Integrated Design Project

Final Report

Group 5: Patient Monitoring Device

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Contents of Final Report

1.0 Introduction

The Covid-19 pandemic accentuates the shortcomings in the existing healthcare systems available for the public. It is said that the Sars-cov-2 is an infectious virus and constricts the work of the healthcare workers thus crimping the healthcare system worldwide. Health care workers are unable to attend or monitor their patient at close distance without the possibility of risking themselves of being infected by the diseases. Medical workers are required to constantly wear Personal protective equipment (PPE) when in contact with patient and with the number of Covid-19 cases continuously rising hospitals are not able to keep up with the demand due to limited medical facilities such as medical equipments, medical staff, PPE and number of bed wards for quarantine. In this aspect, an Internet of Things (IoT) based health monitoring system offers a practical solution to help the healthcare system in such a situation where health can be monitored remotely. IoT is the new revolution of internet where the network of physical objects—“things” or objects—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the Internet.

2.0 Motivation/Objective

The main objective of this project is to design and implement a patient monitoring system that has sensors to track and monitor patient health and utilizes the internet to enable healthcare personnel to access patient data remotely through the IoT cloud. The objective of developing monitoring systems enable the reduction in healthcare management costs by reducing physician office visits, hospitalizations, and diagnostic testing procedure [1]. Sensors are attached to the patient body and are connected to a microcontroller to monitor and trace the patient current health status which is subsequently interfaced to any remote computer. Remote Patient Monitoring system also allows observation of patients from home and out of usual clinical settings, and this expands healthcare services accessible to everyone and also reduces additional expenses such as hospital ward room fees [2].

The marketability and its effect to the society are also taken into account to ensure the product is suitable and competitive for the existing market. At the moment, there are no patient monitoring system that implements a remote monitoring system existing in the market. Doctors and medical staffs in the hospital are required to attend to each patient daily to observe and update on the current health of the patient directly from the patient monitor LCD screen. Despite there are some machines that feature a central monitoring system (CMS) that allows monitoring multiple patients simultaneously, there are limitations with the current devices. Limitations such as patient data storage and review is only available for 240 hours, data transfer directly from the machine is required, high cost, limited measured parameters and some do not have data storage to store patient data.

3.0 Hardware design and implementation

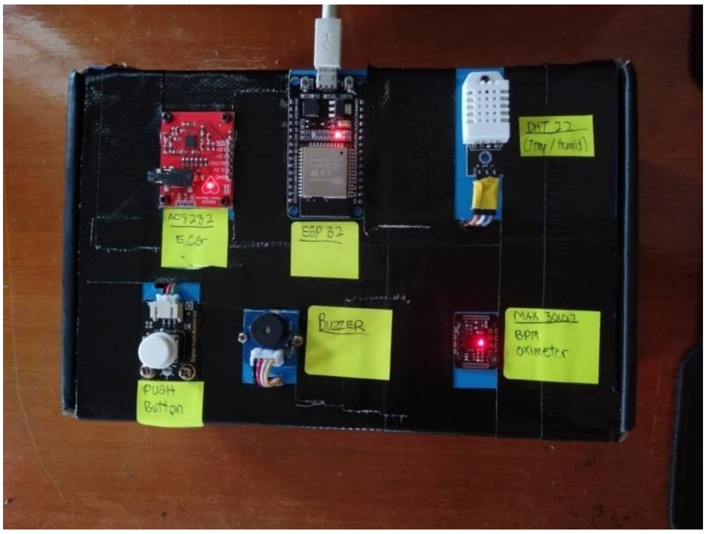

Figure 1: Hardware design of the prototype

The patient monitoring system consists of three important sensors interfacing with Ubidots IOT cloud. The three sensors are MAX30102 pulse oximeter and heart rate sensor (To measure heart rate and body temperature), DHT 22 temperature and humidity sensor (To measure surrounding temperature and humidity), and AD8232 electrocardiogram sensor (To measure ECG data). The data and parameters are measured by the sensors and then sent to the processor ESP32. In Ubidots cloud, the data acquired by the processor is compared with the threshold values of the desired sensors. If the sensor values move above the values, then an emergency or alert message is passed to the doctors through SMS with the details of each sensor.

Besides, the system is integrated with emergency hardware system which is established by a passive buzzer module and a DFR0029 Digital Push Button. The digital push button acts as an emergency indicator for patients and visitors if patients feel any uncomfortable. The five components and the processor ESP32 are connected together with a breadboard. The breadboards and the wires are hide inside a box and the sensors are attached on the box for measurement as shown in Figure 1.

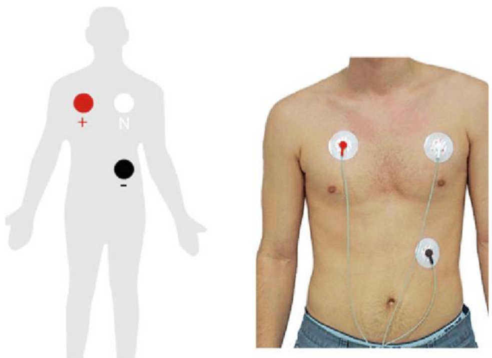

Figure 1: Connection of ECG electrodes to patient body

Figure 2: Patient finger placing on MAX30102

MAX30102 Pulse oximeter and heart rate sensor

The pulse oximeter and heart rate sensor measures the heart rate and body temperature of the patient. It includes low noise electronics with ambient light rejection. To measure the parameters of the patient, patient's finger is placed on the sensor as shown in Figure 2. For heart rate, it calculates the amount of blood in the capillary tube according to the amount reflected. The difference in the amount of light transmission and reflection is the result heart rate. For body temperature, it measures the insulation resistance (IR) value in the IR LED.

DHT 22 Temperature and humidity sensor

Temperature and humidity sensor measures the surrounding temperature and humidity. The sensor can measure temperature from −55 degree Celsius to +150 degree Celsius. The output changes by 10mV for every 10 degrees rise in temperature.

AD8232 electrocardiogram sensor (ECG)

The ECG sensor reads the electrical activity of heart and sends data to ESP32 to serial monitor and serial plotter. It has three electrodes connections, one of them is used to read heart beat and other two used to make connection. The method of connection to patient body is shown in Figure 1. For testing, the three electrodes of ECG sensor are attached to patient body as shown in Figure 1.

Push Button and Buzzer

The function of the digital push button and passive buzzer module is to act as an emergency indicator for visitors or patient to alert the medical staffs through noise. Once the buzzer is being triggered for every 1 minute, an alert message will also be sent to medical staffs.

WIFI module

The processor ESP32-WROOM-32 is integrated with Wi-Fi connectivity which take SSID and password to connect to wifi and Ubidots API to connect to the Ubidots web server using port 80. It sends data and information to Ubidots cloud after every 1 second.

