Assignment 3: Elevator System Simulator in Qt C++

Submitted on Brightspace by March 9th 11:59pm

Grace period of 2 days at 10 marks per day penalty for lateness

With Assignment 2 you have delivered your first version of the design to Raven Elevators Inc. (REI) and the company is confident that you can implement a high quality elevator system simulator in Qt C++ as per the implementation requirements and constraints listed below. REI asks you to proceed with the implementation and testing for a system that is configurable in number passengers, floors, elevators, ~~and allocation strategy~~. Understanding that design can, and typically does, change during implementation, REI asked you to update the documentation. You will be delivering use cases, design documentation, source code, tests and requirements traceability matrix, and a video of its use. It is recommended you proceed in two iterations: first, implement and test the basics, and second, implement and test the variability.

Learning objectives:

- Exploring Qt/C++ architecture and functionality.
- Implementing the elevator system simulation using elements of the Qt/C++ Framework and updating your design from Assignment 2 as needed.
- ~~Developing a test plan.~~
- Building a requirements traceability matrix that includes implementation and testing columns.

Deliverables (5 parts)

- **Use cases** (can borrow from A1 or A2)
- **Design documentation** – structure and behavior – updated as needed (can borrow from A2 & grading feedback)
    - UML Class diagram (including significant Qt Framework classes used in your implementation)
    - UML Sequence diagrams for 2 **different** success scenarios from normal use and 2 safety scenarios (select 2 safety features), for a total of 4 scenarios. Assume there are 3 passengers, 5 floors, and 2 elevators.
    - UML State Machine Diagram for the simulation controller(s).
    - UML State Machine Diagram for an elevator.
    - Textual explanation of your design decisions including use of design patterns, if any.
- **Implementation requirements and constraints**
    - Source code of your Qt C++ project that **builds and runs on the course VM, COMP3004-F24.ova** found at **https://carleton.ca/scs/tech-support/virtual-machines/**
    - Tests based on the scenarios specified in your design
    - REI asks that your implementation have the following properties:
        - Deal with variable number of passengers, floors, elevators, ~~and allocation strategy.~~

        - Display simulation time in the GUI. Simulation time starts at 0 and progresses until all events are handled. Simulation starts by pressing a “Start” button, and proceeds one simulation time step at a time.
        - Display elevator location and its state (idle, moving, etc.). You are not required to animate movement of elevators.
        - When an elevator is moving from floor 1 to floor 4, that movement is displayed as the location of that elevator changing from floor 1, floor 2, floor 3, and floor 4. An elevator cannot teleport from floor 1 to floor 4.
- **Video:** record a video of running the simulation through the 4 scenarios corresponding to your sequence diagrams.
- **Traceability matrix** (can borrow from A2 & grading feedback)
    - Update the traceability matrix from A2 to include “implemented-by” and “tested-by” columns

Elevator system specification (same as Assignment 2)

<Paragraph 1> To setup the simulation corresponding to the specification starting at <Paragraph 2> the administrator 1) selects the number of floors and elevators in the building, 2) specifies number of passengers and their behavior (floor request and simulation time step at which it occurs, car request, help button, open/close door), 3) specifies safety events and simulation time steps at which they occur. Once the initial setup is completed, the simulation is started. During the simulation the log console displays the passenger actions and system responses. The administrator can pause, continue, and stop the simulation, as well as let it run until all the events are handled and all elevators are idle. As the simulation runs, 1) the current time step is displayed, 2) location of each elevator in the building and its state (moving or idle), and 3) active safety conditions.

<Paragraph 2> A building is serviced by a group of M elevators (also called cars). On each of the N floors is a pair of buttons marked “up” and “down”. When a button is pressed it illuminates, and remains illuminated, until an elevator arrives to transport the customers who, at this floor, have requested an elevator going in a certain direction. When the elevator arrives, it rings a bell, opens its doors (the elevator and floor doors) for a fixed time (10 seconds) allowing people to exit or board, rings the bell again, closes its doors and proceeds to another floor. Once on-board passengers select one or more destination floors using a panel of buttons; there is one button for every floor. The elevator has a display which shows passengers the current floor of the elevator. There is also a pair of buttons on the elevator control panel marked “open door” and “close door”. These buttons can be used by a passenger to override the default timing of the doors. The door will remain open beyond its default period if the “open door” button is held depressed; the doors can be closed prematurely by pressing the “door close” button. Inside the elevator there is also a help button linked to building safety service.

<Paragraph 3> Each elevator has a sensor that notifies it when it arrives at a floor. The elevator control system should ensure that the group of elevators services all (floor and on-board) requests expeditiously.

<Paragraph 4> Each elevator has a display and an audio system. The display shows the current floor number and warning messages that are synced with audio warnings.

Safety features:

<Paragraph 5> Help: The control system receives a “Help” alarm signal from an elevator indicating that the “Help” button has been pressed. In that case, the passenger is connected to building safety service through a voice connection. If there is no response from building safety within 5 seconds or if there is no response from a passenger a 911 emergency call is placed.

<Paragraph 6> Door obstacles: If the light sensor is interrupted when the door is closing, the control system stops the door from closing and opens it. If this occurs repeatedly over a short period of time, a warning is sounded over the audio system and a text message is displayed.

<Paragraph 7> Fire: The control system receives a “Fire” alarm signal from the building and commands all elevators to move to a safe floor. Similarly, a “Fire” alarm signal from the elevator itself will cause that elevator to go to a safe floor. In both cases an audio and text message are presented to passengers informing them of an emergency and asking them to disembark once the safe floor is reached.

<Paragraph 8> Overload: The control system receives an “Overload” alarm signal from an elevator if the sensors indicate that the passenger or cargo load exceeds the carrying capacity. In that case, the elevator does not move and an audio and a text messages are presented to passengers asking for the load to be reduced before attempting to move again.

<Paragraph 9> Power out: The control system receives a “Power Out” alarm signal. In that case, an audio and a text messages are presented to passengers informing them of the power outage. Each elevator is then moved to a safe floor and passengers are asked to disembark via audio and text messages. The battery backup power is sufficient to do all of this.