# Health Project 2024

## Course: ELTC H3024 Project Part 2

## Supervisor: [Mark Deegan]

## Project Title: [GP Virtual Monitoring System]

Table of Contents

1. [Project Description 3](#_Toc158429223)

[1.1: Key functionalities and features of the health system: 3](#_Toc158429224)

[1.2: The technologies and platforms I used: 3](#_Toc158429225)

1. [System Architecture 5](#_Toc158429226)

2.1: Health Monitoring System Block Diagram ………………………………………………………………………………………………………………………..5

[2.2: Components Description: 5](#_Toc158429227)

1. [Project Scope 7](#_Toc158429228)

[3.1: Deliverables of the project: 7](#_Toc158429229)

[3.2: Bounderies of the project: 8](#_Toc158429230)

[3.3: Limitations and Challenges: 8](#_Toc158429231)

1. [Project Schedule 9](#_Toc158429232)

4.1: Health Monitoring System Gnaat Chart……………………………………………………………………………………………………………………………10

1. [Resources Required 11](#_Toc158429233)

[5.1: Hardware: 11](#_Toc158429234)

[5.2: Software 11](#_Toc158429235)

[5.3: Components – Resources and Cost 11](#_Toc158429236)

1. [Expected Outcomes 11](#_Toc158429238)

[6.1: Intended impact and benefits 11](#_Toc158429239)

[6.2: Benficts for the gadget 11](#_Toc158429240)

[6.3: Probem solving and addressing audience needs 11](#_Toc158429241)

[6.4: Performance Evaluation Criteria: 12](#_Toc158429242)

1. [Ethical/ Safety Considerations 12](#_Toc158429243)

[7.1: Potential Safety Issues Related to Hardware Deployment: 12](#_Toc158429244)

[7.2: Potential Ethical Issues Related to Data Privacy, Security, or Environmental Impact: 12](#_Toc158429245)

[7.3: Addressing Ethical Concerns in Project Design and Implementation: 13](#_Toc158429250)

[**8.** Conclusion 13](#_Toc158429255)

[Appendix: 13](#_Toc158429256)

[Note: 13](#_Toc158429257)

## Table of Figures

## Figure 1 - Pinout of the ESP32

## Figure 2 – TCP/IP Protocol

## Figure 3 – The Health’s MQTT Breakdown

## Figure 4 – I2C Communication

## Figure 5 – SPI Breakdown

## Figure 7 - DS18B20 Temperature Sensor Pinout

## Figure 8 - Schematic design of the DS18B20 Temperature Sensor

## Figure 9 - Breadboard connection for temperature sensor and ESP32

## Figure 10 – Tasmota connection for the temperature sensor

Figure 11 – SEN0203 Heart rate Sensor

## Figure 12 - Pinout of the Heart rate sensor

## Figure 13 - Breadboard connection of the Heart rate sensor and ESP32

## Figure 15 – Tasmota connection for the Heart rate sensor

## Figure 16 – Data flow of the components

## Figure 17 – Gnatt Chart

## Project Description

The project aims to oversee a health monitoring system utilizing a health gadget equipped with SEN0203 Heart rate sensor, DS18B20 Temperature Sensor and Bluetooth Blood Pressure monitor.

This gadget enables remote monitoring of an individual's health by detecting pulse/heart rate and body temperature. The collected health information is transmitted to a dedicated website using HTTP, generating a comprehensive health report accessible to both the patient and their General Practitioner (GP) or doctor.

The main beneficiaries of this project are vulnerable individuals worldwide, especially those unable to travel. The system provides timely and accurate information regarding body temperature, heart rate, and blood pressure. It also serves the patient by providing them with the access of the health data over periods of years or months, facilitating medical choices based on the health status of the patient.

# 1.1: Key functionalities and features of the health system:

**Remote Health monitoring:**

* Patients can regularly monitor their health status using the health gadget.
* In case of abnormal readings, such as fever due to high body temperature, a virtual meeting with the GP or doctor can be organised, avoiding the need for physical visits in a clinic or hospital.

**Real-time Report Updates:**

* System ensures the medical reports are updated accordingly each time a patient measures their health parameters.
* Information will be displayed on a HTTP-based website, accessible to both patients and GP or doctors.

