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EVD1

PoC – Proof Of Concept

Engineering Design Process Application

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2)1) Define the problem

Our solution is designed for the archives needing a reliable system allowing them to preserve sensitive documents. This system meets the keeping constraints imposed by such documents. Furthermore, it facilitates the storing and the borrowing of those documents, while ensuring their safety and these of the people using it.

2)2) Do background research

Another project of a connected bookshelf: https://www.maisonapart.com/edito/decorer-s-inspirer-s-equiper/equipement-electromenager-high-tech/bibliotheque-connectee---bientot-dans-nos-maisons--11303.php

– Identify questions to ask about your target user or customer:

- Who might be interested?
- What are their needs?
- What are their budgets?

– Identify questions to ask about the products that already exist to solve the problem you defined or a problem that is very similar.

- Do they prefer their archives to be closed and the documents be retrieved and stowed by a robot? Or open with just a simple system of localisation
- Which filters should the digital environment have to split the documents?
- How should the conservation conditions (temperature, humidity, luminosity, …) be controlled? (VMC, radiators, …)

– Plan to research how your product will work and how to make it.

- What already exists on the market?
- How is an archive organised?
- How to register and organise all the books in an application?
- How to create the user interface and the background system?

– Network with other people with more experience than yourself: your mentors, parents, and teachers. Ask them: "What should I study to better understand my engineering project?" and "What area of science covers my project?" Better yet, ask even more specific questions. Before moving forward with an idea for your engineering project, be sure to evaluate your problem.

- FAUBERTEAU
- COURBIN
- Some friends of us

Is our project on the right track?

First, we are two students. Then we have many ideas of features: regulation of temperature in the closed room, control of the air quality, detection of motion in the room, display on a map thanks to the LED which indicates the location of the document needed, control of luminosity in order to preserve the documents, security control which prevent oxygen from entering in the room when a fire break out in the room.

Yes, it is something new which interesting both of us. We have many different ideas of features, some with sensors which are familiar, others news what is very interesting.

Not for the subject itself but for each feature:

- BCDI Manuel: http://documentation.solutionsdoc.net/bcdi/special/
- Motion sensor: https://raspberry-pi.developpez.com/cours-tutoriels/capteur/mag-pi-utiliser-port-gpio/partie-1-detection-mouvement/
- Motion sensor: https://www.framboise314.fr/raspberry-pi-et-detecteur-de-presence-infra-rouge/
- Books conservation: http://www.artdoctor.fr/content/93-conserver-ses-livres-anciens#:~:text=Il%20est%20conseill%C3%A9%20de%20conserver,de%20trop%20serrer%20les%20livres.
- Control of the air quality: https://www.raspberrypi.org/forums/viewtopic.php?t=248909

As the solution is supposed to be a room, there is no problem about storing or disposing of it. Considering the using of it, we must adapt it to the way the clients will want to use it, maybe not integrate the mechanical arm if they want to get into the room or insert places where we can hide it if someone wants to get inside. If then room is supposed to be closed and only accessible to maintenance, we just need to add a way to stop the mechanism to make sure the people who want to enter may not be harmed by the arm.

We already have the different sensors and Led. Maybe we will also need a motion sensor too, but it's supposed to be available in the Pole.

As we have more than 4 ideas of features, if we are taking too much time or have problem with one, we will have the possibility to change it for another one which may be easier for us.

