CS5373 – Model and Software Architecture **Spring 2022**

Term Project: Phase I

You are required to develop an Analysis model of the Smart Home System (SHS), which includes:

a) Develop a System Context Class Model depicted on a class diagram showing how the system interfaces to the external environment. (5 pts)

b) Develop a static model that describes entity classes, attributes, and relationships between entity classes. (5 pts)

c) Develop sequence (or communication) diagrams (one for each use case), depicting the sequence of interactions among the objects participating in each use case. Define the object structuring criteria used. (12 pts)

d) Develop the statechart for the control object. Show the alternative paths on the sequence diagrams (or communication diagrams) and the statechart. Ensure that the statechart is consistent with the sequence (or communication) diagram for use cases. (8 pts)

State any assumptions you make.

Term Project: Phase II

For Phase II of the project, you need to develop a Design Model for the SHS. In particular:

a) Develop an integrated (consolidated) communication diagram(s) showing all the objects and messages (or abstract messages) in the system. (4 pts)

b) Define the subsystem architecture (depicted on a concurrent communication diagram), showing the subsystems and their interactions. Describe the criteria used for subsystem structuring. Define the message communication interfaces between the subsystems. (6 pts)

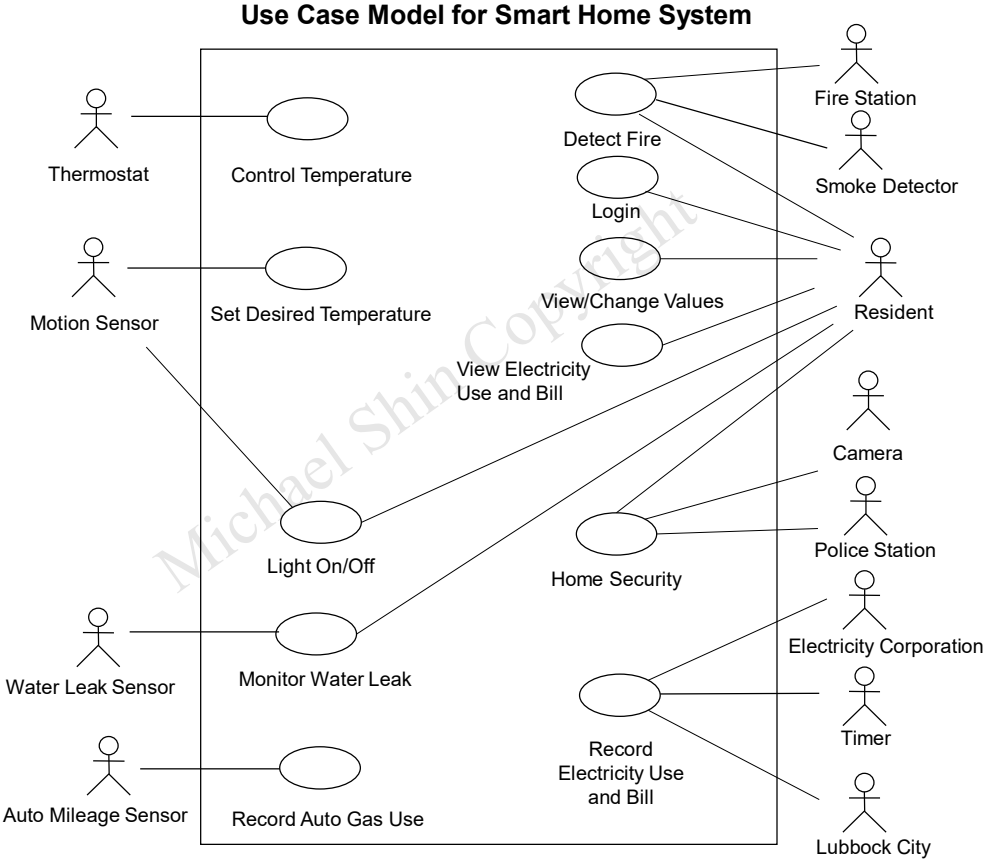
c) Define the task architecture (depicted on concurrent communication diagrams), showing each subsystem's concurrent tasks and interfaces. Describe the criteria used for task structuring. Define the message communication interfaces between tasks (6 pts)

d) Define the information hiding classes in the system. (4 pts)

e) Design the database to store the attributes of entity classes. (4 pts)

f) Design the blockchain database to store monthly electricity usage. Define the data stored in the blockchain data and operations provided by the database. Specify the logic of each operation. (6 pts)

State any assumptions you make.