**Health Data Access:**

* The website stores the health reports, enabling patients and doctors to review the health data over various timeframes (e.g. Years from 2024 to 2019), facilitating the understanding of the patient's health status.

**Secure Data Transmission:**

* Ensure’s the patient data is confidential and secured, the system utilizes secured HTTP protocols for transmitting health data from the gadget to the website.
* Additionally, username and password encryption are implemented to secure information during transmission.

**Virtual Appointments:**

* Through the system, patients engage in virtual appointment meetings with their GP or Doctor using platforms like Zoom or Microsoft Teams.
* Faster process and allows the health status of the patient to be assessed without the need for physical assistance.

**Alert Notification:**

* In case of abnormal readings or critical health conditions detected by the sensors, the system will have a led blink to indicate the abnormal readings.
* Notifications regarding upcoming virtual appointments or changes in health data are also sent to ensure timely communication and appointments can also be made through the HTTP website.

## 1.2: The technologies and platforms I used:

**Microcontrollers:**

**ESP32 – S3**

* Acts as an access point facilitating communication between the health system and patients.
* Ensures accurate collection of patient information and provides precise health status updates.

A circuit board with many different colored letters

Description automatically generated

## Figure 1 - Pinout of the ESP8266(Node MCU)

**Technologies:**

**TCP/IP Protocol**

* Defines data transmission standards over computer networks, including the internet.
* It breaks the data into packets, transmitting them to their destination.
* Enabling devices to communicate using a common language.

A blue and red table with text

Description automatically generated

**Application layer:**

* Facilitates networking communication, primarily through HTTP. [Hypertext transfer protocol].
* User applications include email services and messaging layers.
* An HTTP website is created in this project to display all medical reports accessible by doctors and patients.

**Transport layer:**

* Manages error free packet exchange between devices involves data packetization.
* Enables reliable communication between medical devices and the central monitoring system, optimizing patient care and safety.

**Networking layer:**

* Involves data transmission across the network, mainly using IP address.
* Connection of operating to tasmota is based on an IP address and access to medical reports on smartphones or laptops is also based on an IP address.

**Data Link layer or Physical layer:**

* Manages physical data transmission, primarily using ethernet.
* Implements protocols for the reliable transmission of data packets over Ethernet connections, ensuring data integrity.

## Figure 2 – TCP/IP Protocol

**MQTT**

* Customized IoT messaging protocol facilitating device communications.
* Tasmota facilitates the transmission of sensors data to the cloud data service.
* MQTT parameters link Azure to Tasmota, Node-RED, InfluxDB, and Grafana via muhammad03.westeurop.cloudapp.azure.com, ensuring smooth connectivity.
* Employing MQTT technology, the two websites developed for this project will utilize MQTT to enhance updates and ensure accuracy on the website.

A diagram of a company

Description automatically generated

## Figure 3 – The Health’s MQTT Breakdown

**I2C** **Communication**

* Utilizes two communication lines (SDA and SCL) for sensor connections to allow readings on Tasmota and health system to operate.
* MAX30100 pulse oximeter sensor and SDP610-025PA pressure sensor both uses the I2C communication protocol in order to communicate with microcontroller.

A diagram of a computer

Description automatically generated

## Figure 4 – I2C Communication

**Wireless Networking**

* Utilizes radio frequency (RF) connections between nodes and networks like telecommunication networks.
* Allows open-source platforms like tasmota or web servers like node red to operate using a wireless network such as Hotspot network connection or House network connection.

**SPI (Serial Peripheral Interface)**

* Synchronous serial communication interface used for short-distance communication in embedded systems.
* It operates as a master-slave protocol, facilitating straightforward interactions between microcontrollers.
* SPI includes clock and data lines, along with a select line, for efficient communication.

A diagram of a computer program

Description automatically generated with medium confidence

## Figure 5 – SPI Breakdown

**Microsoft Azure Cloud service**

* Platform used for secure data transmission and storage.
* Ensures the secure and the data transfer process for improved overall system functionality.