3.1 Features and Limitations of components in proposed Patient Monitoring System

Component Name	**Component Function**	**Features**	**Limitations**
Pulse heart Rate Sensor (ECG)	- Measures and monitors electrical activity of hearts. - Able to detect possible heart attacks.	- Low current/power supply required - Common Mode Rejection Ratio (CMRR) of 80db. [5] - 8kV Human Body Model (HBM) Electrostatic Discharge (ESD) rating - 2-pole adjustable high pass filter - 3-pole adjustable low pass filter - Wide operating Temperature range (-40℃ to 85℃) [5] - Internal Radio Frequency Interference (RFI) filter [5] - High signal gain with DC blocking	- Voltage above input limit can damage the component. Hence, for safety resistors placed in series to the inputs. - CMRR though positive (80db) is lower than recommended value of 100db. - Damage of device can still occur if ESD exceeds rating value hence proper precaution to be taken during usage. - High pass filter can cause signal distortion. [5]
Pulse Oximeter & Heart-Rate Sensor	- Detect oxygen levels in the blood - Measures pulse rate and body temperature	- Tiny Optical Module with Integrated Cover Glass - Programmable Sample Rate and LED Current - Low Power Heart Rate Monitor (<1mW) [7] - Ultra-Low Shutdown Current (0.7µA) - High Sample Rates for fast data output - High Signal to Noise Ratio (SNR) (89dB) [7] - Operating temperature range (-40℃ to 85℃) - Ambient light cancelation (ALC) - Internal temperature sensor (-40℃ to 85℃) [7]	- ALC can trigger interrupt when it has reach maximum and this can affect output of ADC. Interrupt is cleared by reading Status 1 register (0x00). - Maximum Sample rate is dependent on the pulse width. Higher pulse width the lower the maximum sample rate. [7] - Pulsed currents for LEDs due to power saving can translate to optical noise at the LED output. [7]
DHT 22 Temperature and Humidity Sensor	- Measures temperatures and humidity of surrounding area.	- Low cost digital temperature and humidity sensor - Consist of a capacitive humidity sensor and termistor. - Input power around 3V to 5V - Humidity reading between 0 to 100% with 2-5% accuracy. [6] - Temperature reading from -40℃ to 80℃ with accuracy of < ±0.5 ℃ [6]	- Lower sampling rate compared to DHT 11 (1Hz) however DHT 22 has higher accuracy and range for temperature and humidity. [8] - Larger in size and cost slightly more than DHT 11 however still within budget. [8]

		- Sampling rate of 0.5Hz [6] - Low Weight 2.4 grams	
ESP 32 Development Board	- Microcontroller for Patient Monitoring Device	- Wide operating temperature range (-40℃ to 125℃) [3] - Ultra Low power supply (3.3V) - Integrated solutions for Wi-Fi and Bluetooth compatible to a wide variety of devices. [3] -Dual core 32 bit microprocessor enhances speed - Supports multiple external QSPI flash and SRAM chips [4] - Supports hardware encryption and decryption - Multiple power modes for efficient power management - Two I2Cbus interfaces [4]	- ESP 32 costs slightly more than ESP 8266. [11] - Some existing libraries are more compatible to ESP 8226 compared to ESP 32. [11] - External connections are limited since the GPIOs 6 to 11 are reserved for SPI flash. [10] - Limitations in debugging for ESP 32 due to reset behaviours when programming SPI flash. [10] - ESP 32 is limited to 2 hardware breakpoints for the SPI flash. - Does not have built in temperature sensor. [11]
Push button	- Patient trigger button to alert medical staff	- Wide voltage range of 3.3V to 5V - Simple icons to illustrate sensor functions and sensor interfaces - High quality connector - Small in size (22 x 30) mm and easy to use push button. - Large button keypad and high-quality first-class hat - Interface: Digital	- Based on datasheet no limitation stated. - However, possibility of frequent using of the button might affect elasticity and disable the push button. [12]
Grove - Buzzer	- Produce sound to alert medical staff when triggered	- Audio signalling device powered by piezoelectricity and produces sound when output is high - Can be connected to digital output - Can be connected to analog pulse width modulation (PWM) for various tones and effects. - Small in size - Cheap in price (RM 3.80) - Compatible with all push buttons. - Low operating voltage (3.3V) - Sound output > 85dB sufficient to detect the source.	- Based on datasheet no limitation stated. - 85 dB though loud enough to alert nearby staff it might be too loud for the patient.

Table 1: Features and Limitations of components in proposed Patient Monitoring System

3.2 Tradeoff Issues Faced in optimising the proposed Patient Monitoring System

This section discusses particularly on the tradeoff issues between budget and features and design and features when designing the proposed product. It is important that the issues are properly studied to ensure that the decisions made are in line with the optimisation according to the expected final design of the product.

During selection on the components for the prototype, the total cost of prototype needs to be taken account as it should not exceed RM 300 hence a tradeoff issue of budget and the features of the product is formed. For example when selecting the microcontroller, even though the M5Stack basic kit was recommended it was decided to use just a ESP-32. This is because though M5Stack is relatively new and has many product features such as ESP-32 based, built in speaker, LCD screen, T-Flash (TF) card slot for memory, battery, can integrate with WIFI and Bluetooth and supports program platform such as MicroPhyton and Adruino, the price is significantly higher when compared to only a ESP-32 controller [9]. The average price of M5 stack is RM 150 which is almost six times the price of only a ESP-32 controller which is RM 23 [9]. The additional features provided by M5Stack are not used such as LCD screen and TF card slot or is replaced with different components. For example, built in speaker is replaced with a buzzer and battery is replace with a direct power supply. LCD screen and TF card slot is not needed since all the data can be accessed and viewed remotely through the cloud.

Another example for tradeoff issue between budget and features is the component selection between DHT 11 and DHT 22 as a temperature and humidity sensor. In comparison, the DHT 11 costs lower and has higher sampling rate when compared to the DHT 22 [8]. However, the DHT 22 has a larger operating range for temperature and humidity and it also has a higher accuracy or lower error in measurement [8]. Therefore, the DHT 22 is selected as temperature and humidity sensor since the additional cost is insignificant to the benefits of the features when compared to the DHT 11.

The main design objective of the product is to be a product that is small and compact compared to the existing products which can result in a tradeoff issue between the design and features for the product. Unlike the existing product, the proposed product requires continuous connection to the power supply since it has no battery. Since the product is a patient monitoring system and is connected to the patient body for a long time, a continuous supply power is needed and this requires a large sized battery. This is not in line with the small and compact design objective of the product hence the decision is that the product will be supplied power directly from the power socket and since it is small, the power consumption is also lower. Furthermore compared to existing products, the small size of the product takes less space in a patient’s ward and is easier for medical workers to remove or install the product.

Another example of tradeoff issue between design and features for the product is the alerting system. The patient monitoring system also consists of an alerting system which is designed to alert medical staff to attend to the patient immediately during emergency or if the patient requires assistance. Initially, the alerting system consists of 3 components which includes a switch button, a LED light and a buzzer. However, the LED light was removed from the design since the LED light is not entirely effective to alert medical staff. Furthermore to include the LED light, it would require the box consisting of all the components to be a clear box or transparent so that the LED light is visible. However, a clear box will result in all the components inside the box to be also seen easily and this is not aesthetically pleasing for a product. Hence, this feature is removed from the design.

