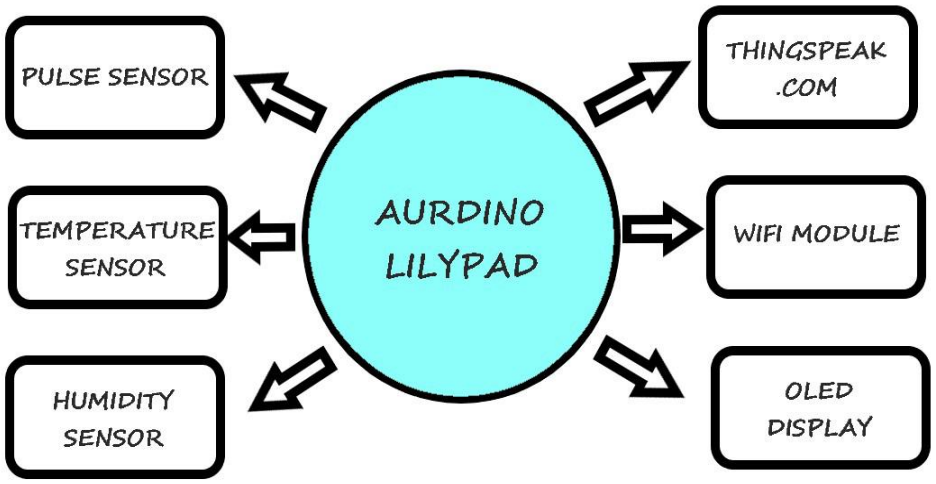

Figure 2.1

The main objective is to detect for vital parameters such as Heartbeat rate and body temperature of a user in real-time and process the data for convenient use. The data collected by the sensors: Pulse and body temperature are inputted to Arduino lilypad. The received data are processed accordingly and a decision is made depending on the threshold set. A preset Threshold which is considered to be the normal ideal human vital parameter rate is set. A notification SMS will be sent to the user, doctor and family members depending on the measured values.

The normal resting heart rate for adults' ranges from 60 to 100 beats per minute; for instance, let us assume that the lower and higher threshold is set to 30 and 150 respectively. The measured values will be compared with the maximum and minimum stored values in the microcontroller, if the measured values are less than 30 or beyond 150, an SMS notification will be sent immediately to the relevant person with all the precautions and measures that are to be taken in order to attain the normal ideal vital levels. Here, Arduino acts as the heart and brain of the system, wherein decisions are made appropriately based on the measured values. By Using specific sensors, the data will be captured and compared with a configurable threshold via microcontroller (Arduino lilypad) which is defined by a specialized doctor who follows the patient; in any case of emergency a short message service (SMS) will be sent to the Doctor's mobile number along with the measured values through data module. The precaution contains future remedies that is to be followed in order to normalize the body parameters. The mode of communication is via SMS which is achieved using data Module. Moreover, the feasibility of realizing a complete endto-end smart health system responding to the real health system design requirements by taking in consideration wider vital human health parameters such as respiration rate, nerves signs etc. The system will be able to bridge the gap between patients - in dramatic health change occasions- and health entities who response and take actions in real time fashion.

Heart Beat Monitor with microcontroller . Heart Beat Monitoring circuit using ttemperature sensor. The use of microcontroller is in every field even we can use it in the design and fabrication of biomedical equipments.An example is given here. The microcontroller is here used for development of a heartbeat

monitoring system. By placing your finger in between, a LED and photo resistance,person can easily detect the pulses of heart, the analog voltages are further processed with an operational amplifier LM 358, this chip has two built in Op-Amps. The TTL pulses or digital pulse are then feed to the external interrupt of AVR microcontroller. By using a software counter in the code, they can count the pulses, and the result the process is displayed on an OLED.

HB = 5184/t

Where t is average of time delay between 2 consecutive pulses here use of first 5 pulses for calculation of HB.

CHAPTER 3

PROJECT TECHNOLOGY

Apart from basis engineering knowledge, certain technologies covering Arduino, Pulse Sensor, Body temperature sensor, and data (Global System for Mobile Communication) have been used for the project implementation.