# System Architecture

## 2.1: Health Monitoring System Block Diagram

A diagram of a company

Description automatically generated with medium confidence

## Figure 6 – Block diagram of the Health project

## 2.2: Components Description:

**DS18B20 Digital Temperature Sensor:**

* Measures the body temperature of the patient by inserting a silver tube (probe) in the patient's mouth.
* Connected to the ESP8266 microcontroller chip via a 4.7k ohm resistor.
* Accuracy: ±0.5°C from temperature readings of -10°C to +85°C.

A diagram of a transistor

Description automatically generated Figure 7 - DS18B20 Temperature Sensor Pinout

A circuit board with wires

Description automatically generated

## Figure 9 - Breadboard connection for temperature sensor and ESP8266

A screen shot of a device

Description automatically generated

## Figure 10 – Tasmota connection for the temperature sensor

**SEN0203** **– Heart rate sensor**

* Measures heart rate of the patient.
* Utilizes to be a thumb-sized heart rate monitor, it can be wrapped around the finger, wrist, earlobe or other areas where it has contact with the skin.
* Calculates a simple and low-cost optical technique to detect blood volume changing in the tissues of the patient’s body.
* Heart rate measures techniques using the PPG (PhotoPlethysmoGraphy) techniques.

A close-up of a circuit board and a strap

Description automatically generated

Figure 11 - SEN0203 Sensor

A black and white diagram of a device

Description automatically generated

## Figure 13 - Pinout of the Heart rate sensor

## Figure 14 - breadboard connection of the Heart rate sensor and ESP32

## Figure 15 – Tasmota connection for the Heart rate sensor

**Tasmota Firmware:**

* Open-source firmware based on ESP32-S3, used for displaying sensor readings and controlling LEDs.
* Purpose-built firmware platform equipped with features for monitoring vital signs and health parameters, enhancing patient care in healthcare settings.

**Virtual Machine (VM):**

***Node Red***

* Utilizes as a programming tool for integrating hardware devices.
* Setup includes configuring a network port (1880) on Microsoft Azure.
* Node-RED reads sensor values from Tasmota and interfaces with a SQL database for patient data analysis.

**SQL Server Database**

* Created from Node-RED, with each sensor-detected health value generating a new entry.
* Monitors health values from sensors and allows GP or doctor input to determine health status

**Website:**

**GP Virtual Monitoring System:**

* Provides Services about the system and displays patient health status databases and reports,

**Medical Reports:**

* Allows access to Current and yearly medical reports for signed-in users.
* Allows access to Prescriptions for the GP or doctor use for signed-in users.

## 2.2 Data flow components

A diagram of a company

Description automatically generated

## Figure 16 – Data flow of the components

## **3.** Project Scope

## 3.1: Deliverables of the project:

**Overall Data Analysis Report:**

* Includes information on components used, block diagram of the system, description of each component, technologies, and communication protocols utilized.
* Provides an overview of the project's architecture, functionality, and data flow.

**HTML Website:**

* Provides a website for testing health sensors data for each patient.
* Updates the patient's health status based on the data received from the sensors.
* Accessible via web browsers on mobile or laptop by entering the IP address.

**Health Data Access Servers:**

* Allows access to the patient's health data from anywhere using the IP address of the website or through the downloaded app.
* Provides flexibility and convenience for patients and healthcare providers to review health reports.

**Health Database:**

* Utilizes SQL Server database connected to the medical reports website and Tasmota.
* Automatically updates with sensor data, organizing entries based on detected values.

## 3.2: Boundaries of the project:

**Inclusions:**

* Monitoring a health system gadget for patients.
* Implementation of an alert led system for abnormal readings or critical conditions detected by sensors.
* Utilization of Heart rate, Body Temperature and Blood pressure to ensure accurate operations.
* Patients and GP or doctor access the health reports through the HTML website
* Integration with MQTT, Node Red, SQL Database, ESP8266 WI-FI chip and other designated technologies

**Exclusions:**

* Physical sensor adjustments beyond the automated health system)
* Quality control and consistency in the production of hardware components.
* Specific integration with smart home systems is not mentioned in the health system context.
* Creation of HTML website and SQL database for platforms accessing the health system
* Including third party technologies that aren’t listed in the project descriptions.

## 3.3: Limitations and Challenges:

**Hardware Limitations:**

* Design and materials used determine the accuracy of all sensors, defining the accuracy of health status for each patient.

