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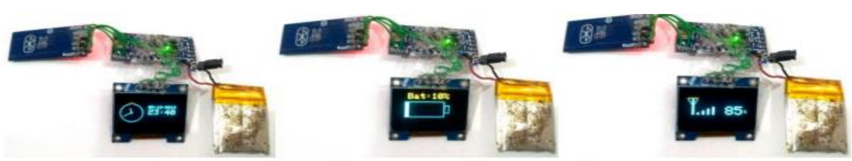
A smartwatch that uses an Android phone to monitor heart rate variability and predict and resolve potential emergencies



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- **University number:** 201920247.
- **Article number:** BMT_484.

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AKNOWLEDGMENT

I thank God Almighty for what His bounty bestowed on me. I dedicate the owner of the fragrant biography and the enlightened thought. He had the first credit for my attainment of higher education, (my beloved father), may God prolong his life.

To whom do I prefer it over myself, and why not; She sacrificed for me and spared no effort to always make me happy (my beloved mother).

To the one who drank the cup empty to give me drops of knowledge, and to the one whose fingertips fed me up to offer us a moment of happiness, and to the one who reaped the thorns from my path to pave the path of knowledge: the professor. Dr. Husham Farouk.

To my brothers, friends and colleagues; Those who had a great impact on many obstacles and hardships.

To all my honorable teachers; For those who did not hesitate to extend a helping hand, I dedicate to you the smart watch project using the Internet of Things technology.

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Chapter 1

Abstract

Background: Information and communication technologies and mobile applications capable of monitoring arrhythmias and heart rate (HR) are increasingly working to screen, diagnose and monitor arrhythmias and rhythms such as atrial fibrillation (AF) as this alters our social interactions and lifestyles, one of the most The most promising applications of information technology is health care management and wellness featuring early case detection, prevention, and long-term health care management and these applications include a handheld external electrical recording device attached to a mobile phone or wristband. **OBJECTIVE:** Conducting a study of the actual literature on mobile applications for measuring and monitoring heart rate (for Android devices), which is to create a smartwatch by connecting an OLED screen to your Android phone using an Arduino, knowing the total number of heart beats per minute with the heart rate traditionally shown in the watch And via the mobile app, this can help you measure your heart rate anywhere, anytime, especially during workouts. Through the mobile app, you can also keep a heart rate history for personal reflection and share with your provider.

Elevation (sitting and relaxing) corresponds to a higher risk of heart disease. An email is sent with a report on the user's condition to the doctor before any danger or crisis occurs, alerting the user if his condition is abnormal by sending a notification, history and graphs about his tests, and allowing the user to measure Anyone but the application will not send any report to the doctor, call first aid before the occurrence of the problem in the heart for a period of time and locate the patient and send the nearest emergency aid by identifying the lock Mount the longitude and latitude of the patient's location and save him from death.

Introduction

The internet of things is the inter-connection of devices, apps, sensors and network connectivity that complements these entities to collect and change facts. The distinguishing feature of net of things inside the healthcare machine is the constant monitoring a affected person through checking diverse parameters and additionally infers a very good result from the records of such steady tracking. Many such devices geared up with medical sensors are present in the ICUs now-a-days. There may be instances where the medical doctor couldn't be alerted in time whilst there may be an emergency, despite of 24 hours of monitoring. Also there might be hurdles in sharing thedata and information with the specialist doctors and the concerned family members and relatives. The generation that complements these features is already available but is not accessible and less costly by the general public in developing international locations which include India. Healthcare is a critical part of existence. Sadly, the gradually ageing populace and the associated upward thrust in chronic illness is putting large strain on current healthcare systems , and the demand for sources from sanatorium beds to docs and nurses is extraordinarily high. Clearly, an answer is required to reduce the stress on healthcare systems while continuing to provide terrific care to at-hazard patients.

The internet of things (IoT) has been drastically recognized asa capacity approach to alleviate the pressures on healthcare systems, and has for that reason been the focus of a whole lot present day research. A considerable amount of this research looks at monitoring patients with specific conditions, such as diabetes or Parkinson's disease. Further research looks to serve specific purposes, such as aiding rehabilitation through constant monitoring of a patient's progress.

