Sri Lanka Institute of Information Technology

Internet of Things and Big Data Analytics (IT4021)

Continuous Assignment – 2023, Semester 1

Initial Document

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Brief Description

Heat is the leading cause of death due to weather. Heat may lead to a variety of hazardous health problems. Humidity has a significant effect in this. When the humidity level is high, it is more difficult for the human body to drain perspiration. and the inability to cool off will aggravate a person's heat discomfort. In order to overcome this problem, heat index was developed.

Heat index, also known as the apparent temperature, describes how the temperature feels to the human body when relative humidity and air temperature are combined. [1] This has significant implications for human body comfort. And thus, this was developed assist better communicate the consequences of extreme heat on the human body, as well as to explain how hot the present weather conditions are making it feel to the average person. [2]

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

The Internet of Things (IoT) is a network of physical devices, often known as "things," that are linked to the internet and equipped with a wide range of technologies like sensors, actuators, and software. Without direct human involvement, these devices can perform data analytics and exchange data with other devices. [3]This indicates that communication between things is possible without the involvement of humans or computers. IoT opens up new possibilities for automation, data collecting, and analysis by enabling physical devices to communicate with one another and transmit and receive data via the internet. [2]

In this project, we have aimed to develop a basic IOT system that can indicate if the current heat index of an environment is healthy. By using HiveMQ and MQTT, the NodeMCU temperature and humidity sensor can transmit data to other devices and systems, such as cloud services or other IoT devices, which can then process and analyze the data to provide insights or automate processes.

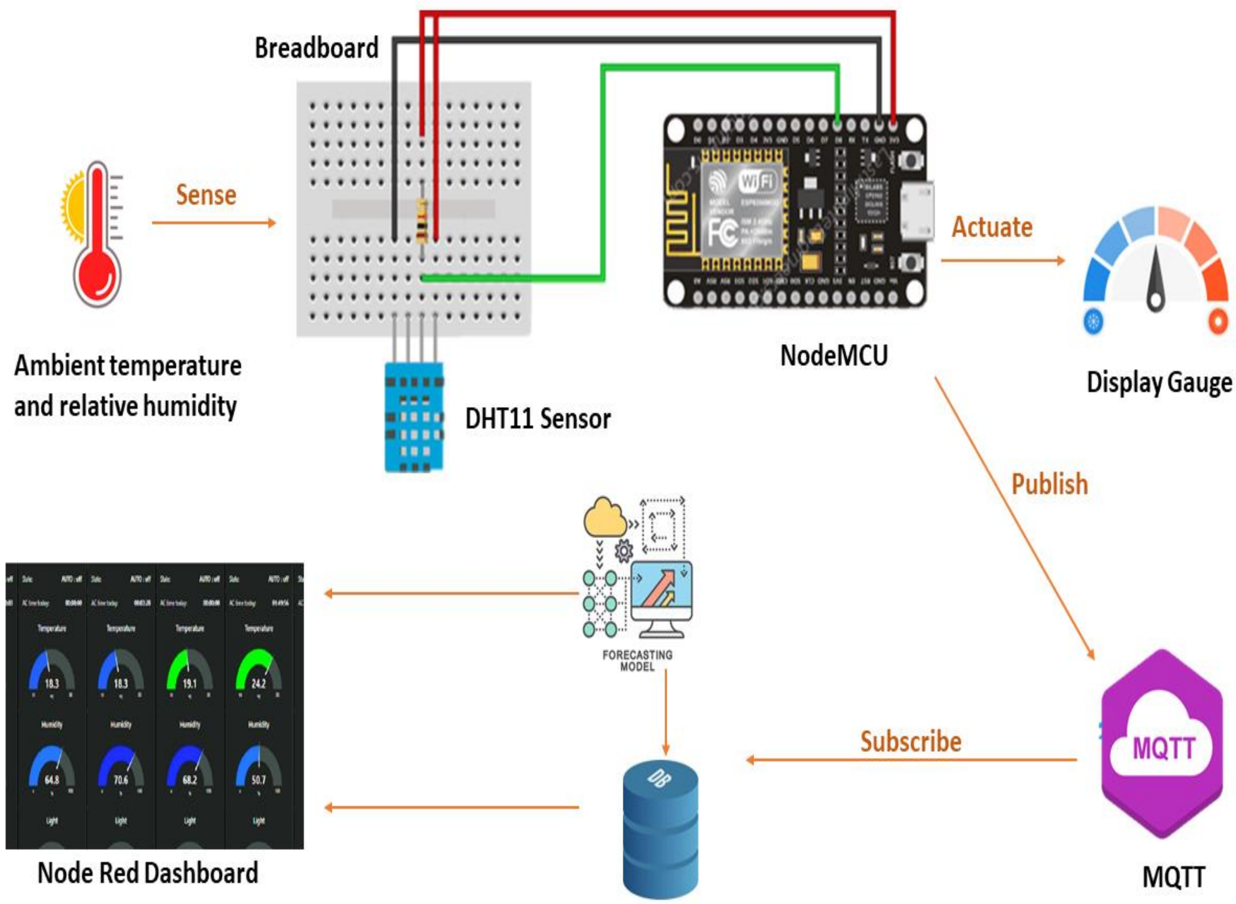
The proposed system would be able to:

