CS698T: Introduction to IoT and its Industrial Applications
Assignment 2
Due Date: November 03, 2021 (11:59 PM)

General Instructions:

- This is a group assignment with TWO members in a team. (You can also submit the assignment individually; however, it is advisable to form a group.)
- 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 servo motors that control the water supply to the farm, based on the present humidity, temperature levels 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. Aravind also does not want to water the plants during nighttime.

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 the IoT simulator at this link (https://wokwi.com/arduino/new?template=arduino-mega) and design a farm irrigation circuit using Arduino Mega board. Identify the required sensors needed to build the irrigation system based on Aravind's requirements from the list of sensors provided by the simulator. The irrigation system should feed the sensor readings to a machine learning model and produce the correct signal (% of water flow) to control the water supply. Use a servo motor to control the water supply.

The farm irrigation system should contain **four sensor units** such that each unit sense temperature and humidity values. These values will be provided to ML model on the Arduino board to predict the water flow in percentage. Then the water flow percentage will be provided as input to the servo motor (Map the percentage values with servo motor rotation 0° to 180°). The sensor values from each sensor unit should control a servo motor. Also, display the % of water flow that is fed as input to servo motors on an LCD (Refer to **Figure. 1**). The block diagram for the circuit schematic is shown in **Figure 2**.

Figure 1: LCD Display

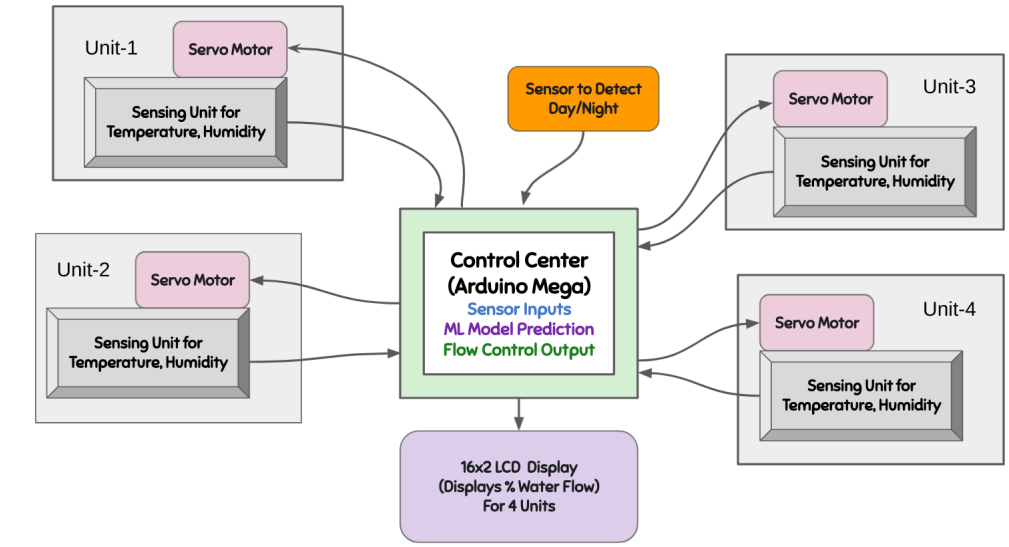

Figure 2: Block Diagram of Irrigation System

Train the machine learning model separately and obtain the optimal parameter set. Then build the ML model using the optimal parameter set on the simulator only for performing inference based on sensor readings. Do not train the model on the simulator. Data needed to train the model is provided here.

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. Also, provide the link to your simulated project in the report (You can generate the link for your project from the simulator by signing in and saving the project).

2. The solution for the assignment should be submitted as a zip file. The file should be named as Member1RollNumber_Member2RollNumber.zip.

3. The submission should contain the following:

   - The report (as pdf)
   - A video clearly demonstrating the following cases:
     - How the simulation works at night time
     - How the simulation works during day time. Changing the temperature and humidity sensor values should change the state of the correct servo motor and LCD reading.
   - 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.**

- Downloaded zip file of the simulation from the simulator (It should contain sketch.ino and diagram.json files).

Expected functionality from your simulation:

- The sensors present in the simulator contain slider bars to adjust the sensor readings. When adjusting the sensor inputs (Temperature, Humidity, Day/Night), the ML model should perform the forward pass and predict the appropriate water flow in percentage. Your simulation should print the predicted water flow % on LCD screen and control the servo motor proportional to the water flow %.
- When a particular sensor values are changed, only the servo motor that uses data from that sensor should change its state. Rest of the motors should remain as it is.
- Apart from the training data provided to you, we have some test inputs. We will set the sensor values as per the test data and see how close your predictions are on the LCD screen.
- You should also simulate day and night using the appropriate sensor from the sensor list. The water flow should be set to zero during the nighttime, irrespective of temperature and humidity values. All the servo motors should come to their zero position, and LCD should display water flow as 0% for all four units.
- Once the simulation is started, it should run in a loop. Reflecting any changes done to the sensor values automatically by modifying motor positions and values on LCD without restarting the simulation. Refresh the readings on the LCD display in every iteration. You can use some delay time inside the loop so that displayed values don't change too quickly.

Hints:

- Use a two-layer perception machine learning model (input layer + 2 hidden layers + output layer) to predict the servo motor's signal. Use ReLu activation function.
- Refer to Wokwi documentation for setting up required components on the simulator.
- For simulating Day/Night, set the threshold sensor value as 50 units, i.e., if the sensor value is set to less than 50 units, your simulation should treat it as night, and if the sensor value is greater than 50 units, treat it as day time.

Evaluation Scheme for Assignment:

1. Building the Circuit in the Simulator (30 Marks)
2. Training the ML Model and Implementing the forward pass in the Simulator, Accuracy of the Model (45 Marks)
3. Writing Report and Making a Video demonstrating the working of the Simulation. (25 Marks)