4.0 Design and Data Analysis of Proposed Patient Monitoring System

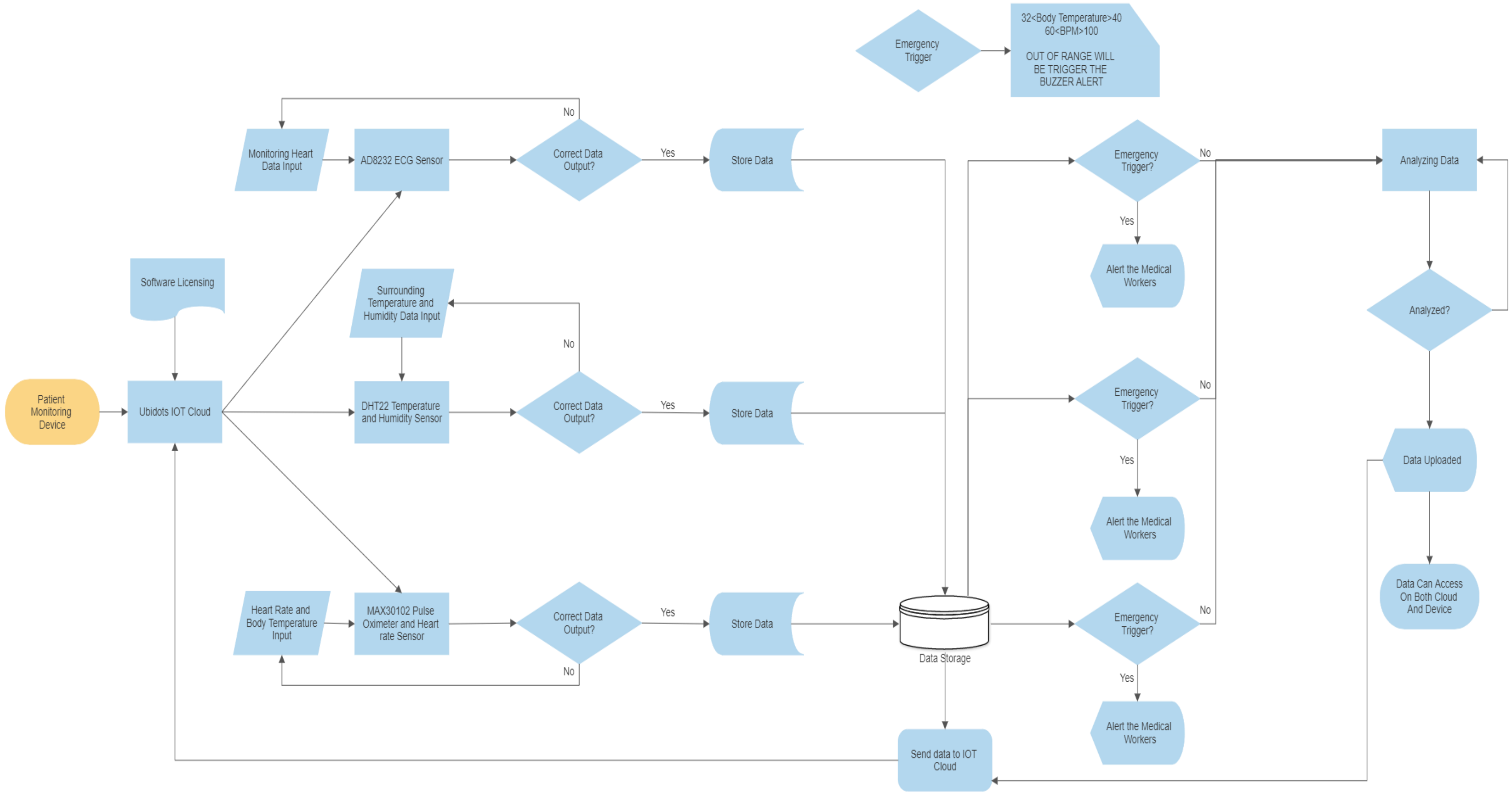

Figure 3: Design Architecture of the Patient Monitoring System

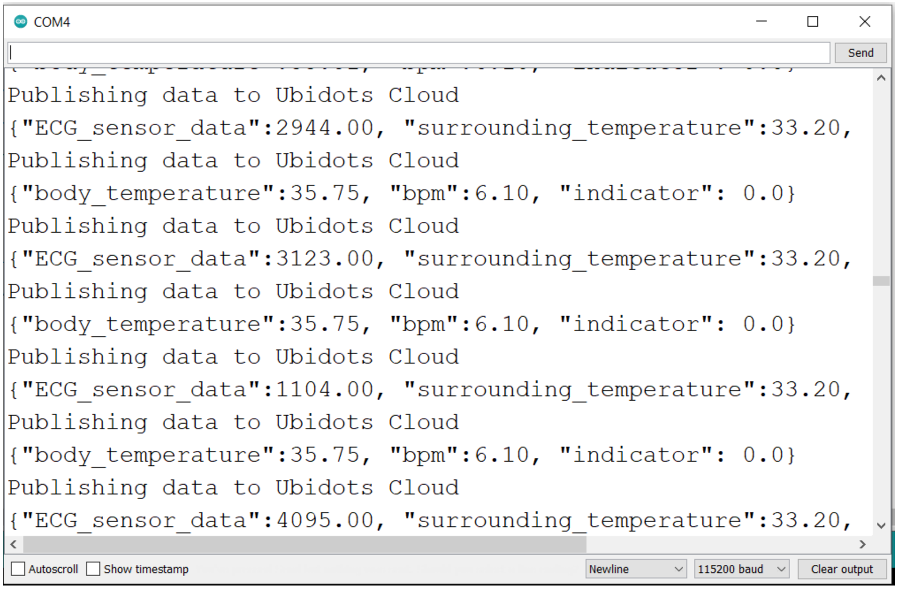

Figure 4: Data published to Ubidots Cloud through MQTT protocol

The analysis software has been developed in Arduino IDE and the code is as shown in Appendix. The processor ESP32 processes the data acquired by sensors and the processed data is then publish to the cloud through a Wi-Fi module and Message Queuing Telemetry Transport (MQTT) Protocol as shown in Figure 4. The real-time vital parameters are measured and published to cloud for every 1 seconds. The parameters are heart rate, body temperature, surrounding temperature, surrounding humidity, ECG data, and emergency indicator output. The processed data from Ubidots cloud is updated to the Ubidots dashboard as shown in Figure 5 which can be seen using the computer or the mobile. In Ubidots cloud, if the parameter data exceeds the threshold values, then the medical staffs will receive an alert message.