**Data Accuracy:**

* Precision of all sensors influences how health readings are measured and accurately reflected in the Medical Report.

**Website Combability:**

* The compatibility of website IP addresses might be restricted to web servers like Firefox or operating systems, potentially leading to errors for patients.

**Real Time connection:**

* Reliable and accurate real-time connection is essential for the system to operate effectively; network disruptions can impact this connection.

**Regulatory Compliance:**

* Monitoring and controlling health-related measures in accordance with local standards and regulations may pose challenges and need to be addressed.

## Project Schedule

## 4.1: Health Monitoring System Gannt Chart

## Figure 17 – Gannt Chart

## **5 .** Resources Required

## 5.1: Hardware/Technologies:

* WIFI based hardware - the SEN0203 Heart rate sensor and DS18B20 Temperature Sensor
* Bluetooth based hardware – SBM70 Blood pressure Monitor
* Microcontroller used to operate the hardware with WIFI – ESP8266
* Bluetooth module to enable Bluetooth functionality with the ESP8266 – HC05

## 5.2: Software

* Tasmota
* Node Red
* SQL database
* PHP servers
* HTML, CSS and Java coded Website’s – GP Virtual Monitoring System.html and Patients Medical Reports.html
* MQTT
* IP Addresses to access websites.

## 5.3: Components – Resources and Cost

|  |  |  |
| --- | --- | --- |
| **COMPONENT** | **Resources** | Cost |
| SEN0203 – Heart rate monitor | [SEN0203 DFRobot | Development Boards, Kits, Programmers | DigiKey](https://www.digikey.ie/en/products/detail/dfrobot/SEN0203/6588613?s=N4IgTCBcDaIIwHYDMAOAtHOBOMaByAIiALoC%2BQA)[ie.rs-online.com/web/p/sensor-development-tools/1360770?cm\_mmc=IE-PLA-DS3A-\_-bing-\_-PLA\_IE\_EN\_Catch+All-\_-Electronic+Components,+Power+%26+Connectors-\_-13607 70&matchtype=e&pla-4575342782844439&gclid=a7114a664846171702162fa2834af1a1&gclsrc=3p.ds&msclkid=a7114a664846171702162fa2834af1a1](https://ie.rs-online.com/web/p/sensor-development-tools/1360770?cm_mmc=IE-PLA-DS3A-_-bing-_-PLA_IE_EN_Catch+All-_-Electronic+Components,+Power+%26+Connectors-_-1360770&matchtype=e&pla-4575342782844439&gclid=a7114a664846171702162fa2834af1a1&gclsrc=3p.ds&msclkid=a7114a664846171702162fa2834af1a1) | €18.77 (incl VAT) |

## **6.** Expected Outcomes

## 6.1: Intended impact and benefits

* The project aims to revolutionize health monitoring by providing individuals worldwide with a convenient solution to assess their heart rate, body temperature and blood pressure from the comfort of their own homes.

## 6.2: Benefits for the gadget

* Saves time and effort by eliminating the need for travel to a GP or hospital for routine health checks.
* Additionally, the gadget can be used repeatedly on various occasions and by different individuals (just to be careful clean it after everyone has used it).
* This is particularly for individuals who require frequent health monitoring due to lifetime/chronic conditions or elderly individuals who may need regular check-ups.

## 6.3: Problem solving and addressing audience needs

* The gadget serves to accurately access an individual’s health status, facilitating early detection of health issues through regular monitoring of vital sensors.
* Addresses the common problem of individuals inaccurately measuring their vital signs, which can lead to potential health risks.
* Enables remote monitoring with healthcare professionals via platforms like Zoom or Microsoft Teams, allowing patients to share real-time health data during online meetings with their doctor or GP. This facilitates informed decision-making and personalized healthcare advice, addressing the diverse needs of individuals seeking timely medical advice or managing chronic conditions.
* Enhances continuity of care by providing accessibility to previous health reports through the dedicated website (Patients Medical Reports.html), enabling healthcare providers to track health data effectively.

