User Guide
Home Automation Using CoT

Ghazi Tounsi, Mohamed Karaa
ghazi.tounsi@supcom.tn, mohamed.karaa@supcom.tn

1 Introduction

As the world evolves each day, everyday objects are becoming smart and able to communicate with each other. The internet of Things, IoT, is in a huge way, and people are inventing new gadgets that enhance lives. Objects are now equipped with sensors and can measure different units and execute orders received from users.
This IoT-based home automation project is done using a *Raspberry Pi* as its core and other different components to enable users to interact with appliances in their home and interact with different objects.

Homes of the 21st century will become more and more self-controlled and automated due to the comfort home automation provides, especially when employed in a private home. A home automation system is a means that allows users to control electric appliances of varying kinds.

Many existing, well-established home automation systems are based on wired communication. This does not pose a problem until the system is planned well in advance and installed during the physical construction of the building. But for already existing buildings, the implementation cost goes very high.

This is where wireless home automation comes into place. It can be installed on an existing building, costs a small amount of money, and provides nearly full control over the home.

Also, using a specifically designed application, homeowners can interact with their homes from elsewhere in the world and even take action in critical situations.

2 Objectives

This project aims to prototype as many appliances as possible and connect as many objects. It is also mandatory to give homeowners full control over their homes to make life much easier. By realizing this project, we aim to:

- **Develop a Home Automation Remote system:** Conception and realize a full prototype of a home automation system with the ability to connect and control it remotely.
- **Use different Inner and Outer network technologies:** The use of different communication techniques between the objects, main server, and the homeowner's control application.
- **Use devices that are easy to install:** When choosing the components to install and work with, an optimal combination of components needs to be chosen to reduce the cost, can be easily installed in existing buildings, easy to work with, and interact with.
- **Make it suitable for inexperienced users or even disabled users:** Making the user experience as easy as possible is one of the main objectives, as the automation system can be used by different categories from children to elders to disabled persons, etc... so mainly, the control application needs to be easy to use and understand.
- **Scalability:** The network needs to be scalable, which means that the possibility to add new appliances and new smart things to the IoT network should be easy, and the integration of the new object in the control application needs to be straightforward.

3 Functionalities

In this section, a detail of the functionalities of the project. We can split the functionalities into two parts: The first one details the sensors and the IoT network, and the second is the details of the mobile application used to control the appliances.

3.1 Sensors and IoT netwok

Different sensors will be used to monitor different measures.

- **Security:** The smart home can detect the presence of a potential fire in the house, a gas leak, a potential augmentation of the carbon monoxide level in the living rooms, the presence of thieves, and initializing a silent alarm, and then an audible alarm.
- **Heating an cooling:** Using a set of predefined values and rules to run a central heating and cooling system as per the required settings. For example, an air conditioner is set to an energy-saving mode when the house is vacant and sets back to the normal setting when the resident is about to return home.
- **Power saving:** Detect the presence of people in the house and ensure that devices are in power-saving or sleep modes. Ensure that the lightning in the room is optimal by sensing the room's luminosity and trying to keep it at a predefined level.

3.2 Mobile application

- The mobile application can be used from different platforms like Android, iOS, Web, etc.
- The homeowner can register an account into the application with full access to all objects and register his relatives (wife, children, etc.) to interact with different objects. For example, children can only control their room's light; the wife can use the vacuum robot, etc.
- The homeowner can add new sensors to the mobile application using the sensor id.
- The homeowner can get the state of all the objects in the house and get readings from different sensors in real-time.
- The application offers the ability to set the rules for how the sensors need to work (when to turn on the cooler, when to turn off the lights, etc.)
- The user can get push notifications through the application to alert him if anything gets wrong (detecting suspicious activity inside the house, fire, gas leak, etc.)
- Limit the interaction with certain objects to the position of the user. For example, the garage can only be opened when the owner is close to the house.