ARDUINO LILYPAD

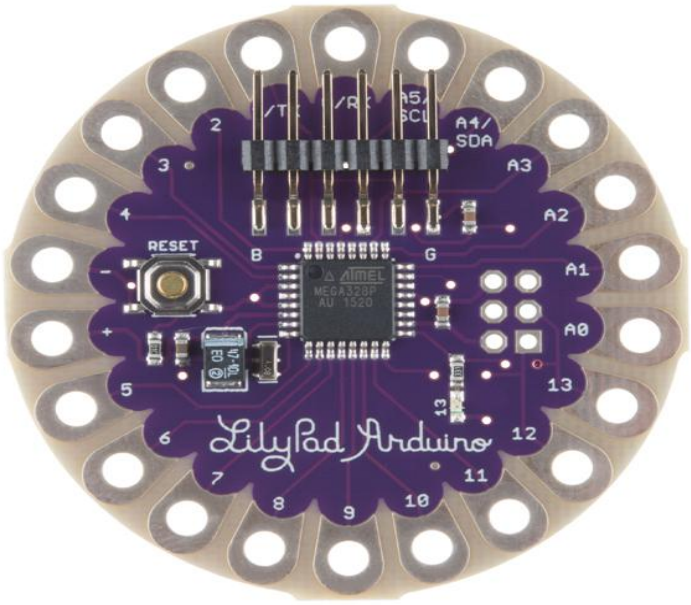

Figure 3.1

The LilyPad Arduino Main Board is based on the ATmega168V (the low-power version of the ATmega168) or the ATmega328V. The LilyPad Arduino was designed and developed by Leah Buechley and SparkFun Electronics.
The LilyPad Arduino can be powered via the USB connection or with an external power supply.

If an external power supply is used, it should provide between 2.7 and 5.5 volts. This can come either from an AC-to-DC adapter (wall-wart) or battery. Again, don't power the LilyPad Arduino with more than 5.5 volts, or plug the power in backwards: you'll kill it.

The LilyPad Arduino can be programmed with the Arduino Arduino Software (IDE). Select "LilyPad Arduino" from the **Tools > Board** menu (according to the microcontroller on your board). For details, see the reference and tutorials.

The ATmega168V or ATmega328V on the LilyPad Arduino comes preburned with bootloader that allows you to upload new code to it without the use of an external hardware programmer.

You can also bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header. While the holes are too small to insert pins into, you can insert male header pins into the ISP connector on your programmer and press them against the ICSP header on the board

The LilyPad Arduino can be powered via the USB connection or with an external power supply.

If an external power supply is used, it should provide between 2.7 and 5.5 volts. This can come either from an AC-to-DC adapter (wall-wart) or battery. Again, don't power the LilyPad Arduino with more than 5.5 volts, or plug the power in backwards

The LilyPad USB is a board fitted with an ATmega32u4 microcontroller: Most commonly used with the Arduino Leonardo boards, the ATmega32u4 microcontroller has the great advantage of including 2 USB protocols that can operate simultaneously.

The LilyPad Arduino USB board has 9 input/output pins: 4 of them can be used as PWM outputs and 4 others as analogue inputs. It also has an 8 MHz electric resonator, a micro USB connection, and a JST connector allowing powering via a 3.7 V LiPo battery.

hanks to its use of an ATmega32u4 microcontroller, the LilyPad Arduino USB board can be powered via a micro USB connection.

What makes the LilyPad Arduino board so different from the other models in the series is of course its ATmega32u4 microcontroller (the ‘u’ stands for USB). LilyPad Arduino boards are usually fitted with an ATmega168V or ATmega328V microcontroller. This type of microcontroller requires use of a USB port to serial port adaptor. Using the ATmega32u4, this is unnecessary, as your computer will recognise your LilyPad Arduino USB board as a mouse and keyboard, while the CDC serial interface can continue to send and receive information. You can therefore connect up your LilyPad Arduino USB board directly to your computer via a USB cable to start with, or of course more simply use your LiPo battery.