## 6.4: Performance Evaluation Criteria:

* **Accuracy of Vital Sensor Measurements:** Evaluate the gadget's ability to accurately measure vital signs such as body temperature, heart rate and blood pressure.
* **User Satisfaction:** Gather feedback from users regarding the usability, reliability, and effectiveness of the health gadget in monitoring their health status and facilitating remote communication with healthcare professionals.
* **Health Outcomes:** Assess the impact of the gadget on improving health outcomes, such as early detection of health issues, prevention of complications, and overall health management.
* **Healthcare Provider Feedback:** Feedback from doctors or GPs regarding the usefulness of real-time health data generated by the gadget in providing timely medical advice and interventions.
* **Continuity of Care:** Accessibility and usefulness of previous health reports through the dedicated website in enhancing continuity of care and enabling healthcare providers to track health data effectively.

## **7.** Ethical/ Safety Considerations

## 7.1: Potential Safety Issues Related to Hardware Deployment:

* Risk of electrical hazards due to the use of electronic sensors
* Addressing physical safety concerns related to the hardware, ensuring the precision of sensors, and maintaining data accuracy on the website.
* Possibility of overheating or short circuits in the hardware setup.
* Ensuring the design of a PCB for the health gadget is user-friendly and intuitive for patients to understand and analyse.

## 7.2: Potential Ethical Issues Related to Data Privacy, Security, or Environmental Impact:

## Privacy concerns regarding the collection and storage of sensitive health data.

## Risks of data breaches or unauthorized access to personal health information.

## Implementation of encryption and secure login mechanisms on the health report website using a PHP server to protect patient confidentiality.

## Ethical considerations regarding the use of patient data for research or commercial purposes without explicit consent.

## 7.3: Addressing Ethical Concerns in Project Design and Implementation:

## Implementing health data encryption and access controls to safeguard patient privacy and prevent unauthorized access.

## Ensuring compliance with relevant data protection regulations such as PHP and through accurate HTML coding for the website to operate.

## Designing a PCB with precise sensor accuracy for devices such as the SEN0203 Heart rate sensor and DS18B20 Temperature Sensor, HC05 Bluetooth module and microcontrollers like the ESP8266 chip.

## Obtaining informed consent from patients regarding the use of their health data and maintaining transparency about data usage for both patients and healthcare providers.

## **8.** Conclusion

## 8.1 Key Aspects:

* Integration of sensors like SEN0203 Heart rate sensor, DS18B20 Temperature Sensor with a connection of an Open Source Tasmota ensures precise measurements of heart rate and body temperature.
* Integration of Bluetooth-based technology, such as the SBM70 Blood Pressure sensor, with a connection to the ESP8266 ensures accurate blood pressure readings
* Data processed is conducted through Node-RED and stored in a SQL database for convenient access.
* Real-time updates of sensor measurements are accessible via an HTML-operated website, for both patients and medical professionals.

## 8.2 Value Proposition and Expected Outcomes:

* The health monitoring system offers comprehensive health solutions through virtual meetings with health professionals, enabling remotely health problems and minimizing the need for hospital visits.
* Timely detection of health issues is facilitated by the system’s ability to monitor health parameters effectively.
* Enhanced communication and collaboration between patients and medical professionals are facilitated through the user-friendly interface.

## 8.4 Problems throughout my project:

* Serial connection between the laptop and ESP32 chip was problematic, resulting in an error message on the laptop indicating "USB not recognized" each time the ESP32 chip was connected. To resolve this issue, I had to reset the chip by pressing the boot button, and then proceed to set up Tasmota and all MQTT connections on Tasmota.
* Another challenge throughout my project was the timing of ordering components and creating a PCB. Delay’s in ordering the components occurred due to difficulty in finding specific components like the Blood pressure unit that would connect to ESP8266 and Arduino, as well as sourcing all required sensors from specific websites recommended by our Lecturer. To address this issue, I conducted more research and discovered that I could connect an HC05 Bluetooth module to the blood pressure sensor to obtain accurate readings.
* Additionally, managing time during the semester and missing classes due to holidays posed a significant challenge, affecting the progress of the project. The short duration of the semester combined with a heavy workload intensified this issue. To overcome this problem, I allocated more time both at college and at home to reduce the workload and enhance the quality of work.
* Another major problem was changing the microcontroller in the middle of the semester, midway through the semester presented another obstacle, this had a significant impact as the connections between Wi-Fi and Bluetooth differed, as did the corresponding codes on Arduino, knowing the codes for WIFI or Bluetooth connections. To overcome this challenge, I conducted additional research and eventually found that all connections were manageable, requiring only minor adjustments to ensure functionality as expected.