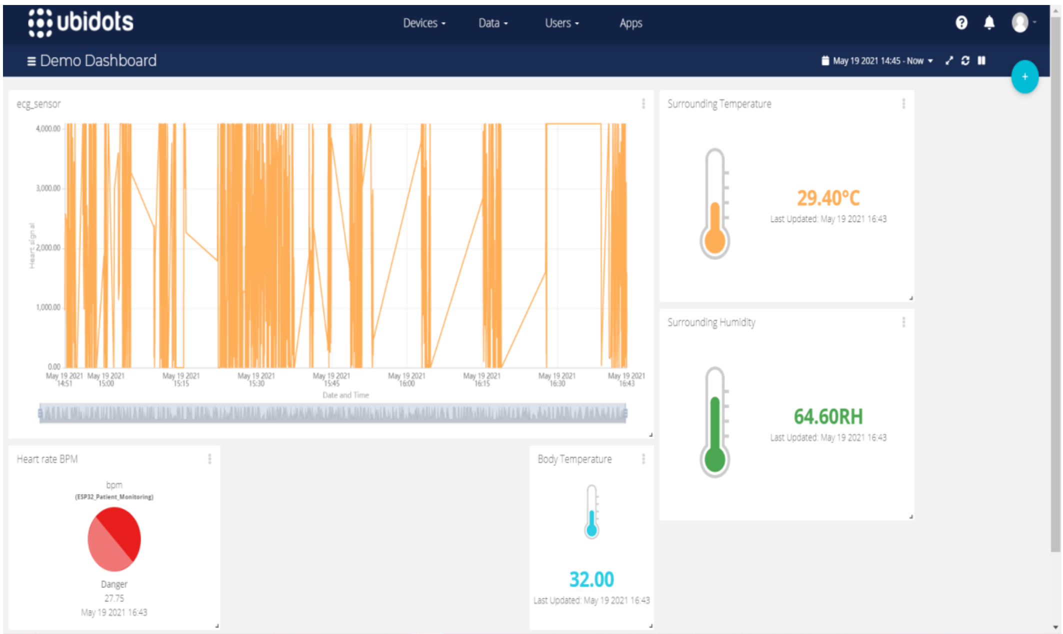

Figure 5: Data updated to Ubidots dashboard

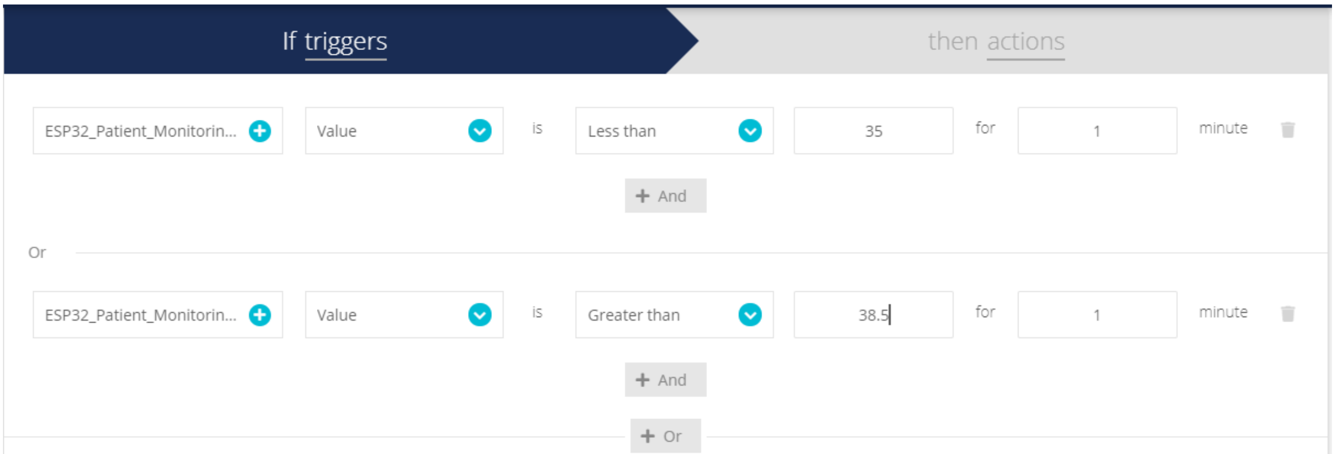

Figure 6: Alerting notifications set for body temperature

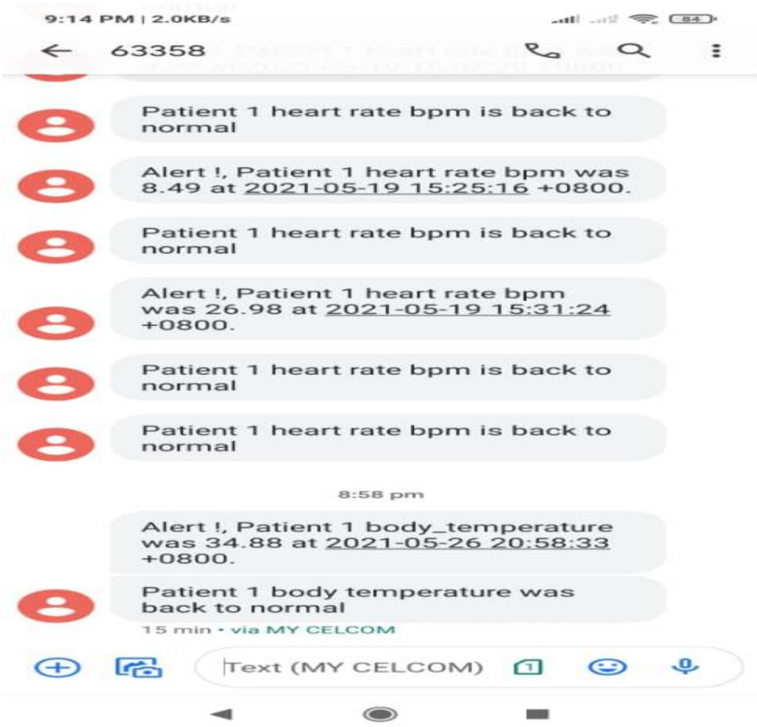

Figure 7: Alerting notifications sent to mobile when exceeding threshold values

The body temperature is considered normal in the range of 36.5 to 37.5 °C. The temperature from 37.5 to 38.5°C is considered to be a fever. The temperature below 35.0 °C is called hypothermia while the temperature above 38.5 is called hyperpyrexia. These two zones are dangerous for human body. Therefore, for the threshold value of body temperature, when the patient's body temperature is below 35.0 °C and above 38.5 for 1 minute as shown in Figure 6, then an alert message is sent to the medical staffs mobile through SMS with the details of the sensor and timestamp. The example of alerting notifications is shown in Figure 7.

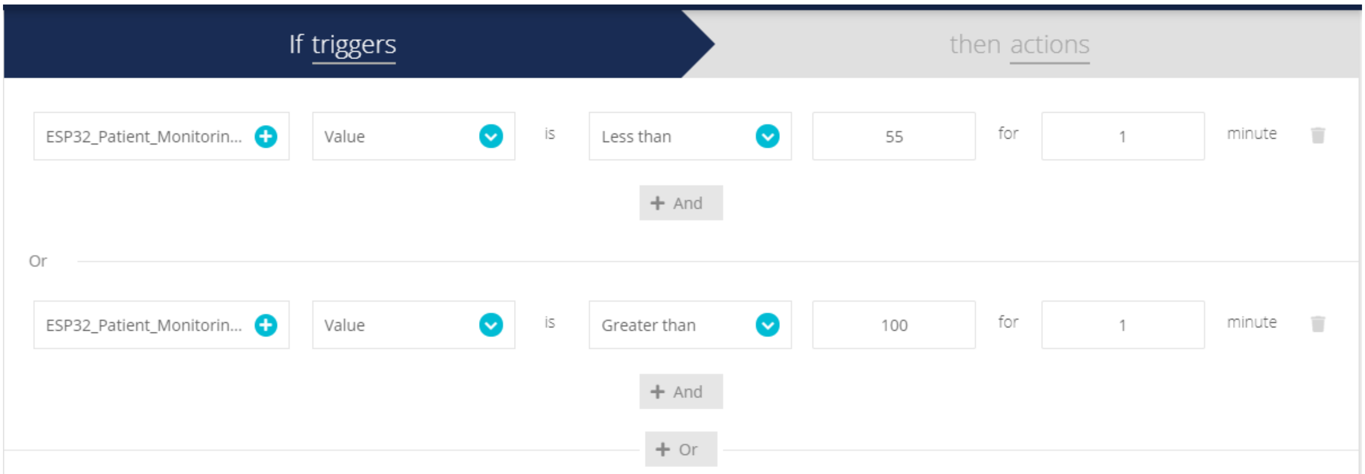

Figure 8: Alerting notifications set for heart rate

Heart rate values above 100 bpm and below 55 bpm are set as the threshold value as shown in Figure 8. If the patient heart rate remains at above 100 bpm and below 55 bpm for 1 minute, then the alert message is also sent to medical staffs mobile with the details of sensor and timestamp. The output of the emergency indicator will be published to Ubidots cloud to alert the medical staffs through sending alert message from cloud. Besides, the system is also designed such that the indicator output to alert the medical staffs while the patient or visitor is pressing the emergency indicator or the indicator output is 1.