Emergency healthcare has also been identified as a possibility by related works but has not yet been widely researched.Several related works have formerly surveyed particular regions and technologies associated with IoT healthcare. an in depth survey is provided in with recognition located on commercially to be had solutions, viable programs, and closing issues. Each subject matter is considered one after the other, instead of as part of an overarching gadget. In data mining, storage, and analysis are considered, with little mention of integration of these into a system. Sensor sorts are comparedin with some focus placed on communications. However, it is tough to draw a photo of an entire gadget from this paper. Eventually, sensing and huge facts control is taken into consideration, with little regard for the community that will help communications.This paper therefore makes a unique contribution in that it identifies all key components of a cease-to-quit net of things healthcare machine, and proposes a established model that could be implemented to all IoT-based totally healthcare structures. That is essential as there are nonetheless no known stop-to-stop systems for remote tracking of health inside the literature. This paper in addition offers a comprehensive survey of the today's technology that fall within the proposed version. Focus is placed onsensors for monitoring various health parameters, short-and long-range communications standards, and cloud technologies. Distinguishes itself from the previous predominant survey contributions by thinking about each vital aspect of an IoT-based totally healthcare system each one at a time and as a device.

Chapter 2

Component of Smart Watch

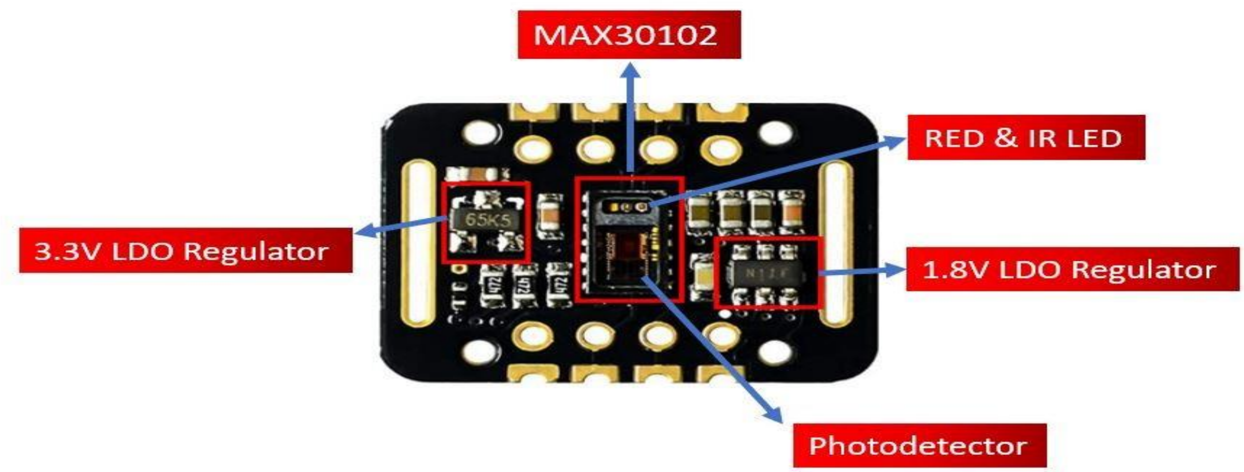
2.1 System of MAX30102 Sensor

A digital pulse oximeter and heart rate sensor is an electronic device which can measure the heart rate of a person by measuring the difference between oxygen rich and oxygen less blood. Not only heart rate, this device can also measure the concentration of oxygen in blood, also It can be used by students, hobbyists, engineers, manufacturers, and game & mobile developers who want to incorporate live heart-rate data into their projects.

2.1.1 MAX30102 Module Hardware

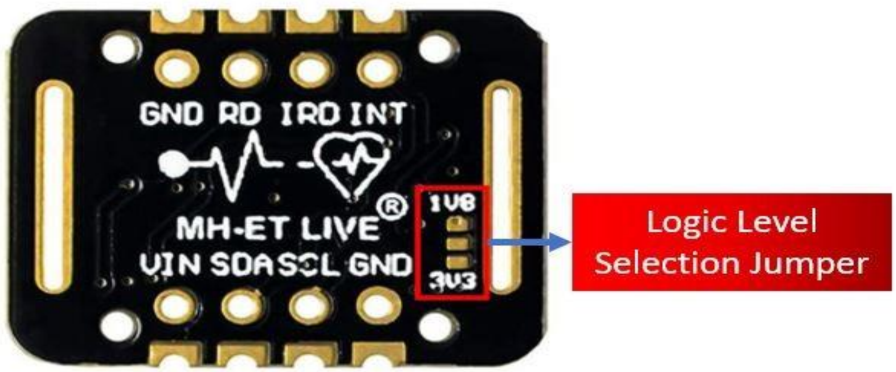
The module features the MAX30102 – a modern (the successor to the MAX30100), integrated pulse oximeter and heart rate sensor IC, from Analog Devices. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximetry (SpO2) and heart rate (HR) signals.

Behind the window on one side, the MAX30102 has two LEDs – a RED and an IR LED. On the other side is a very sensitive photodetector. The idea is that you shine a single LED at a time, detecting the amount of light shining back at the detector, and, based on the signature, you can measure blood oxygen level and heart rate.