2)3) Specify requirements

Design requirement:

- Conserve the books:

  -Control the humidity (sensor + ventilation + humidifier)

  -Control the air quality (sensor + ventilation)

  -Control the luminosity (sensor + adaptable light)

  -Control the temperature (sensor + climatization + heater)

  -Adapt the position of the books (different size of shelfs)

- Manage the books (WebApp):

  -Easy to use Web Page (few steps)

  -Show available books (complete list with indicators)

  -Indicate the characteristics of the books (entries for: binding, conservation state, …)

  -Classify clearly the books (multiple filters)

- Protect the book from fire:

  -Control the entry of dioxygen in the room (create a vacuum inside the room)

  -Control the heat and carbon dioxide inside the room (sensor)

- Protect the access to the room:

  -Detect motion in the room (motion sensor + alarm)

- Protect the users inside the room:

  -Disable the robotic arm when someone enters the room (presence sensor + sleep mode for the arm)

- Retrieve/store the books:

  -Robotic arm

  -Books localisation systems (LED + plan)

2)4) Brainstorm solutions and product a Design

- Conservation of the books:

  - For the luminosity, we suppose that the lighting is uniform in all the room. For that, there a no windows and the lights are symmetrically distributed on the ceiling.

  - For the temperature, it must be kept around 18°C, one sensor should be enough, but it is important that the insulation of the room is well made in order not to create differences of temperature inside. Any type of heating can be used if the source is not to close to the books, but we would prefer it to be from the floor or the ceiling. The cooling can be managed with some air conditioners.

  - For the air quality, we just need to make sure it is kept good. We can control its level with one sensor and ventilate the room when needed with an AHU.

  - Some books need to be lengthened for a better conservation. Provide a special zone for these books.

  - We will separate the room in two parts and install in each one sensor, one ventilation and a humidifier to make sure the humidity stays as close as possible to 50%.

- Manage the books:

  - Simple app with two functionalities: A list of the books with the information about whether they are disponible or not (a list of filters allows the user to sort the books); an interface to return a book with the name of the author, the title, the year of the book and the category (stores the book if it already has an emplacement or allows it one if it has not).

  - When you select a book, a description indicates the characteristics of the book: type of binding, state of conservation, …

- Protect the books form fire:

  -We adapt the number of fire detectors to the size and the shape of the room.

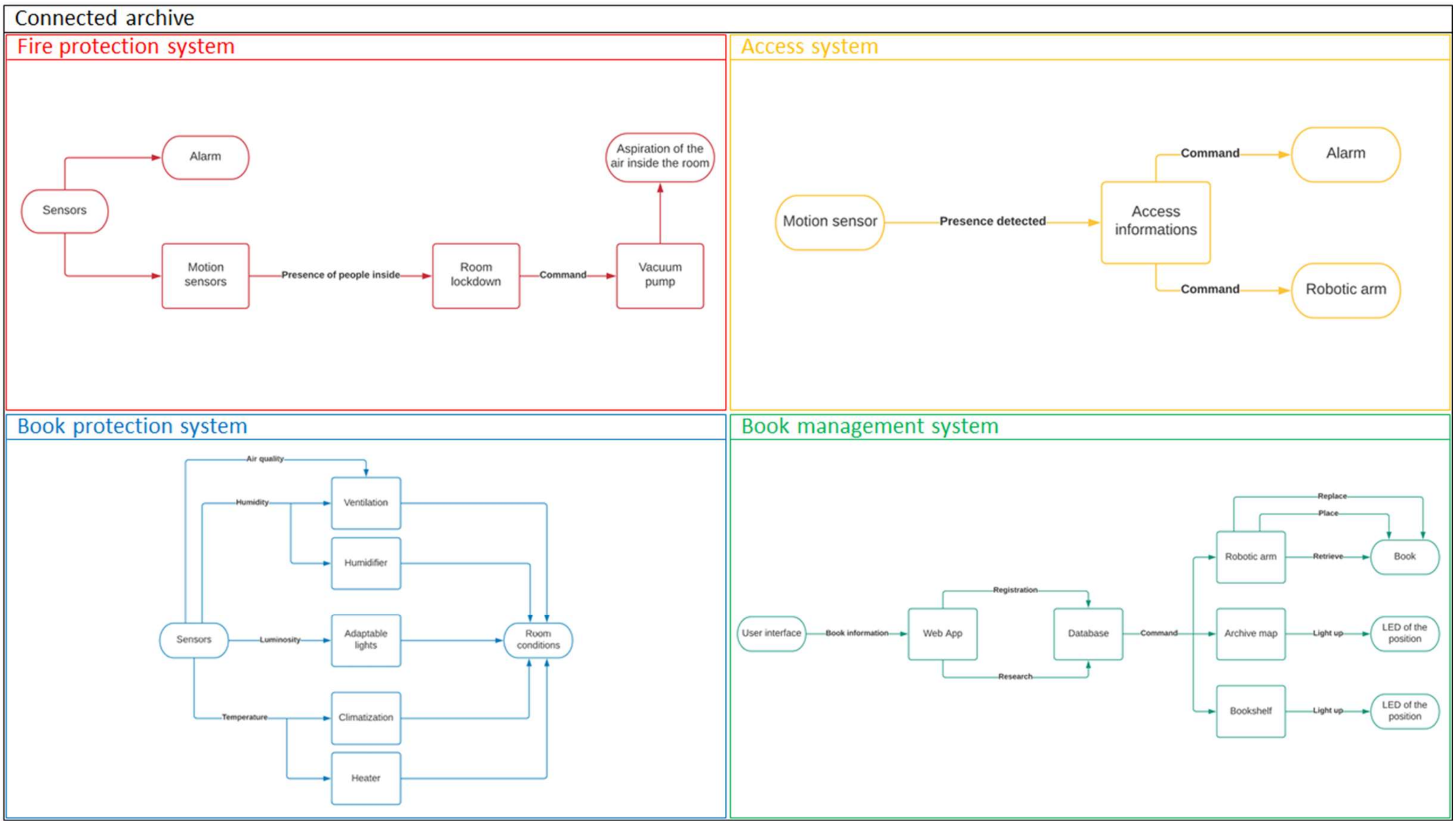
  -In case a fire start is detected, a vacuum pump vacuums all the air outside of the room to suffocate the fire.