5.0 Future Associated Works or Improvements

Few improvements and possible future associated works that can be done on the proposed system are discussed below to further improve its quality and feasibility into the current market.

5.1 Design / Hardware Improvement

The design improvement could be making the patient monitoring unit (PMU) small compact wearable. The design structure could be a waterproof wrist-band like smartwatch or medical smart-belt which can be worn by not only patients but everyone at all times.

The smartwatch will have the ECG or EKG tracker which can detect and identify the atrial fibrillation (Afib). The temperature sensor that can detect not only the body but also detect the surrounding environments at all times and alert the user to avoid extreme temperature or sudden temperature changes.

The medical smart-belt design will have the same functionality as the smartwatch. Although the design might not be as easy or comfortable as the smartwatch design, it could be a modular device that can add other additional IOT devices like insulin pump or diabetic devices.

The hardware improvement would be putting a better microcontroller, sensors, battery and GPS tracker which can geotag the location of the users at all time for emergencies. Microcontrollers could be improved with better WIFI/ bluetooth coverage with less energy consumption.

5.2 Software IOT System Improvement

The software system improvement could have a better security system, option to interact with both personal emergencies healthcare system and general hospitals and clinics, emergencies trigger for ambulances and contract with insurance companies.

During normal monitoring, the real time system can only show the data on IOT cloud will be limited to the general medical workers except for the personal and related medical workers or the person that users allowed. During emergencies the conditions will be by-pass and will alert the nearest hospital or clinics and ambulances to contact with a location. The data of the users can be found by the hospital or clinic and can access the healthcare system under the insurance policies. Geotag location will never be revealed unless the emergency conditions are met.

Other additional software systems and data analyzing will be added depending on modular devices or other IOT devices. These additional emergency conditions will be added by the company with the users conditions during registration of new modular IOT devices.

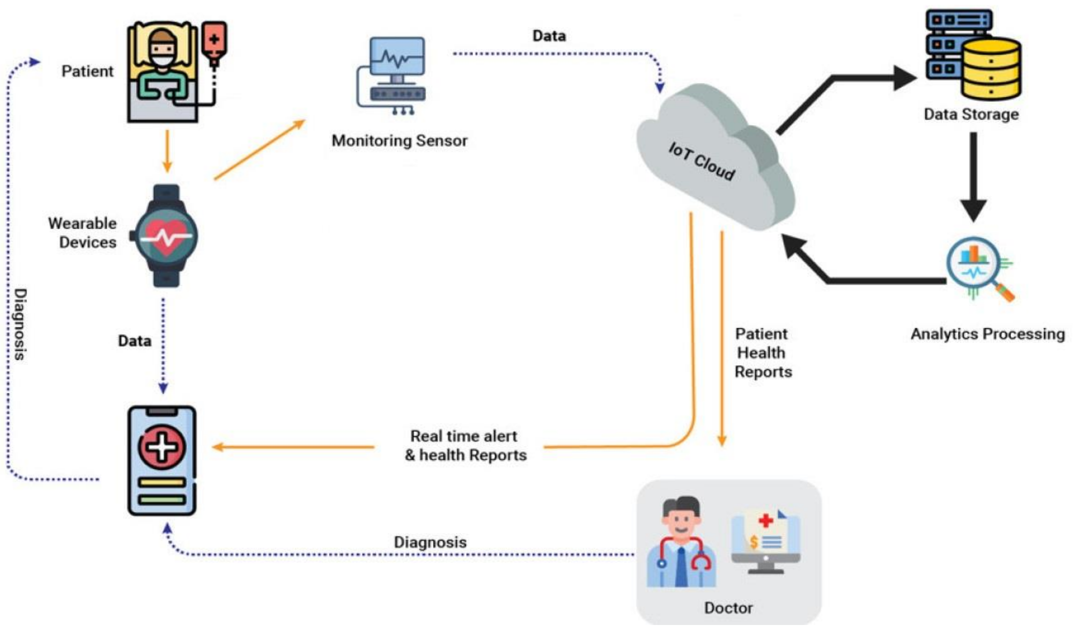

Figure 9: An Example of flow diagram of the system.

5.3 Addition New IOT Devices Improvement

The new improved design of the system will be module which can connect other new IOT devices with an interaction of bluetooth or WIFI to synchronize with the improved Patient Monitoring Unit. The new IOT devices would not be needing the microcontroller to connect the unit to transmit the data. It will connect via bluetooth or WIFI and then after synchronising the data will be added and shown in the same IOT system which is under the same policy for security and insurance for the devices.

Devices like insulin pumps that need to be changed after a few days use will have uninterrupted data synchronization on the IOT cloud which the system will have an alert trigger to the users for changing a new pump and a new emergency trigger will be added accordingly to the new devices on the IOT cloud system.

6.0 References

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7.0 Appendix

7.1 Adruino Code

sketch_may12a §

```
/***************************************
 * Include Libraries
 ***************************************/
#include <WiFi.h>
#include <PubSubClient.h>
#include <NTPClient.h>
#include <DHT.h>
#include <WiFiUdp.h>
#include <Wire.h>
#include "MAX30105.h"
#include "heartRate.h"

MAX30105 particleSensor;
const byte RATE_SIZE = 4; //Increase this for more averaging. 4 is good.
byte rates[RATE_SIZE]; //Array of heart rates

float beatsPerMinute;

const int PushButton=32; //emergency indicator push button pin
int buzzer = 2; //buzzer pin

#define WIFISSID "LAI-2_2.4GHz" // Put your WifiSSID here
#define PASSWORD "LAI0148878881" // Put your wifi password here
#define TOKEN "BBFF-EXqrex4p8TucfAifliba5gUA4qkUBK" // Put your Ubidots' TOKEN
#define MQTT_CLIENT_NAME "mymqttclient" // MQTT client Name, please enter your own 8-12 alphanumeric character ASCII string;
                                        //it should be a random and unique ascii string and different from all other devices
```

sketch_may12a §

```
/***************************************
 * Define Constants
 ***************************************/
#define VARIABLE_LABEL "ECG_sensor_data" // ubidots variable label (ECG data)
#define VARIABLE_LABEL_1 "surrounding_temperature" // ubidots variable label (surr temp data)
#define VARIABLE_LABEL_2 "surrounding_humidity" // ubidots variable label (surr humd data)
#define VARIABLE_LABEL_3 "body_temperature" // ubidots variable label (body temp data)
#define VARIABLE_LABEL_4 "bpm" // ubidots variable label (bpm data)
#define VARIABLE_LABEL_5 "indicator" // ubidots variable label (indicator output)
#define DEVICE_LABEL "ESP32_Patient_Monitoring" // ubidots device label
#define SENSOR A0 // Set the A0 as ECG SENSOR pin
#define DHTTYPE DHT22 //DHT type
uint8_t DHTPin=4; //DHT22 pin
DHT dht(DHTPin, DHTTYPE);
char mqttBroker[]  = "industrial.api.ubidots.com";
char payload[100];
char topic[150];
float x;


// Space to store values to send
char str_sensor[10];
char str_sensor1[10];
char str_sensor2[10];
char str_sensor3[10];
char str_sensor4[10];
char str_sensor5[10];
```

