CS698T: Introduction to IoT and its Industrial Applications
Assignment 2
Report Submission: September 16, 2022 (12:00 PM)
Demonstration: September 16, 2022 (17:00 PM - 19:00 PM), KD-101

General Instructions:

- This is a group assignment with FIVE members in a team. You can work with your project team as well, Project Teams.
- Please pick up the hardware from the Samsung IoT lab (KD building 3rd floor) on September 6, anytime from 3:30pm to 5:30pm or on September 7, anytime from 9:30am to 12:30pm.
- Only electronic submissions will be accepted. Your solution has to be submitted via the mookit (Hello IITK) platform.
- Late submission penalty (10%): We will be accepting late submissions up to 24 hours after the deadline. We won't be able to accept submissions after that.
- **Only one person from the group should submit the assignment.**

Question 1 (100 Marks)

Aravind is an ambitious farmer who wants to improve the yields from his farmland. While looking for ways to improve the yields, he came across tech buzzwords like the Internet of Things and Machine Learning. He wants to try them out to build an intelligent irrigation system for his field.

The irrigation system he wants to build contains temperature and humidity sensors that control the water supply in the farm. Using sensor data, Aravind wants to build a machine learning model that predicts how much water (in percentage) should be supplied to his farm.

However, Aravind is good at farming and does not have much experience building Machine learning models and IoT systems. So, build an irrigation system for Aravind using temperature and humidity sensor and design a farm irrigation circuit using Raspberry Pi. The sensor which will be used for building IoT system is DHT11 temperature-humidity Sensor.

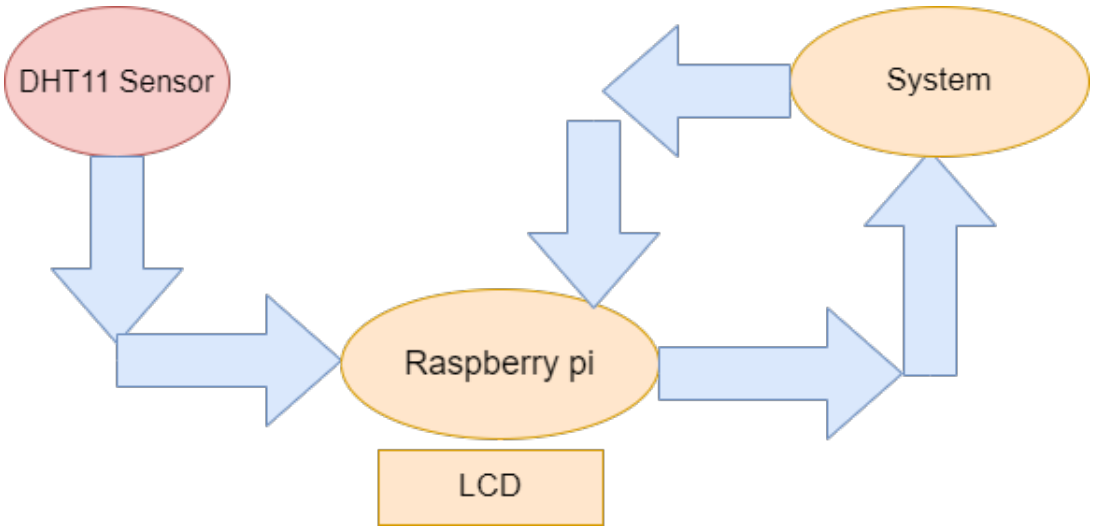

Figure 1: Data Transfer and Water Flow Prediction Setup

1 Building Farm Irrigation System

1.1 Transfer of Sensor Values from Raspberry Pi to Laptop

1. The farm irrigation system will consists of a Raspberry Pi, one DHT11 temperature-humidity sensor and a LCD to show the water flow prediction after training the Machine Learning (ML) model. The data collected from the sensor should be transferred to another system using MQTT communication protocol. Figure 1.1 shows the setup for data transfer between DHT11 sensor to the system through Raspberry Pi. The steps required to show transfer of sensor values and finally show the water flow prediction are as follows:

    - Please setup Raspberry pi hardware with the DHT11 temperature-humidity sensor. In order to test whether the code for setting up the sensor works correctly or not, you can display the sensor values on the LCD screen. You don't need to show the sensor values on LCD during the final demo. This is only for you to validate your code.
    - The Raspberry Pi should consist of a Broker and Publisher.
    - The Publisher will then publish the Temperature-Humidity values in the another system (e.g. Laptop). The Laptop will contain the Subscriber installed which will subscribe to the same topic published by the Broker.
    - Once the Publisher-Subscriber connection is established, the Temperature and the Humidity values will get displayed in the Laptop.
    - Once the values are displayed in the Laptop, train your ML model as described in section 1.2. The predicted water flow is then displayed back to the LCD screen attached with the Raspberry Pi.

NOTE: For making the sensor collects different temperature and humidity values, change the environment for data collection (e.g. taking the temperature-humidity sensor from hot place to cooler place).

1.2 ML Model Training

1. The farm irrigation system sense temperature and humidity values. These values will be provided to ML model to predict the water flow in percentage. The data needed to train the model

is provided with this assignment.

- Divide the dataset into training and testing data. You can divide it as 70% and 30%.
- Train the ML model with the training data.
- Evaluate the model with the test data.
- The predicted output of water flow for each sensor value provided in the test data should be displayed in the LCD screen. You can display the predicted water flow % after a delay of 30 seconds.

Expected functionality:

- You have to show whether you are able to establish connection properly between publisher and subscriber using MQTT Broker (Raspberry pi) or not on different sets of topics.
- You have to use the sensors provided to gather at-least 3 different pairs of Temperature and Humidity values. Using these values as input the ML model should perform the forward pass and predict the appropriate water flow in percentage.
- Apart from the training data provided to you, we have some test inputs. Your model should use these input values in order to predict the water flow % and display it on the LCD screen.

Deliverables:

1. Submit a report mentioning how you have built the irrigation system, the sensors used, the architecture of the ML model, epochs used for training, evaluation metrics. Please mention the % contribution of each member in the team. The marks will be allocated to each member accordingly.
2. Submit the code along with the README file for your assignment as well.
3. The solution for the assignment should be submitted as a zip file. The file should be named as GroupName.zip.
4. The submission should contain the following:
   - The report (as pdf)
   - ML model (used for generating optimal parameters). Clearly mention the instructions of running the ML model in the report. **Display/Print the optimal parameters obtained after training the model.**

Hints:

- Use a two-layer perception machine learning model (input layer + 2 hidden layers + output layer) to predict the water flow %. Use ReLu activation function.
- You can use Paho MQTT library to install the MQTT Brokers and Clients,

2 Demonstration

1. Display the values of Temperature and Humidity sensors on the computer terminal via MQTT.
2. Show the water flow percentage predicted by the ML model on the LCD screen. Use atleast 3 different pairs of temperature and humidity data from the test dataset. You can display the predicted water flow % after a delay of 30 seconds.
3. Code review.

Evaluation Scheme for Assignment:

1. Building the Farm Irrigation System and Demonstration (50 Marks)
2. Training the ML Model and displaying the predicted output on LCD, Accuracy of the Model (30)
3. Writing Report (20 Marks)