POLYTECHNIC INSTITUTE OF CÁVADO AND AVE

Smart Campus - Residence

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Bachelor in Computer Systems Engineering

Supervisor: Prof. Eduardo Peixoto

January 14, 2023

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Abstract

The concern with process optimisation and cost reductions are some of the main focuses that occur when managing a university.

The aim of this project is to build a smartphone application (Android) that can control the environment someone (in this case, a student) is in, such as turning on/off the lights, controlling the temperature and other aspects, all at just one click of a button.

This project not just only facilitates the life of a regular student, but is also built thinking of students with disabilities, since the handling/control of the environment is easier.

“You should be glad that bridge fell down.
I was planning to build thirteen more to that same design”

Isambard Kingdom Brunel

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Abbreviations and symbols

AI	Artificial Intelligence
API	Application Programming Interface
IPCA	Instituto Politécnico do Cávado e do Ave - (Polytechnic Institute of Cávado and Ave)
LCD	Liquid-Crystal Display
QR	Quick Response (code)

Chapter 1

Introduction

This project was conceived as a joint of the curricular units “Projeto Aplicado”, “Sistemas Embebidos e de Tempo Real”, “Integração de Sistemas de Informação”, “Programação de Dispositivos Móveis” and “Inteligência Artificial”.

1.1 Contextualization

The aim of this project is to be applied on IPCA’s new university residencies, as a way of bringing technology to improve communication between all the involved ones.

1.1.1 Who’s the customer

The customer is IPCA, represented by teacher Eduardo Peixoto, our mentor of “Projeto Aplicado”.

1.1.2 Who are the users

The users are all the involved parts when it comes to a student’s room, such as the cleaning staff, the admin, the student’s guests (in case they want to visit them) and the student themselves.

1.1.3 Improvements of the project on daily life of users

This project brings lots of benefits, such as: enabling the student to control the environment they’re in; improving the communication between the student and the cleaning staff, throughout the LCD display built on every door, telling the staff if they desire their room to be cleaned or not; providing an easier way for disabled people to control the environment they’re in, through AI and distance-of-a-click buttons; bringing IPCA to the next level when it comes to technology.

1.1.4 Stakeholders and interested parts

The main stakeholder of this project is IPCA and its partners.

1.2 Deliveries

- All documentation including: analyze the problem, contextualization, requirements, product backlog, diagrams, mockups and workgroup documentation
- Front-end, mobile application
- Back-end, web API
- Methodology **Scrum(?)**[1] will be used for project planning
- The chosen working repository is GitHub, where the project's version control will also be done
- This document is organised and described in the document structure
- Group organisation dossier will be on Appendix of this document

Problem identification:

- Deliver 1, analysis of requirements and modelling. Specification of the functional and non-functional requirements of the system, complete backlog and initial planning of sprint 1
- Deliver 2, ER and UC diagrams, plus additional Product Backlog and important information
- Deliver 3, Sequence and Activities diagrams, plus mockups and additional information
- Deliver 4, poster plus first code
- Deliver 5, final code
- (ISI) Information Systems Integration, all the information in this project related to this curricular unit
- (PDM) Mobile Device Programming, all the information in this project related to this curricular unit;
- (SETR) Embedded and Real Time Systems, all the information in this project related to this curricular unit;

[1] Scrum is a framework that helps teams work together.

Chapter 2

Deliver 1

In this initial phase of the project, the deliverable pieces are as follows:

- Business Canvas Model
- Functional Requirements
- Non-Functional Requirements
- Wireframe
- Budget
- Group organisation dossier
  - Internal rules of procedure
  - Timetable
  - Internal evaluation system

2.1 Contextualization

2.1.1 Business Canvas Model

- Key partners:
  - IPCA, represented by teacher Eduardo Peixoto
  - From our partners, we expect to receive financial and moral support
  - Key activities performed by them will give us clear information about necessities and desires, so the project can be quickly developed
  - Main motivation to work with them is their ability to help us grow and freedom of choice; they believe us enough to hand us the project
- Key activities:

  - Extensive safety testing to ensure the best performance of the application
  - Automation using AI

- Key resources:
  - Human capital in engineers (team and installation technicians)
  - Capital resources in manufacturing equipment, frameworks and licenses
  - Raw materials such as sensors and power units

- Value propositions:
  - To provide an easiest way to the management of Campus Residence
  - Use of technology to increase the energy efficiency

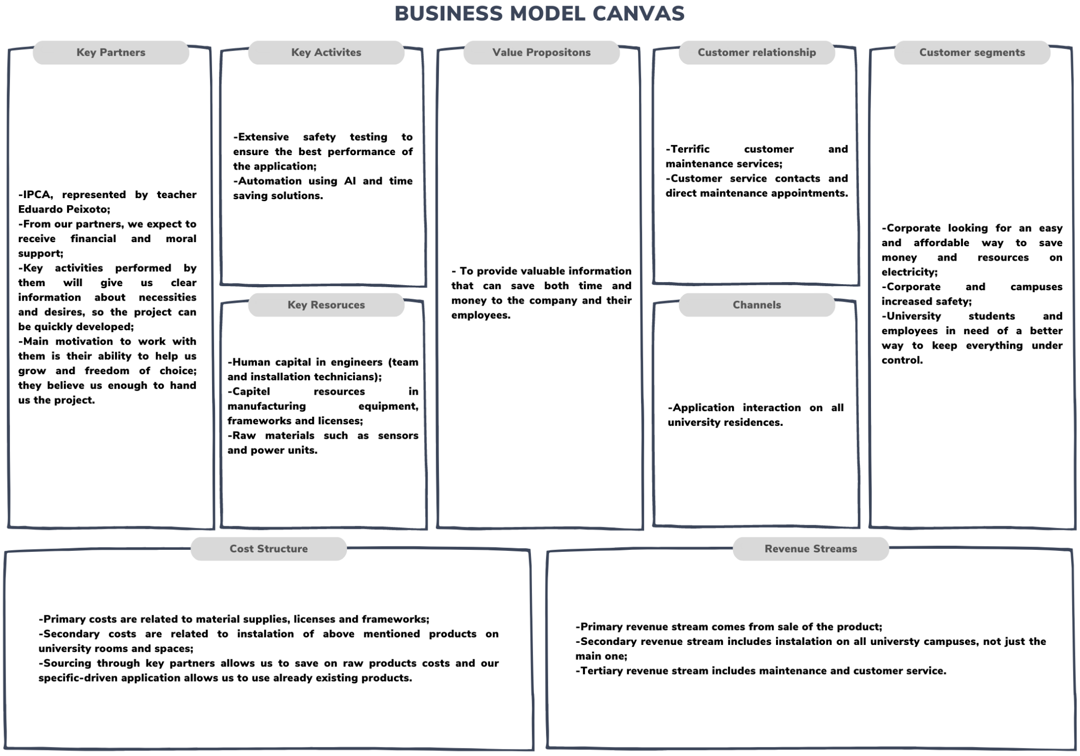
- Customer relationship:
  - Terrific customer and maintenance services
  - Customer service contacts and direct maintenance appointments

- Channels:
  - Application integration on all university residences.

- Customer segments:
  - Corporate looking for an easy and affordable way to save money and resources on electricity using AI
  - Residences increased safety
  - University students and employees in need of a better way to keep everything under control

- Cost structure:
  - Primary costs are related to material supplies, licenses and frameworks
  - Secondary costs are related to installation of above mentioned products on residence rooms and spaces
  - Sourcing through key partners allows us to save on raw products costs and our specific-driven application allows us to use already existing products

- Key resources:
  - Primary revenue stream comes from sale of the product
  - Secondary revenue stream includes installation on all university residences and their partners, not just the main one
  - Tertiary revenue stream includes maintenance and customer service



BUSINESS MODEL CANVAS

Key Partners

-IPCA, represented by teacher Eduardo Peixoto;
-From our partners, we expect to receive financial and moral support;
-Key activities performed by them will give us clear information about necessities and desires, so the project can be quickly developed;
-Main motivation to work with them is their ability to help us grow and freedom of choice; they believe us enough to hand us the project.

Key Activites

-Extensive safety testing to ensure the best performance of the application;
-Automation using AI and time saving solutions.

Key Resoruces

-Human capital in engineers (team and installation technicians);
-Capitel resources in manufacturing equipment, frameworks and licenses;
-Raw materials such as sensors and power units.

Value Propositons

- To provide valuable information that can save both time and money to the company and their employees.

Customer relationship

-Terrific customer and maintenance services;
-Customer service contacts and direct maintenance appointments.

Channels

-Application interaction on all university residences.

