School of Health and Society
Department Design and Computer Science
Kristianstad University

Course: DT581B

Program: Master in Computer Science

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Smart Home

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Available at:
https://github.com/iloveyii/mobile-platforms-dt581b-project/blob/master/documentation/DT581B-Report.pdf

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1. Introduction

The Internet has brought many innovations into our daily life, organizations and industries. The recent advancement in IPv6 and 5G networks, has made it possible to connect billions of devices. This technology is backed by a well known area which is more commonly known as the internet of things (IoT). IoT is tremendously changing our lives, our routine tasks that we do all day and night, our behaviors and even the way we do businesses.

IoT is composed of many small devices, sensors in home, vehicle, e-health, industry, education and collects data. The size of this network changes exponentially, for example in 2017 there were 7.1 billion IoT devices which are expected to grow upto 30 billion in 2022(1) .

Homeowners can benefit from smart homes by saving time and money, and people with disabilities can take advantage of voice supported systems to do their daily tasks better and easier.

The concept of smart home has existed since 1960(2). It has continuously improved services in health, automation for convenience, using sensors on doors, furniture, consumer electronics, wearable devices, and video camaras. Monitory data from these devices are helpful for health services, improving daily living, home security and surveillance(3).

IoT devices use less energy and hence bring more energy awareness(4) and energy utilization. A smart home also provides comfort and efficiency to its users. Smart home really brings smart devices and intelligence into your home and hence gives better life standards.

SUSTAINABLE DEVELOPMENT GOALS
17 GOALS TO TRANSFORM OUR WORLD
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

17 Sustainable development goals

Smart homes provide better accessibility as it uses IP networks and mobile devices. Therefore everyone can use and control the systems. Smart home devices use software as a major component which provides more affordable solutions than hardware. Having a smart solution in the home can save a lot of resources. (5)

Embedding smart IoT devices in consumer appliances such as smart TVs, smart speakers, heating, ventilation, lights etc brings more functionality such as smart grid, connectivity and manageability(5).

The motivation of smart homes is to improve the living experience through new functionality like a remote control and automation of appliances, better management of heating, improved security, or through assisted living standards by monitoring and detecting health incidents(6) etc.

The main aim of the project is to develop a smart home automation system in support of **SDG goals** [**7**-affordable and clean energy, **8**-Industry innovation and infrastructure, **11**- Sustainable cities and communities].

We specifically focus on energy conservation, home security for better life in this project. The project converts a traditional house into a smart home and controls the devices using either an android or ios based mobile phone or even a desktop computer. The benefit is a flexible and low cost solution, at the same time extendable. It provides a user friendly interface to control a variety of devices lights, tv, heating, etc. It monitors and saves sensor data in the cloud for further processing and even further improving services in the future.

To monitor energy consumption and the degree of comfort and safety in residential buildings, energy saving devices are used in IoT which use very low power for example ZigBee, Bluetooth. The network of the devices can be used and connected with a gateway that communicates with the Wi-Fi router at your home at one end and controls your smart devices using either Bluetooth or ZigBee protocols.

Kristianstad City provides accommodation facilities to many inhabitants including students, families and workers in the area.

Accommodating various cultures also brings poor energy awareness and law and order problems in the area. Therefore it is very important to provide good and secure services to all inhabitants and bring peace of mind.

In this project we are building a smart IoT based solution for not only energy conservation but also smart locking systems for better living experience. It will not only improve energy conservation but also reduce expenses for locking systems.

2. Requirements

Tables 1, 2 below lists all the requirements for this project.

Table 1 - Functional Requirements

Req. No	Req. Name: Description
1	**Login**: The application should provide a secure login system.
2	**Stats**: The application should be able to show some important statistics
3	**Registration**: The application should provide a user friendly interface to add , remove entities.
4	**Settings**. The application should provide easy global settings
5	**Database**: The application should interact with a DB at the backend side
6	**Responsive**: The application should be responsive on different screen sizes
7	**Sensor devices:** The app shall contain one or more sensor devices/simulator that collects data and save in DB
8	**Admin:** The app should have an admin account for administration
9	**Graph :** The application should show statistics using graphs
10	**Filters, Sorting:** Filtering and sorting data based on various criteria
11	**Historic data :** The app should be able to show historic data like one day/week ago

Table 2 - Non-Functional Requirements

Req. No	Req. Name: Description
1	**Version control:** The source code should be handled with version control system using Git and Github
2	**Hosting:** The application should be hosted on a cloud service
3	**Deployment:** Deployment of the application should be easy and automatic
4	**Cross platform:** The app should be runnable on desktop, mobile device, ipad, tablet
5	**Performance:** The app should be fast and responsive i.e using Redux - chap 5
6	**Useability**: The app should be user friendly and responsive to different devices
7	**Technologies:** May use technologies in chapter 3, 4 (JS, Node), chapter 5 (React)

3. Design and Implementation

Architecture

The system has the following main components. The admin is the main administrator of the system, which controls users, devices and permissions. When the user login to the mobile app, he can control the devices in his/her list. The command from the mobile app is sent to the server which then forwards it to the gate keeper component who is responsible to interact with the device/simulator. The database component gets continuous data from the sensors.