- Detect the current ambient temperature and relative humidity.
- Indicate and inform the users about the readings through a gauge depending on the current temperature and relative humidity.

Using node-red the following visualizations will be displayed.

- Current Relative Humidity data coming from the sensors.
- Predicted past 12 months Relative Humidity.
- Predicted Relative Humidity 12 months ahead in the future.

Overall Architecture Diagram



[5]

Overall Architecture Description

This system uses a NodeMCU development board as the main control point to carry out all the necessary tasks. To monitor temperature and humidity, a DHT11 sensor is used to collect readings and send them to the NodeMCU via a connected breadboard. Based on the data collected, the heat index classification will be calculated and displayed, which could fall into one of five categories: Normal, Caution, Extreme Caution, Danger, or Extreme Danger. The servo motor will move the axel to indicate the relevant heat index category.

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

The gauge will show the heat index categories according to a specific scale. Normal will be between 18°C and 26°C, Caution between 26°C and 32°C, Extreme Caution between 32°C and 39°C, Danger between 39°C and 51°C, and Extreme Danger at 125°F or higher. The NodeMCU will control the servo motor to move the axel based on the calculated heat index reading.

The NodeMCU will publish the data to a cloud-hosted broker using a unique topic. The Node Red dashboard will act as a subscriber to capture the data sent through the MQTT topic. The captured data will be stored in a database and represented as the current heat index using a gauge display in the dashboard. The dashboard will also show past data visualization and predictions for the next 12 months using the forecasting model implemented in Node Red.

Member Contributions

Member 1: IT20216900 – De Silva S.R.

This component focuses on using ARIMA model to make predictions for the next 12 months based on time series data. Autoregressive Integrated Moving Average(ARIMA) model is a form of forecasting model that analyzes patterns in the data and forecasts future values using measures of autocorrelation. To implement the ARIMA Model, the time series library will be installed. Then the required pre-processing techniques will be carried out. After that data will be trained and few models will be implemented using the ARIMA model. The best model will be considered for the predictions and finally using Node-RED dashboard, the data will be visualized. In addition to this, the sensors and actuators used in the project will be studied, as well as the optimal way to regulate the actuator's movement depending on input. Finally, information about MQTT, a messaging protocol utilized for IoT connectivity, will be gathered.

Member 2: IT20207854 – De Silva M.

This component focuses on assembly of the hardware components to monitor the temperature and relative humidity to compute the heat index. A DHT11 sensor is used to collect the temperature and relative humidity. This sensor has 3 pins, namely VCC, Data and Ground(GND). VCC pin of the DHT11 goes into the power supply of the NodeMCU . In order to obtain accurate and reliable readings, a power supply of 3.5V to 5.5V is recommended for the DHT11 sensor. [5] The Data pin of the DHT11 goes into Digital Pin D4 of the NodeMCU and the GND pin of the DHT11 goes into Ground Pin (GND) of the NodeMCU [1]. In order to use the DHT11 sensor with NodeMCU, the DHTLib library should be installed. This library contains all the functions needed to get the humidity and temperature readings from the sensor. Adding a resistor is recommended to minimize the electrical interference and to stabilize the electrical signal. The resistor should be placed between the VCC pin and the data pin of the NodeMCU board.

