Documentation

Team E

16.06.2023

1 Team members

1. *Md Limon Apu*
2. *Yashodhan Vishvesh Deshpande*

2 Introduction

For our project, we aim to develop a comprehensive health monitoring system. This system will enable real-time tracking and analysis of vital health parameters. We will be implementing an IoT-WSN architecture to facilitate seamless data collection and transmission. The architecture includes different layers: the sensing layer, control layer, backhaul layer, application layer, and decision layer. The sensing layer incorporates sensors such as the KY-039 Heartbeat Sensor and KY-028 Temperature Sensor to capture essential health data. These sensors will interact with the environment to measure the user's vital signs. The collected data will be wirelessly transferred to the control nodes in the control layer. These control nodes will handle data transfer to the backend of our system and control the actions of actuators, if required. Communication between the layers will be facilitated by a synchronous Message Queuing Telemetry Transport (MQTT) protocol, ensuring efficient and reliable data exchange. The application layer will handle the integration of heterogeneous sensor data and define the system's functionalities. Finally, the decision layer will analyze the collected data to make informed decisions and control the overall functionality of the system. This health monitoring system can be seamlessly integrated with IoT devices like smartphones for easy accessibility and monitoring. The overall implementation is discussed further along the paper.

3 Concept description

I. Main Application:

Our health monitoring system utilizes advanced sensors to continuously monitor vital parameters such as heart rate and temperature. The measured data is then displayed on an LCD display, providing users with real-time insights into their health status. By tracking these parameters, individuals can stay informed about their well-being and take necessary actions if any abnormalities are detected. The compact and user-friendly design of the system ensures convenient access to vital information, empowering users to proactively manage their health and make informed decisions for a healthier lifestyle.

II. Block Diagram:

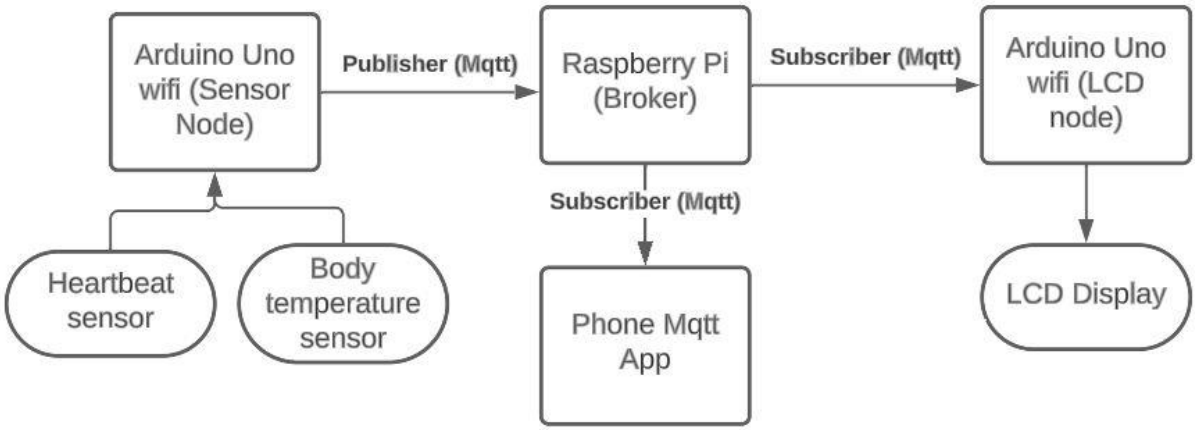


Fig.1: Block diagram of our target application.

The block diagram illustrates the interaction between various sensors in our health monitoring system. The heart rate sensor, temperature sensor collect essential data for monitoring users' health. These sensors are connected to an Arduino Uno Wifi (sensor node) which serves as sensor node for the system. The data is then published on to the server using mqtt protocol which is located on the raspberry pi. The raspberry pi is the broker of the whole system. The system also includes an LCD display that visually presents the sensor readings. Another Arduino Uno, equipped with MQTT client functionality, controls the LCD display and communicates with the raspberry pi (broker) by subscribing to the server. The entire system is connected to the Raspberry Pi, which acts as the MQTT broker and enables communication with a smartphone application, such as the IoT MQTT Panel.

4 Project/Team management

We have chosen to adopt an iterative development model for our project, allowing us to work on the implementation and testing of our scenario in an iterative manner. This approach provides us with the flexibility to revisit and refine previous steps as needed, ensuring that we can make necessary improvements throughout the development process. To ensure effective collaboration and communication, we have assigned specific tasks to each team member and hold regular meetings to discuss progress and plan future actions. By working closely together and leveraging our collective skills and expertise, we aim to successfully realize our target scenario and deliver a well-executed project. A documentation of group member progress is shown below. The dates stated indicate we had a meeting in each of these dates.