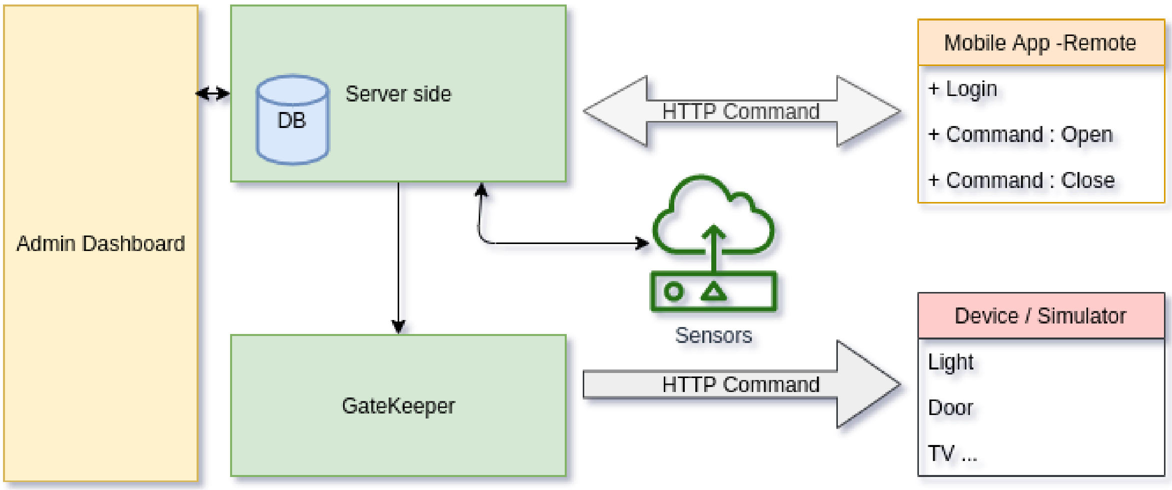


Figure 1 - System Architecture

Modules

We have divided the project into 4 separate modules namely backend (in typescript), frontend (in JS, ES6, React), mobile/device (JS, ES 6, React Native) and mobile/remote (JS, ES 6, React Native). We have kept the design very simple, and have developed mobile apps to simulate different devices.

We have used the **MERN** stack which means mongodb, express, react and node which is one of the latest and highly demanding technologies in the industry.

The database is mongodb which gives the flexibility of easy data management. There are **5** relations in the database which are shown in the **figure** 2 below.

Entity relationship diagram (ERD)

The entity relationship diagram below shows the main tables and their mutual relationships in the database. The user table holds info about all the users, devices save all the smart devices registered in the system, while the permissions table shows who has permission on which device.

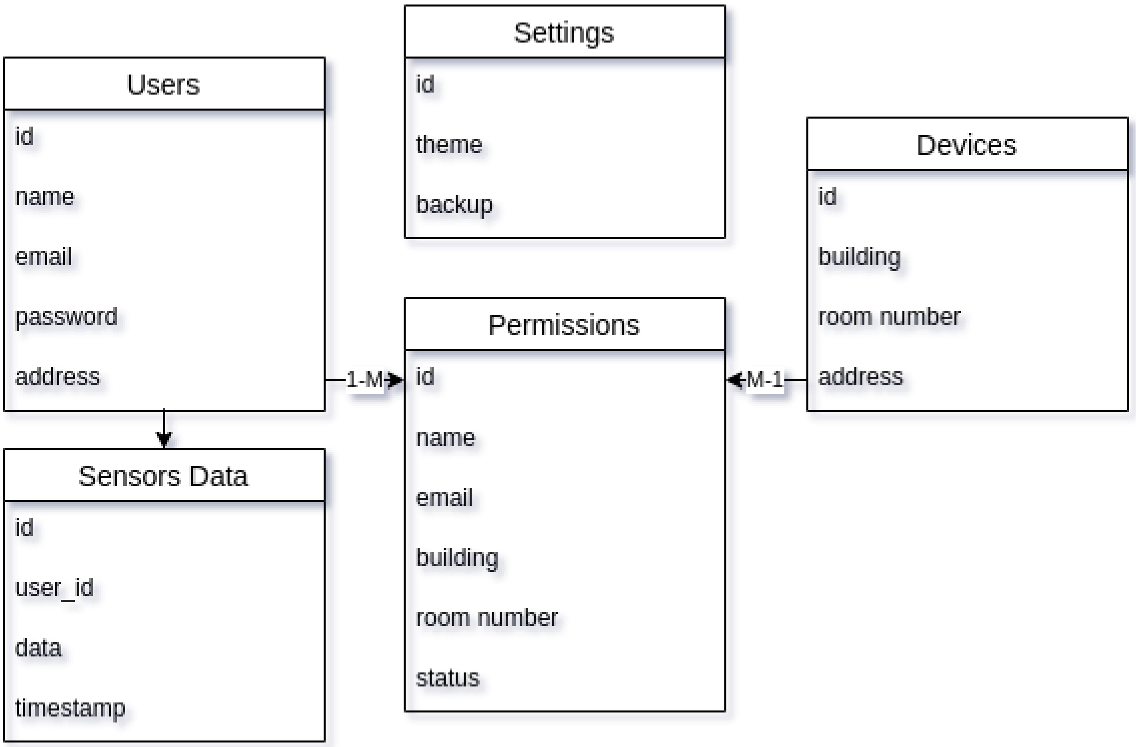


Figure 2 - Entity relationship diagram of the database

UML Class Diagram

The uml class diagram in **figure** 3 below shows the class objects in the system, their public interface methods and how they interact with other classes.

