JEAN MONNET UNIVERSITY/ECOLE DE MINES

DIGITAL TWIN OF A SMART BUILDING (SYSTEM MODELLING PROJECT).

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SOFTWARE REQUIREMENT DOCUMENT FOR THE TWIN OF BUILDING PROJECT

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1. INTRODUCTION

1.2. Purpose

From significantly reducing the risks of the covid-19 pandemic, air pollution and a host of other air related problems. Ventilation has in recent times risen as a major factor in improving user health. One of the major ways to improve ventilation in a building is to keep the windows open. However, here in Saint Etienne where it could get really cold during some seasons, It is important that heaters (which are better effective in closed rooms) be turned on to keep the user warm.

This brings up the question as to how we can manage the conflicting functions of windows and hearts in a public building to keep the air safe, give the user comfort in cold seasons and also to optimize energy consumption. This is in fact what our intended solution aims to solve.

1.2. Scope And Intended Audience

The purpose of this document is to define the Digital Twin system which is to be developed to manage the CONFLICTING functions of windows and heaters in smart public buildings. The system will be based on an arrangement where rooms in a smart building are equipped with a window opening device, a user interaction device, and a room management system. The overall structure of the system is described as follows. This document is developed for reference by the product owner (The Government of Saint Etienne), building manager(s), visitor(s) to the smart building and most importantly, the players in the software development lifecycle including system designers, developers, testers etc.

The goal of this system is to:

- Make the decision process between opening the window and putting on heaters easier for the customer.
- Maintain a stable and conducive temperature for users.
- Conserve energy.

2. ACTORS

The actors in our system include:

a. **The product Owner**
   The Government of Saint Etienne (Is considered an administrator level user)

b. **Users**, can be a staff of the government or individual in the following categories:
   - Building Manager: The person or people who will be in charge of the overall management of the system. (Is considered an administrator level user).
   - Visitors: People, who will at one time or the other, are in the building. (Is considered an end user of the system).

3. FUNCTIONAL REQUIREMENTS

3.1 HARDWARE

The functional hardware requirements of our system are described as follows:

a. Internal Hardware:

i. Window Opening Device:

- Can push and pull the two shafts of a window.
- Can display some information on a small screen.
- Has two buttons that enable simple user interaction of type (*mode* and *select*).

ii. User Feedback Device:

- Can push and pull the two shafts of a window.
- Can display some information on a small screen.
- Has two buttons that enable simple user interaction of type (*mode* and *select*).

iii. Room Management System:

- Connected to the same WiFi networks as other devices and centralizes the management for a couple of rooms.
- This device has access to a database that stores when rooms are theoretically occupied.
- It can command the heaters and change the temperature set points.
- It is also connected to the internet and can therefore access the weather forecast service.
- It has enough computational power to run simple simulations, and can therefore forecast the evolution of the temperature and CO2 levels in rooms.

b. External Hardware

Networks:

Internet: For the Room Management System to access weather forecast services.

Local Area Network: For the User feedback Device and the room Management System to communicate. Each User feedback device on the network is uniquely identified by its MAC address.

3.2. SOFTWARE:

The software functional requirements of our system are described as follows:

a. Internal Software:

i. Web Portal:

- Can be accessed by authorized user from any browser.
- Has access to a database that can show a list of empty and occupied rooms.

- Can show the history of the temperature,
- Display CO2 levels,
- Displays window open/close status.

b. External Software:

ii. Browser

- To access the web portal by authorized user.

System Interaction:

In the figure below , we illustrate how the various actors in the system interact.