Use Case Description for the Smart Home (SH) system

Use case name: Control Temperature
Summary: The system controls the heater or air conditioning (AC) on or off to increase or decrease the home temperature to meet the desired temperature.
Actor: Thermostat
Precondition: The desired temperature for the home has been specified. The resident switched on Air Conditioning (AC)/heater thermostat, and the AC and heater are off.
Main sequence:

1. The thermostat measures the current home temperature.
2. The system turns on the heater via the thermostat if the current temperature is below the desired temperature.
3. The system records the time to turn on the heater, current temperature, and desired temperature.
4. The thermostat continues to measure the current temperature until the temperature reaches the desired temperature.
5. The system turns off the heater/AC if the current temperature has reached the desired temperature.
6. The system records the time to turn off the heater/AC, current temperature, and desired temperature.
7. Repeat steps 2-6 to maintain the desired temperature.

Alternative sequence:

- Step 2: The system turns on AC via the thermostat if the current temperature is above the desired temperature. The system records the time to turn on AC, current temperature, and desired temperature.

Postcondition: The system has maintained the desired temperature for the home.

Use case name: Set Desired Temperature
Summary: The system sets the desired temperature to a comfortable temperature for residents or a minimum safe temperature for a vacant house.
Actor: Motion Sensor
Precondition: The desired temperature has been set to a minimum safe temperature.
Main sequence:

1. The motion sensor detects motion and sends a message to the system.
2. The system sets the desired temperature to a comfortable temperature.
3. The system records the time to change the desired temperature to a comfortable temperature.

Alternative sequence:

- Step 1: If the motion sensor does not detect motion for a while (e.g., 30 minutes), the system sets the desired temperature to a minimum safe temperature and records the time to change the desired temperature.

Postcondition: The system has set the desired temperature.

Use case name: Record Automobile Gas Use
Summary: The system records the automobile gas amount used.
Actor: Auto Mileage Sensor
Precondition: None.
Main sequence:

1. The auto mileage sensor reads the current mileage when the resident turns off the engine of an automobile in the garage and sends it to the system.
2. The system calculates the gas amount used since the last update.
3. The system records the mileage and gas usage.

Alternative sequence: None
Postcondition: The system has recorded the automobile gas use.

Use case name: Light On/Off
Summary: The system turns on/off the light depending on the resident staying or not in a room.
Actor: Resident, Motion Sensor
Precondition: None.
Main sequence:

1. The resident switches on the light.
2. The motion sensor detects no presence of the resident.
3. The system turns off the light.
4. The motion sensor detects the presence of the resident.
5. The system turns on the light.
6. Repeat steps 2-5
7. The resident switches the light off.

Alternative sequence: None
Postcondition: The system has lit on/off the light.

Use case name: Monitor Water Leak
Summary: The system alerts the resident for water leaks.
Actor: Water Leak Sensor, Resident
Precondition: None.
Main sequence:

1. The water leak sensor detects water leaks.
2. The system notifies the resident via a smartphone of the water leak alert.
3. The system records the time for water leaks and the place to leak.

Alternative sequence: None
Postcondition: The system has sent the water leak alert to the resident.

Use case name: Detect Fire
Summary: The system detects smoke or fire and extinguishes it.
Actor: Smoke Detector (carbon monoxide detector), Fire Station, Resident
Precondition: None.
Main sequence:

1. The smoke detector detects smoke or fire.
2. The system activates the fire alarm and notifies the resident via a smartphone.
3. The system records the time to start the fire alarm.
4. The system activates the sprinkler if the smoke detector detects a fire or smoke exposing more than a specified CO level (e.g., 400 parts per million).
5. The system records the time to activate the sprinkler and CO level.
6. The system notifies the fire station if the smoke detector still detects smoke or fire five minutes after the system has activated the sprinkler.
7. The system records the time to notify the fire station.