After the admin registers the users and gives them proper permissions on devices, the user login to the system (using Remote mobile app) and sends an open/close command to the device. The gatekeeper receives the user request and validates it against the permission table. If it is valid then it sends a command to the device/simulator (Mobile app Device) which acts accordingly.

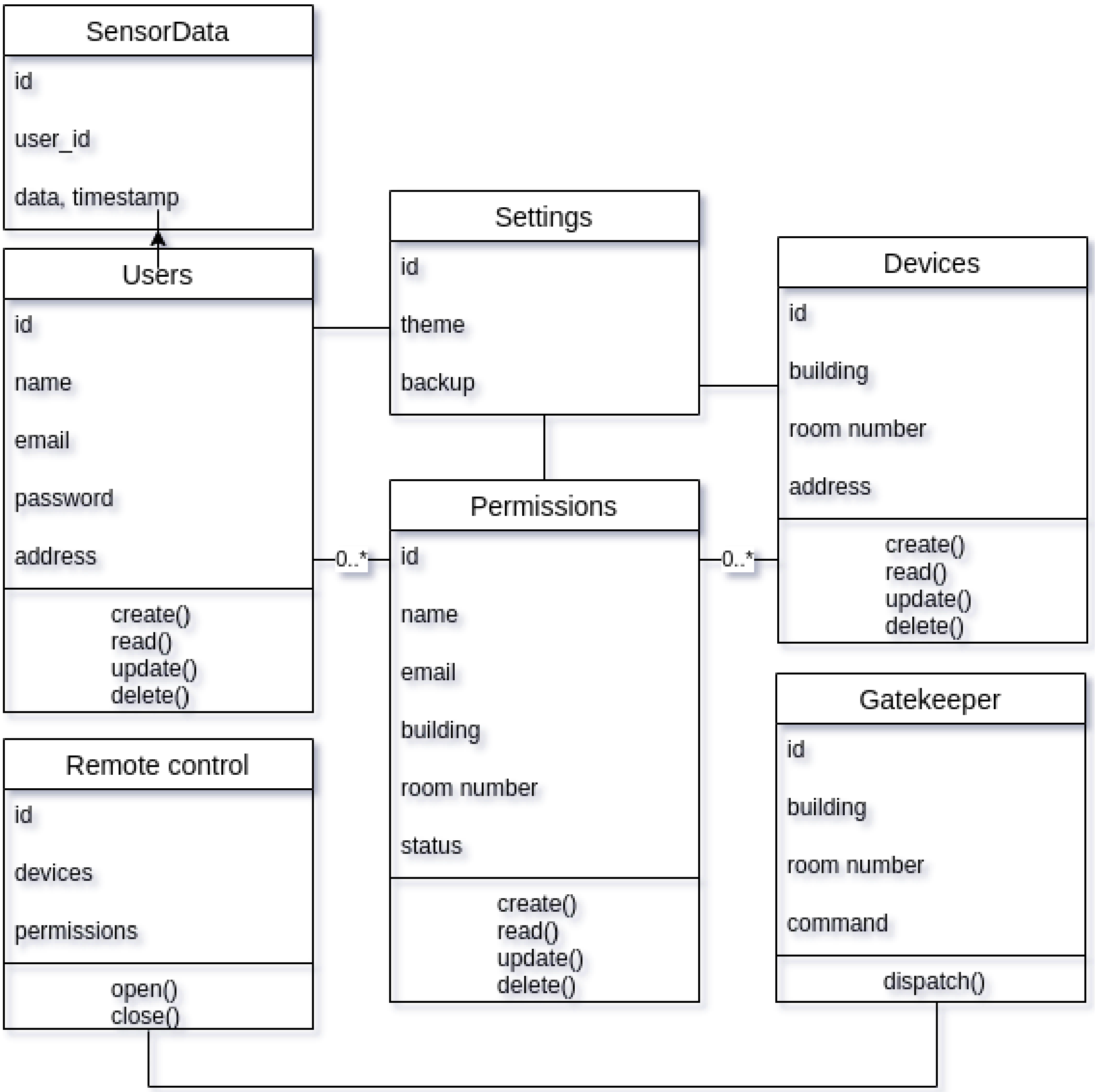


Figure 3 - UML Class Diagram

Flow chart - Login

The flow chart in **figure** 4 below shows the step by step process of how the login process works in the developed system.