Customer segments

-Corporate looking for an easy and affordable way to save money and resources on electricity;
-Corporate and campuses increased safety;
-University students and employees in need of a better way to keep everything under control.

Cost Structure

-Primary costs are related to material supplies, licenses and frameworks;
-Secondary costs are related to instalation of above mentioned products on university rooms and spaces;
-Sourcing through key partners allows us to save on raw products costs and our specific-driven application allows us to use already existing products.

Revenue Streams

-Primary revenue stream comes from sale of the product;
-Secondary revenue stream includes instalation on all universty campuses, not just the main one;
-Tertiary revenue stream includes maintenance and customer service.

Figure 2.1: Business Model Canvas as described in page 3

2.1.2 Budget

At this moment it is not yet possible to determine the budget of the project because:

- Technical elements of the project are still missing and will be identified later
- It will also be difficult to determine the time needed for the development of the project because the elements of the project do not all have the same response capacity in fulfilling the tasks

2.1.3 Functional Requirements

- The mobile app must have four types of users: the administrator, the users (students), the cleaning staff and the guests.
- Only the authorized users must be able to use the mobile app.
- All users must be able to login on the system using the mobile app.
- Administrator must be able to register or manage the users on the mobile app.
- Student must be able to change the temperature using the mobile app.
- Student must be able to turn on/off the lights using the mobile app.

- Cleaning staff must be able to enter the users' rooms using their RFID card.
- Cleaning staff's chores/rooms should all be organized by sections/floors.
- Cleaning staff must change the room status as soon as they're done with the room.
- Student must be notified by push notifications when the cleaning staff enters and leaves their room.
- Guest must be able to enter their room unlocking the door using the mobile app.
- Student must be able to send a request to their guests so they can create an account and, after registration, have the permission in their account.
- Student must be notified by push notifications when their guests unlock or lock the room.
- Student must have access to their guests permissions.
- Student must have access to the status of his room and change it.

2.1.4 Non-Functional Requirements

- The API must support receiving, sending and processing information from all the sensors and all clients using the mobile app
- The mobile app must be user-friendly
- The mobile app and all communications must be secure and protected
- The mobile app must run on Android smartphones

2.2 Wireframes

The wireframes represent a basic layout of the project.

These wireframes represent the home page where we can choose the option to login. A login page for each option. As well as a page for controlling the room and another for scheduling cleaning and giving access to guests.

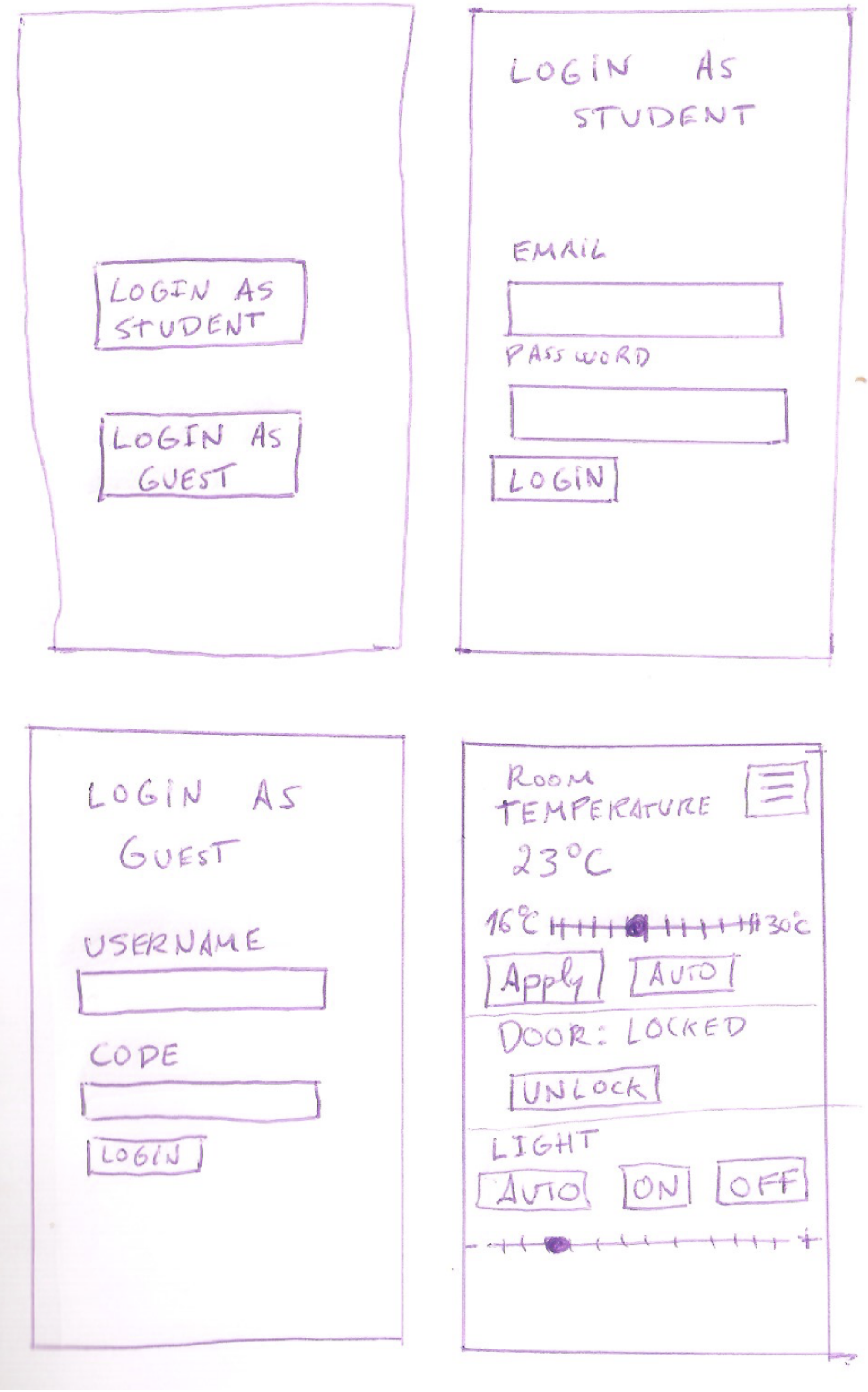


Figure 2.2: Wireframes from Login pages and Room Control UI

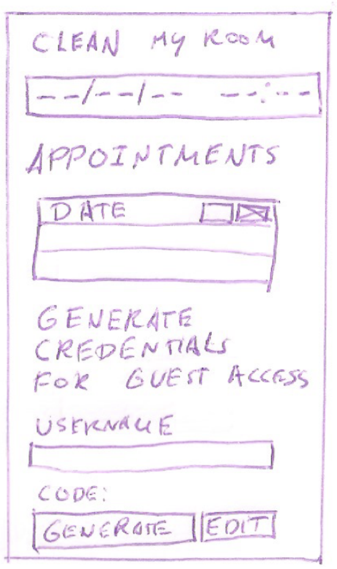


Figure 2.3: Wireframe from Other Funcionalities UI

Chapter 3

Deliver 2

In this chapter, it's gonna be presented the Product Backlog, along with the Entity-Relation and Use Cases Diagram.

3.1 Product Backlog

Actors: Cleaning Staff, User, Admin, Guest

3.1.1 User

- as a Student, I want to login so I can control my room through mobile app
- as a Student, I want to logout so I don't have the session open on the mobile app
- as a Student, I want to change my profile so I can update my personal info
- as a Student, I want to turn on/off the lights so I can control the lights on the mobile app
- as a Student, I want to change the room status to "do not disturb" or "away", so people act accordingly
- as a Student, I want to change the room temperature, so I can feel more confortable
- as a Student, I want to unlock the door through my RFID card or mobile app so I can access my room
- as a Student, I want to give permission to someone to enter my room, so a friend or family can access my room
- as a Student, I want to inactivate the AI feature so I can control the room acclimatization myself
- as a Student, I want to activate the AI feature so the room will be self-manageable/self-acclimatized

3.1.2 Cleaning staff

- as a Cleaning Person, I want to open the door using the RFID card so I can clean the room
- as a Cleaning Person, I want to change the room status (by scanning the card) so they can know that the room was cleaned
- as a Cleaning Person, I want to login, so I can have access to the rooms that I have to clean and register all work done
- as a Cleaning Person, I want to logout, so I don't have the session opened on the mobile app

3.1.3 Admin

- as the Admin, I want to register a User, so the User can have access and control to their room
- as the Admin, I want to check a User, so I can use the User information when needed
- as the Admin, I want to edit/manage a User, so the system will have updated data
- as the Admin, I want to receive a push notification when there's something unusual happening in a room so I can take action

3.1.4 Guest

- as a Guest, I want to login, so I can access the room from my friend or family with permission, even if they're not there
- as a Guest, I want to logout, so I don't have the session opened on the mobile app
- as a Guest, I want to open the door through the mobile app, so I can access the room with permission

3.2 Use Cases Diagram

The presented Use Case Diagram describes the main functionalities of each actor (including the system). For a better understanding of the diagram, it's given the Use Case Slices right above it, plus the Product Backlog.