	Date	23.05.23	30.05.23	5.06.23	12.06.23
	Task	Task-1	Task-2	Task-3	Task-4
Md Limon Apu	To-do	Research on project	Research on sensors	Implement in Audrino	Connect to Audrino & resberry pi
	Status	Done	Done	Done	Done
Yashodhan Vishvesh Deshpande	To-do	Research on project	Research on MQTT	Implement in Audrino	Connect to Audrino & resberry pi
	Status	Done	Done	Done	Done

5 Technologies

Below we discuss all the technological aspects we have used throughout our project.

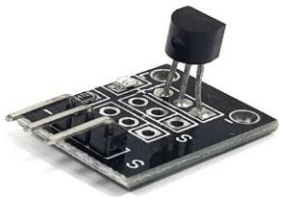
1. **Sensor and actuator technologies:**

I. KY-039(Heartbeat Sensor):

The KY-039 Heartbeat Sensor is a critical component of our health monitoring system, designed to accurately measure the user's heartbeat. It works by using light and a photodetector to detect changes in blood volume, allowing us to monitor the pulsating blood flow when the sensor is placed on the user's fingertip. This sensor is really convenient to use and provides real-time feedback on the heartbeat, making it easy for us to keep track of cardiovascular activity. Its affordable price and reliable performance make it a great choice for continuous monitoring of the heartbeat in our health monitoring system. By using the KY-039 Heartbeat Sensor, we can detect any irregularities or abnormalities in the heartbeat, enabling us to assess heart health and take timely action if needed. It's a user-friendly and dependable sensor that plays a vital role in our project.

II. KY-028 TEMPERATURE SENSOR (THERMISTOR):

The KY-028 Temperature Sensor, also known as a thermistor, plays also a vital role in our health monitoring system by accurately measuring the surrounding temperature. It uses a special type of resistor called a thermistor that changes its resistance based on temperature changes. This allows us to precisely determine the temperature in our environment. The KY-028 Temperature Sensor is not only affordable but also highly reliable in providing accurate temperature readings. It conveniently provides a digital signal output, making it easy to integrate into our system without any additional complicated wiring. However, it's important to note that to obtain the most accurate temperature readings, we need to be mindful of the timing and consider that the sensor readings may have a slight delay of up to two seconds. By incorporating the KY-028 Temperature Sensor into our health monitoring system, we can continuously monitor and track the ambient temperature, ensuring optimal conditions for our well-being.



III. LCD DISPLAY

The LCD display is like the "eyes" of our health monitoring system, allowing us to see and interact with important health data. It presents real-time information on vital parameters like heart rate and body temperature in a clear and understandable format. With its alphanumeric capabilities, the LCD display makes it easy for us to read and interpret the displayed values. It enhances our experience by providing a visual feedback loop, helping us stay informed and make informed decisions about our well-being. The LCD display is a crucial component that brings the data to life and empowers us to take control of our health.

LCD Screen (compatible with Hitachi HD44780 driver) was used for the displaying of the data. The Lcd display was equipped with I2C bus to simplify its use.

2. Communication protocols: (MQTT)

The MQTT (Message Queue Telemetry Transport) protocol plays a crucial role in our health monitoring system by facilitating seamless communication between the Raspberry Pi (broker) and Arduino Uno Wifi. MQTT offers efficient and reliable two-way communication, enabling data production and consumption through message publishing and topic subscription. Its selection was based on its superior speed, efficiency, and power consumption characteristics compared to other protocols like HTTP. By implementing MQTT, our system can transmit real-time sensor data from the Arduino Uno Wifi to the Raspberry Pi, while also receiving configuration information and control commands promptly. This bidirectional communication ensures effective coordination and timely responses, enhancing the overall functionality and performance of our health monitoring system.

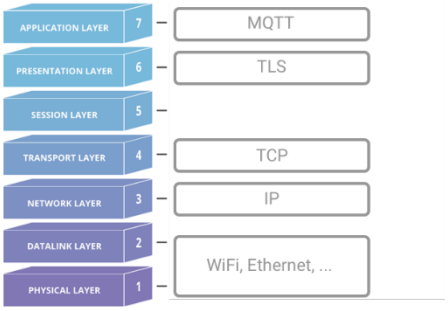


Figure.2: Layer of MQTT [1]

The integration of MQTT in our health monitoring system enables smooth and efficient communication between the Raspberry Pi and Arduino Uno Wifi.MQTT's real-time capabilities, low overhead, and power efficiency make it the ideal choice for transmitting sensor data, receiving control commands, and ensuring seamless coordination within our health monitoring system.