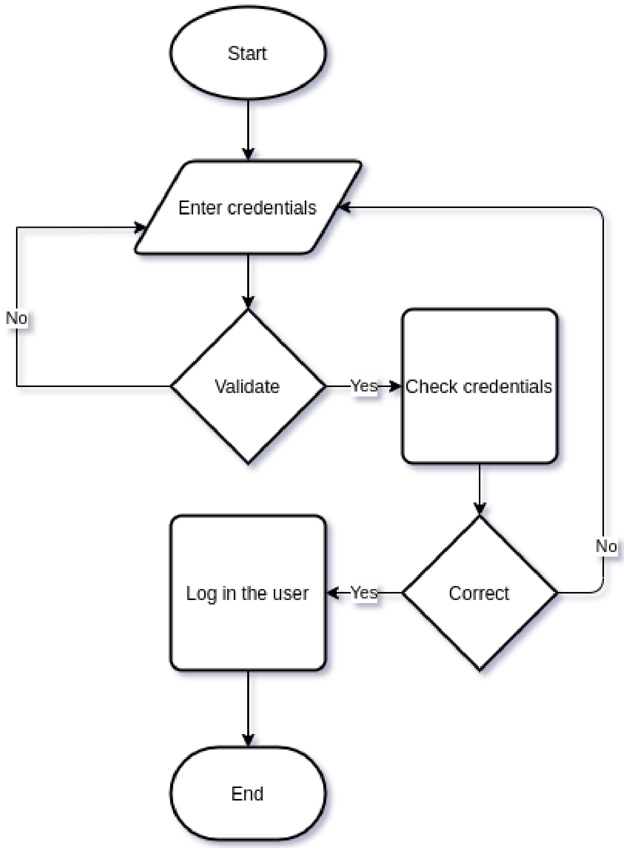


Figure 4 - Login user flow chart

Flow chart - Remote control

The **figure** 5 below shows the process of controlling a device using the mobile app (remote control). If the user has proper permissions set by the admin he will get a list of devices he/she had permissions for. Hence he/she will be able to control all the registered devices.

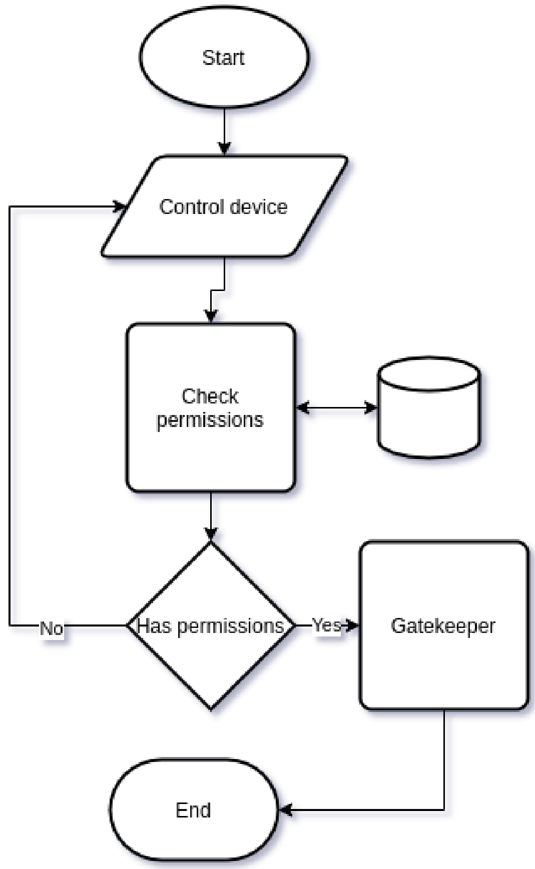


Figure 5 - Flow chart for controlling the device using mobile app

4. Results

How it works ?

The user first login into the system using the mobile app on his mobile device. After successful authentication by the server system, the user gets a list of devices on his mobile that he / she can control. The user sends a command to the devices in the list to the server, which then instructs the different devices to start/stop different services.