- Login- Both user and guest can login into the system;
- Give permission- The user can give permission to a guest, so they can enter their room;
- Monitor space- The user must be able to monitor their space when they're not around (such as temperature, humidity, check if there's strange activity going on, etc);

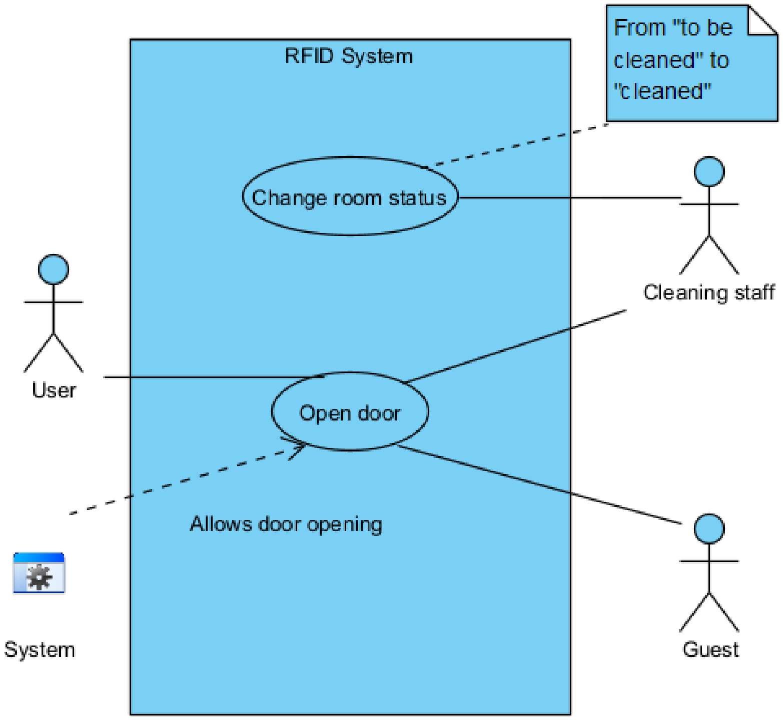


Figure 3.1: Use Case Diagram 1 from the system

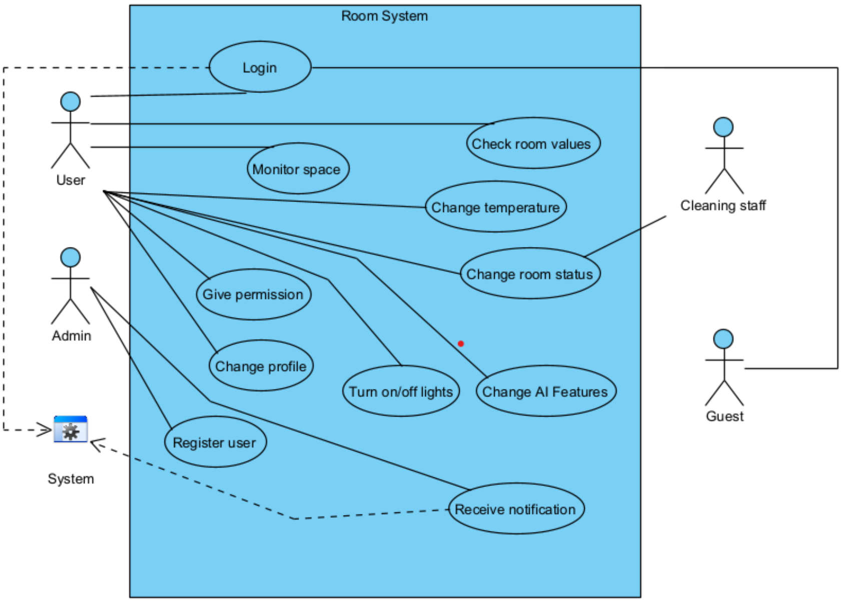


Figure 3.2: Use Case Diagram 2 from the system

- Change profile- The admin must be able to manage/edit the user's profile if they need to, but the user, while active, must also be able to manage their own profile;

- Open door- The user must be able to open their own door; the guest and the cleaning staff must be able to open a door it they have permission for it;

- Turn on/off lights- The user must be able to turn on/off the lights of their own room, both manually and through the app from their phone;

- Change temperature- The user must be able to change the temperature of their own room through the app from their phone;

- Check room values- The user must be able to check the values of their room through the app;

- Change room status- The user must be able to change their room status to "needs to be cleaned" or "do not disturb" when they want to;

- Receive notification- Both admin and the user must receive a notification when there's strange activity detected by the sensors;

- Change AI features- The user must be able to unable/enable the AI features if they want to (like change the light/temperature automatically);

- Register user- The admin must be able to register a user

3.3 Entity-Relation Diagram

As seen on the figure 3.3:

The data model from the system is composed of the following entities:

- User, as known as Student
- Cleaning Person
- Guest
- Sensor
- Room
- Cleaning Appointment

In this system we have the rooms that will be accessed by the users authorized (students, guests or cleaning person) for each room in certain time. Each student will be able to schedule cleanings. And the cleaning will be carried out by a cleaning person. All rooms have sensors to retrieve information about the rooms. Each room can accomodate more than one student.

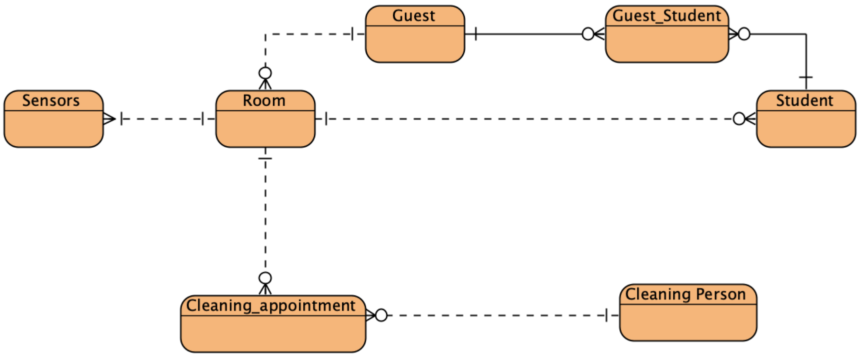


Figure 3.3: Entity-Relation Diagram from the system

Chapter 4

Delivery 3

In this chapter, it's gonna be presented the State Diagram, along with the Activities Diagram, Sequence Diagram and Mockups.

4.1 State Diagram

The State Diagram on the figure 4.1 describes the states of the RFID door system, ilumination and cleaning of the room. Whenever someone accesses the interior of the room, its status must be Unlocked, only then can the lights be turned on. Whenever a person leaves its interior, be it a student, a guest, or a cleaning staff, the status must return to Locked. This way you can efficiently help to control the lights, in case we forget to switch them off.

4.2 Activities Diagram

The presented Activities Diagram on the figure 4.2 describes the dynamic aspects of the system. It is an essential advanced flow chart that models the flow from one activity to another activity.

4.3 Sequence Diagram

The Sequence Diagram on the figure 4.3 represents the interactions between objects in the sequential order that those interactions occur.