Specifications of the LilyPad Arduino USB board

- ✓ Microcontroller: ATmega32u4
- ✓ Flash memory: 32 kB, of which 4 kB are used by the bootloader
- ✓ SRAM: 2.5 kB
- ✓ EEPROM: 1 kB
- ✓ Operating voltage: 3.3 V
- ✓ Input voltage: 3.8–5 V
- ✓ Digital input/output pins: 9
- ✓ PWM channels: 4
- ✓ Analogue input channels: 4
- ✓ Direct current per I/O pin: 40 mA
- ✓ Clock speed: 8 MHz

PULSE SENSOR

Figure 3.2

A heart rate monitor (HRM) is a personal monitoring device that allows one to measure/display heart rate in real time or record the heart rate for later study. It is largely used to gather heart rate data while performing various types of physical exercise. Measuring electrical heart information is referred to as Electrocardiography (ECG or EKG).

Medical heart rate monitoring used in hospitals is usually wired and usually multiple sensors are used. Portable medical units are referred to as a Holter monitor. Consumer heart rate monitors are designed for everyday use and do not use wires to connect.

The electrical monitors consist of two elements: a monitor/transmitter, which is worn on a chest strap, and a receiver. When a heartbeat is detected a radio signal is transmitted, which the receiver uses to display/determine the current heart rate. This signal can be a simple radio pulse or a unique coded signal from the chest strap (such as Bluetooth, ANT, or other low-power radio link). Newer technology prevents one user's receiver from using signals from other nearby transmitters (known as cross-talk interference) or eavesdropping. Note the older Polar 5.1 kHz radio transmission technology is usable underwater. Both Bluetooth and Ant+ use the 2.4 GHz radio band, which cannot send signals underwater.

More recent devices use optics to measure heart rate by shining light from an LED through the skin and measuring how it scatters off blood vessels. In addition to measuring the heart rate, some devices using this technology are able to measure blood oxygen saturation (SpO_2). Some recent optical sensors can also transmit data as mentioned above.

Newer devices such as cell phones or watches can be used to display and/or collect the information. Some devices can simultaneously monitor heart rate, oxygen saturation, and other parameters. These may include sensors such as accelerometers, gyroscopes, and GPS to detect speed, location and distance.

In recent years, it has been common for smartwatches to include heart rate monitors, which has greatly increased popularity.[3] Some smart watches, smart bands and cell phones often use PPG sensors.

The newer, wrist based heart rate monitors have achieved almost identical levels of accuracy as their chest strap counterparts with independent tests showing up to 95% accuracy, but sometimes more than

30% error can persist for several minutes.[4] Optical devices when used with rigorous activity can be less accurate[5] or when used underwater.

Currently heart rate variability is less available on optical devices.[6] Apple introduced HRV data collection to the Apple Watch devices in 2018.[citation needed]

Modern heart rate monitors commonly use one of two different methods to record heart signals (electrical and optical). Both types of signals can provide the same basic heart rate data, using fully automated algorithms to measure heart rate, such as the Pan-Tompkins algorithm.[2]

ECG (Electrocardiography) sensors measure the bio-potential generated by electrical signals that control the expansion and contraction of heart chambers, typically implemented in medical devices.

PPG (Photoplethysmography) sensors use a light-based technology to measure the blood volume controlled by the heart's pumping action.

Heart rate data can be really useful whether you're designing an exercise routine, studying your activity or anxiety levels or just want your shirt to blink with your heart beat. The problem is that heart rate can be difficult to measure. Luckily, the Pulse Sensor Amped can solve that problem!
The Pulse Sensor Amped is a plug-and-play heart-rate sensor for Arduino. It can be used by students, artists, athletes, makers, and game & mobile developers who want to easily incorporate live heart-rate data into their projects. It essentially combines a simple optical heart rate sensor with amplification and noise cancellation circuitry making it fast and easy to get reliable pulse readings.
Also, it sips power with just 4mA current draw at 5V so it's great for mobile applications. Simply clip the Pulse Sensor to your earlobe or fingertip and plug it into your 3 *or *5 Volt Arduino and you're ready to read heart rate! The 24" cable on the Pulse Sensor is terminated with standard male headers so there's no soldering required. Of course, Arduino example code is available as well as a Processing sketch for visualizing heart rate data.
Pulse Sensor is a well-designed plug-and-play heart-rate sensor for Arduino. It can be used by students, artists, athletes, makers, and game & mobile developers who want to easily incorporate live heart rate data into their projects. The sensor clips onto a fingertip or earlobe and plugs right into Arduino. It also includes an open-source monitoring app that graphs your pulse in real time.
The Pulse Sensor can be connected to arduino, or plugged into a breadboard.The front of the sensor is the pretty side with the Heart logo. This is the side that makes contact with the skin. On the front you see a small round hole, which is where the LED shines through from the back, and there is also a little square just under the LED. The square is an ambient light sensor, exactly like the one used in cellphones, tablets, and laptops, to adjust the screen brightness in different light conditions. The LED shines light into the fingertip or earlobe, or other capillary tissue, and sensor reads the light that bounces back. The back of the sensor is where the rest of the parts are mounted.