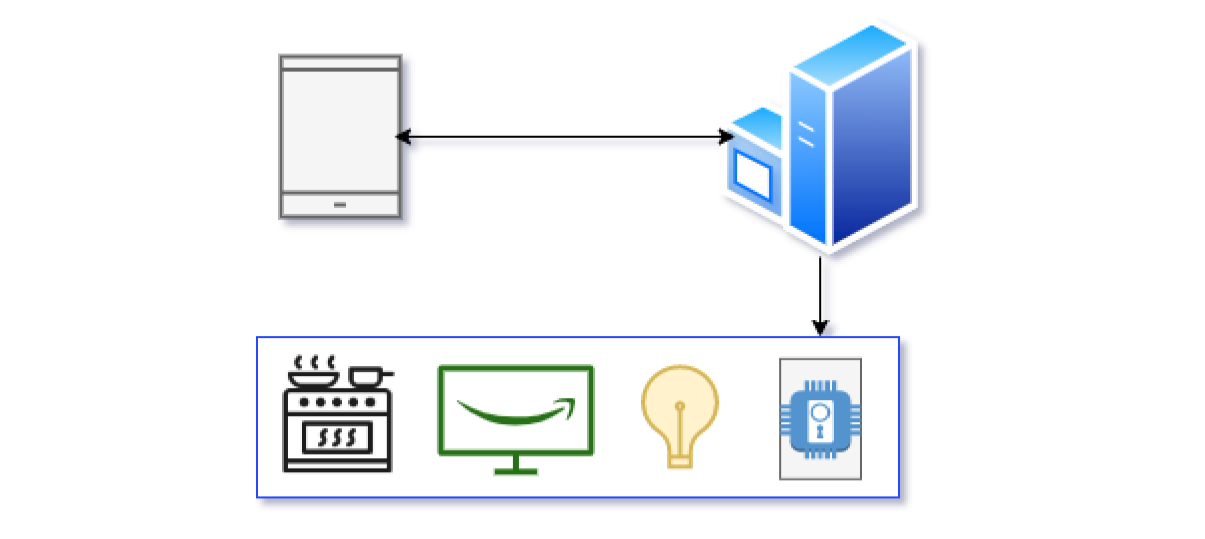


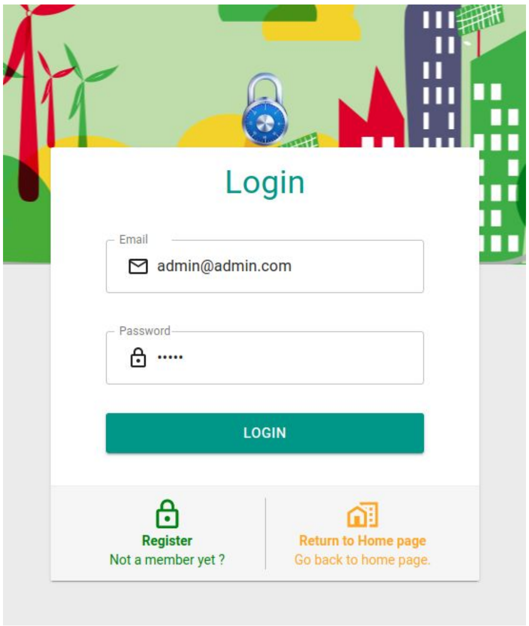
Figure 6 - How it works ? The user uses mobile app to control different devices

User Interface

Login

The registered users with proper permissions can access the resources like building, rooms, devices.

The user first login to the system, and then he gets a list of devices for which he has permissions. The user then can send a request to the server for any operation like open/close.



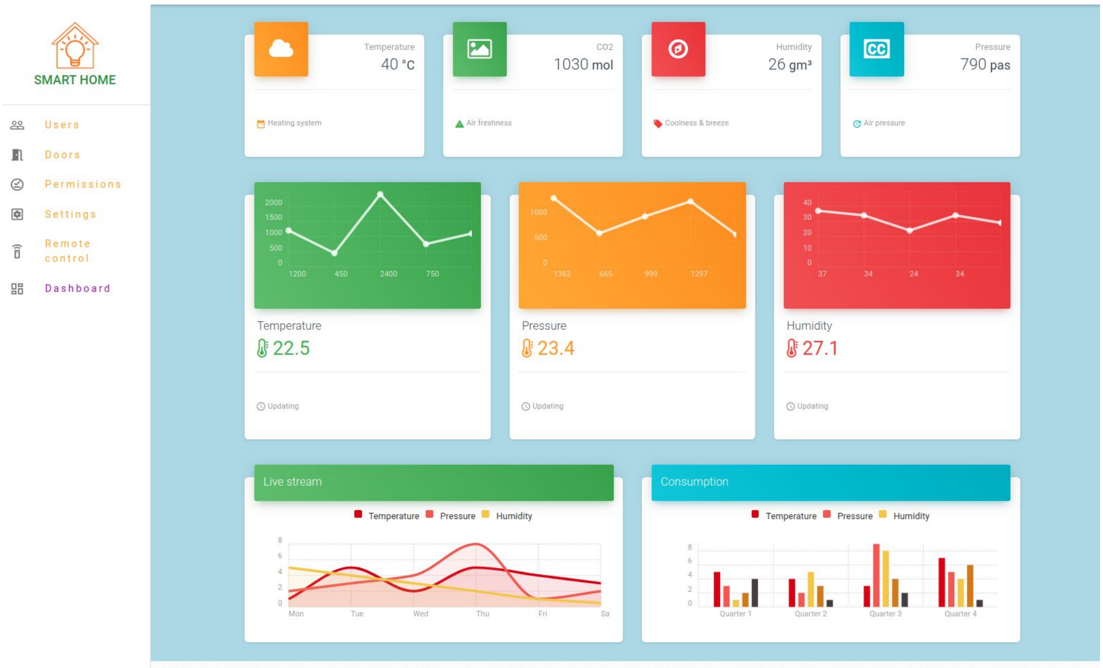
Email
admin@admin.com

Password
•••••

Figure 7 - Login user interface

Dashboard

The dashboard is used by the admin /user to see different statistics about the energy consumption for any specific period. He may also observe the log for his/her arrival to his home. There are also some interesting sensor data like, humidity, temperature, C02 levels in the home at any moment of time in history.