4.4 Mockups

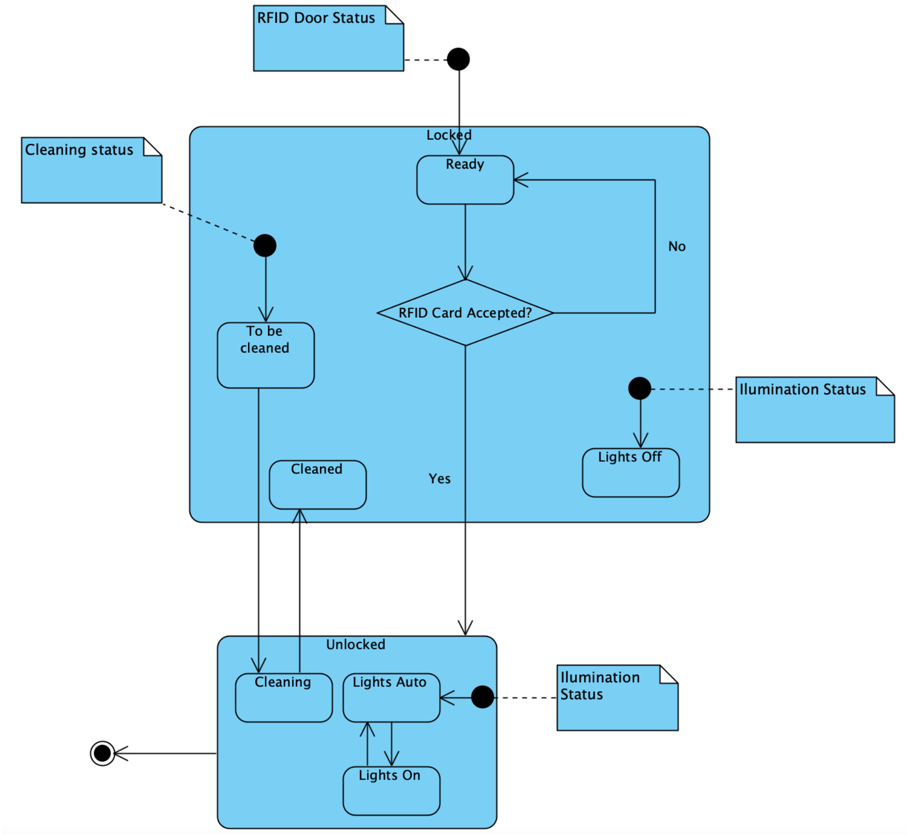


Figure 4.1: State Diagram from the system

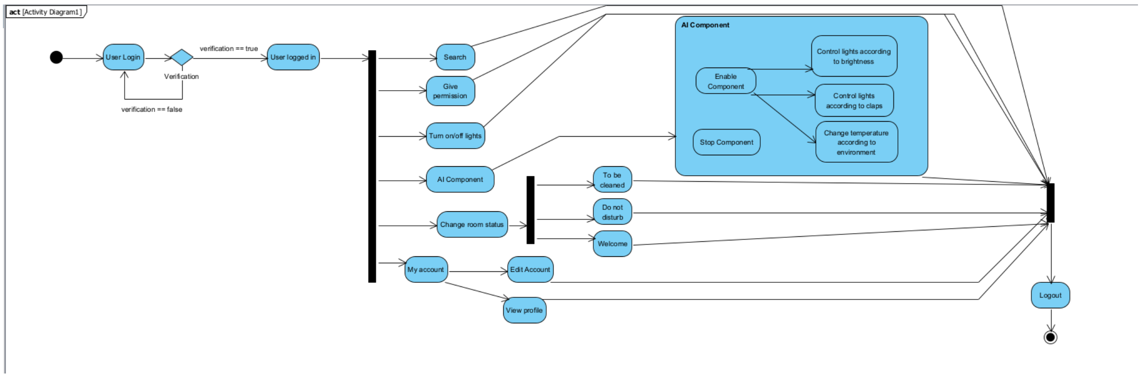


Figure 4.2: Activities Diagram from the system

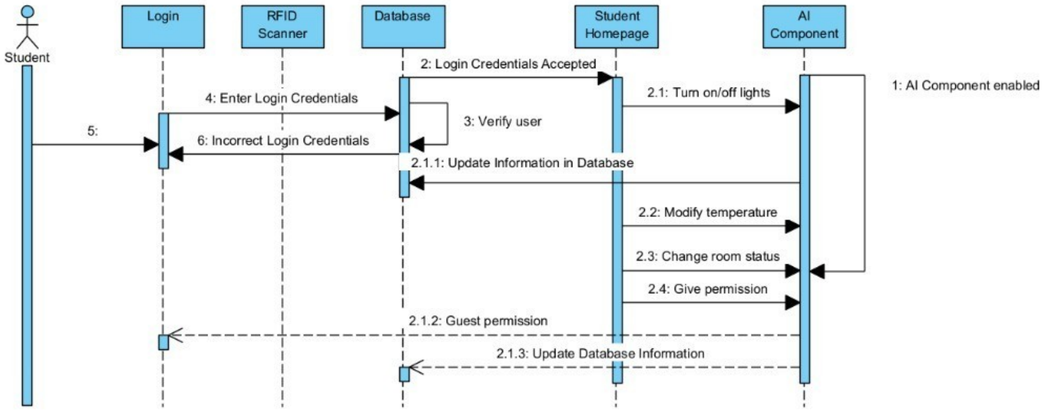


Figure 4.3: Sequence Diagram from the system

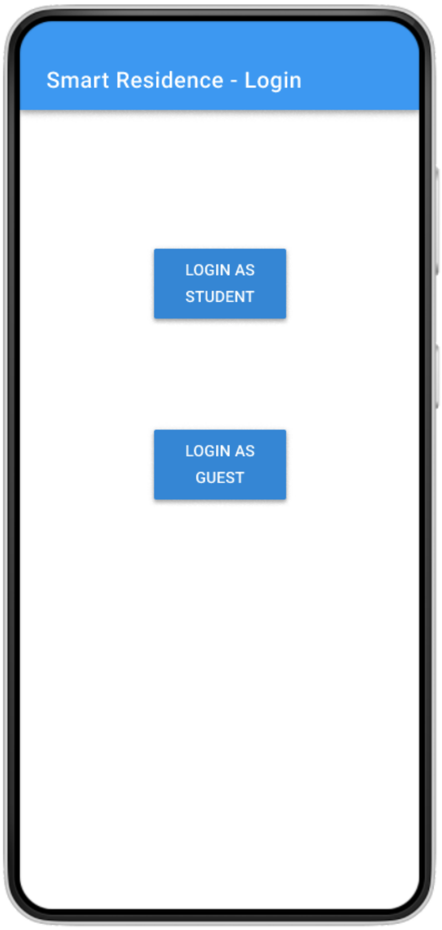


Figure 4.4: Initial Page mockup

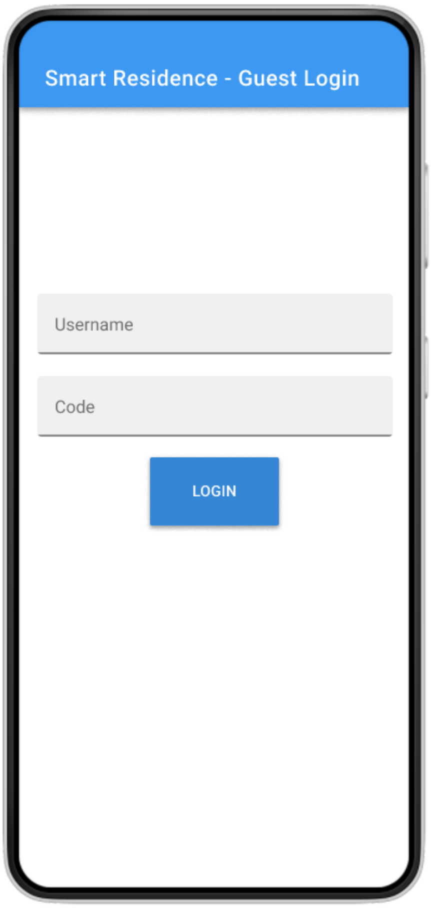


Figure 4.5: Guest Login mockup

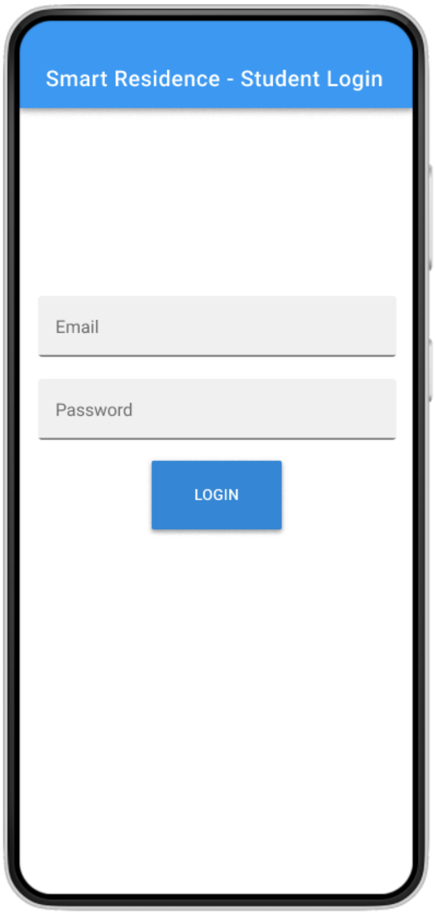
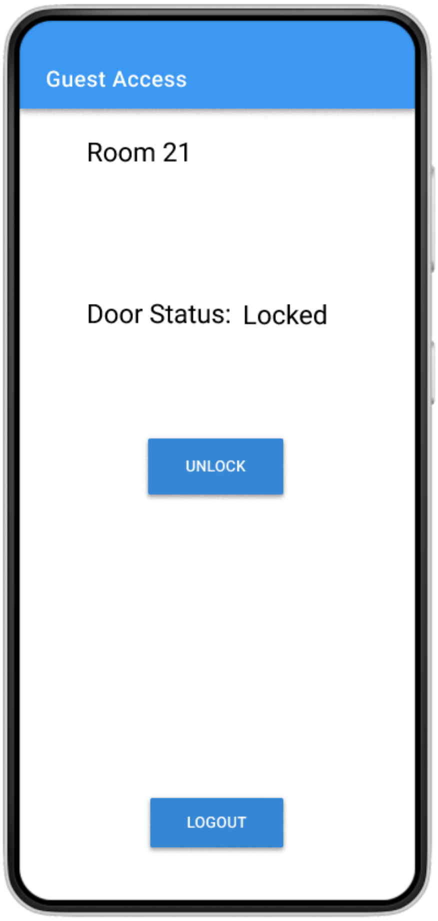