Features:

- ✓ Biometric Pulse Rate or Heart Rate detecting sensor
- ✓ Plug and Play type sensor
- ✓ Operating Voltage: +5V or +3.3V
- ✓ Current Consumption: 4mA
- ✓ Inbuilt Amplification and Noise cancellation circuit.
- ✓ Diameter: 0.625”

TEMPERATURE AND HUMIDITY SENSOR

Figure 3.3

The digital temperature and humidity sensor DHT11 is a composite sensor that contains a calibrated digital signal output of temperature and humidity. The technology of a dedicated digital modules collection and the temperature and humidity sensing technology are applied to ensure that the product has high reliability and excellent long-term stability.

A **humidity sensor** senses,measures and regularly reports the relative humidity in the air. It measures both moisture and air temperature.Relative humidity, expressed as a percent, is the ratio of actual moisture in the air to the highest amount of moisture air at that temperature can hold.The warmer the air is, the more moisture it can hold, so relative humidity changes with fluctuations in temperature.
The sensor includes a resistive sense of wet component and an NTC temperature measurement device, and is connected with a high-performance 8-bit microcontroller. The schematic diagram of the Humiture Sensor Module is as shown

Only three pins are available for use: VCC, GND, and DATA. The communication process begins with the DATA line sending start signals to DHT11, and DHT11 receives the signals and returns an answer signal. Then the host receives the answer signal and begins to receive 40-bit humiture data (8-bit humidity integer + 8-bit humidity decimal + 8-bit temperature integer + 8-bit temperature decimal + 8-bit checksum).

A humidity sensor (or hygrometer) senses, measures and reports both moisture and air temperature. The ratio of moisture in the air to the highest amount of moisture at a particular air temperature is called relative Humidity .Humidity sensors work by detecting changes that alter electrical currents or temperature in the air. Relative humidity becomes an important factor when looking for comfort.

Humidity sensors detect the relative humidity of the immediate environments in which they are placed. They measure both the moisture and temperature in the air and express relative humidity as a percentage of the ratio of moisture in the air to the maximum amount that can be held in the air at the current temperature. As air becomes hotter, it holds more moisture, so the relative humidity changes with the temperature.

Most humidity sensors use capacitive measurement to determine the amount of moisture in the air. This type of measurement relies on two electrical conductors with a non-conductive polymer film laying between them to create an electrical field between them. Moisture from the air collects on the film and causes changes in the voltage levels between the two plates. This change is then converted into a digital measurement of the air's relative humidity after taking the air temperature into account.

The applications of humidity sensor range far and wide. People with illnesses affected by humidity, monitoring and preventive measure in homes employ humidity sensors. A humidity sensor is also found as part of home heating, ventilating and air conditioning systems (HVAC systems). These are also used in offices, cars, humidors, museums, industrial spaces and greenhouses and are also used in meteorology stations to report and predict the weather.

This DHT11 Temperature and Humidity Sensor features a calibrated digital signal output with the temperature and humidity sensor capability.Its technology ensures the high reliability and excellent long-term stability. This sensor includes a resistive element and a sensor for wet NTC temperature measuring devices. It has excellent quality, fast response,anti-interference ability and highperformance.

Each DHT11 sensors features extremely accurate calibration of humidity calibration chamber. The calibration coefficients stored in the OTP program memory, internal sensors detect signals in the process, we should call these calibration coefficients. The single-wire serial interface system isintegrated to become quick and easy. Small size, low power, signal transmission distance up to 20 meters, enabling a variety of applications and even the most demanding ones.