3. **Programming**:

i. In our project, we use the Arduino Uno Wifi Rev2 as the central control unit. The Arduino board is programmed using the Arduino IDE and the C/C++ programming language to interface with sensors like the KY-039 Heartbeat Sensor and KY-028 Temperature Sensor. The collected sensor data is transmitted to the Raspberry Pi via the MQTT protocol for further processing. On the Raspberry Pi, we utilize Python as the programming language to receive, analyze, and make decisions based on the sensor data. By combining C/C++ on the Arduino and Python on the Raspberry Pi, our system can effectively monitor and respond to health-related information in real-time.
Sensor libraries have been used in this project which are officially commissioned on arduino website. For example
#include <SPI.h>
#include <WiFiNINA.h>
#include <OneWire.h>
#include <DallasTemperature.h>
#include <ArduinoMqttClient.h>

Mqtt protocol libraries have been used for raspberry pi during the server setting up phase.

6 Implementation

1. ***Static version of the environment:***

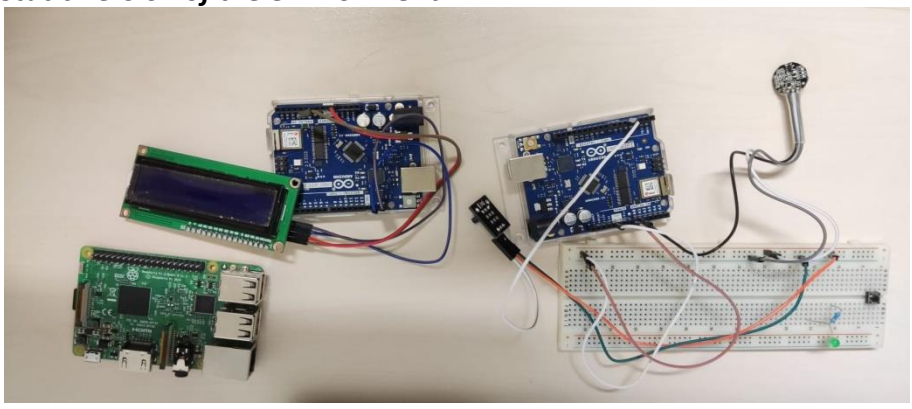


Figure 3

The environment in which this project is implemented should a stable internet connectivity for the server to run. Also a constant power supply is needed for all the elements to function.