Figure 4.6: Student Login mockup



Guest Access

Room 21

Door Status: Locked

Figure 4.7: Guest Access mockup

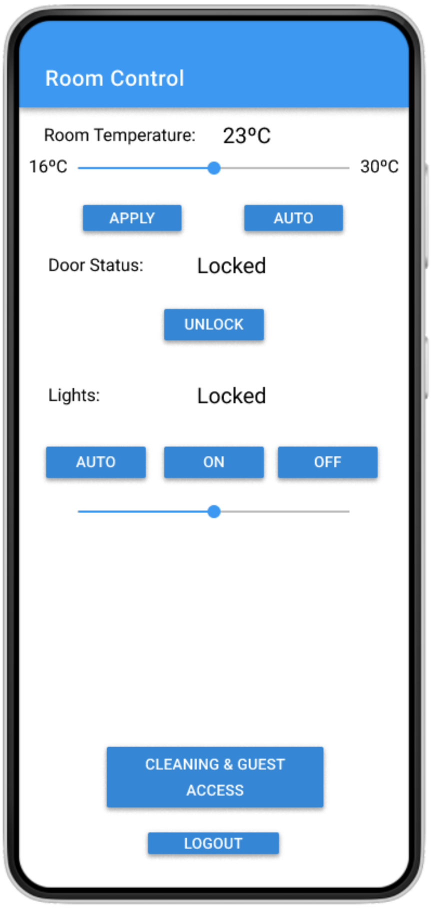
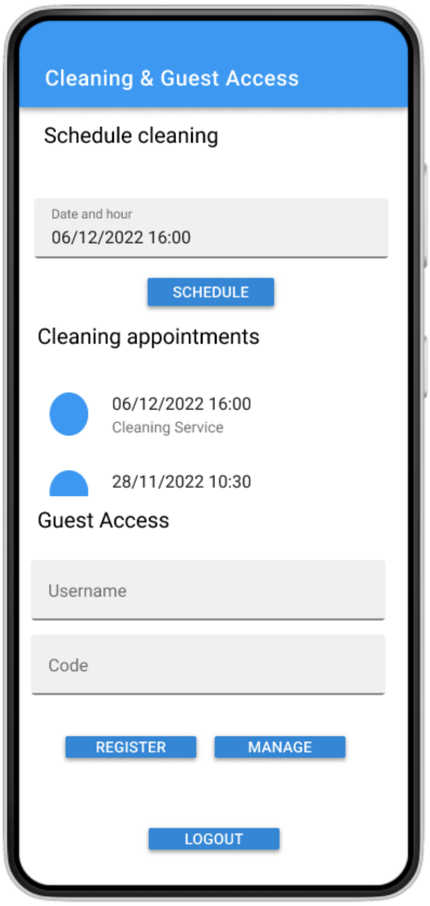


Figure 4.8: Student's Room Control mockup



Cleaning & Guest Access

Schedule cleaning

Date and hour
06/12/2022 16:00

Cleaning appointments

06/12/2022 16:00
Cleaning Service

28/11/2022 10:30

Guest Access

Username

Code

Figure 4.9: Cleaning and Guest Access Management mockup

Chapter 5

Conclusions and future work

In this final chapter, we're going to analyze the development of the project so far anc conclude the project.

5.1 Achievement of goals

The original development process of the project has undergone some changes, since the goal was too ambitious and the group was aware that some features would only take place in a future update. Another fact that delayed its development was the merge of all applications, since they were programmed in different languages and were very complex.

Despite those facts, the deliveries were all completed and the majority of the goals were achieved.

- The C# API was built and the majority of the features were developed
- The hardware system, based in Arduino, was successfully built and some extra features were added, along with efficient code
- The mobile application is corresponds to expectations, having everything that is needed

5.2 Future work

Since the beginning, the team saw that this project would come with great opportunities and would be very helpful, therefore it can be upgraded and optimized to cover dozens of clients' needs.

As the main theme of it is related to smart spaces, it can easily be placed in a vast range of spaces; the features just need to be adapted to that same place.

Some additional features could be new sensors addition (like gas, humidity, etc).

5.3 Conclusion

In conclusion, the team is very proud of their project and sees that their hard work paid off. They see great potential for this project, since there’s a market for such products.

Chapter 6

Information System Integration

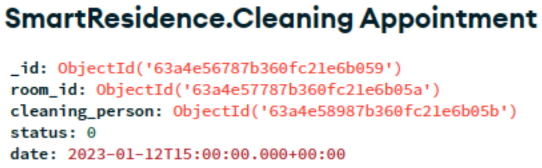
6.1 Architecture of the System

As mentioned in previous chapters, this project revolves around the idea of implementing an application for our university campus' residence, making it easier for students and other people to control it.

This chapter is based on the API, developed in C# language, that will allow the software components to communicate with eachother.

6.1.1 Database

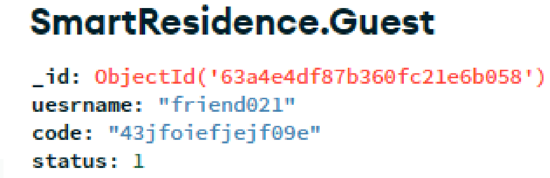
Despite the ER Diagram of the system on the figure 3.3, the database of the system is no-SQL and is supported by MongoDB document-based with the data structures examples of the figures 6.1, 6.2, 6.3, 6.4 e 6.5.



```
SmartResidence.Cleaning Appointment

_id: ObjectId('63a4e56787b360fc21e6b059')
room_id: ObjectId('63a4e57787b360fc21e6b05a')
cleaning_person: ObjectId('63a4e58987b360fc21e6b05b')
status: 0
date: 2023-01-12T15:00:00.000+00:00
```

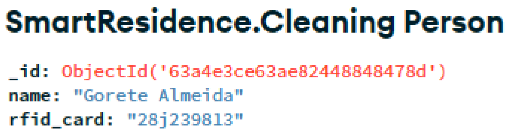
Figure 6.1: Document-based MongoDB of the entity Cleaning Appointment



```
SmartResidence.Guest

_id: ObjectId('63a4e4df87b360fc21e6b058')
uesrname: "friend021"
code: "43jfoiefjejf09e"
status: 1
```

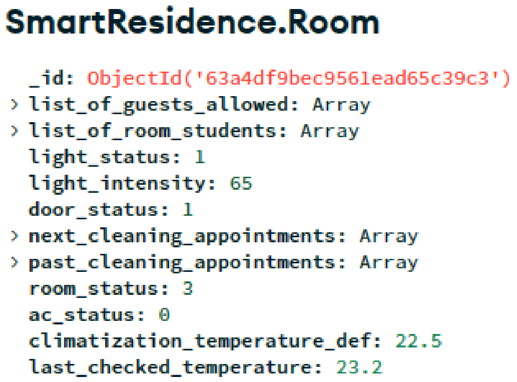
Figure 6.2: Document-based MongoDB of the entity Guest



```
SmartResidence.Cleaning Person

_id: ObjectId('63a4e3ce63ae82448848478d')
name: "Gorete Almeida"
rfid_card: "28j239813"
```

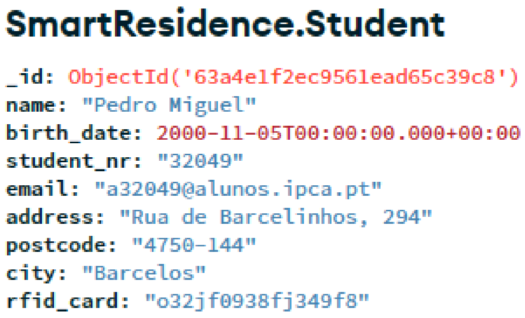
Figure 6.3: Document-based MongoDB of the entity Person



```
SmartResidence.Room

  _id: ObjectId('63a4df9bec9561ead65c39c3')
> list_of_guests_allowed: Array
> list_of_room_students: Array
  light_status: 1
  light_intensity: 65
  door_status: 1
> next_cleaning_appointments: Array
> past_cleaning_appointments: Array
  room_status: 3
  ac_status: 0
  climatization_temperature_def: 22.5
  last_checked_temperature: 23.2
```