(Figure 2.1 System of MAX30102 Sensor)

2.1.2 Power Requirement



(Figure 2.2 power requirement)

The MAX30102 chip requires two different supply voltages: 1.8V for the IC and 3.3V for the RED and IR LEDs. So, the module comes with 3.3V and 1.8V regulators. On the back of the PCB, you'll find a solder jumper that can be used to select between 3.3V and 1.8V logic level. By default, 3.3V logic level is selected which is compatible with logic levels for Arduino. But you can also select 1.8V logic level as per your requirement. This allows you to connect the module to any microcontroller with 5V, 3.3V, even 1.8V level I/O.

One of the most important features of the MAX30102 is its low power consumption: the MAX30102 consumes less than 600µA during measurement. Also, it is possible to put the MAX30102 in standby mode, where it consumes only

0.7μA. This low power consumption allows implementation in battery powered devices such as handsets, wearables or smart watches.

2.1.3 On-Chip Temperature Sensor

The MAX30102 has an on-chip temperature sensor that can be used to compensate for the changes in the environment and to calibrate the measurements.

This is a reasonably precise temperature sensor that measures the ‘die temperature’ in the range of -40˚C to +85˚C with an accuracy of ±1˚C.

2.1.4 I2C Interface

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

2.1.5 FIFO Buffer

The MAX30102 embeds a FIFO buffer for storing data samples. The FIFO has a 32-sample memory bank, which means it can hold up to 32 SpO2 and heart rate samples. The FIFO buffer can offload the microcontroller from reading each new data sample from the sensor, thereby saving system power.

2.1.6 Interrupts

The MAX30102 can be programmed to generate an interrupt, allowing the host microcontroller to perform other tasks while the data is collected by the sensor. The interrupt can be enabled for 5 different sources:

1- Power Ready: triggers on power-up or after a brownout condition.

2- New Data Ready: triggers after every SpO2 and HR data sample is collected.

3- Ambient Light Cancellation: triggers when the ambient light cancellation function of the SpO2/HR photodiode reaches its maximum limit, affecting the output of the ADC.

4- Temperature Ready: triggers when an internal die temperature conversion is finished.

5- FIFO Almost Full: triggers when the FIFO becomes full and future data is about to be lost.

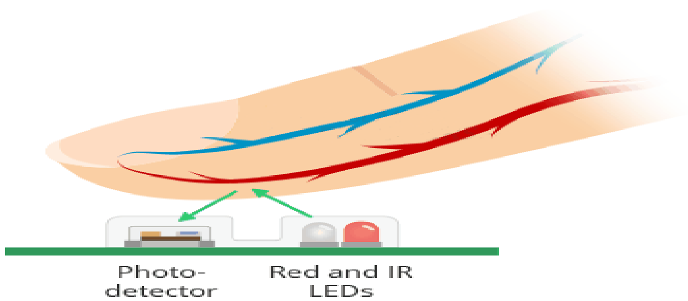
2.1.7 Technical Specifications

= Here are the technical specifications:

Power supply	3.3V to 5.5V
Current draw	~600µA (during measurements) ~0.7µA (during standby mode)
Red LED Wavelength	660nm
IR LED Wavelength	880nm
Temperature Range	-40˚C to +85˚C
Temperature Accuracy	±1˚C

Table 2.1 List of technical specifications

2.1.8 The works of MAX30102 Pulse Oximeter and Heart Rate Sensor



The MAX30102, or any optical pulse oximeter and heart-rate sensor for that matter, consists of a pair of high-intensity LEDs (RED and IR, both of different wavelengths) and a photodetector. The wavelengths of these LEDs are 660nm and 880nm, respectively.

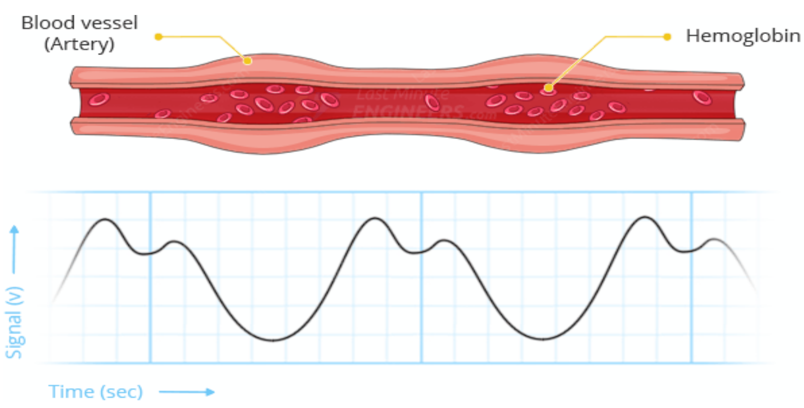
(Figure 2.3 work of MAX30102 Pulse oximeter, heart rate sensor)

The MAX30102 works by shining both lights onto the finger or earlobe (or essentially anywhere where the skin isn't too thick, so both lights can easily penetrate the tissue) and measuring the amount of reflected light using a photodetector. This method of pulse detection through light is called Photoplethysmogram.