Top of Form

## Appendix:

* Include any additional information, diagrams, or data relevant to your project proposal.
* Be sure to discuss your project proposal with your supervisor and get feedback before finalising it.

Need to do and links:

[Monitor SpO2/BPM with ESP32 & MAX30100 Pulse Oximeter on Blynk (how2electronics.com)](https://how2electronics.com/esp32-max30100-pulse-oximeter-blynk/#:~:text=We%20will%20now%20interface%20MAX30100%20Pulse%20Oximeter%20with,The%20power%20supply%20required%20by%20MAX30100%20is%203.3V.)

[Interface MAX30100 Pulse Oximeter Sensor with Arduino (microcontrollerslab.com)](https://microcontrollerslab.com/max30100-pulse-oximeter-heart-rate-sensor-arduino-tutorial/)

[DP\_DS\_SDP600\_Series\_v1\_7\_C1 (farnell.com)](https://www.farnell.com/datasheets/1720196.pdf)

[MYO004\_AdvancedGuide\_v12 (mouser.ie)](https://www.mouser.ie/datasheet/2/813/MyoWare_v2_AdvancedGuide_Updated-3224997.pdf)

[node red send data to mysql - Search (bing.com)](https://www.bing.com/search?q=node+red+send+data+to+mysql&cvid=49be80cec3034ed2b3340856c9a300ec&gs_lcrp=EgZjaHJvbWUqBggBEAAYQDIGCAAQRRg5MgYIARAAGEAyBggCEAAYQDIGCAMQABhAMgYIBBAAGEAyBggFEAAYQDIGCAYQABhAMgYIBxAAGEAyBggIEAAYQNIBCTE0OTI3ajBqOagCALACAA&FORM=ANAB01&PC=SMTS)

[Bing Videos](https://www.bing.com/videos/riverview/relatedvideo?q=how+to+connect+esp32+to+bluetooth&mid=F38CDDA579FADF0E570BF38CDDA579FADF0E570B&FORM=VIRE)

1. #define BLYNK\_TEMPLATE\_ID "TMPL4Z1bQMHXZ"
2. #define BLYNK\_TEMPLATE\_NAME "Health Monitoring System"
3. #define BLYNK\_AUTH\_TOKEN "CFVgmH-KhODf6eoa2nN2cOnnh0Wjlxq6"

Workbench access

MySQL – port 3300

Root password: Abdullah3434

Windows service name: MySQL80

Username: Project2024

Code to create the login table

CREATE TABLE `gpvirtualsystem`.`login` (

`id` INT NULL,

`Username` VARCHAR(45) NULL,

`Password` VARCHAR(45) NULL,

`Medical ID` VARCHAR(45) NULL);

PRIMARY KEY (`id`);

A close-up of a computer screen

Description automatically generated

INSERT INTO `gpvirtualsystem`.`login` (`id`, `Username`, `Password`, `Medical ID`) VALUES ('10', 'jed', '654321', 'jed123');

Code above is the makes the table of the database

A screenshot of a computer

Description automatically generated-A screenshot of a computer

Description automatically generated

A screenshot of a device

Description automatically generated

A screenshot of a computer

Description automatically generated

A computer screen with white text

Description automatically generated

A screenshot of a computer

Description automatically generated

[how to connect a sbm 70 to bluetooth using iot blynk app - Search (bing.com)](https://www.bing.com/search?q=how+to+connect+a+sbm+70+to+bluetooth+using+iot+blynk+app&cvid=0030bfab71c045afba8e469f3f56a0ca&gs_lcrp=EgZjaHJvbWUyBggAEEUYOdIBCTE5MTkxajBqNKgCALACAA&FORM=ANAB01&PC=SMTS&showconv=0)

A blue and green electronic components

Description automatically generated

A computer screen shot of a circuit board

Description automatically generatedA computer circuit board with wires and wires

Description automatically generated