sketch_may12a §

```
/*****************************************
 * Auxiliar Functions
 ****************************************/
WiFiClient ubidots;
PubSubClient client(ubidots);

void callback(char* topic, byte* payload, unsigned int length) {
  char p[length + 1];
  memcpy(p, payload, length);
  p[length] = NULL;
  Serial.write(payload, length);
  Serial.println(topic);
}

void reconnect() {
  // Loop until we're reconnected
  while (!client.connected()) {
    Serial.println("Attempting MQTT connection...");

    // Attemp to connect
    if (client.connect(MQTT_CLIENT_NAME, TOKEN, "")) {
      Serial.println("Connected");
    } else {
      Serial.print("Failed, rc=");
      Serial.print(client.state());
      Serial.println(" try again in 2 seconds");
      // Wait 2 seconds before retrying
      delay(2000);
```

sketch_may12a §

```
/*****************************************
 * Main Functions
 ****************************************/
void setup() {
  Serial.begin(115200);
  WiFi.begin(WIFISSID, PASSWORD);
  // Assign the pin as INPUT
  pinMode(SENSOR, INPUT);
  pinMode(DHTPin, INPUT);
  pinMode(PushButton, INPUT);
  pinMode(buzzer, OUTPUT);
  dht.begin();
  Serial.println();
  Serial.print("Waiting for WiFi...");

  while (WiFi.status() != WL_CONNECTED) {
    Serial.print(".");
    delay(500);
  }

  Serial.println("");
  Serial.println("WiFi Connected");
  Serial.println("IP address: ");
  Serial.println(WiFi.localIP());
  client.setServer(mqttBroker, 1883);
  client.setCallback(callback);
  if (!particleSensor.begin(Wire, I2C_SPEED_FAST)) //Use default I2C port, 400kHz speed
  {
```

sketch_may12a §

```
  if (!particleSensor.begin(Wire, I2C_SPEED_FAST)) //Use default I2C port, 400kHz speed
  {
  Serial.println("MAX30105 was not found. Please check wiring/power. ");
  while (1);
  }
  particleSensor.setup(); //Configure sensor with default settings
  particleSensor.setPulseAmplitudeRed(0x0A); //Turn Red LED to low to indicate sensor is running
  particleSensor.setPulseAmplitudeGreen(0); //Turn off Green LED
  }


void loop() {
  if (!client.connected()) {
    reconnect();
  }
  long irValue = particleSensor.getIR(); //read MAX30102 bpm

  float sensor = analogRead(SENSOR); //read ECG sensor
  float sensor1= dht.readTemperature(); //read dht22 temperature (surrounding)
  float sensor2= dht.readHumidity();  //read dht22 humidity
  float temperature = particleSensor.readTemperature(); //read MAX30102 temperature (body)
  int Push_button_state = digitalRead(PushButton); //read push button (indicator) output

  if (checkForBeat(irValue) == true)
  {
  //We sensed a beat!
  long delta = millis() - lastBeat;
  lastBeat = millis();
```

sketch_may12a §

```
 }

 dtostrf(sensor, 4, 2, str_sensor); //change float to character with 2 decimal places
 dtostrf(sensor1, 4, 2, str_sensor1);
 dtostrf(sensor2, 4, 2, str_sensor2);
 dtostrf(temperature, 4,2, str_sensor3);
 dtostrf(beatsPerMinute, 4,2, str_sensor4);
 dtostrf(x, 4,1, str_sensor5);

 sprintf(topic, "%s%s", "/v1.6/devices/", DEVICE_LABEL); // Adds device
 sprintf(payload, "%s", ""); // Cleans the payload content
 sprintf(payload, "{\"%s\":%s,", VARIABLE_LABEL, str_sensor); // Adds the variable label
 sprintf(payload, "%s \"%s\":%s,", payload, VARIABLE_LABEL_1, str_sensor1); // Adds the variable label
 sprintf(payload, "%s \"%s\":%s}", payload, VARIABLE_LABEL_2, str_sensor2); // Adds the variable label
 Serial.println("Publishing data to Ubidots Cloud");
 Serial.println(payload);
 client.publish(topic, payload); //publish to Ubidots cloud

 sprintf(topic, "%s%s", "/v1.6/devices/", DEVICE_LABEL); // Adds device
 sprintf(payload, "%s", ""); // Cleans the payload content
 sprintf(payload, "{\"%s\":%s,", VARIABLE_LABEL_3, str_sensor3); // Adds the variable label
 sprintf(payload, "%s \"%s\":%s,", payload, VARIABLE_LABEL_4, str_sensor4); // Adds the variable label
 sprintf(payload, "%s \"%s\":%s}", payload, VARIABLE_LABEL_5, str_sensor5); // Adds the variable label
 Serial.println("Publishing data to Ubidots Cloud");
 Serial.println(payload);
 client.publish(topic, payload); //publish to Ubidots cloud
 /* 4 is mininum width, 2 is precision; float value is copied onto str_sensor*/
}
```

sketch_may12a §

```
 beatsPerMinute = 60 / (delta / 1000.0);
 }
  digitalWrite (buzzer, HIGH); //turn buzzer on
 if ( Push_button_state == HIGH )
 {
 digitalWrite (buzzer, HIGH); //turn buzzer on
 x=1;
 }
 else
 {
 digitalWrite (buzzer, LOW); //turn buzzer on
 x=0;
 }

 dtostrf(sensor, 4, 2, str_sensor); //change float to character with 2 decimal places
 dtostrf(sensor1, 4, 2, str_sensor1);
 dtostrf(sensor2, 4, 2, str_sensor2);
 dtostrf(temperature, 4,2, str_sensor3);
 dtostrf(beatsPerMinute, 4,2, str_sensor4);
 dtostrf(x, 4,1, str_sensor5);

 sprintf(topic, "%s%s", "/v1.6/devices/", DEVICE_LABEL); // Adds device
 sprintf(payload, "%s", ""); // Cleans the payload content
 sprintf(payload, "{\"%s\":%s,", VARIABLE_LABEL, str_sensor); // Adds the variable label
 sprintf(payload, "%s \"%s\":%s,", payload, VARIABLE_LABEL_1, str_sensor1); // Adds the variable label
 sprintf(payload, "%s \"%s\":%s}", payload, VARIABLE_LABEL_2, str_sensor2); // Adds the variable label
 Serial.println("Publishing data to Ubidots Cloud");
 Serial.println(payload);
```

7.2 Weekly Minutes of Meeting

MINUTES OF MEETING (Week 1)

Group 5 (BEng)

Date of Meeting	5th March 2021
Time	4.00 p.m. to 4.30 p.m.
Location	Online (Google Meet)
Prepared by	Jason Santhanaraj A/L Zavour

Attendees
• Jason Santhanaraj A/L Zavour
• Lai Chia Hern

Agenda
• Discuss on possible topics to be selected for the project.
• Discuss on equipments and tools needed for project.
• Discuss on tasks to be completed before meeting with lecturer.