= The working of MAX30102 can be divided into two parts: ***Heart Rate Measurement and Pulse Oximetry (measuring the oxygen level of the blood).***

2.1.9 Heart Rate Measurement

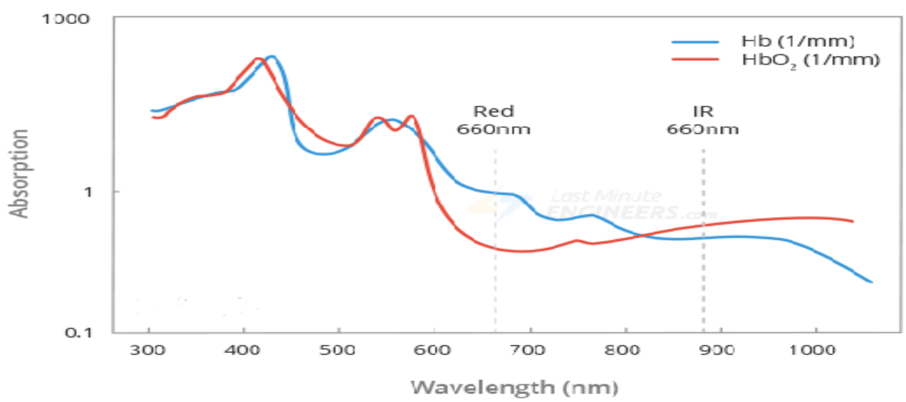
The oxygenated hemoglobin (HbO2) in the arterial blood has the characteristic of absorbing IR light. The redder the blood (the higher the hemoglobin), the more IR light is absorbed. As the blood is pumped through the finger with each heartbeat, the amount of reflected light changes, creating a changing waveform at the output of the photodetector. As you continue to shine light and take photodetector readings, you quickly start to get a heart-beat (HR) pulse reading.



(Figure 2.3.1 heart rate measurement)

2.1.10 Pulse Oximetry

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

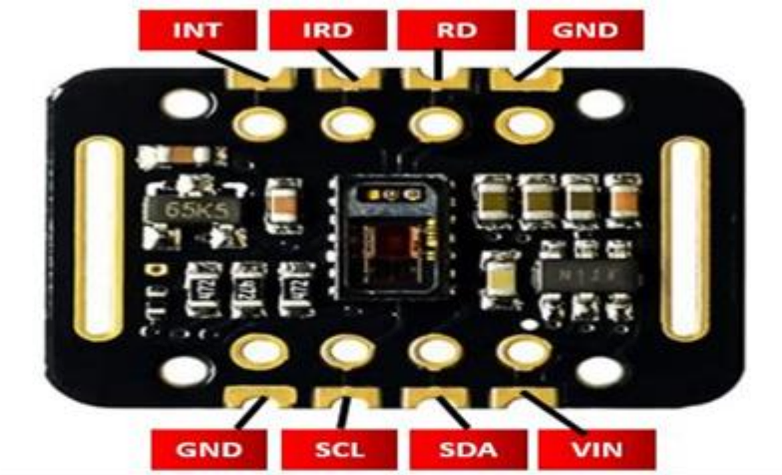


(Figure 2.3.2 pulse oximetry rate)

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

2.1.11 MAX30102 Module Pin-out

The MAX30102 module brings out the following connections:



(Figure 2.4 MAX30102 Module Pin-out)

PIN	Description
VIN	This pin is used to supply power to the sensor. This sensor is powered on at 3.3-5V.
SCL	This is the I2C serial clock pin.
SDA	This is the I2C serial data pin.
INT	This is the active low interrupt pin. It is pulled HIGH by the onboard resistor but when an interrupt occurs it goes LOW until the interrupt clears.
IRD	IR LED Cathode and LED Driver Connection Point
RD	Red LED Cathode and LED Driver Connection Point
GND	This is used for supplying ground to this sensor and it is connected to the source ground pin.

Table 2.2 List of MAX30102 Module Pin-out

2.2 the ESP32

2.2.1 Wi-Fi capabilities

The ESP32 can easily connect to a Wi-Fi network to connect to the internet (station mode), or create its own Wi-Fi wireless network (access point mode) so other devices can connect to it—this is essential for IoT and Home Automation projects—you can have multiple devices communicating with each other using their Wi-Fi capabilities.