Temperature
40 °C
Heating system

CO2
1030 mol
Air freshness

Humidity
26 gm³
Coolness & breeze

Pressure
790 pas
Air pressure

Temperature
22.5

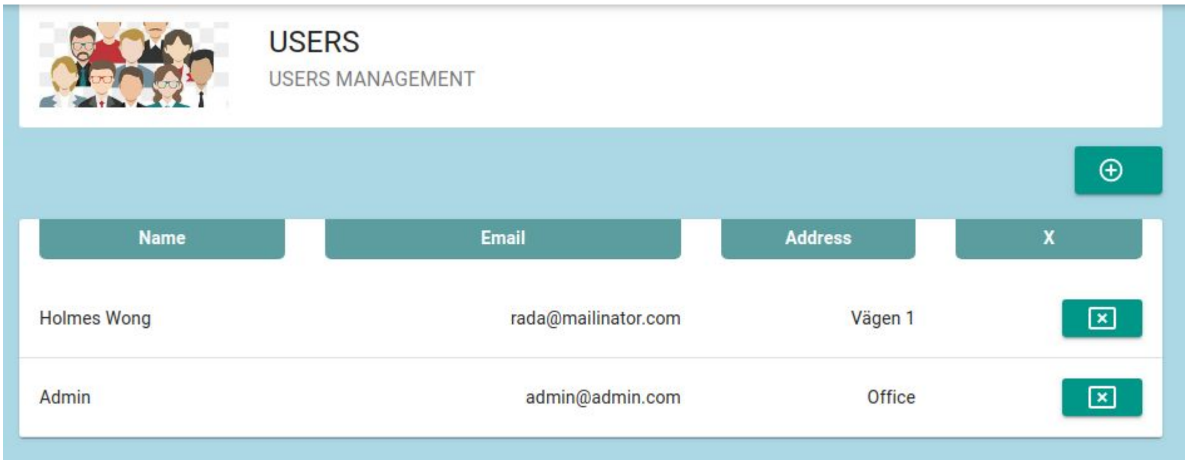
Pressure
23.4

Humidity
27.1

Figure 8 - Dashboard

Users

The admin can manage users, by adding, deleting them and assigning them different permissions in this dashboard section.



USERS

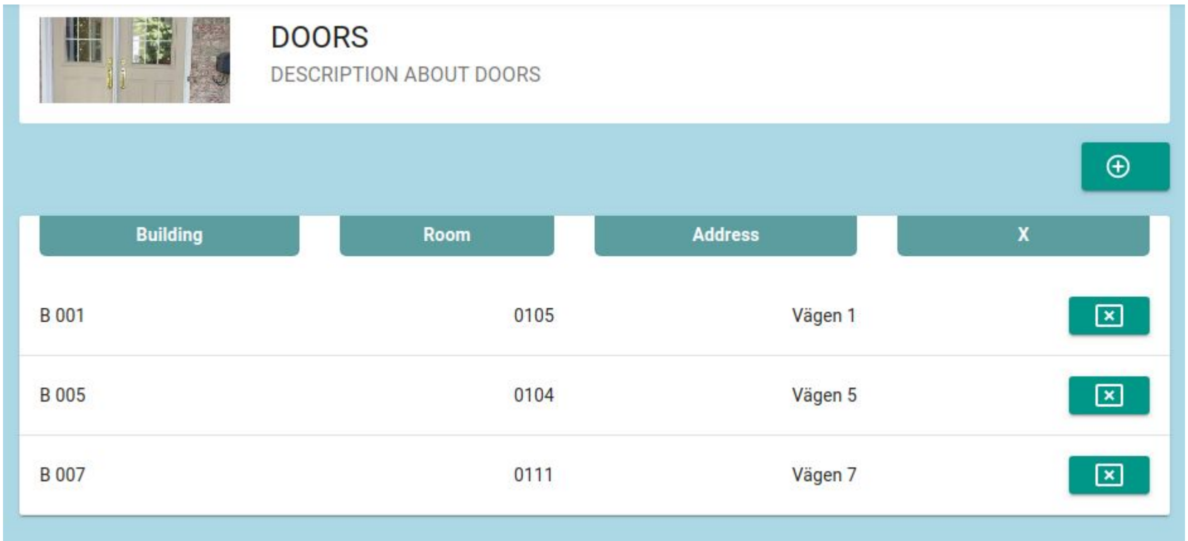
USERS MANAGEMENT

Name	Email	Address	X
Holmes Wong	rada@mailinator.com	Vägen 1	☒
Admin	admin@admin.com	Office	☒

Figure 9 - Users management

Doors

In order to give access to any door, the admin first adds information about doors and buildings into the system.