- To protect the access to the room we put motion sensors in many places (depending the form and the room size). If a motion is detected whereas no one should be there, an alarm sounds in the building.

- To protect the users inside the room: if the robotic arm is not installed or not working, there is no other problem else than putting to sleep the vacuum until the door is closed and the people gone. If the robotic arm is installed, it must be put to sleep and store somewhere in the room before the people get inside.

- To retrieve and store the books, we're going to use a robotic arm that will navigate inside the room and grab the book we want to retrieve and bring it to the user or store the one we want to return and bring it back to its place.

3)1) Block Diagram



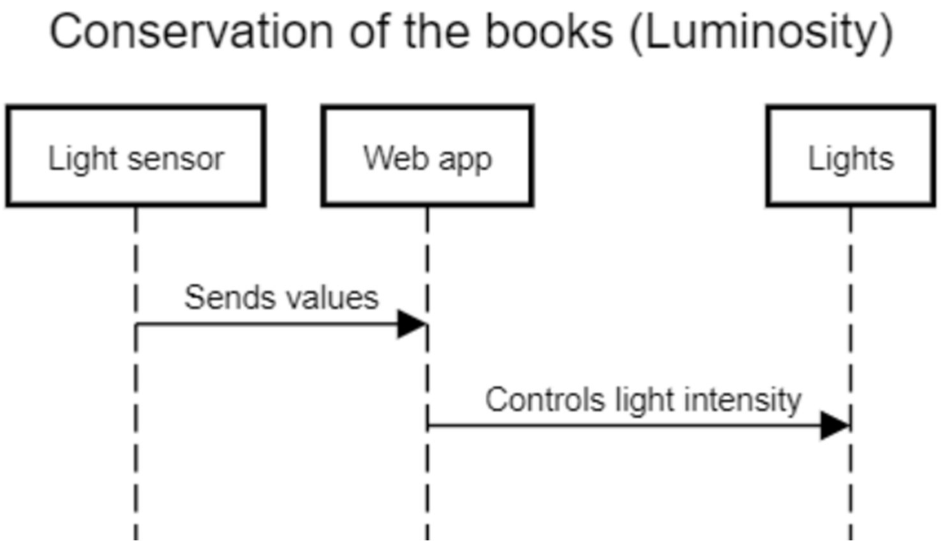
Fire protection system: The fire sensors are directly connected to the alarm. If they detect a start of fire, they will send an electric signal, which will make the alarm ring. They are also connected to the motion sensors, which will authorise the initiation of the room lockdown if they do not detect any presence inside the room (they send a binary message: 0 for nobody inside, 1 for people inside). Once the lockdown is initiated, it starts the vacuum pump and the process of aspiring the air outside the room.