Figure 6.4: Document-based MongoDB of the entity Room



```
SmartResidence.Student

_id: ObjectId('63a4e1f2ec9561ead65c39c8')
name: "Pedro Miguel"
birth_date: 2000-11-05T00:00:00.000+00:00
student_nr: "32049"
email: "a32049@alunos.ipca.pt"
address: "Rua de Barcelinhos, 294"
postcode: "4750-144"
city: "Barcelos"
rfid_card: "o32jf0938fj349f8"
```

Figure 6.5: Document-based MongoDB of the entity Student

6.1.2 Technology of Infrastructure

- The base technology used is .NET 7 as Web API
- All the external communications of the API use REST architecture except Database operations
- Most of the API consumption use Authorization and Authentication with JSON Web Tokens
- The API is consumed by an application connected to an embedded system and by a mobile application (Android)

The REST API used in this project works through the solicitation of data from the client to the server and the server will use those entries to return the output data. In other words, the client can run CRUD functions (such as GET, PUT, DELETE, etc) to access the server's data. They communicate through HTTP.

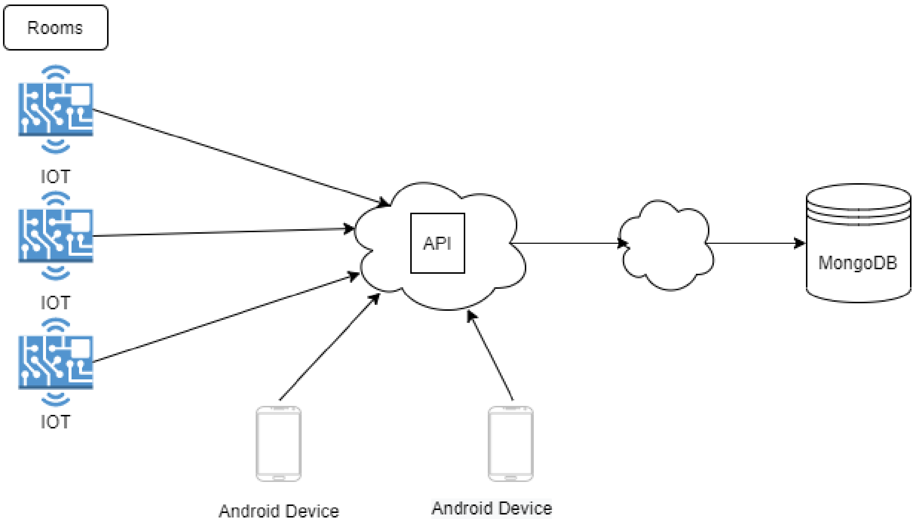


Figure 6.6: Architecture of the System

6.1.3 Security- Roles

In this application, we have three (3) main roles for authentication:

- Student
- Guest
- Admin

Cleaning person is also a role presented in our application, but, when it comes to security, it's not part of it.

The person's passowrds are encrypted through JWT (*JSON Web Tokens*) and tokens are valid for one (1) hour.

6.1.4 Integration levels

When it comes to integration levels, the API wil receive two (2) different types of clients:

- Embedded systems- residence rooms
- Mobile apps- students and guests

6.1.5 Problem Solution

The main problems that appeared during the evolution of the project tend to be related with connecting the API with the other systems. For example, the API needs to be connected to a C# application so the Arduino can consume its data. This also needs to be connected to the mobile application so the user can control it through its phone. Also, some problems occured due to the upgraded technologies, such as .NET 7.0.

To solve the above mentioned problems, the group needed to work in all projects at the same time, adding new functions and informations as the program was being developed.

The base of the entire project is a RESTful API that supports all CRUD operations, protected by JWT for authorization. The rest of the project is related to the entire Campus API.

The group didn't see any needs when it came to use SOAP services, since REST services would be faster.

6.1.6 Endpoints

Our API contains six (6) main paths in endpoints:

- api/Student
- api/Admin
- api/Room
- api/Guest
- api/CleaningPerson
- api/cleaningappointment

Depending on the according method, authorizations are personalized in a way that users from determined roles have access to those endpoints.

6.1.7 Code Implementation

The following code is responsible for encrypting the passwords using a private key (*salt*).

```
namespace SmartResidenceAPI.Services
{
    /// <summary>
    /// Hashing class using BCrypt
    /// </summary>
    public class Hashing
    {
        /// <summary>
        /// Get random salt from BCrypt to hash password
        /// </summary>
        /// <returns></returns>
        private static string GetRandomSalt()
        {
            return BCrypt.Net.BCrypt.GenerateSalt(12);
        }

        /// <summary>
        /// Hash password using a generated salt
        /// </summary>
        /// <param name="password"></param>
        /// <returns></returns>
        public static string HashPassword(string password)
        {
            return BCrypt.Net.BCrypt.HashPassword(password, GetRandomSalt());
        }

        /// <summary>
        /// Validate password
        /// </summary>
        /// <param name="password"></param>
        /// <param name="correctHash"></param>
        /// <returns></returns>
        public static bool ValidatePassword(string password, string correctHash)
        {
            return BCrypt.Net.BCrypt.Verify(password, correctHash);
        }
    }
}
```

Listing 6.1: Hashing Code

6.1.8 Conclusion

The application is working correctly, although not everything that was originally planned is implemented.

There is a file (*README.txt*) with the Github repository that have some files, like the URL from Cloud deployment since the URL could change anytime and some instructions how to use this API.

Despite that, the group is planning to implement a Load Balancer ("efficiently dstributing incoming network traffic accross a group of backend servers, also known as *server farm* or *server pool*") in the future, since rooms will fetch data in a ms matter in a cyclic way.

Another point to improve revolves around the fact that only RESTful functions were used and the group was planning to dive into the world of Web Sockets, that makes a two-way interactive communication session between the user's browser and the server possible. That way, the client can send messages to a server and receive responses until one of them closes the connection. Since it's bidirectional, it's more complex that HTTP, and also more complicated to implement, reason why this is not (yet) part of our project.

With this retrospection, the group makes a positive balance of the project.

6.1.9 Bibliography

Load Balancing

Web Socket

Chapter 7

Embedded Systems

7.1 Contextualization and Motivation

The goal of this project is to create the hardware based system, to be implemented in the academic residence.

Since the academic residences project was approved, we thought on an idea to develop a smart system to manage the rooms.

The rooms will have a RFID system, a display, a press button, eletronic lock on the doors and a smart light system.

7.2 Architecture of the System

To demonstrate this system, we will show our project in Tinkercad and, later, through a video.

This project integrates a very important component: an Ethernet shield, capable of connecting our Arduino to the Internet through a RJ45 cable. It also has an onboard micro-SD card slot, which can be used to store files for serving over the network.

With the shield connected to the Arduino, we connected the rest of the components:

- a LED to simulate the light system of the room
- a press button on the wall that the cleaning person must press to finish the cleaning service
- a RFID module that allows people to enter the room by reading their card/tag RFID
- an I2C dislay 16x2 that shows the relevant information
- a motor servo that simulates an automatic lock on the doors
- a photoresistor that detects the brightness of the light
- needed resistors (1 x 220 Ohms)
- needed breadboards (1 x large breadboard)

With these components, we built our system, represented by the circuit on the figures 7.1 and 7.2.

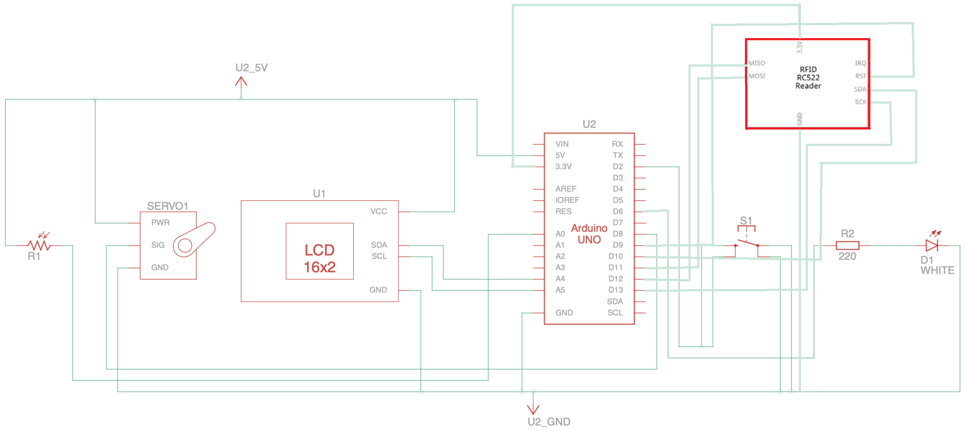


Figure 7.1: Circuit of the residence system

7.2.1 Justification of the measures taken

Originally, we thought about using more than one Arduino Uno, but later we decided to use only one Arduino Uno, in order to sync every data, since, if we had two or more, the other one could need that data and wouldn't have it. In real life, this could be solved by having cables that would connect the components to the main Arduino.