2. ***Class Diagram:***

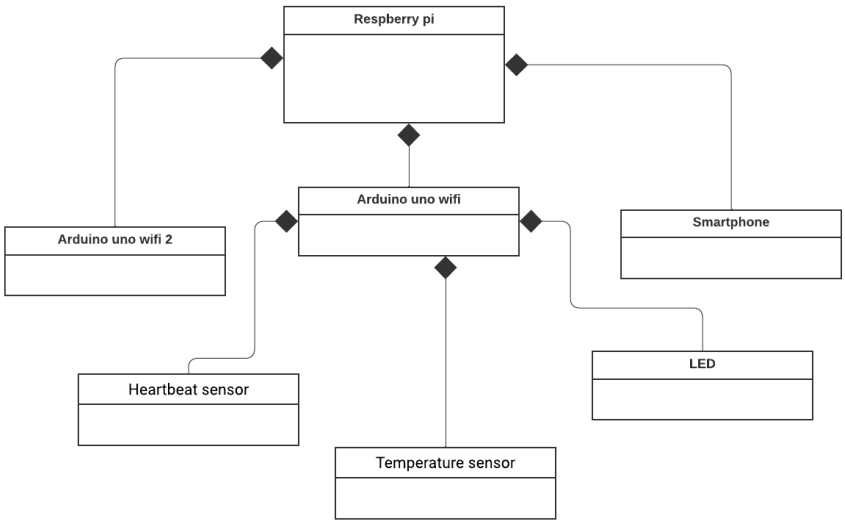


Fig.4: Class diagram

3. ***Use Case of the environment:***

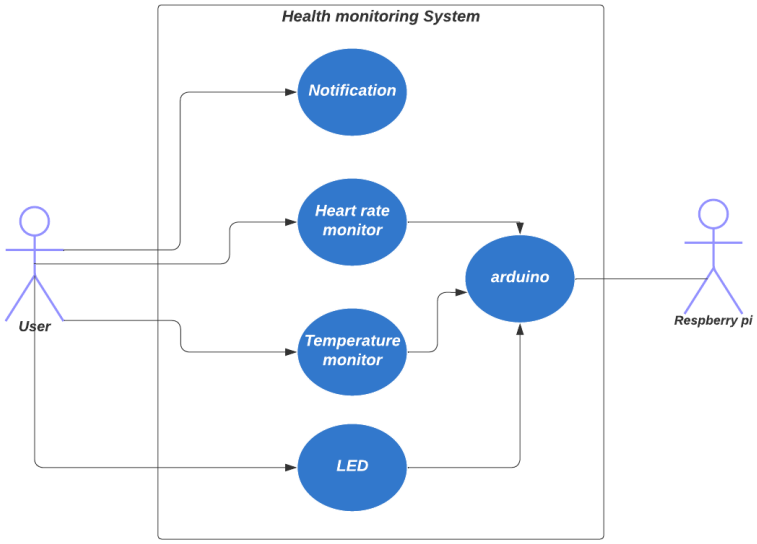


Fig.5: Use case of the environment

4. **Implementation**

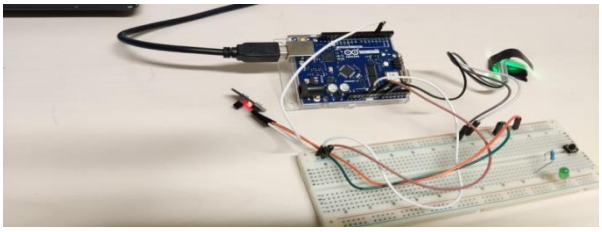
a) Download the raspberry pi OS on the SD card and set up the raspberry pi using the imager, monitor and keyboard. Use the sudo raspi-config command to access the configuration menu. Setup and use VNC viewer on laptop if needed.

b) Setup the mqtt protocol on raspberry pi by downloading and configuring mosquito. This will make the raspberry pi into a broker. Also setup the wifi and the sever as per your mobile hotspot.

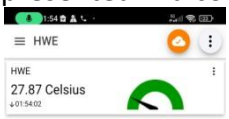
c) Next, setup the arduino sensor node for input and the LCD display node for output. Connect the heartbeat sensor and temperature sensor to the arduino uno as per

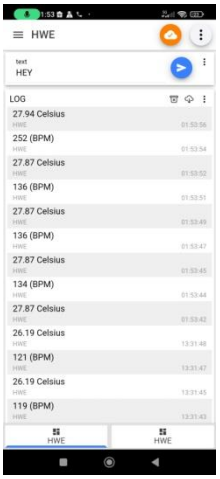
the pin mentioned in the code . Also connect the LCD display to the arduino as per the pins in the code and figure 3.

d) Upload the input code to the sensor node arduino and the LCD display code to the Arduino which is connected to the LCD display. Change the SSID and password of the wifi as per the sever setup. Also recheck the name of the topic to be subscribed/published.



e) Setup the IOT MQTT panel to subscribe the topic to display the sensor reading on smartphone. Setup the related connection and panel in the app so that the data is presented in a concise manner. Example log, text or gauge.





f) **Results of implementation** :
Upon placing the finger on heartbeat sensor and temperature sensor, the heart rate of per minute and body temperature is published over the mqtt protocol on the LCD display and IOT MQTT panel app. It requires 1 minute time for the sensors to self calibrate themselves. After 1 minute the data published is accurate to a high degree although it still has a small percentage of error due sensor complexities.

7 Use Case

The system monitors real-time information of the heartbeat and body temperature while using the same wifi network. It can display the data on LCD display and on IOT MQTT panel app. This data can be further analyzed by medical professionals to make better and healthier lifestyle choices.

8 Sources/References

GitHub: https://github.com/Yashodhandesh/HW-AEE-Group-E
[1]https://www.particle.io/iot-guides-and-resources/iot-protocols-and-standards/

9 Contributions

1. Yashodhan Vishvesh Deshpande:

- Block diagram and description of block diagram
- Flowchart diagram for input and output in presentation slides.
- Implementation documentation part and Use case part in this document.
- Contributions to the LCD Display and programming part documentation of this paper regarding use of libraries and use of LCD display component.
- Setting up the Raspberry pi and Mqtt protocol sever using mosquito on raspberry pi, VNC server and IOT MQTT Panel app to publish and subscribe data for further use.

2. MD Limon Apu:

- Introduction, concept description, class diagram, use case diagram of the environment, project team management , information of sensors used and communications protocol mqtt parts of this document.
- Contributions to the LCD Display and programming part documentation of this paper regarding use of programming language and the use of LCD display component.
- Connecting heartbeat sensor and temperature sensor to arduino. Programming the arduino for reading the senor data and algorithms to interpret the data coming from the sensor to logical and meaningful information.

3. The integration of the arduino nodes and raspberry pi was jointly carried out by Yashodhan Vishvesh Deshpande and MD limon Apu together as combining both the nodes and the server over mqtt protocol so the system behaves coherently.