DOORS

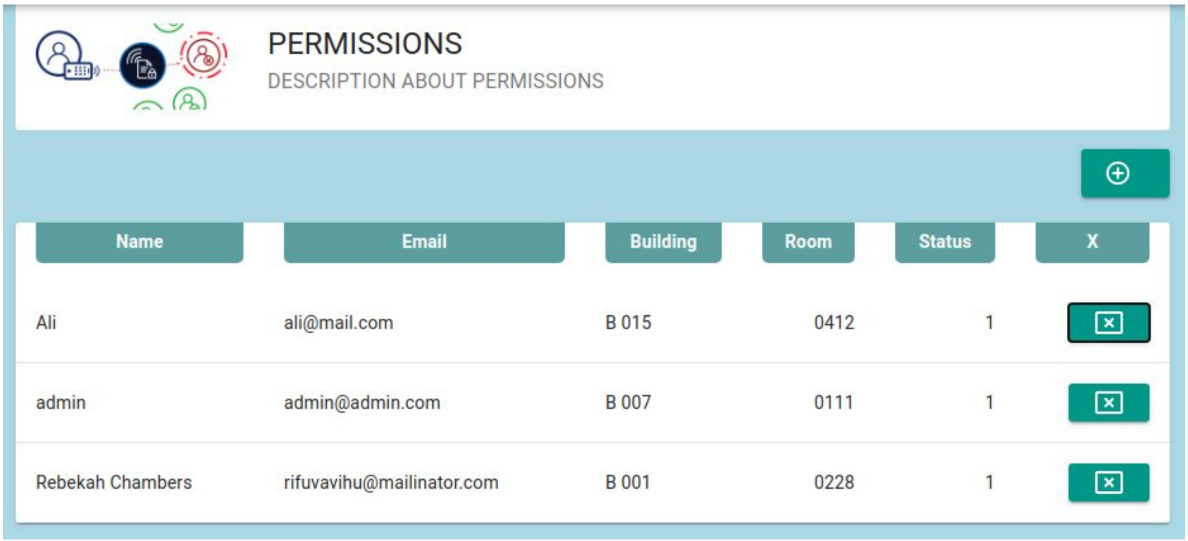
DESCRIPTION ABOUT DOORS

Building	Room	Address	X
B 001	0105	Vägen 1	☒
B 005	0104	Vägen 5	☒
B 007	0111	Vägen 7	☒

Figure 10 - Doors entry

Permissions

Once we have the resources (devices, users) to manage, the admin can grant/revoke access to these resources to different users in the system.



PERMISSIONS

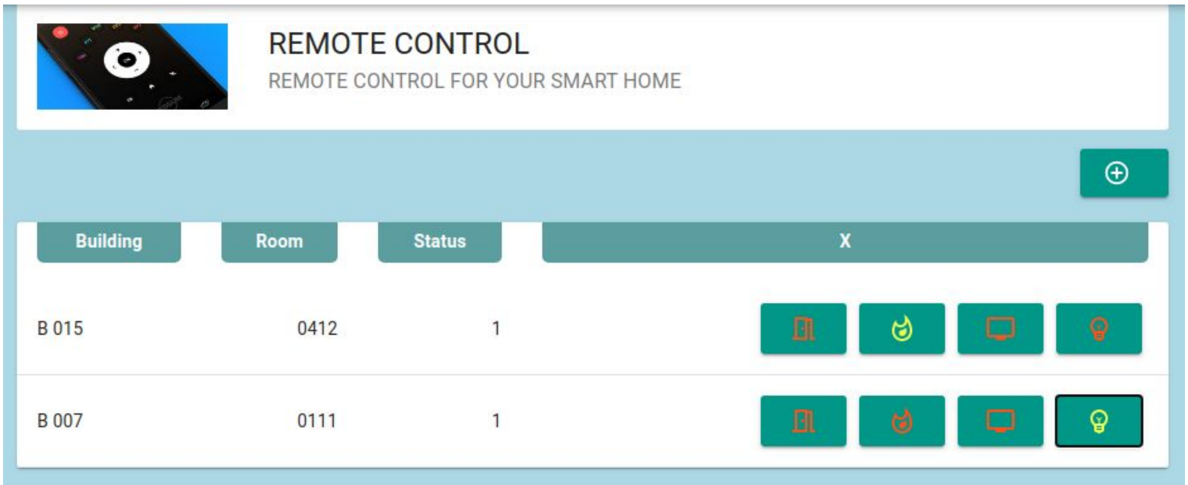
DESCRIPTION ABOUT PERMISSIONS

Name	Email	Building	Room	Status	X
Ali	ali@mail.com	B 015	0412	1	☒
admin	admin@admin.com	B 007	0111	1	☒
Rebekah Chambers	rifuvavihu@mailinator.com	B 001	0228	1	☒

Figure 11 - Permissions user interface

Remote control

This is more like a tester remote control for the admin to see if the permissions work.



REMOTE CONTROL

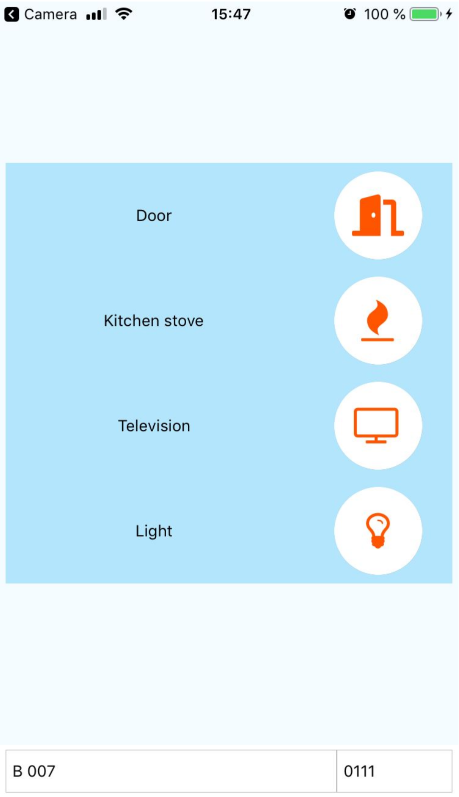
REMOTE CONTROL FOR YOUR SMART HOME

Building	Room	Status	X
B 015	0412	1	🚪 🔥 🖥 💡
B 007	0111	1	🚪 🔥 🖥 💡

Figure 12 - Remote control for controlling devices

Device Simulator

Here is the device simulator developed in React Native and hence it works on both iOS and Android devices. It is configured to simulate any device for example entering building and room numbers at the bottom of the app.