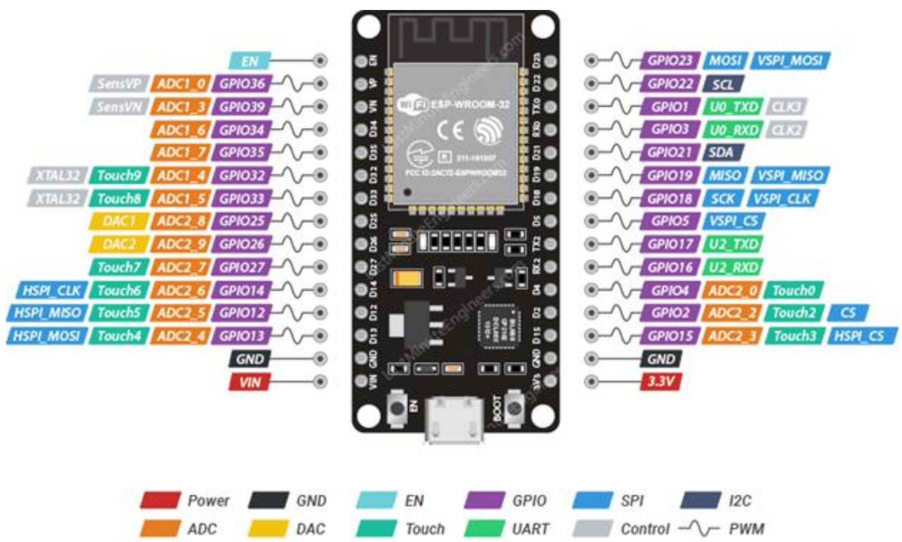
2.2.2 Dual-core

Most ESP32 are dual-core— they come with 2 Xtensa 32-bit LX6 microprocessors: core 0 and core 1.

2.2.3 Rich peripheral input/output interface

The ESP32 supports a wide variety of input (read data from the outside world) and output (to send commands/signals to the outside world) peripherals like capacitive touch, ADCs, DACs, UART, SPI, I2C, PWM, and much more.
It is one of the best solutions for DIY Internet of Things Projects and Smart Home Projects. Using the next quick links, you'll find all our ESP32 Guides with easy-to-follow step-by-step instructions, circuit schematics, source code, images and videos.

The ESP32 is a series of low-cost and low-power System on a Chip (SoC) microcontrollers developed by Expressive that include Wi-Fi and Bluetooth wireless capabilities and dual-core processor.



(Figure 2.5 ESP32 Module Pin-out)

2.2.4 ESP32 pinout

1- **Wireless connectivity Wi-Fi:** 150.0 Mbps data rate**.**

2- RTC slow SRAM: 8KB (for co-processor accessing during deep-sleep mode).

1.a.1 **Effuse:** 1 Kbit (of which 256 bits are used for the system (MAC address and chip configuration) and the remaining 768 bits are reserved for customer applications, including Flash-Encryption and Chip-ID).

SPECS/BOARD	ESP32	ESP8266	ARDUINO UNO
Number of Cores	2	1	1
Architecture	32 Bit	32 Bit	8 Bit
CPU Frequency	160 MHz	80 MHz	16 MHz
WiFi	YES	YES	NO
BLUETOOTH	YES	NO	NO
RAM	512 KB	160 KB	2 KB
FLASH	16 MB	16 MB	32 KB
GPIO PINS	36	17	14
Busses	SPI, I2C, UART, I2S, CAN	SPI, I2C, UART, I2S	SPI, I2C, UART
ADC Pins	18	1	6
DAC Pins	2	0	0

(Figure 2.6 ESP32 Module & Arduino)

2.3 OLED Screen (128 * 64)

An organic light-emitting diode (OLED) is a light-emitting diode (LED) in which the emissive electroluminescent layer is a film of organic compound that emits light in response to an electric current.

This organic layer is situated between two electrodes; typically, at least one of these electrodes is transparent.

OLEDs are used to create digital displays in devices such as television screens, computer monitors, portable systems such as smartphones, handheld game consoles and PDAs. A major area of research is the development of white OLED devices for use in solid-state lighting applications.

(Figure 2.6 OLED Screen (128 per 64))

We have two programs to control this screen:

1- The first where we can display a text.

2- The second where we can display geometric figures.

1.1.1 Connections (first program)

1- Arduino --> Screen.

2- 3.3V --> VCC.
3- GND --> GND.
4- SDA --> SDA.
5- SCL --> SCL.

1.1.2 Connections (second program):

1- 3.3V --> 3.3V

2- GND --> GND

3- SCL --> A5

1.1.3 Features of OLED Screen:

1- OLED internal drive chip: SSD136.

2- Compatible with 3.3V and 5V control chip I / O level.

3- Viewing angle: greater than 160 degrees.

4- Dimension: 29.28 x 27.1 mm (LW).

