CS499/CSA499 Fall 2021 Project

Theme:

Home IoT

Project Description:

The advancement of smart homes in recent years has evolved very quickly. The variety of sensors, monitors, automation, and human interface options are almost endless. The Home IoT project will simulate sensor data and user interaction with a smart home.

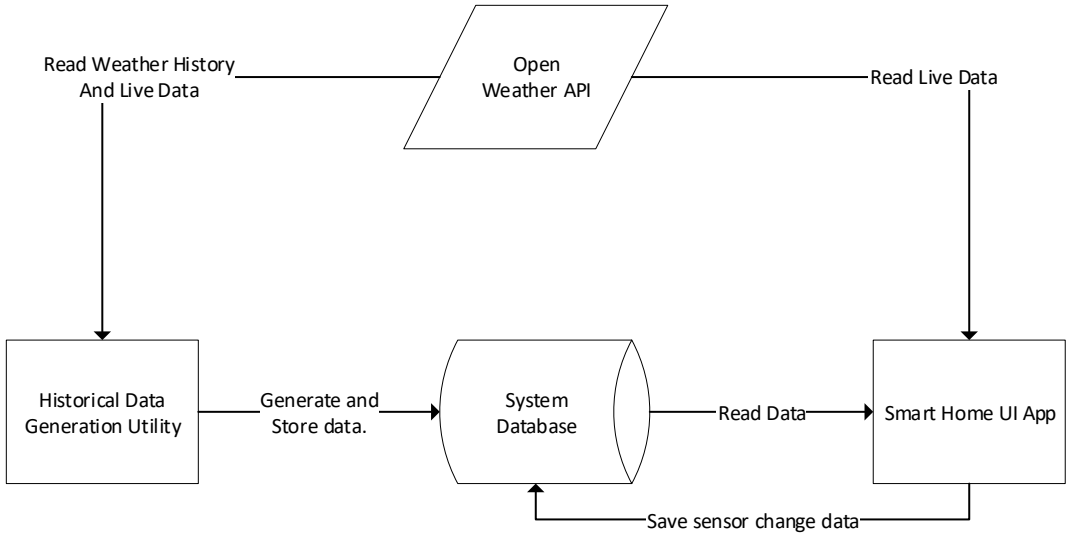
There are two main parts to the project – 1. Sensor data generation and 2. User interaction (inputs and outputs) with the system. Some project elements will be required in every teams' project and some will be chosen by the teams. The project will handle both current state information (I.e. what are the sensors indicating right now) and historical information (I.e. what did the sensors report for the last X days).

A smart home should help inform the user about their home. Some of the possible questions this system should answer:

- Is the garage door closed?
- Are there any open windows?
- What was the water usage last week?
- How much electricity do we expect to use next week?
- How much electricity did we use last week and how did it compare to the estimate?
- Where is the dog in the house?
- What is the current estimated monthly electric and water expenses?

Exact questions to be answered will be defined in the project requirements document.

Generic Architecture



Application Requirements:

Teams will meet with the instructor to define the specific application requirements for their project and define the statement of work (SOW). The following requirements list is not a complete list and some of these may or may not be required in the teams' final project.

Application Type: web application with web services, console application for data generation , others can be discussed

Language Options: HTML, CSS, Javascript/Jquery, SQL, Python, Java, C#, C++ ,NodeJS, others can be discussed

Database: PostgreSQL

Source Control: GitLab

User Input Requirements:

- Menu selection
- Sensor manipulation
    - Open and close doors
    - Turn lights and TV on/off
    - Set thermostat
    - Etc.
- Optional - Natural language processing
    - Typed text
    - Speech to text

System Response Requirements:

- Screen graphics
- Screen text
- Utility usage and cost calculations
    - Historical and predicted for current month.
- Optional - Text to speech

Project Evaluation:

- Demonstrate object-oriented concepts
- Proper source control use
- Properly commented code
- Code Readability
- User Interface Usability
- Addresses documented requirements
- Properly defined WBS and properly updated WBS
- Documented team meeting minutes

Sensor Data:

A process will be required to generate historical sensor data and record the data into a database. General formula and values are defined below. Data randomization should be included with the below defined data. Sensor settings can be manually manipulated or manipulated based on calculations of other factors.