Summary of Discussion
1) Narrowed down to 2 possible topics which are: • Facial Recognition and Temperature door lock system • Covid-19 Patient Monitoring System
2) Details of the project objectives, real life problems it solves and project design were discussed.
3) Equipments and tools needed for the project were listed.
4) Contents for preparing Gantt Chart and Minutes Of Meeting were discussed.
5) Tasks for next week: • Chia Hern prepare Gantt Chart and budget list for items needed for project. • Jason prepare minutes of meeting and do further research on project concept and design.

MINUTES OF MEETING (Week 2)

Group 5 (BEng)

Date of Meeting	9th March 2021
Time	12.00 p.m. to 1.00 p.m.
Location	Online (Google Meet)
Prepared by	Jason Santhanaraj A/L Zavour

Attendees
• Jason Santhanaraj A/L Zavour
• Lai Chia Hern
• Htike Aung Lwin
• Leslie Gunting Jonathan Ensawing

Agenda
• Finalize topic for project and discuss the workflow of project.
• Discuss on tasks to be completed for this week.

Summary of Discussion
1) Meeting with Dr.Wong regarding topic selection and complexity of thermal Imaging, and facial identification are discussed.
2) Workflow, challenges, feasibility, longevity, and item requirements for the product of both projects are discussed.
3) Team members agree on finalizing Patient Monitoring System as the project topic.
4) Design of the product and a draft of possible items that is required are discussed.
5) Tasks to be completed by next week: • All members do further research on feasibility and similar existing product in the market. • Leslie and Htike research and finalize list of items needed, items specification, pricing. • Chia Hern and Jason research on setting up IOT platform. • Htike place order for items by end of the week once finalized. • Leslie revise and prepare Gantt Chart based on selected project topic. • Jason prepare Minutes of Meeting for week 2.

MINUTES OF MEETING (Week 3)

Group 5 (BEng)

Date of Meeting	15th March 2021
Time	9.00 a.m. to 10.00 a.m.
Location	Online (Google Meet)
Prepared by	Jason Santhanaraj A/L Zavour

Attendees
• Jason Santhanaraj A/L Zavour
• Lai Chia Hern
• Htike Aung Lwin
• Leslie Gunting Jonathan Ensawing

Agenda
• Clarification on product design and the potential customer.
• Division of the task for this week.

Summary of Discussion
1) Discussion on Dr.Wong's comments regarding the project topic clarity.
2) Discussion if patient monitoring system should be wearable/portable or fixed and its challenges.
3) Sketching a rough design drawing of the Patient Monitoring System.
4) Finalize the Gantt Chart
5) Preparation for consultation with Dr.Wong at 10.00 a.m. regarding project.
6) Tasks for this week: • Htike prepare detailed product design drawings with connections. • Jason research on components specifications for design proposal. • Leslie market research on proposed product design. • Chia begin preparing coding for sensor components. • Jason prepare Minutes of Meeting for week 3.

MINUTES OF MEETING (Week 4)

Group 5 (BEng)

Date of Meeting	22th March 2021
Time	9.00 a.m. to 10.00 a.m.
Location	Online (Google Meet)
Prepared by	Jason Santhanaraj A/L Zavour

Attendees
• Jason Santhanaraj A/L Zavour
• Lai Chia Hern
• Htike Aung Lwin
• Leslie Gunting Jonathan Ensawing

Agenda
• Discussion on design proposal report contents.
• Discussion on campus returning form.

Summary of Discussion
1) Discussion on Dr.Wong's comments regarding the Gantt chart and editing contents of the chart table.
2) Finalize the contents of the Gantt Chart
3) Discussion on venue for components and product hardware construction.
4) Discussion on procedure for applying for campus returning form.
5) Discussion on design proposal contents and division of work to each member.
6) Tasks for this week: • Htike, Leslie and Lai apply for campus returning form. • Htike and Lai connect sensors to ESP32 (hardware construction). • Design Proposal Report tasks division: a) Jason finalise the specification of selection of components. b) Leslie continue market research on existing similar products and identify any design codes/safety concerns to be followed. c) Lai determine method to test performance of product. d) Finalise the design drawing of last week for the product. • Setup ESP32 and connect ESP32 to IOT cloud using Wi-Fi module • Jason prepare Minutes of Meeting for week 4.

MINUTES OF MEETING (Week 5)

Group 5 (BEng)

Date of Meeting	29th March 2021
Time	10.00 a.m. to 10.30 a.m.
Location	Online (Google Meet)
Prepared by	Jason Santhanaraj A/L Zavour

Attendees
• Jason Santhanaraj A/L Zavour
• Lai Chia Hern
• Htike Aung Lwin
• Leslie Gunting Jonathan Ensawing

Agenda
• Discussion on design proposal report contents.
• Discussion on work division for design proposal report.

Summary of Discussion
1) Discussion on Dr.Wong's comments on including milestones in Gantt Chart for every week.
2) Dividing task for Design proposal to each member since the due date for report is this week.
3) Discussion on details of each tasks for member in design proposal report based on marking rubrics.
4) Discussion on compiling receipts of items bought for preparing claims.
5) Tasks for this week: • Htike and Leslie research and complete the design and safety code for the product based on existing IEEE codes. • Htike update on the design drawing with the updated port connections. • Leslie complete and update the details in report of similar existing products in the market. • Jason finalise the list of function and specifications of selected items and include the budget list of items in the design report. • Jason complete the sketch drawing of proposed product connected to user and describe the innovation of proposed product. • Lai complete a full description of design architecture of product description and performance and product testing. • Jason prepare Minutes of Meeting for week 5.

MINUTES OF MEETING (Week 6)

Group 5 (BEng)

Date of Meeting	5^{th} April 2021
Time	4.00 p.m. to 4.30 p.m.
Location	Online (Google Meet)
Prepared by	Jason Santhanaraj A/L Zavour

Attendees
• Jason Santhanaraj A/L Zavour
• Lai Chia Hern
• Htike Aung Lwin
• Leslie Gunting Jonathan Ensawing

Agenda
• Discussion on tasks to be completed this week.

Summary of Discussion
1) Discussion on completed design report and finalising claims.
2) Discussion on Dr.Wong suggestion on using UDEMY account to study how to setup IOT for AWS.
3) Discussion on tasks to do this week with consideration of tuition free week.
4) Tasks for this week: • All members take turns during the week to go through the IOT course in UDEMY as suggested by Dr.Wong. • Htike and Leslie can research on available codes online for sensors used in the proposed design. • Htike and Leslie can learn and determine how to edit codes specific to criteria for the proposed product. • Lai and Jason go through the IOT course in UDEMY and learn how to setup the AWS account and IOT cloud. • Lai and Jason can try to setup the AWS IOT cloud and Node-Red • Jason prepare Minutes of Meeting for week 6.

MINUTES OF MEETING (Week 7)

Group 5 (BEng)

Date of Meeting	14th April 2021
Time	2.00 p.m. to 2.30 p.m.
Location	Online (Google Meet)
Prepared by	Jason Santhanaraj A/L Zavour

Attendees
• Jason Santhanaraj A/L Zavour
• Lai Chia Hern
• Htike Aung Lwin
• Leslie Gunting Jonathan Ensawing

Agenda
• Discussion on progress update and problems faced for previous week.
• Discussion on upcoming task to be completed

Summary of Discussion
1) Discussion on Dr.Wong's comments regarding current progress and problems faced with IOT setup.
2) Discussion on issues faced when setting up Node-Red (MQTT) however as advised by Dr.Wong this step can be skipped and continue with the subsequent steps to setup the IOT.
3) Discussion on sensor interfacing coding and soldering of the components.
4) Tasks for this week: • Htike and Leslie prepare the coding for the sensors. • Htike begin soldering of the components and sensors. • Jason and Lai continue with the AWS IOT cloud setup and prepare for connection of the IOT cloud with the ESP 32. • Coding of sensors and IOT setup to be completed by Friday night and a meeting on Friday night to do connection of sensors to ESP 32 and solve errors for connection if there is any. • Jason prepare Minutes of Meeting for week 7.