5- Temperature: -30°C to 70°C.

Wide power supply range: DC 3V-5V.

7- Power: 0.06W.

8- Resolution: 128×64.

9 -Interface: IIC/I2C, only two I / O ports.

10- Backlight: OLED self-light, no backlight.

11- VCC: 2.2V-5.5V.

12- SCL: CLK clock (High level 2.2V-5.5V).

13- SDA: MOSI data (High level 2.2V-5.5V) SDA.

14- Pin Configuration.

15- GND: Power Ground.

1.2 bread board

1- These mini universal soldieries breadboard is composed of ABS plastic and tin phosphorus plated bronze contact chips; it has 400 contacts tie-points available. It can work with 20-29AWG wire, perfect for circuit prototype design.

2- Type: Mini Solder-less Breadboard

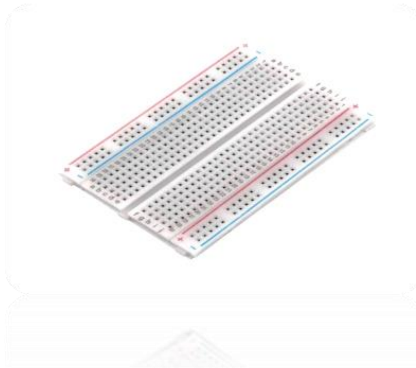
3- Model: BB-801

4- Available Contacts Tie-points: 400

5- Material: ABS Plastic & Tin Phosphorus Plated Bronze Contact Chip

6- Voltage: 300V.

7- Electric Current: 3-5A



(Figure 2.7 bread board)

8- Features: 400 Contact Tie-points Available, Mini Universal Solder-less Breadboard.

2.4.1 Features & details:

1- This mini universal solder-less breadboard is composed of ABS plastic and tin phosphorus plated bronze contact chips; it has 400 contacts tie-points available. It can work with 20-29AWG wire, perfect for circuit prototype design.

2- Type: Mini Solder-less Breadboard.

3-Model: BB-801.

4- Available Contacts Tie-points: 400.

5- Material: ABS Plastic & Tin Phosphorus Plated Bronze Contact Chip.

6- Voltage: 300V.

7- Electric Current: 3-5A.

8- Features: 400 Contact Tie-points Available, Mini Universal Solder-less Breadboard.

Manufacturer	Other
Item model number	5581242523618
Package Dimensions	14.1 x 7.6 x 1.3 cm; 48 Grams
ASIN	B092333JCK

Figure 2.8 Table of Product information)

2.5 Jumber Wire

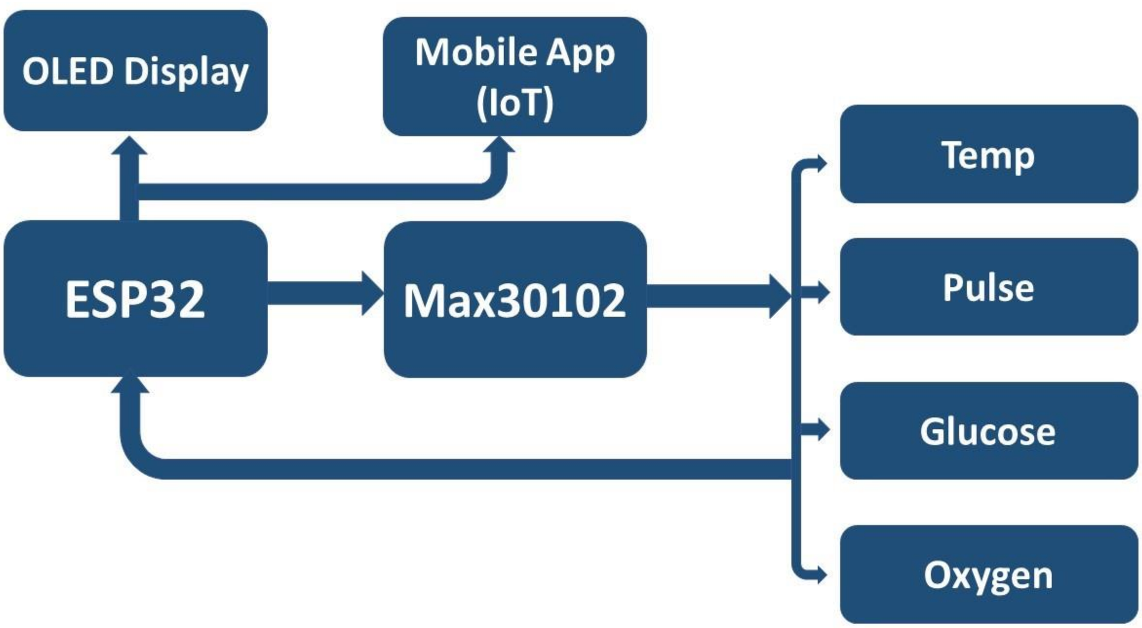
Also known as jumper, jumper wire, DuPont wire is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a bread bord or other prototype or test circuit, internally or with other equipment or components, without soldering.