FEATURES

- ✓ A humiture sensor module to test temperature and humidity, which uses the sensor DHT11.
- ✓ Humidity measurement range: 20 - 90%RH
- ✓ Temperature measurement range: 0 - 60℃
- ✓ Output digital signals indicating temperature and humidity
- ✓ Working voltage:DC 5V; PCB size: 2.0 x 2.0 cm
- ✓ Humidity measurement accuracy: ±5%RH
- ✓ Temperature measurement accuracy: ±2℃

WIFI MODULE

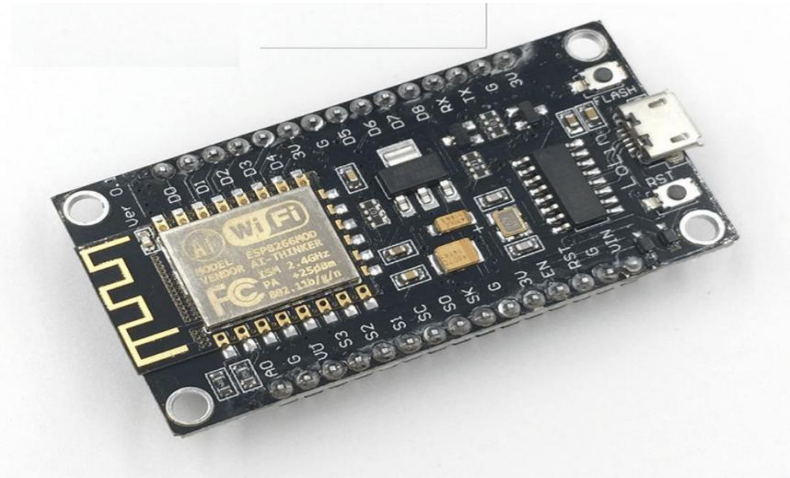

Figure 3.4

Wi-Fi (/ˈwaɪfaɪ/)[1] is a family of wireless networking technologies, based on the IEEE 802.11 family of standards, which are commonly used for local area networking of devices and Internet access. Wi- Fi is a trademark of the non-profit Wi-Fi Alliance, which restricts the use of the term Wi-Fi Certified to products that successfully complete interoperability certification testing.[2][3][4] As of 2010, the Wi-Fi Alliance consisted of more than 375 companies from around the world.[5] As of 2009, Wi-Fi-integrated circuit chips shipped approximately 580 million units yearly.[6] Devices that can use Wi-Fi technologies include desktops and laptops, smartphones and tablets, smart TVs, printers, digital audio players, digital cameras, cars and drones.

Wi-Fi uses multiple parts of the IEEE 802 protocol family, and is designed to interwork seamlessly with its wired sibling Ethernet. Compatible devices can network through wireless access points to each other as well as to wired devices and the Internet. The different versions of Wi-Fi are specified by various IEEE 802.11 protocol standards, with the different radio technologies determining radio bands, and the maximum ranges, and speeds that may be achieved. Wi-Fi most commonly uses the 2.4 gigahertz (120 mm) UHF and 5 gigahertz (60 mm) SHF ISM radio bands; these bands are subdivided into multiple channels. Channels can be shared between networks but only one transmitter can locally transmit on a channel at any moment in time.

Wi-Fi's wavebands have relatively high absorption and work best for line-of-sight use. Many common obstructions such as walls, pillars, home appliances etc. may greatly reduce range, but this also helps minimize interference between different networks in crowded environments. An access point (or hotspot) often has a range of about 20 metres (66 feet) indoors while some modern access points claim up to a 150-metre (490-foot) range outdoors. Hotspot coverage can be as small as a single room with walls that block radio waves, or as large as many square kilometers using many overlapping access points with roaming permitted between them. Over time the speed and spectral efficiency of Wi-Fi has increased. As of 2019, at close range, some versions of Wi-Fi, running on suitable hardware, can achieve speeds of over 1 Gbit/s (gigabit per second).

Wi-Fi is potentially more vulnerable to attack than wired networks because anyone within range of a network with a wireless network interface controller can attempt access. To connect to a Wi-Fi network, a user typically needs the network name (the SSID) and a password. The password is used to encrypt Wi-Fi packets so as to block eavesdroppers. Wi-Fi Protected Access (WPA) is intended to protect information moving across Wi-Fi networks and includes versions for personal and enterprise networks. Developing security features of WPA have included stronger protections and new security practices.