House Detail:

- Single story slab home
- 2 adults, 2 kids
- 3 Bed (overhead light, two lamps, 1 TV in master bedroom, 2 windows)
- 2 Bath (overhead light, exhaust fan, 1 window)
- 2 car attached garage (two garage doors)
- Clothes washer and dryer
- 3 exterior doors (front, back, house into garage)
- Living room (overhead light, two lamps, TV, 3 windows)
- Kitchen (overhead light, stove, oven, microwave, refrigerator, dishwasher, 2 windows)

IoT Sensor Data Sources:

- Door sensor (exterior doors and garage doors)
- Window sensors
- Beacon tags (pets, keys, purse, etc.) (Optional)
- Water flow (kitchen, bathrooms (sink/shower), outside faucet)
- Lights on/off
- HVAC (external temp, internal temp, thermostat high/low settings)
    - External temp history and real time readings from online source

Formulas and Constants

Teams will need to define the mathematical implementation of the formulas using the following information.

- HVAC Operation - +/- 1 deg F per minute of operation
- HVAC will maintain the set temp within 2 degrees (i.e. if the inside temp goes beyond 2 degrees of the set temp, then it will start operation to bring the temp back to the set temp).
- Interior Temp Change
    - House Closed – For every 10 deg F difference in external temp, interior temp will +/- 2 deg F per hour
    - Open Door – For every 10 deg F difference in external temp, interior temp will +/- 2 deg F per 5 min door is open
    - Open Window - For every 10 deg F difference in external temp, interior temp will +/- 1 deg F per 5 min window is open
- Door Opening
    - Exterior door is open 30 seconds each time a person enters or leaves the house
    - M – F : 16 exit/enter events per day

    - S – S : 32 exit/enter events per day
- Electricity Cost - $0.12 per kWh (1w = 1/1000 kw)
- Water Cost –
    - $2.52 per 100 Cubic Feet of water
    - 1 Cubic Feet of water is 7.48 Gallons
    - 100 Cubic Feet is 748 Gallons
    - So 748 Gallons costs $2.52
- All Light Bulbs are 60w
- Bath exhaust fan – 30w
- HVAC – 3500w
- Refrigerator – 150w
- Microwave
    - 1100w
    - M – F : 20 min/day
    - S – S : 30 min/day
- Hot Water Heater
    - 4500w
    - 4 minutes to heat 1 gallon of water
- Stove
    - 3500 watts
    - M – F : 15 min/day
    - S – S : 30 min/day
- Oven
    - 4000 watts
    - M – F : 45 min/day
    - S – S : 60 min/day
- TV
    - Living Room TV
        - 636 watts
        - M – F : 4 hrs/day
        - S – S : 8 hrs/day
    - Bedroom TV
        - 100 watts
        - M – F : 2 hrs/day
        - S – S : 4 hrs/day
- Baths
    - M – F : 2 showers and 2 baths per day
    - S – S : 3 showers and 3 baths per day
    - Shower – 25 gallons of water used (65% hot water, 35% cold water)
    - Bath – 30 gallons of water used (65% hot water, 35% cold water)
- Dishwasher
    - 1800 watts
    - 6 gallons of hot water per load
    - Runs 45 min per load

    - 4 loads of dishes per week
- Clothes Washer
    - 500 watts
    - 20 gallons of water (85% hot water, 15% cold water) per load
    - Runs 30 min per load
    - 4 loads of clothes per week
- Clothes Dryer
    - 3000 watts
    - Runs 30 min per load
    - 4 loads of clothes per week
- Adults wake at 5AM, go to bed at 10:30PM
- Kids wake at 6AM, go to bed at 8:30PM
- Adults leave for work at 7:30AM, return home at 5:30PM
- Kids leave for school at 7:30AM, return home at 4PM

Generic Project Sequence

- Meet with instructor (customer) to define project requirements
- Design database
- Design application
    - Define psudo code for data generation
    - Define psudo code for UI logic
    - Design data generation
    - Design UI and logic
- Define WBS / Kanban
    - Define tasks to be done
    - Assign tasks to team members
    - Define task schedules
- Schedule team meetings
- Develop system components
- Integrate system components
- Submit final project
- Present final project

Artifacts to Turn In

- Project source code
- Database ERD design
- Psudo code design
- Requirements document
- Presentation slides (if any)
- Final WBS
- Team meeting minutes

Resources:

Weather API - https://dev.meteostat.net/

CS GitLab - https://gitlab.cs.uab.edu/CS499F202x/Teamy (replace x with the current year, and y with your team number)

Speech to Text/Text to Speech - https://azure.microsoft.com/en-us/services/cognitive-services/speech/

Database - TBD