Internet of Things and Big Data Analytics (IT4021)

Assignment – 2024, Semester 1

Important Details

- This assignment carries 50% of the total marks for the IT4021 Module.
- This is to be carried out as a group project by a group of four members. However, assessments will be done focusing on individual students. Therefore, members of the same group will get different marks based on their performance.
- Assignment release date: **23rd March 2024**
- Submission deadline: **5.00pm, 17th May 2024** (GMT +05.30)

Description of the assignment

The task of this assignment is to design and implement,

1. A Smart Home (a model) that automatically manages inside temperature depending on the Heat Index by manipulating the windows automatically.
2. A visualization of the current Heat Index and the predicted Heat Index data up to 12 months ahead and from the current date and 12 months before from the current date, using a dashboard for the benefit of the occupants of the home.

What is the Heat Index (HI)?

The heat index, also known as the apparent temperature, is **what the temperature feels like to the human body** when relative humidity is combined with the air temperature. This has important considerations for the human body's comfort. When the body gets too hot, it begins to perspire or sweat to cool itself off. If the perspiration is not able to evaporate, the body cannot regulate its temperature. Evaporation is a cooling process. When perspiration is evaporated off the body, it effectively reduces the body's temperature. When the atmospheric moisture content (i.e., relative humidity) is high, the rate of evaporation from the body decreases. In other words, the human body feels warmer in humid conditions. The opposite is true when the relative humidity decreases because the rate of perspiration increases. The body actually feels cooler in arid conditions. There is direct relationship between the air temperature and relative humidity and the heat index, meaning as the air temperature and relative humidity increase (decrease), the heat index increases (decreases).

Classification	Heat Index	Effect on the body
Caution	80°F - 90°F	Fatigue possible with prolonged exposure and/or physical activity
Extreme Caution	90°F - 103°F	Heat stroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity
Danger	103°F - 124°F	Heat cramps or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity
Extreme Danger	125°F or higher	Heat stroke highly likely

Figure 1: The heat index classification

Source: https://www.weather.gov/ama/heatindex

The heat index (HI) in degrees Fahrenheit can be calculated using the following formula,

*HI = -42.379 + 2.04901523*T + 10.14333127*RH - .22475541*T*RH - .00683783*T*T - .05481717*RH*RH + .00122874*T*T*RH + .00085282*T*RH*RH - .00000199*T*T*RH*RH*

where ***T*** *is temperature in degrees Fahrenheit* and ***RH*** *is relative humidity in percent.* ***HI*** is the heat index expressed as an apparent temperature in degrees Fahrenheit.

Source: https://www.wpc.ncep.noaa.gov/html/heatindex_equation.shtml

Tasks of the assignment

1. Sense the current ambient temperature (T) and relative humidity (RH) within the smart home.
2. Depending on the Heat Index (HI) inside the home, manipulate at least one window of the smart home to keep the Heat Index as close as possible to a comfortable temperature (It is enough to demonstrate that the windows open/ close proportionately to the Heat Index).
3. Display a visualization of,
    a. Current HI data based on sensor readings
    b. Predicted past 12 months HI
    c. Predicted HI 12 months ahead

    on a Node-RED dashboard. Use the ARIMA model for predictions (Relevant datasets have been provided with the assignment to build your model).

4. The overall design of the system and additional mechanisms to warn the occupants of the house of extreme HI levels should comply with the design principles discussed in the module.

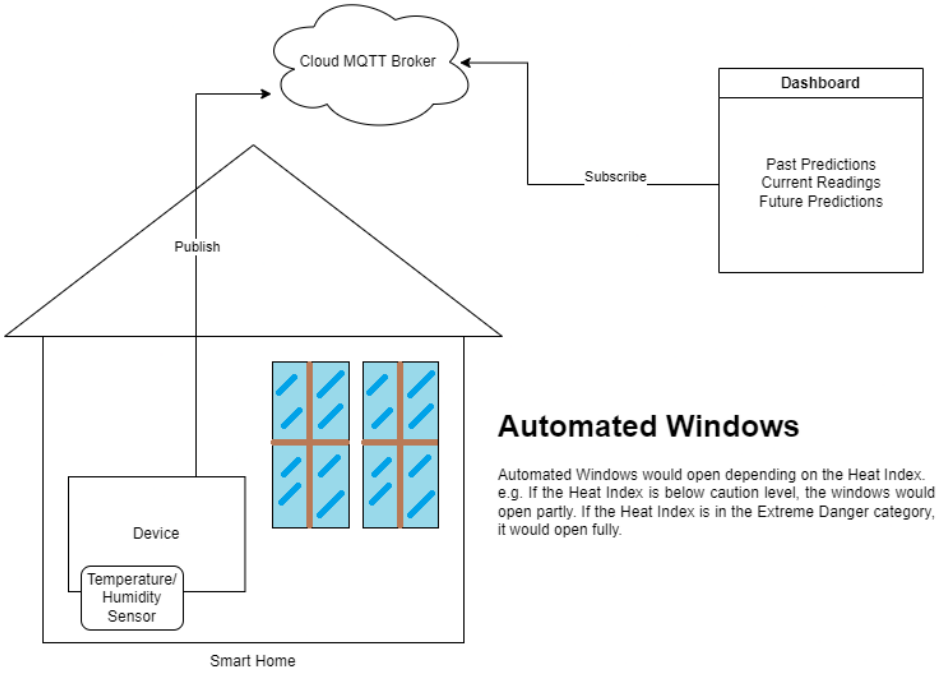
Technical requirements

1. The IoT system should be built on a Single Board Computer or a Microcontroller board.
2. The IoT system should contain at least one sensor and an actuator.
3. The sensor readings should be periodically published to a cloud broker (e.g., HiveMQ)
4. The dashboard should utilize MQTT data for the visualizations.
5. The dashboard should be created using Node RED.
6. The device should run Headless.

Other requirements

1. Each group must maintain a GitHub classroom repository and commit code regularly. Failure to do so may result in low marks. A GitHub classroom repository creation link will be provided later.
2. A team is provided with the freedom to be creative with how the IoT system is designed and developed, especially with regards to going beyond the given requirements to make the system more user friendly.
3. Make sure to use conventional units of measurement for the Dashboard (e.g., if displaying temperatures, display them in degrees Celsius rather than degrees Fahrenheit).

Architecture diagram of the system to be developed



Marks breakdown

Initial Document explaining the group's approach	5 marks
Mid project progress review submission (4th week)	5 marks
Overall system design (based on Design Principles)	15 marks
Hardware Implementation	20 marks
Dashboard Implementation	10 marks
RH model creation	15 marks
Future 12 months HI predictions	5 marks
Past 12 months HI predictions	5 marks
MQTT Implementation	5 marks
Good code quality and version controlling	5 marks
Overall creativity	10 marks
Total	**100 marks**

Special Notes

- The group can decide how the work breakdown is done among group members. Each member of the team will be graded individually. Therefore, make sure that each member has a sufficient workload.
- Submitted codes will be checked for plagiarism using the GradeScope Code Similarity tool. All students are strictly expected to maintain academic honesty.
- For the final assessment submissions, all groups must provide,
    - A presentation slide deck (.ppt) explaining the system – maximum of 10 slides.
    - A three (3) minute video demonstration of the complete system.
- Assessment dates will be notified via the CourseWeb.