Member 3: IT20231200– Zoysa E.S.

Temperature and humidity sensors must be connected to the dashboard and set up for the dashboard to read sensor data in order to implement a Node-RED dashboard. The real-time sensor data can then be displayed in graphical representations on the dashboard. The dashboard can be configured to display a message when the humidity or temperature reaches a particular level. The dashboard may display forecasts for historical and present values reverting up to 12 months using an ARIMA model. Users can see whether the environment is getting too hot or cold by configuring the dashboard with customized temperature and humidity parameters. Connecting the sensors to the dashboard and setting up the dashboard to read the sensor data are the significant steps in creating a Node-RED Dashboard with temperature and humidity sensors. The dashboard may then be used to classify temperature levels, display predictions from an ARIMA model, and display real-time sensor data in charts and graphs.

Member 4: IT20203726– Maldeniya M.M.D

Temperature and humidity sensors are used to monitor real-time readings of the environment. The input data obtained from the sensor is computed and calculated to obtain the heat readings. Next, using the received Heat Index value, program the system to realistically view the Normal, Caution, Extreme Caution, Danger, and Extreme Danger sections on the gauge. For the above purposes, the MG90S Servo Motor will act as an actuator and perform a physical action to visualize the heat reading on the gauge using the arm after properly programmed to rotate to the exact angle depending on the value of the heat Index. The actuator point will tilt differently depending on temperature and humidity. Also involved in building the ARIMA model and predicting relative humidity up to 12 months before the current. Participate in data analysis collected, processed, and predicted. [2]

List of Hardware

Sensor - DHT11 Temperature and Relative Humidity sensor

A typical temperature and humidity sensor is the DHT11. The sensor includes a dedicated NTC for temperature measurement and an 8-bit microprocessor for serial data output of temperature and humidity information. Furthermore, factory calibrated, the sensor makes it simple to integrate with other microcontrollers. The sensor has an accuracy of 1°C and 1% and can measure temperature from 0°C to 50°C and humidity from 20% to 90%. Hence, if you want to measure in this range, this sensor might be the best option. [2]

Actuators - MG90S Micro Servo Motor

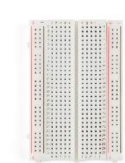
MG90S is a micro servo meter with metal gear. This is a lightweight servo and comes with a 4.8V to 6v operating voltage. [7] It can be further rotated only from 0° to 180° due to their gear arrangement. Here, 2.2kg/cm torque which comes with the MG90 motor which means it can pull a weight of 2.2kg. servo motor can be controlled using NODEMCU to go to a specified position.

Microcontroller - NODEMCU ESP8266

NODEMCU 8266 is an open-source hardware and software development environment that uses an inexpensive System-on-a-Chip (SoC) called the ESP8266 as its main microcontroller board. It is designed to provide an easy-to-use platform for building Wi-Fi enabled projects. One of the advantages of NODEMCU is that it can operate using a voltage of 3.3V, which makes it compatible with many other electronic components. It also includes a USB-to-serial converter for programming and debugging and supports various programming languages, including Lua and Python. [9]

Other components

- **Jumper wires** -To connect NodeMCU to the Breadboard.
- **Breadboard** -To connect sensors to the NodeMCU
- **Micro USB Cable -** To get power supply for NodeMCU
- **Resistors**



Cost Breakdown

Component	Price (Rs)
NodeMCU ESP8266 Wi-Fi Internet Development Board Module	1780.00
MG90S Micro Servo Motor	690.00
DHT11 Temperature and Relative Humidity Sensor	520.00
Breadboard	350.00
330Ω Resistor	25.00
Jumper wires	420.00
Total	**3785.00**

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