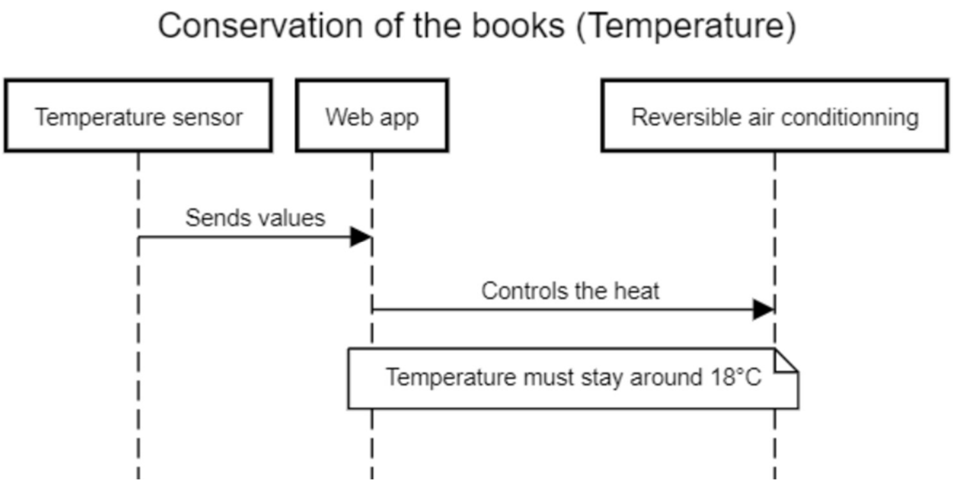
Access system: If a motion is detected when the access to the room is authorized, then the robotic arm is disabled by an electric signal from the Web app; If a motion is detected when the access to the room is denied, then a signal from the web app activate the alarm.

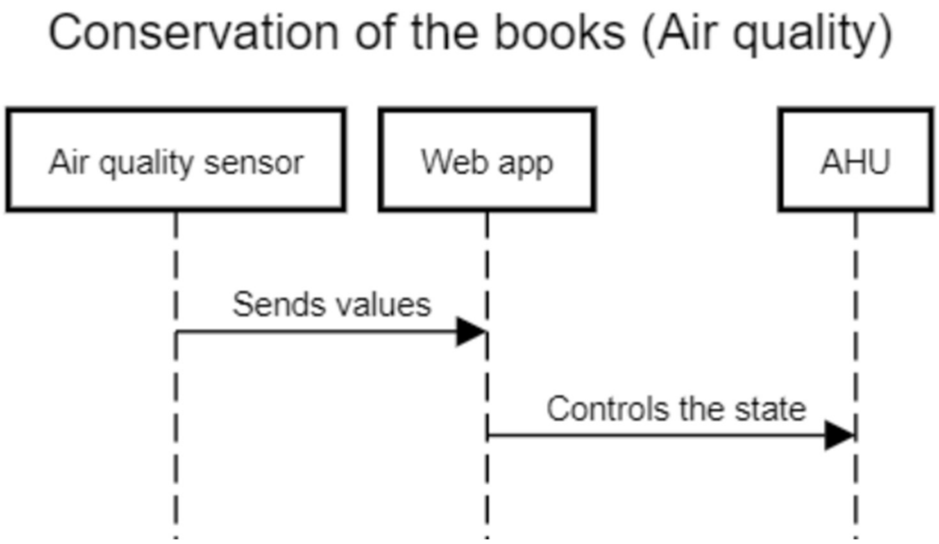
Book protection system: Different sensors (air quality, humidity, luminosity and temperature) are connected to the mechanisms (ventilation, humidifier, adaptable lights, climatization, heater) inside the room via the ESP32, which will automatically start and stop them once the values send by the sensors are back in the desired range. The ESP32 sends binary signals to the equipment.