MINUTES OF MEETING (Week 8)

Group 5 (BEng)

Date of Meeting	20th April 2021
Time	8.00 p.m. to 8.30 p.m.
Location	Online (Google Meet)
Prepared by	Jason Santhanaraj A/L Zavour

Attendees
• Jason Santhanaraj A/L Zavour
• Lai Chia Hern
• Htike Aung Lwin
• Leslie Gunting Jonathan Ensawing

Agenda
• Discussion on progress update and problems faced for previous week.
• Discussion on upcoming task to be completed

Summary of Discussion
1) Discussion regarding the cancelation of previous Friday meeting due to emergency of a team member and also unavailability to move meeting to the subsequent days due to exam on Monday.
2) Discussion on completion of the AWS setup and only require to test connection with ESP32.
3) Reviewing issue with some sensor of the sensor coding and so far the ECG and DHT22 sensor are working fine.
4) Tasks for this week: • All members will meet on coming Wednesday to do the sensor coding together and if there is any errors found will be corrected. • Once, all sensors are fully coded and connected to the ESP 32 successfully Hitke and Leslie can begin to solder the remaining components. • Lai and Jason can test if data is able to be sent from the sensors to the IOT cloud once the ESP32 is connected successfully to the IOT cloud. • Lai and Jason can begin researching on visualisation of data in AWS • Jason prepare Minutes of Meeting for week 8.

MINUTES OF MEETING (Week 9)

Group 5 (BEng)

Date of Meeting	26th April 2021
Time	9.00 a.m. to 10.00 a.m.
Location	Online (Google Meet)
Prepared by	Jason Santhanaraj A/L Zavour

Attendees
• Jason Santhanaraj A/L Zavour
• Lai Chia Hern
• Htike Aung Lwin
• Leslie Gunting Jonathan Ensawing

Agenda
• Discussion on progress update and problems faced for previous week.
• Discussion on upcoming task to be completed

Summary of Discussion
1) Discussion on problem with ESP 32, since it is unable to provide connection from ESP 32 to the serial monitor and also unable to upload to the ESP 32.
2) Problem with ESP 32 continues to persist even though a different PC is used. Hence, a new ESP 32 is required.
3) AWS setup is completed and next step is to connect to the ESP 32 to ensure data streaming is possible.
4) Coding for the sensors are mostly compiled but due to problem with ESP 32 not able to fully test the connection.
5) Tasks for this week: • Leslie order a new ESP 32 since there is problem with the current one. • Leslie and Htike continue to revise the codes for each sensor to ensure it is correct. • Leslie try to solve the problem for the current ESP 32 while waiting for the new ESP32 to arrive. • Jason and Lai study on the visualisation for data streaming using Quicksight dashboard. • Jason update the Minutes of Meeting for week 9.

MINUTES OF MEETING (Week 10)

Group 5 (BEng)

Date of Meeting	3rd May 2021
Time	9.00 a.m. to 9.40 a.m.
Location	Online (Google Meet)
Prepared by	Jason Santhanaraj A/L Zavour

Attendees
• Jason Santhanaraj A/L Zavour
• Lai Chia Hern
• Htike Aung Lwin
• Leslie Gunting Jonathan Ensawing

Agenda
• Discussion on progress update and problems faced for previous week.
• Discussion on upcoming task to be completed.

Summary of Discussion
1) Ordered ESP 32 arrived on Saturday and Leslie will start with to do the connection with the other sensors.
2) Problem with Max30102 sensor due to improper soldering and overheating. Hence, need to order another Max30102.
3) DHT 22 is able to detect temperature and show at the serial monitor however the ground pin is broken. Hence, another DHt 22 is required.
4) Discussion on issues with the AWS account since there are some charges to use the account and if not paid the account can be terminated. Will have to recreate the AWS account or find alternative IOT system.
5) Tasks for this week: • Leslie order a new DHT22 and Max 30102 since there is problem with the current one. • Htike assist Leslie with setting the codes, connection and sensoring for ECG. • Jason and Lai create a new AWS account and if there are still issues, can try to setup Ubidots another IOT system as suggested by Leslie. • Jason and Lai start to look into Final Report requirements. • Jason update the Minutes of Meeting for week 10.

MINUTES OF MEETING (Week 11)

Group 5 (BEng)

Date of Meeting	10^{th} May 2021
Time	9.30 a.m. to 10.00 a.m.
Location	Online (Google Meet)
Prepared by	Jason Santhanaraj A/L Zavour

Attendees
• Jason Santhanaraj A/L Zavour
• Lai Chia Hern
• Htike Aung Lwin
• Leslie Gunting Jonathan Ensawing

Agenda
• Discussion on progress update and problems faced for previous week.
• Discussion on upcoming task to be completed.

Summary of Discussion
1) Updated claims completed and submitted to Dr.Wong by Leslie.
2) Max 30102 and Dht 22 arrived and next step is to code and connect to the ESP 32 and check if able to stream data.
3) Due to issues with AWS, decision to use Ubidots for IOT platform. Ubidots setup is completed.
4) ECG sensor coding is completed and can stream data to IOT platform (Ubidots) with no issues.
5) Tasks for this week: • Jason and Lai assist Leslie in coding for the remaining sensors to be able to streaming to IOT. • Leslie complete the connection for remaining sensors to ESP32. • Jason and Lai can begin the Final Report for section A and B, design explanation and trade off issues. • Htike prepare the PCB drawing for the Final Report and assist Leslie in soldering the components once all the sensors are successful in data streaming to the IOT cloud. • Jason update the Minutes of Meeting for week 11.

MINUTES OF MEETING (Week 12)

Group 5 (BEng)

Date of Meeting	17th May 2021
Time	9.00 a.m. to 10.00 a.m.
Location	Online (Google Meet)
Prepared by	Jason Santhanaraj A/L Zavour

Attendees
• Jason Santhanaraj A/L Zavour
• Lai Chia Hern
• Htike Aung Lwin
• Leslie Gunting Jonathan Ensawing

Agenda
• Discussion on progress update and problems faced for previous week.
• Discussion on upcoming task to be completed.

Summary of Discussion
1) Discussion on completion of the sensor coding and successfully data streaming to the IOT cloud.
2) Discussion on final design of the prototype before completing the soldering.
3) Further discussion on Final Report and task division for each member.
4) Discussion on how the presentation should be carried out and how to operate the working prototype during presentation to highlight the features of product.
5) Tasks for this week: • Lai complete the product design and results of testing explanations for Final Report. • Leslie complete the soldering of the components based on the finalised design as discussed in the meeting. • Jason complete the trade off issues and details of components used for the design based on their datasheets for the Final Report • Htike prepare a flow diagram of the proposed product works with conditions such as threshold values and future works of the product CB for the Final Report. • Jason update the Minutes of Meeting for week 12 and compile all the Minutes of Meeting and include it in the appendix section of the Final Report.