ESIOT 24/25 Assignment #3 - Report

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1 Introduction

The smart temperature system is made up of four main subsystems:

1. **Window Controller**: it controls an Arduino board, managing the opening of the window.
2. **Temperature Monitoring Subsystem**: it manages an ESP32 board to monitor the temperature through a temperature sensor.
3. **Control Unit Back-End**: the core of the system, managing the communication between the subsystems
4. **Dashboard Front-End**: a web application dashboard that allows operators to interface with the system

2 Window Controller

The window controller is an Arduino-based application designed and implemented using synchronous Finite State Machines and a task-based architecture. It consists of two tasks:

1. **Window Controlling Task**: responsible for controlling the opening of the window, implemented as an FSM shown in **Figure 1**
2. **Communications Task**: responsible for handling the serial line communication with the backend

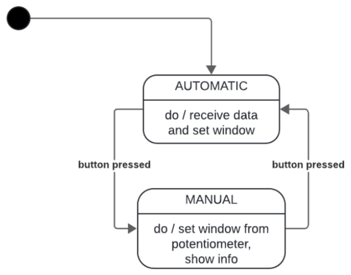

AUTOMATIC
do / receive data and set window
button pressed
button pressed
MANUAL
do / set window from potentiometer, show info

Figure 1: Window Controlling Task State diagram

3 Temperature Monitoring Subsystem

The temperature monitoring subsystem is an ESP32-based application designed and implemented using synchronous Finite State Machines and a task-based architecture.
It is made up of two components:

1. **Temperature Task**: to measure the temperature, implemented as a FSM as shown in **Figure 2**
2. **Communications Component**: used by the temperature task to transmit sampled data to the backend unit via the MQTT protocol, using **broker.mqtt-dashboard.com** as the broker

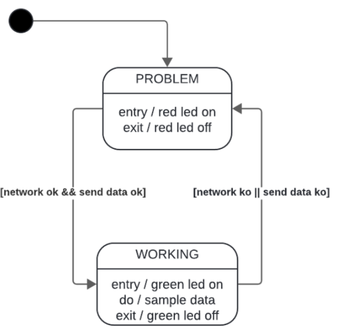


Figure 2: Temperature Task State diagram

4 Control Unit Back-End

The Control Unit Back-End is an application written in Golang responsible for managing and coordinating the execution of all the subsystems. It is designed and implemented as a Finite State Machine, as illustrated in **Figure 3**

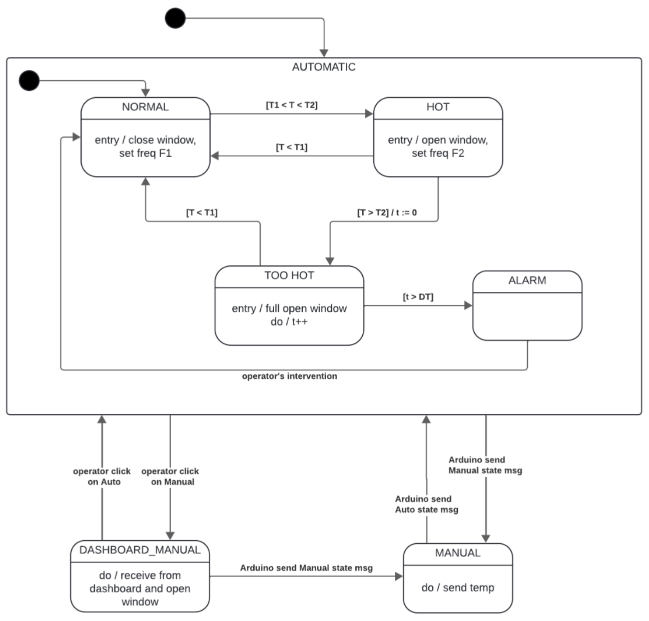


Figure 3: Control Unit State Diagram

The Control Unit Back-End implementation is divided into packages:

- **serial**: manages serial line connection and communications with Arduino
- **mqtt**: manages mqtt connection and communications with ESP32
- **http**: manages http connection and communications with the dashboard
- **models**: implements the logic of the system, including the state machine
- **db**: manages the database to store the historical data

4.1 Temperature Database

The subsystem uses a simple database to store historical data. In this way, it is possible to retain data even if the back-end suddenly crashes.
It is implemented as a **SQLite** database, which is simple to set up but not so reliable if the system needs to scale. However, since we can expect this system to be used by only one user at a time, SQLite is an appropriate choice.