One of the main problems through the development of this project was to connect the system with the Cloud API that is deployed on the Cloud. The idea was to implement another .NET system that would connect the two, but that would be too complicated. So, instead, we used the Ethernet shield, in order to connect the Arduino to our Cloud API.

7.2.2 Conclusion

The group is planning to implement a gas and humidity sensor.

Despite that, the application is working correctly, although not everything that was originally planned is implemented.

With this retrospection, the group makes a positive balance of the project.

7.2.3 Bibliography

Ethernet Shield

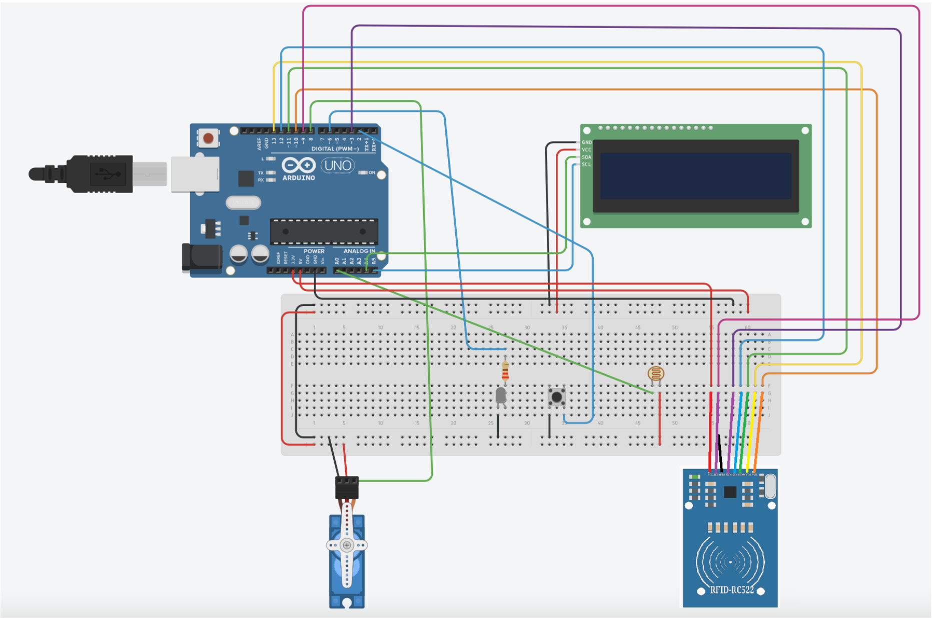


Figure 7.2: Circuit 3D of the residence system

Chapter 8

Mobile Device Programming

8.1 Contextualization and Motivation

The goal of this project is to deliver the mobile application for our system.

Since the academic residences project was approved, we thought on an idea to develop a smart system to manage the rooms, controllable through a mobile application.

The mobile application must have:

- a login main webpage, where both the user and the guest can log in (according to their role, they have different login types)
- a main dashboard where the user can control the room and manage cleaning appointments
- a dashboard where the guest can open the user's door
- additional dashboards according to the project planning

8.2 Architecture of the System

This mobile application was developed in Kotlin, supported by Android Studio. It supports the features presented in 2.1.3.

8.2.1 Justification of the measures taken

For the above mentioned features to be implemented, it was connected to the Ethernet shield, presented in Arduino (7), so it can be able to control the room.

When it comes to the API requests, we chose to use Retrofit and OkHTTP3 because they are two different types of libraries and they manage code in a different way.

- Retrofit simplifies API interactions by parsing requests and responses into POJOs (*P*lain Old Java Object- used to hold the data)
- OkHTTP3 supports both synchronous blocking calls and async calls with callbacks

Although Retrofit uses OkHTTP, some of its features are hidden, so we decided to use both, which makes the project richer and we also learn about two HTTP libraries.

Two other key points of our application are the following:

- The application has authorization and authentication implemented- if a protected Activity receives a response with a status code of 401 (the token expires), the application has a mechanism that takes the user to the main webpage and an error appears
- JWT for authentication- it's stored in the sharedPreferences of the Android smartphone, as it is only accessible by our app (unless it is compromised at a security level), and data is persistent across app launches. This way, they can leave the app and, as long as the token is not expired (1 hour), they don't need to log in again; if they log out, that same token will be deleted from sharedPreferences

8.2.2 Conclusion

The application is working correctly, although not everything that was originally planned is implemented.

Despite that fact, the team chose to focus on data security, since university accounts have very important information about the user, which can be dangerous if leaked and user's safety is very important, so we implemented the above mentined features.

With this retrospection, the group makes a positive balance of the project.

8.2.3 Bibliography

Retrofit

Okhttp3

Retrofit vs. OkHTTP

References

Appendix A

Group organisation dossier

A.1 Internal Rules

A.1.1 Scope

The purpose of this document is to inform about the constitution and functioning of Workgroup 14 in the preparation of the project for the Curricular Unit “Applied Project”. This document also informs of the duties and obligations of the members of Workgroup 14.

A.1.2 Workgroup constitution

The workgroup 14 of the Bachelor Degree in Computer Systems Engineering is made up of the following members:

- Bruna Macieira nr. 21139 - Product Owner - Development
- Ricardo Teixeira nr. 20080 - Scrum Master - Development

This workgroup is guided by the Professor Eduardo Peixoto who can participate in group meetings to help achieve the project’s objectives.

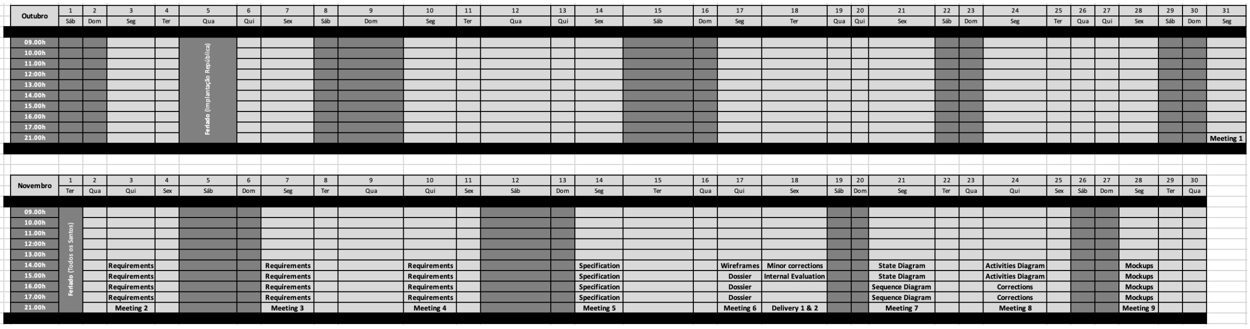
A.1.3 Meetings

- Group meetings are scheduled every week at 9:00 pm on Mondays and Thursdays.
- In case of other more important commitments exist, the meetings can be rescheduled.
- Extraordinary meetings can be scheduled when necessary.
- Notices will only be made when there are extraordinary meetings.
- Small minutes are taken whenever a meeting takes place, describing the topics covered.

A.1.4 Internal evaluation

Grades will be assigned at the end of each evaluation moment, and each member describes the performance of the other taking into account attendance, punctuality, participation, interest, communication, respect between colleagues, deadlines, organization, initiative, quality of work and autonomy.