Individual jump wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, the header connector of a circuit board, or a piece of test equipment.

They are used to connect two points in a circuit without soldering. You can use jumper wires to modify a circuit or diagnose problems in a circuit.

(Figure 2.9 Jumper)

1.3 Part of Smart Watch (Software): -



(Figure 2.10 Block Diagram)

- **The code of display on mobile application by IoT**

```
dtostrf( temp   , 0, 1 ,RemoteXY.text_3);
dtostrf( pulse   , 0, 1 ,RemoteXY.text_1);
dtostrf( oxygen   , 0, 1 ,RemoteXY.text_2);
dtostrf( Glucose, 0, 1 ,RemoteXY.text_4);

}
```

(Figure 2.11 Code of IoT)

- **The code of diagnosis temperature for human :**

```
 if ( pulse> 50)
Temp =particleSensor.readTemperature();
temp=Temp*14/11;
Serial.print("Temp = ");
   Serial.print(temp);
    Serial.print(" C ");
     Serial.print('\n');
}
```

(Figure 2.12 code of Temp)

- **The code of diagnosis glucose in the blood for human**:

```
 if ( pulse< 50)
 Serial.print(" No finger?");
 buttonval = digitalRead (push_button);

if ( pulse> 50){
Serial.print("glucose = ");
Glucose=irValue/1300;
Serial.print(Glucose);
Serial.print('\t');
```

(Figure 2.13 Code of Glucose)

- **Code of measure pulse in the blood**

```
pulse=(particleSensor.getFIFOIR()*5)/8000;
Serial.print("PBM=  ");
Serial.print(pulse);
Serial.print('\t');
```

(Figure 2.14 Code of Pulse)

- **Code of measure oxygen in the blood**

```
oxygen=(particleSensor.getFIFORed()*4)/9000 ;
Serial.print("oxygen = ");
Serial.print(oxygen);
Serial.print(" %");
Serial.print('\t');
```

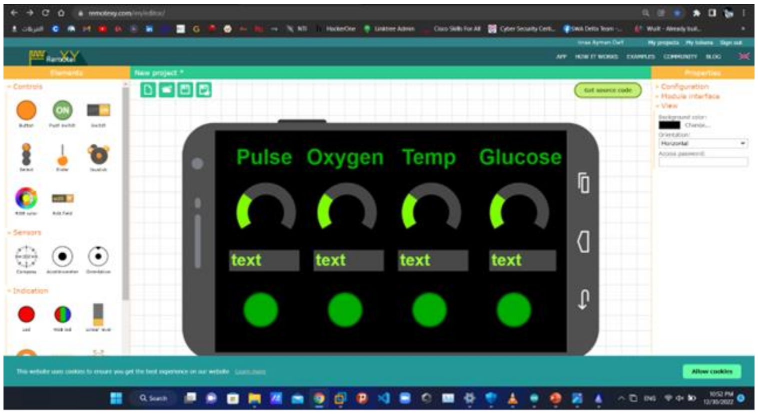
(Figure 2.15 Code of Oxygen)

- **Code of Display measurement on the OLED display**

```
display.clearDisplay();
      display.setTextSize(2);
      display.setCursor(0,0);
      display.println("P:");
     display.setCursor(25,0);
     display.print(pulse);
      display.print('\n');
      display.display();
      display.setCursor(0, 19);
      display.println("T:");
       display.setCursor(25,19);
      display.println(temp);
```

(Figure 2.16 Code of Display on Screen)

1.4 RemoteXY (IoT) :



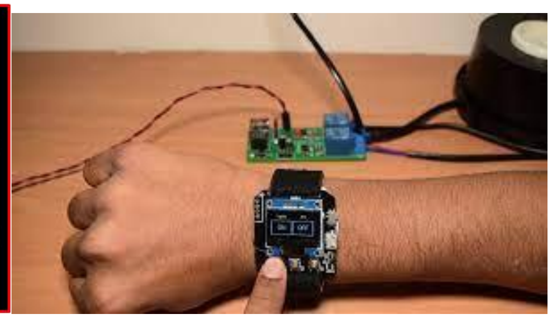
(Figure 2.17 Design Mobile App)

(Figure 2.18 Design Mobile App)

Chapter 3

3.1 Results

In this project we completely analyzed the ECG data which we receiving from the smart watch, if our heart rate tends be abnormal emergency alert has been triggered in our mobile. We can easily find whether the person is in normal or abnormal condition. I created an algorithm for finding the normal as well as abnormal heart rate if the condition fails the trigger has been given to IFTTT. This will forward an emergency alert to concern patient’s relation as shown in the Fig.