The database consists of a single table, containing average, minimum, and maximum temperatures sampled on a specific date. The table is shown in **Figure 4**.

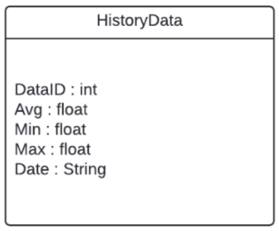
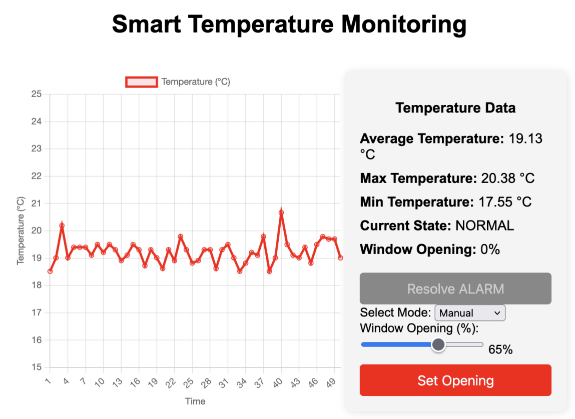


Figure 4: Database Structure

5 Dashboard Front-End

The Dashboard Front-End is a web app that interacts with the back-end, developed with **HTML** and **JavaScript**.
It shows some information about the system and allows to resolve the alarm and manually select the opening of the window. It also displays a graphic of the last measurements, and shows the historical temperature data stored in the backend database.
Figure 5 and **Figure 6** show the dashboard front-end.



Temperature Data

Average Temperature: 19.13 °C

Max Temperature: 20.38 °C

Min Temperature: 17.55 °C

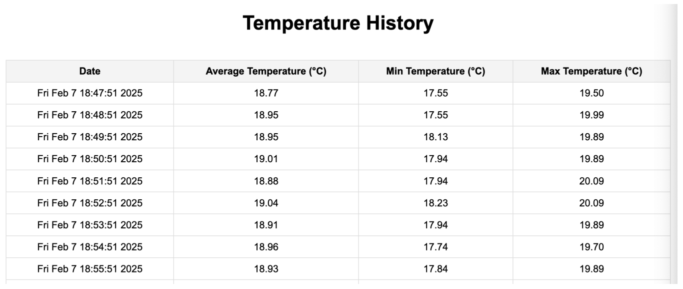
Current State: NORMAL

Window Opening: 0%

Select Mode: Manual

Window Opening (%): 65%

Figure 5: Dashboard



Temperature History

Date	Average Temperature (°C)	Min Temperature (°C)	Max Temperature (°C)
Fri Feb 7 18:47:51 2025	18.77	17.55	19.50
Fri Feb 7 18:48:51 2025	18.95	17.55	19.99
Fri Feb 7 18:49:51 2025	18.95	18.13	19.89
Fri Feb 7 18:50:51 2025	19.01	17.94	19.89
Fri Feb 7 18:51:51 2025	18.88	17.94	20.09
Fri Feb 7 18:52:51 2025	19.04	18.23	20.09
Fri Feb 7 18:53:51 2025	18.91	17.94	19.89
Fri Feb 7 18:54:51 2025	18.96	17.74	19.70
Fri Feb 7 18:55:51 2025	18.93	17.84	19.89

Figure 6: History