Alternative sequence:

- Step 4: If the smoke detector detects smoke that exposes less than a specified CO level (e.g., 400 parts per million), the system continues to monitor the data read by the smoke detector. The system activates the sprinkler if the CO level exceeds the specified level. Go to step 5.

Postcondition: The system has detected smoke or fire.

Use case name: Home Security
Summary: The system guards the home against a suspicious person.
Actor: Camera, Police Station, Resident
Precondition: None.
Main sequence:

1. The camera scans the area around the home and sends the image to the system.
2. The system stores the camera images.
3. The system analyzes the camera images.
4. The system alerts the resident via a smartphone if a suspicious person hangs about the house continuously.
5. The system analyzes the camera images.

6. The system activates the alarm and notifies the resident via smartphone and the police station if the suspicious person breaks into the house.
7. The system records the time to activate the alarm and notify the resident and police station.

Alternative sequence: None
Postcondition: The system has guarded the house.

Use case name: Login
Summary: The resident logs into the system.
Actor: Resident
Precondition: None.
Main sequence:

1. The resident enters credentials (e.g., ID and password) to log into the system.
2. The system validates the ID and password.
3. If the ID and password are valid, the system displays a welcome message.
4. The system records the time to log in and valid login.

Alternative sequence:

- Step 3: if the ID and password are invalid, the system displays a message for a login error. The system records the time to log in and invalid login.

Postcondition: The resident has logged into the system.

Use case name: View/Change Values
Summary: The resident specifies the comfortable temperature and a minimum safe temperature.
Actor: Resident
Precondition: The resident has logged into the system.
Main sequence:

1. The resident selects the view status.
2. The system displays the resident's home status and the edit/logout menu.
3. The resident chooses the edit menu if the resident wants to change the desired temperature.
4. The system prompts the resident to enter the new comfortable or minimum safe temperature.
5. The resident enters the new comfortable or minimum safe temperature.
6. The system updates the new comfortable or minimum safe temperature.
7. The system records the time to change the comfortable or minimum safe temperature.
8. The resident selects the logout.
9. The system terminates.

Alternative sequence:

- Step 3: if the resident selects the logout menu, the system terminates.

Postcondition: The resident has viewed the home status and changed the comfortable or minimum safe temperature.

Use case name: Record Electricity Use and Bill
Summary: The system records the resident's electricity use and monthly bill on blockchain ledgers.

Actor: Timer, Electricity Corporation (EC), Lubbock City (LC)
Precondition: A smart meter has regularly recorded the amount of electricity used by the resident in the system and EC. (Suppose that the LC initiated an incentive program to provide discounts on electricity bills to customers who use lower electricity monthly. The discount rates had been specified.)
Main sequence:

1. The timer signals to the system to record the electricity use and bill on the blockchain ledgers.
2. The system reads the monthly electricity use and calculates the electricity bill based on the discount rates.
3. The system sends the electricity use and bill to the Electricity Corporation (EC) and the Lubbock City (LC).
4. The EC verifies that the electricity use and bill are valid. The EC sends the electricity use and bill to the (smart home) system and LC if they are accurate.
5. The system stores the electricity use and bill on the blockchain ledger. (Meantime, the LC and EC store the electricity use and bill on their blockchain ledgers.)

Alternative sequence:

- Step 4: If the electricity use and bill are invalid, the EC sends an error message to the SH system and LC.

Postcondition: The system has recorded the monthly electricity use and bill on the blockchain ledger.

Use case name: View Electricity Use and Bill
Summary: The resident views the monthly electricity use and bill history.
Actor: Resident
Precondition: The resident has logged into the system.
Main sequence:

1. The resident selects the view electricity usage and a period for the use.
2. The system reads the electricity use and bill from the blockchain ledger.
3. The system displays the electricity use and bill for a period to the resident.

Alternative sequence:
Postcondition: The resident has viewed the electricity use and bill for a period.