Book management system: The user can either register or research a book in the Database via the web app. Then it's going to command many actions: light up a LED where there is the book chosen and command the robotic arm to retrieve, place or replace a book.

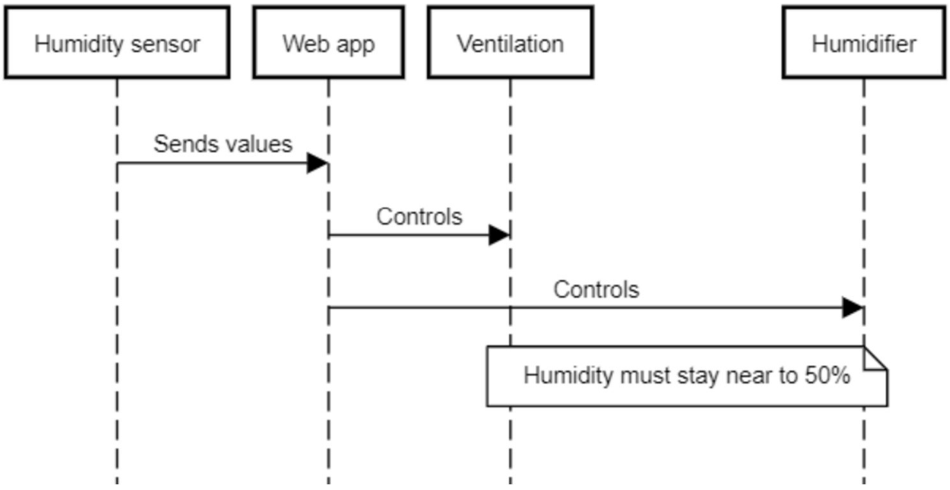
3)2) Sequence Diagram



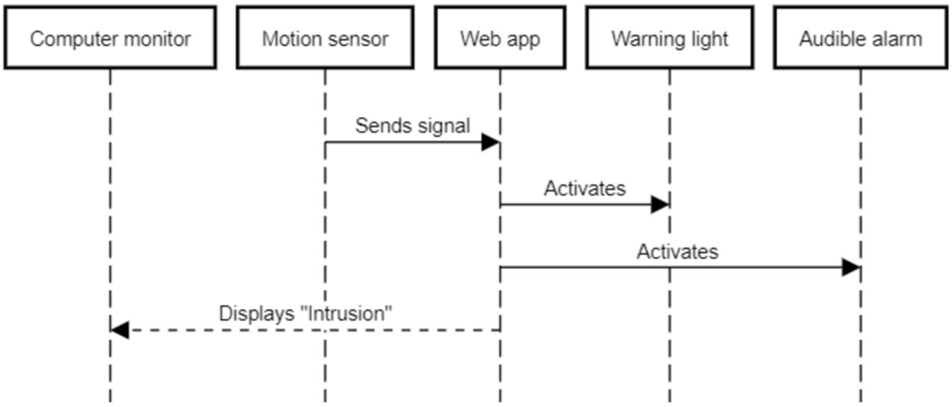

Conservation of the books (Temperature)
Temperature sensor
Web app
Reversible air conditionning
Sends values
Controls the heat
Temperature must stay around 18°C