B 007 | 0111

Figure 13 - Device simulator , Android /iOS App

Remote control

The figure below shows the Remote control mobile app, and can be used on either iOS or Android devices. The user first logins to use this app with his/her email and password. Afterwards he can control all the devices in his/her list.

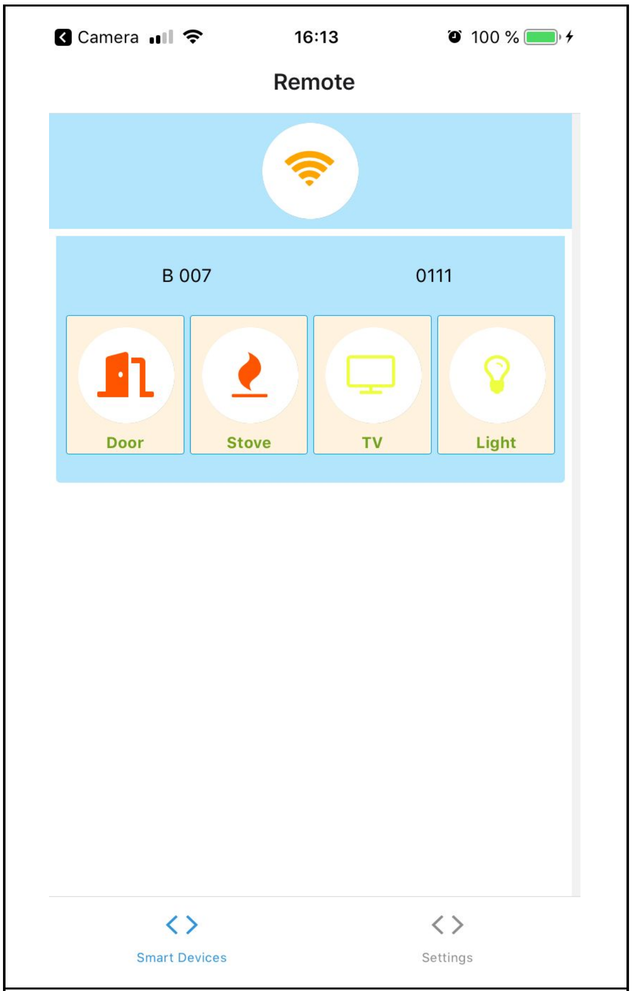


Figure 14 - Remote control, Android / iOS app

Deployment

We have designed a bonus new approach for easy and quick deployment of the application using github hooks. It is a light script that is run after any update to the source code. The beauty is that we don’t need any extra server configuration for it because it can be run by the same backend server(node server) of the application.

The custom method for automated deployment uses github webhooks as a trigger for any change to the master branch, which then in turn calls our deployment url. The shell script then pulls the new changes from the github and builds the app. This process is described in the figure below.

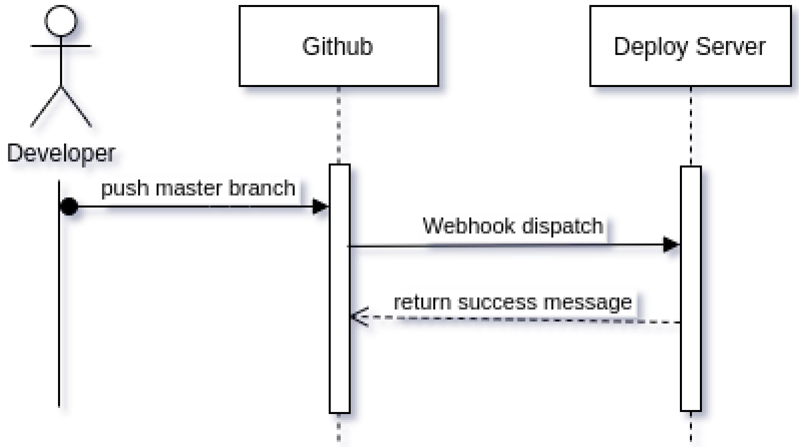


Figure 15 - Sequence diagram of the deployment process

Performance

It is very flexible and may be extended to encompass many other devices, The users can customize their needs and since it uses redux and websocket, it gives a real time experience.

Bottlenecks

Although IoT base smart home appliances have many benefits, at the same time they also bring some challenges [2]. IoT devices usually use the internet to connect and therefore need other resources like IP, and connectivity to a variety of resources which introduces more complexity[3]. Due to connectivity problems some data may be lost because of interference. But these problems could be alleviated by using better internet services (5G technology) and use of IoT devices and services which are optimized for such applications.

5. Summary and Conclusion

We have used successfully the state of the art technologies in mobile platforms in this project. We have demonstrated how modern technologies can improve life standards and can even be extended to better health applications.

Energy awareness, and sustainable cities are important topics of SDG and therefore we tried our best to contribute in this sector by the use of modern techniques and technologies. Affordable and clean energy minimizes pollution, impacts and mitigation global warming(7).

We have challenges of accessing the real devices but overcome those by using mobile apps for simulations. It actually introduced an abstraction layer on real devices which helped us further to invest the short time more usefully in the development of the application.

We invested enough time to achieve most of the requirements in table 1 and table 2. Doing so enables us to learn more from this course.

5 References

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