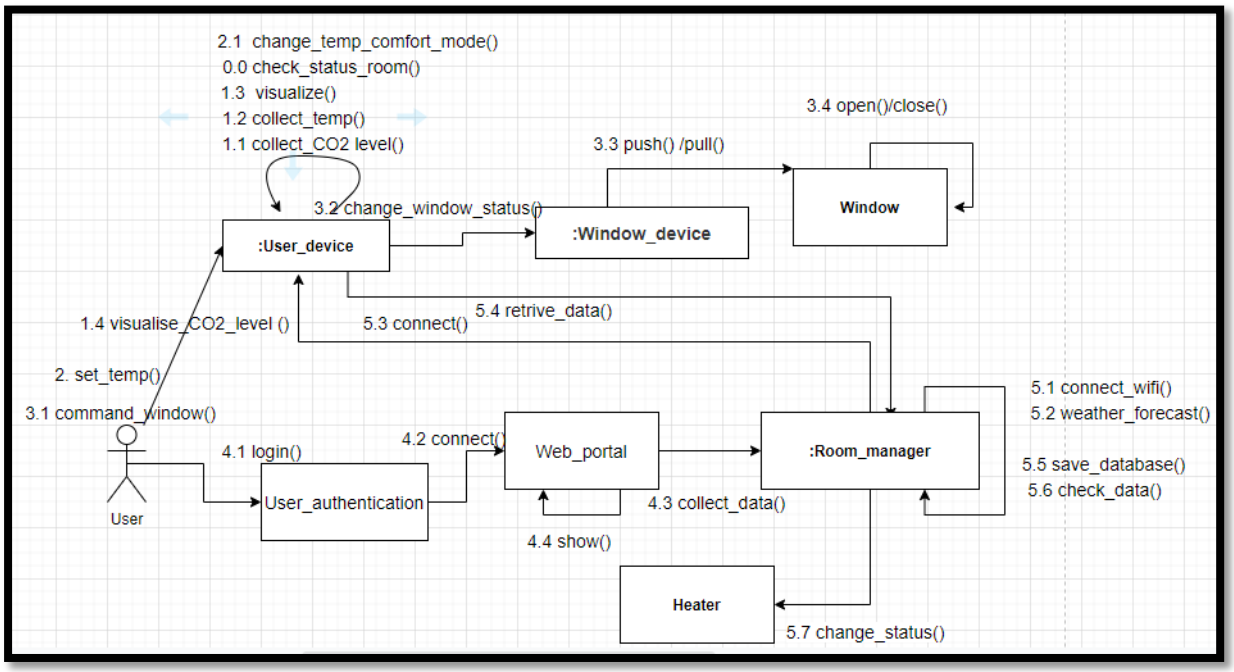

Fig. 1 System Interaction Diagram

4. NON FUNCTIONAL REQUIREMENTS

Security: The system should handle user data very securely.

Availability: The system should respond in real time.

Usability: The system should be easy to use.

Environment: The system should be accessible using any browser.

5.0 USE CASES

Users in our system are divided into two groups. They are categorized as:

1. Building Manager (System Administrator)
2. Visitor (End User)

Below we highlight the use cases of both groups of users:

1. **Building Manager:**
   The Building Manager can configure the devices and interact with the system using both the user interface device and the web portal as highlighted below.

   a. **User feedback Device:**
      Using the two buttons on the user feedback device, the manager should be able to:

      - Configure the devices in each room
      - Turn on the display
      - See the current temperature and CO2 levels
      - Set the temperature comfort mode
      - Command the windows

   b. **Web portal:**

      Using this web portal, the building manager should be able to: see and visualize the history of the temperature, CO2 levels, and window open/close status.

2. **Visitor:**
   Visitors to the public building can only interact with the system using the user feedback device as follows:

   a. **User feedback Device:**
      Using the two buttons on the user feedback device, the visitor should be able to:
      - Turn on the display
      - See the current temperature and CO2 levels
      - Set the temperature comfort mode.
      - Command the windows.