Wi-Fi stations communicate by sending each other data packets: blocks of data individually sent and delivered over radio. As with all radio, this is done by the modulating and demodulation of carrier waves. Different versions of Wi-Fi use different techniques, 802.11b uses DSSS on a single carrier, whereas 802.11a, Wi-Fi 4, 5 and 6 use multiple carriers on slightly different frequencies within the channel (OFDM).[56][57]

As with other IEEE 802 LANs, stations come programmed with a globally unique 48-bit MAC address (often printed on the equipment) so that each Wi-Fi station has a unique address.[a] The MAC addresses are used to specify both the destination and the source of each data packet. Wi-Fi establishes link-level connections, which can be defined using both the destination and source addresses. On the reception of a transmission, the receiver uses the destination address to determine whether the transmission is relevant to the station or should be ignored. A network interface normally does not accept packets addressed to other Wi-Fi stations.[b]

Due to the ubiquity of Wi-Fi and the ever-decreasing cost of the hardware needed to support it, most manufacturers now build Wi-Fi interfaces directly into PC motherboards, eliminating the need for installation of a separate network card.

Channels are used half duplex and can be time-shared by multiple networks. When communication happens on the same channel, any information sent by one computer is locally received by all, even if that information is intended for just one destination.[c] The network interface card interrupts the CPU only when applicable packets are received: the card ignores information not addressed to it.[d] Use of the same channel also means that the data bandwidth is shared, such that, for example, available data bandwidth to each device is halved when two stations are actively transmitting.

A collision happens when two stations attempt to transmit at the same time. They corrupt transmitted data and require stations to re-transmit. The lost data and re-transmission reduce throughput. In the worst case, where multiple active hosts connected with maximum allowed cable length attempt to transmit many short frames, excessive collisions can reduce throughput dramatically. A scheme known as carrier sense multiple access with collision avoidance (CSMA/CA) governs the way the computers share the channel.

The **ESP8266** is a low-cost Wi-Fi microchip, with a full TCP/IP stack and microcontroller capability, produced by Espressif Systems[1] in Shanghai, China.

The chip first came to the attention of Western makers in August 2014 with the **ESP-01** module, made by a third-party manufacturer Ai-Thinker. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands. However, at first there was almost no English-language documentation on the chip and the commands it accepted.[2] The very low price and the fact that there were very few external components on the module, which suggested that it could eventually be very inexpensive in volume, attracted many hackers to explore the module, the chip, and the software on it, as well as to translate the Chinese documentation.[3]

The **ESP8285** is an ESP8266 with 1 MiB of built-in flash, allowing the building of single-chip devices capable of connecting to Wi-Fi.

The ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability as a WiFi Shield offers

(and that's just out of the box)! The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.

This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area. The ESP8266 supports APSD for VoIP applications and Bluetooth co-existance interfaces, it contains a self-calibrated RF allowing it to work under all operating conditions, and requires no external RF parts.

There is an almost limitless fountain of information available for the ESP8266, all of which has been provided by amazing community support. In the Documents section below you will find many resources to aid you in using the ESP8266, even instructions on how to transforming this module into an IoT (Internet of Things) solution!

CHARACTERISTICS :-

- ✓ 802.11 b / g / n Wi-Fi Direct (P2P)
- ✓ soft-AP Built-in TCP / IP protocol stack Built-in TR switch, balun, LNA, power amplifier and matching network Built-in PLL, voltage regulator and power management components 802.11b mode + 19.5dBm output power
- ✓ Built-in temperature sensor Support antenna diversity off leakage current is less than 10uA Built-in low-power 32-bit CPU: can double as an application processor SDIO 2.0, SPI, UART STBC, 1x1 MIMO, 2x1 MIMO A-MPDU
- ✓ A-MSDU aggregation and the 0.4 Within wake 2ms, connect and transfer data packets standby
- ✓ power consumption of less than 1.0mW (DTIM3) Schema.
- ✓ Processor: L106 32-bit RISC microprocessor core based on the Tensilica Xtensa Diamond Standard 106Micro running at 80 MHz[5]
- ✓ Memory:
- ✓ 32 KiB instruction RAM
- ✓ 32 KiB instruction cache RAM
- ✓ 80 KiB user-data RAM
- ✓ 16 KiB ETS system-data RAM
- ✓ External QSPI flash: up to 16 MiB is supported (512 KiB to 4 MiB typically included)
- ✓ IEEE 802.11 b/g/n Wi-Fi
- ✓ Integrated TR switch, balun, LNA, power amplifier and matching network
- ✓ WEP or WPA/WPA2 authentication, or open networks
- ✓ 16 GPIO pins
- ✓ SPI
- ✓ I^2C (software implementation)[6]
- ✓ I^2S interfaces with DMA (sharing pins with GPIO)
- ✓ UART on dedicated pins, plus a transmit-only UART can be enabled on GPIO2
- ✓ 10-bit ADC (successive approximation ADC)