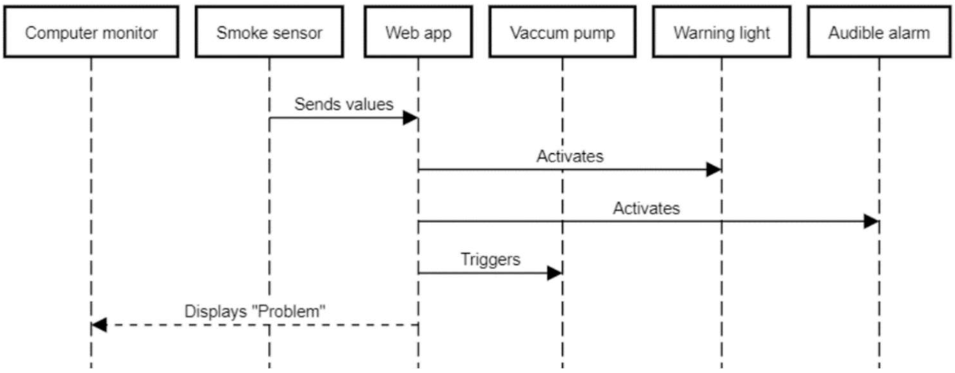
Conservation of the books (Humidity)



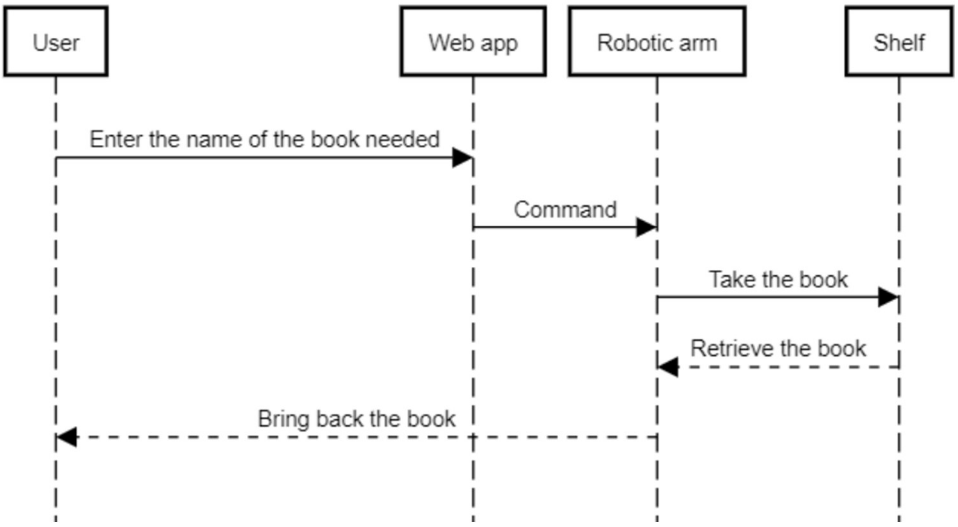
Protect access to the room



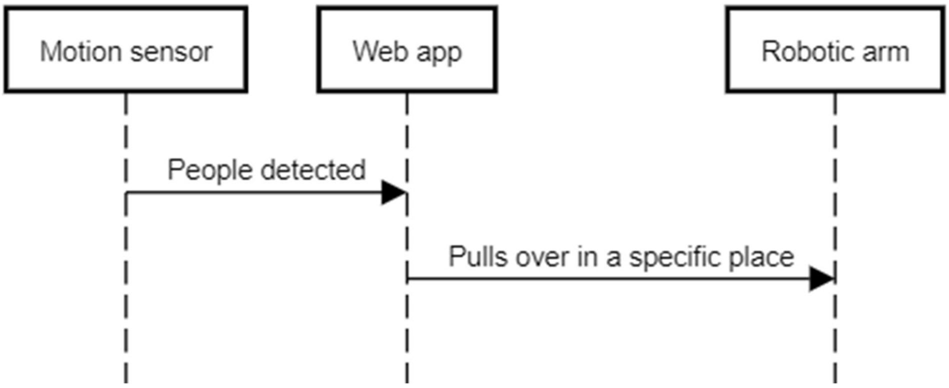
Protect the books from fire



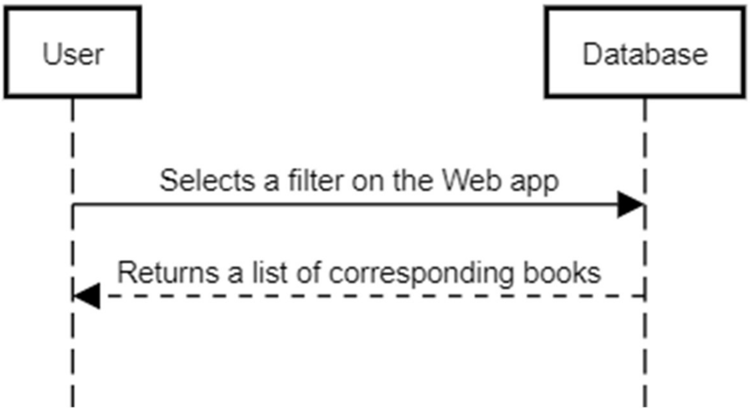
Retrieve the books



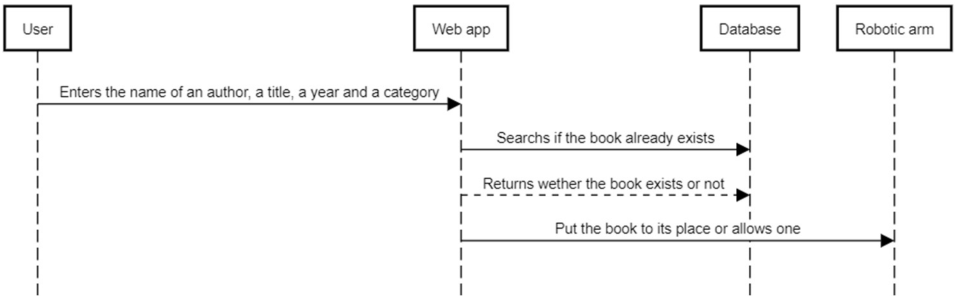
Protect the users insode the room



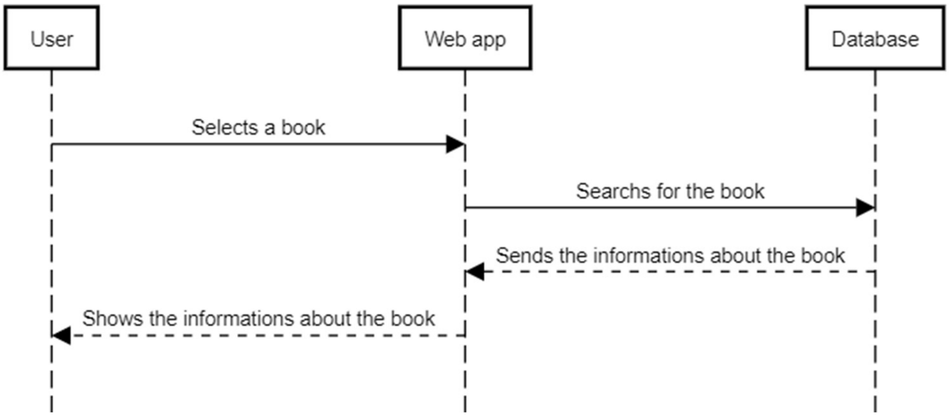
Manage the books


User
Database
Selects a filter on the Web app
Returns a list of corresponding books

Protect the users insode the room


User
Web app
Database
Robotic arm
Enters the name of an author, a title, a year and a category
Searchs if the book already exists
Returns wether the book exists or not
Put the book to its place or allows one

Manage the books


User
Web app
Database
Selects a book
Searchs for the book
Sends the informations about the book
Shows the informations about the book

3)3) List of necessary equipment

- Motion sensor
- Humidity sensor
- Air quality sensor
- Smoke sensor / IR sensor to detect if there is the fire