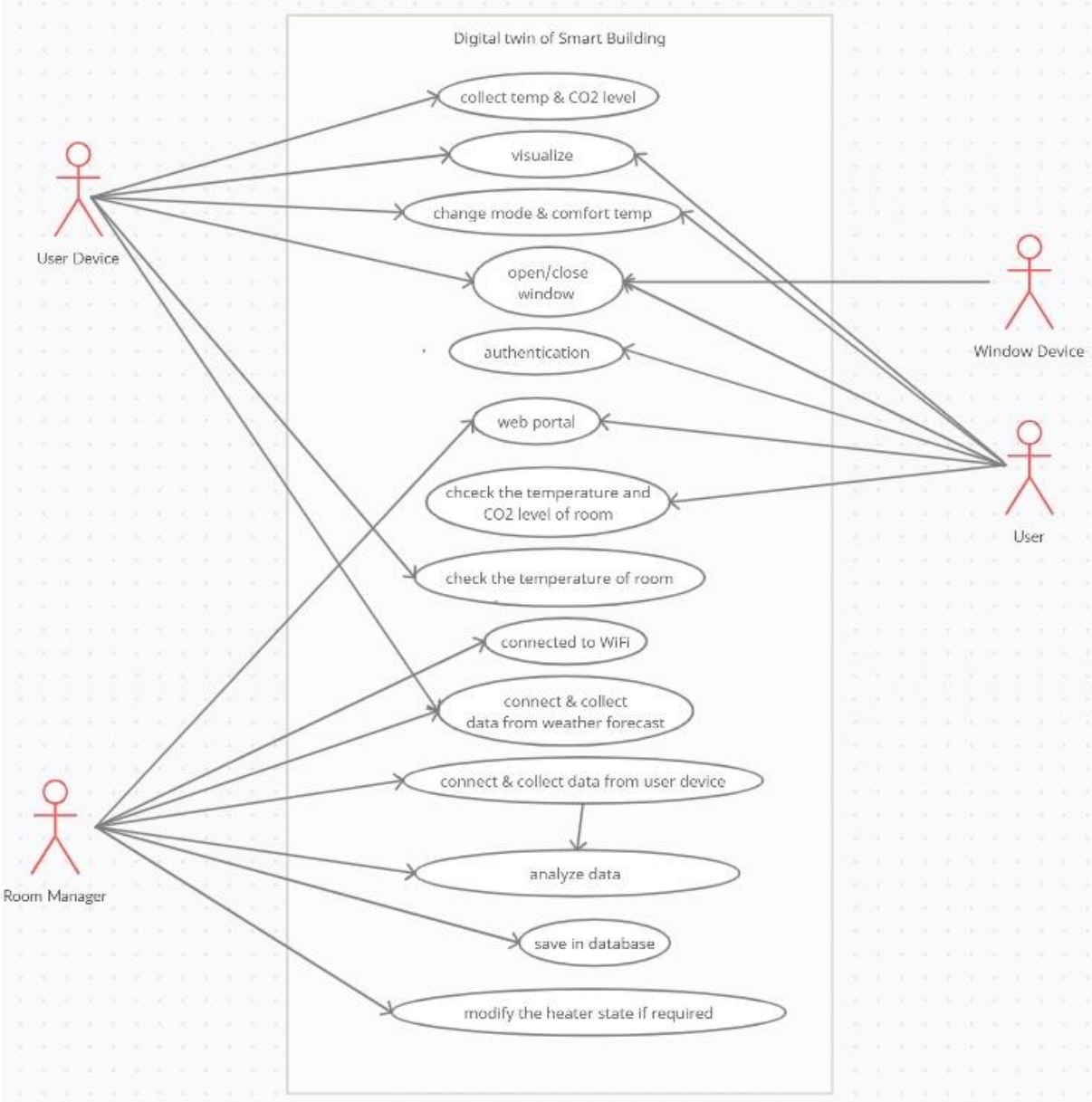

Fig.2 Use Case Diagram

Use case Statements

1. User_device will collect the temperature and CO2 level of the room.

2. Visualize this information to the user

3. User can change comfort temp and change the mode

4. user_ device will change the mode for the user

5. user can able to open/ close the window with the help of the User_device and window_device.

6. user will log in to their portal and can see the CO2 level, the temp of the room.

7.Room_manager will connect with wifi and collect weather information from the weather forecasts.

8. Room_manager will connect and collect data from the user device.

9. Room_manager will save data in the Database.

10. Room_manager It will analyze the data.

11. Room_manager will turn on / turn off the Heater.

Class Diagram:

The following diagram describes the domain of the system.

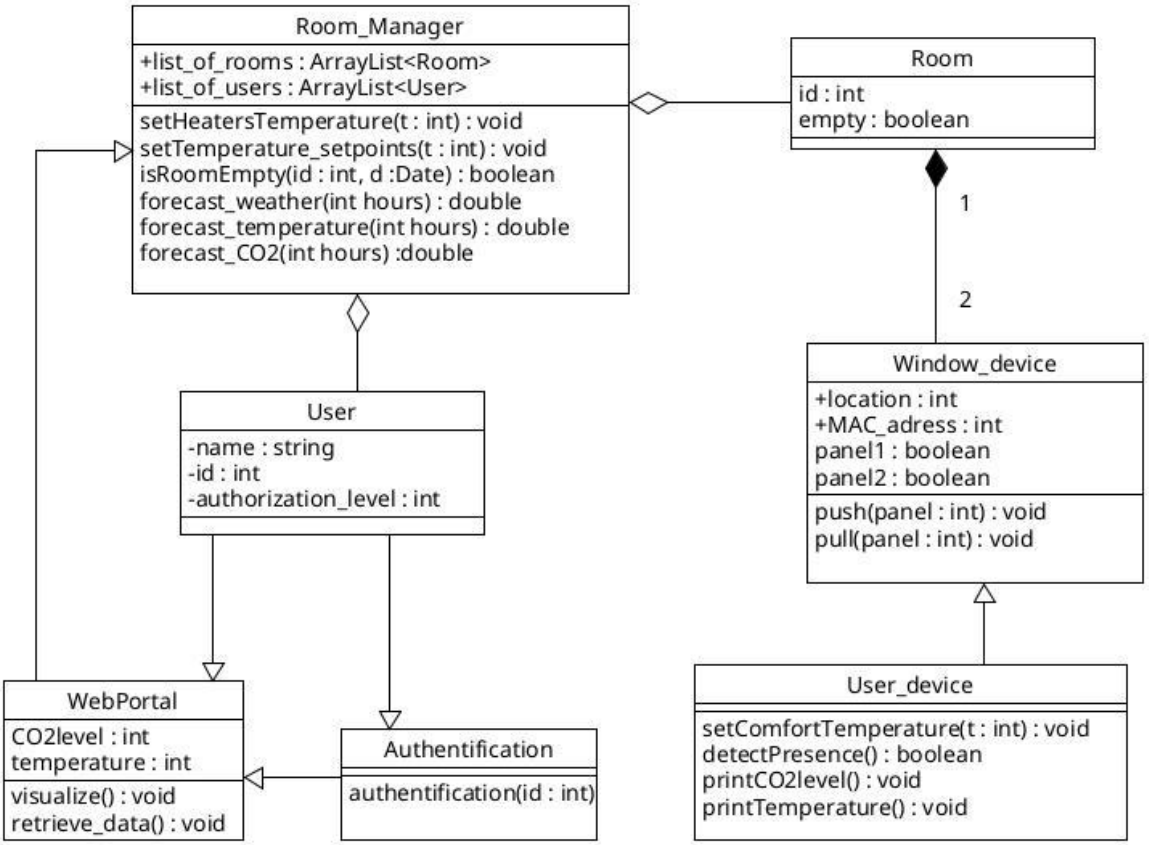

Fig.3 Domain Class Diagram