Thingspeak.com

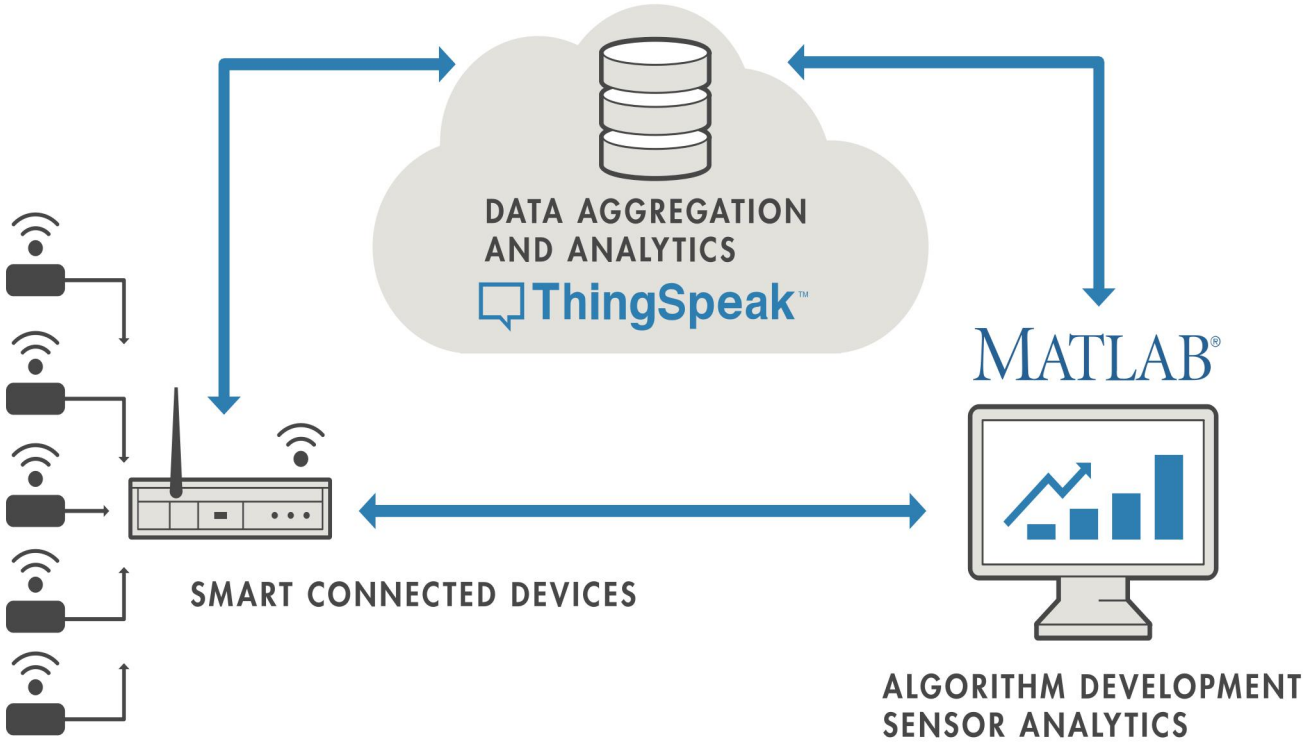

Figure 3.5

ThingSpeak™ is an IoT analytics platform service that allows you to aggregate, visualize and analyze live data streams in the cloud. ThingSpeak provides instant visualizations of data posted by your devices to ThingSpeak. With the ability to execute MATLAB® code in ThingSpeak you can perform online analysis and processing of the data as it comes in. ThingSpeak is often used for prototyping and proof of concept IoT systems that require analytics.