3.2 Conclusion

The spread of diseases and viruses leads to the death of many people for no specific reason We usually hear about a person who died for unknown reasons because of something that raised blood pressure, or something happened in the heart that led to a stroke, or his blood sugar was higher than normal, whether he had diabetes or not, or the temperature was higher than normal. the usual , Since the smart watch is equipped with a set of different components and sensors, as it measures the number of a person's heartbeat, so that if it is more or less than the normal rate, there will be a certain behavior, body temperature, oxygen and blood sugar levels. And all this is saved in the data that is uploaded to the server. If something happens that causes it to go higher or lower than normal, that data is sent to the nearest hospital, and the patient is located so that paramedics can get there and do what they need to do.

As for the chair, it is more for people of determination and the elderly

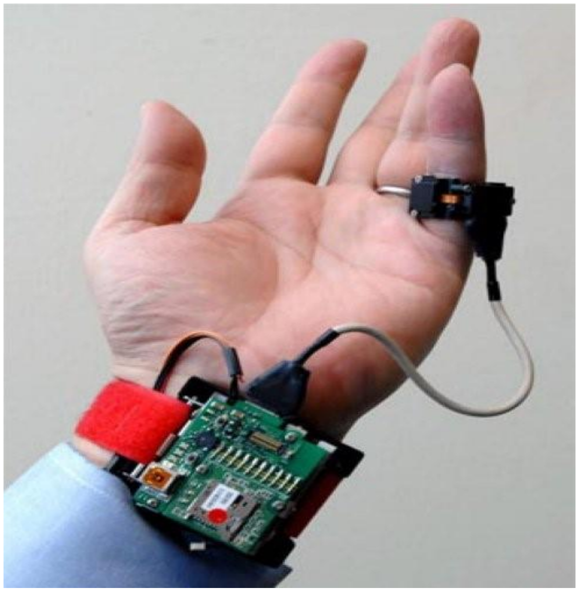
Where something like chair bumping, high blood pressure, or something like that might happen

And they may not have the ability to move the chair, so the wheelchair was used by a Gyroscope Sensor .

4.2 Future Work

➢ Blood Pressure Sensor

In the future we can add blood pressure sensor to our project



(Figure 4.2 The blood pressure sensor)

➢ Cloud Server

We can make cloud server to save the patient measurement history

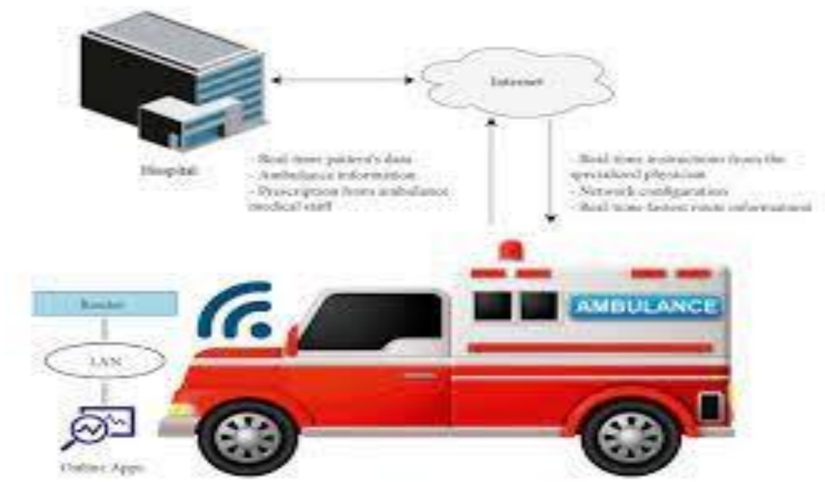
(Figure 4.3 Cloud Server)

➢ Alexa System

We can use Alexa smart system on phone to provide some instructions for patient

(Figure 4.4 Alexa System)

- We can develop a smart system to connect the device with an ambulance



(Figure 4.5 Com system between Patient and Ambulance)

Reference

Reference	Figure
https://www.theengineeringprojects.com/2018/06/introduction-to-arduino-nano.html	Arduino
https://www.analog.com/en/products/max30102.html	Max30102
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https://www.techtarget.com/whatis/definition/transistor	**Transistor**
https://www.allaboutcircuits.com/technical-articles/buck-converters-and-their-cool-applications	**Buck Converter**
https://www.electronicshub.org/what-is-relay-and-how-it-works/	**Relay**
https://www.techtarget.com/searchnetworking/definition/optoisolator	**Optocoupler**