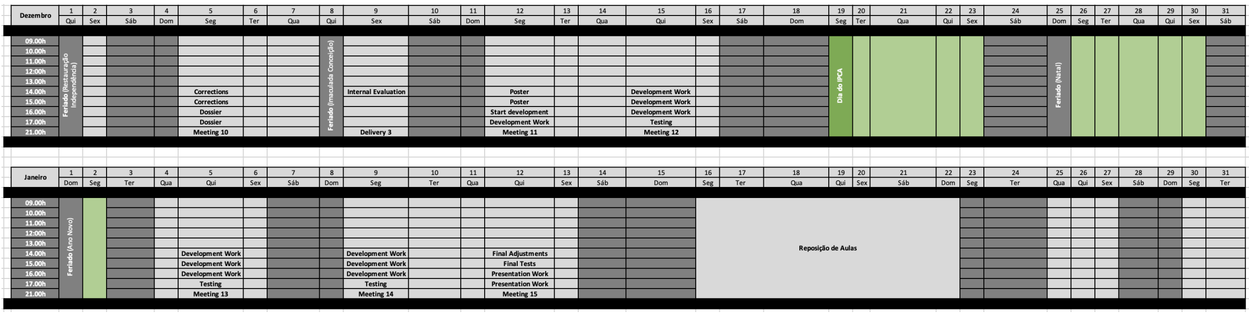
A.2 Timetable



Outubro	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
	Sáb	Dom	Seg	Ter	Qua	Qui	Sex	Sáb	Dom	Seg	Ter	Qua	Qui	Sex	Sáb	Dom	Seg	Ter	Qua	Qui	Sex	Sáb	Dom	Seg	Ter	Qua	Qui	Sex	Sáb	Dom	Seg
09.00h					Feriado (Implantação República)																										
10.00h																															
11.00h																															
12:00h																															
13.00h																															
14.00h																															
15.00h																															
16.00h																															
17.00h																															
21.00h																															Meeting 1

Novembro	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	Ter	Qua	Qui	Sex	Sáb	Dom	Seg	Ter	Qua	Qui	Sex	Sáb	Dom	Seg	Ter	Qua	Qui	Sex	Sáb	Dom	Seg	Ter	Qua	Qui	Sex	Sáb	Dom	Seg	Ter	Qua
09.00h	Feriado (Todos os Santos)																													
10.00h																														
11.00h																														
12:00h																														
13.00h																														
14.00h			Requirements				Requirements			Requirements				Specification			Wireframes	Minor corrections			State Diagram			Activities Diagram				Mockups		
15.00h			Requirements				Requirements			Requirements				Specification			Dossier	Internal Evaluation			State Diagram			Activities Diagram				Mockups		
16.00h			Requirements				Requirements			Requirements				Specification			Dossier				Sequence Diagram			Corrections				Mockups		
17.00h			Requirements				Requirements			Requirements				Specification			Dossier				Sequence Diagram			Corrections				Mockups		
21.00h			Meeting 2				Meeting 3			Meeting 4				Meeting 5			Meeting 6	Delivery 1 & 2			Meeting 7			Meeting 8				Meeting 9		

Figure A.1: Timetable 1 - Meetings and Work Planning



Dezembro	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
	Qui	Sex	Sáb	Dom	Seg	Ter	Qua	Qui	Sex	Sáb	Dom	Seg	Ter	Qua	Qui	Sex	Sáb	Dom	Seg	Ter	Qua	Qui	Sex	Sáb	Dom	Seg	Ter	Qua	Qui	Sex	Sáb
09.00h	Feriado (Restauração Independência)							Feriado (Imaculada Conceição)											Dia do IPCA						Feriado (Natal)						
10.00h																															
11.00h																															
12:00h																															
13.00h																															
14.00h					Corrections				Internal Evaluation			Poster			Development Work																
15.00h					Corrections							Poster			Development Work																
16.00h					Dossier							Start development			Development Work																
17.00h					Dossier							Development Work			Testing																
21.00h					Meeting 10				Delivery 3			Meeting 11			Meeting 12																

Janeiro	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
	Dom	Seg	Ter	Qua	Qui	Sex	Sáb	Dom	Seg	Ter	Qua	Qui	Sex	Sáb	Dom	Seg	Ter	Qua	Qui	Sex	Sáb	Dom	Seg	Ter	Qua	Qui	Sex	Sáb	Dom	Seg	Ter
09.00h	Feriado (Ano Novo)															Reposição de Aulas															
10.00h																															
11.00h																															
12:00h																															
13.00h																															
14.00h					Development Work				Development Work			Final Adjustments																			
15.00h					Development Work				Development Work			Final Tests																			
16.00h					Development Work				Development Work			Presentation Work																			
17.00h					Testing				Testing			Presentation Work																			
21.00h					Meeting 13				Meeting 14			Meeting 15																			

Figure A.2: Timetable 2 - Meetings and Work Planning

A.3 Meeting records

A.3.1 Meeting 1

Date:

31 October 2022

Meeting participants:

Working group and professor.

Scope or Subject matter:

Analyse the theme of the project and its context. The overall theme proposed by the teacher was Smart Campus. The theme decided was Smart Residence. Planning of the delivery 1 and 2.

A.3.2 Meeting 2

Date:

03 November 2022

Meeting participants:

Working group and the teacher.

Scope or Subject matter:

Choose the components to implement within the Smart Residence context and discussion of the idea.

A.3.3 Meeting 3

Date:

07 November 2022

Meeting participants:

Working group and the teacher.

Scope or Subject matter:

Explore more possibilities with our theme. Contextualization.

A.3.4 Meeting 4

Date:

10 November 2022

Meeting participants:

Working group.

Scope or Subject matter:

Requirements. Identify the different sensors to use in hardware implementation.

A.3.5 Meeting 5

Date:

14 November 2022

Meeting participants:

Working group.

Scope or Subject matter:

Use cases and Entity-Relation Diagram discussion.

A.3.6 Meeting 6

Date:

17 November 2022

Meeting participants:

Working group.

Scope or Subject matter:

Validate Wireframe and final adjustments on documentation.

A.3.7 Meeting 7

Date:

21 November 2022

Meeting participants:

Working group.

Scope or Subject matter:

State Diagram and Sequence Diagram discussion and validation.

A.3.8 Meeting 8

Date:

24 November 2022

Meeting participants:

Working group.

Scope or Subject matter:

Activities Diagram discussion and validation. Documentation corrections.

A.3.9 Meeting 9

Date:

28 November 2022

Meeting participants:

Working group and teacher.

Scope or Subject matter:

Meeting with teacher. It was decided that we have to correct some aspects on documentation, some descriptions, diagrams, table of contents and references.

A.3.10 Meeting 10

Date:

5 December 2022

Meeting participants:

Working group.

Scope or Subject matter:

Mockups discussion and validation. Documentation corrections.

A.3.11 Meeting 11

Date:

12 December 2022

Meeting participants:

Working group and teacher.

Scope or Subject matter:

Poster decisions and development start discussion and strategy.

A.3.12 Meeting 12

Date:

15 December 2022

Meeting participants:

Working group and teacher.

Scope or Subject matter:

Development work discussion.

A.3.13 Meeting 13

Date:

5 January 2023

Meeting participants:

Working group and teacher.

Scope or Subject matter:

Development work discussion. Solving problems with some eletronic components.

A.3.14 Meeting 14

Date:

9 January 2023

Meeting participants:

Working group .

Scope or Subject matter:

Development work discussion. Testing.

A.3.15 Meeting 15

Date:

12 January 2023

Meeting participants:

Working group and teacher.

Scope or Subject matter:

Final adjustments. Preparation of final presentation.

A.4 Internal Evaluation

A.4.1 Deliveries 1 and 2

A.4.1.1 Bruna about Ricardo

Ricardo is a great teammate, since he's a hardworking, intelligent and open-minded man. He finds great solutions to solve problems and our minds get in sync really fast when it comes to implement an idea. He's amazing to work with. Evaluation grade (0-20): 19

A.4.1.2 Ricardo about Bruna

Bruna was always interested, concerned and had initiative. She proposed several ideas for implementation in the project and was autonomous in the development of her tasks. We always communicate when necessary even outside of meetings. She was a good co-worker. Evaluation grade (0-20): 19

A.4.2 Delivery 3

A.4.2.1 Bruna about Ricardo

Ricardo couldn't be present much, but he did compensate himself by working remotely. Almost everything went as planned. Evaluation Grade (0:20): 18

A.4.2.2 Ricardo about Bruna

Bruna worked as expected and planned. She was always available to solve any problem or doubt about anything. Evaluation Grade (0:20): 20

A.4.3 Delivery 4

A.4.3.1 Bruna about Ricardo

Ricardo was more present during this stage of the project and everything went as planned. Evaluation Grade (0:20): 19

A.4.3.2 Ricardo about Bruna

Bruna worked as expected and planned. This time we were more united during work. Evaluation Grade (0:20): 19

A.4.4 Delivery 5

A.4.4.1 Bruna about Ricardo

Ricardo worked really hard and helped me when I couldn't perform like expected. He would drive for hours so we could work on the project together. Evaluation Grade (0:20): 20

A.4.4.2 Ricardo about Bruna

Bruna was always by my side on this last week, as expected since this was the last week from our project and it was very important to be together to solve the problems.

Evaluation Grade (0:20): 20