Internet of Things (IoT) describes an emerging trend where a large number of embedded devices (things) are connected to the Internet. These connected devices communicate with people and other things and often provide sensor data to cloud storage and cloud computing resources where the data is processed and analyzed to gain important insights. Cheap cloud computing power and increased device connectivity is enabling this trend.

IoT solutions are built for many vertical applications such as environmental monitoring and control, health monitoring, vehicle fleet monitoring, industrial monitoring and control, and home automation.

On the left, we have the smart devices (the “things” in IoT) that live at the edge of the network. These devices collect data and include things like wearable devices, wireless temperatures sensors, heart rate monitors, and hydraulic pressure sensors, and machines on the factory floor.

In the middle, we have the cloud where data from many sources is aggregated and analyzed in real time, often by an IoT analytics platform designed for this purpose.

The right side of the diagram depicts the algorithm development associated with the IoT application. Here an engineer or data scientist tries to gain insight into the collected data by performing historical analysis on the data. In this case, the data is pulled from the IoT platform into a desktop software environment to enable the engineer or scientist to prototype algorithms that may eventually execute in the cloud or on the smart device itself.

An IoT system includes all these elements. ThingSpeak fits in the cloud part of the diagram and provides a platform to quickly collect and analyze data from internet connected sensors.

ThingSpeak Key Features

ThingSpeak allows you to aggregate, visualize and analyze live data streams in the cloud. Some of the key capabilities of ThingSpeak include the ability to:

- ✓ Easily configure devices to send data to ThingSpeak using popular IoT protocols.
- ✓ Visualize your sensor data in real-time.
- ✓ Aggregate data on-demand from third-party sources.
- ✓ Use the power of MATLAB to make sense of your IoT data.
- ✓ Run your IoT analytics automatically based on schedules or events.
- ✓ Prototype and build IoT systems without setting up servers or developing web software.
- ✓ Automatically act on your data and communicate using third-party services like Twilio® or Twitter®.

CHAPTER 4

CONCLUSION

Implementation of the project will improve healthcare system functioning and operations efficiency. We will be able to ensure monitoring of parameters, which will be transmitted to various devices if necessary and improvise existing monitoring system. The current project will help enhance certain control and monitoring features of the existing healthcare system. Scope of the project can be enlarged by adding more additional healthcare sensors to the proposed system. However, such additional sensors will require higher power supply for model operations which proportionally increases the complexity and challenges of the proposed technique/method.

The field of smart healthcare system in human vision is quite new and emerging. The prospect is huge and there is so much to do. This project successfully opens the doorway for the people to explore the potentials hidden in it. It is been a topic of interest for forensic science over the last few years. The Future scope of the project is to minimize the complexity of model with the usage of additional multiple healthcare sensors.

Aim of Smart City concepts is to provide better life to society and provide innovative and creative solutions in each of the eight pillars of smart city. Healthcare field is one of most delicate and important fields to be developed and enhanced by Smart systems designed to present sustainable medical interventions at manner time where the smart system should be simple, low energy consumption and real time feedback.

The system proposed grantee to improve the quality of health services and to reduce the total cost in healthcare by avoiding unnecessary hospitalisations and ensuring that those who need urgent care get it sooner.

It is a system which can measure heartbeat rate and body temperature and communicate them in cases of extraordinary behaviours to supervision medical entities using data technology to deliver immediate actions to rescue patients life with potentiality in the future to add other vital factors measurements according to available sensor in the market which can achieve the objective of providing a reliable effective application for real time health monitoring and tracking.

The proposed Remote patient monitoring system is integration of embedded and web application , provides a platform in cost efficient manner ,solution for patient and doctor located at a remote location. The doctor can come up to a conclusion by examining and monitoring the health parameters of the patients at remote locations .The abnormal change in values of patients health parameters can alert the doctor and help in taking the necessary actions that are possible . A Remote health care provides real-time reading of vital parameters of patients along with its demographics, which will help in patient health diagnosis and in critical health conditions.

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