4 Components

- **Raspberry Pi:** The Raspberry Pi is a low-cost, credit-card-sized computer that connects to a computer monitor or TV and operates with a standard keyboard and mouse. It is a little capable device that allows interaction with different sensors and can connect via Wi-Fi and Bluetooth. The raspberry pi will be the heart of the home automation project. It will be responsible for the communication of/with the sensors state to/via the mobile application.
- **Analog-to-digital Converter Chip MCP3002:** The MCP3002 has a 10-bit analog to digital converter (ADC) with a simple to use SPI interface. This ADC is used with the Raspberry Pi for reading analog values from the different sensors.

- **Relay:** A relay is a switch that is powered by electricity. It has a set of input terminals for single or multiple control signals and a set of operating contact terminals. The switch may have an unlimited number of contacts in various contact forms, such as making contacts, breaking contacts, or combinations of the two. This allows interaction with high voltage devices from a device that only operates at 5 volts.
- **Resistors**
- **Capacitors**
- **LEDs**
- **Motors**
- **12V power supply for powering the Raspberry Pi.**
- **Sensors**
  - **Gas sensor MQ-2:** MQ2 is one of the commonly used gas sensors in the MQ sensor series for sensing gas.
  - **Motion sensor PIR:** PIR sensors allow to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small and inexpensive.
  - **CO sensor MQ135:** The MQ135 is one of the commonly used gas sensors in the MQ sensor series for sensing air quality and CO percentage.
  - **Temperature sensor DHT11:** The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor.
  - **Photo-resistors:** Enable the measurement of the luminosity in a room.

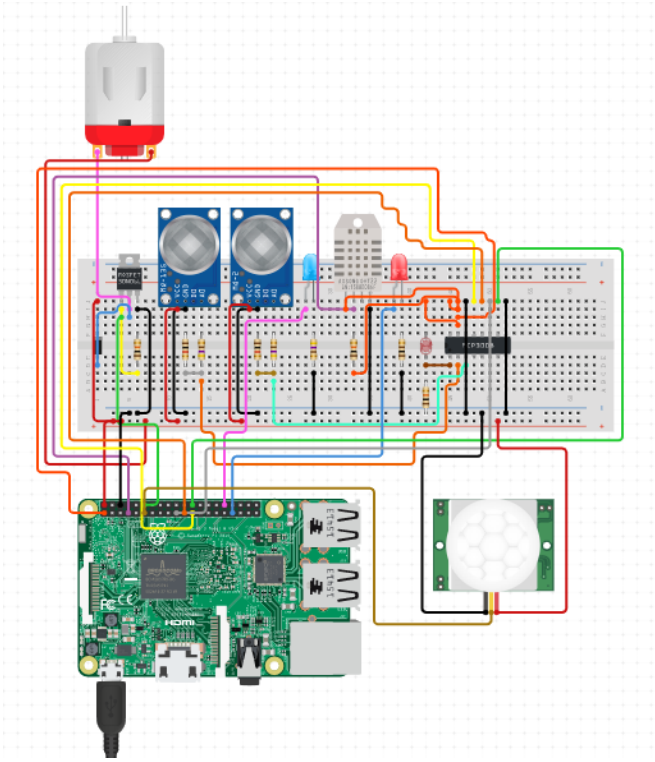

Figure 1: Home Automation device architecture

5 Technologies

In order to implement the different home automation functionalities into the mobile application different technologies will be used to develop this app.

- **Back-end :**
  - **MongoDB:** A NoSQL document-oriented database. MongoDB is used to store users data. MongoDB is practical and easy to use with Node.js.
  - **MQTT:** A lightweight publish-subscribe network protocol used to communicate sensor-collected data to a cloud MQTT broker (Mosquitto).
  - **Flogo:** Handles and manages sensor collected data based on specific events.
- **Middleware:**
  - **Node.js:** It is used for server-side development that matches the needs of a data-intensive and real-time applications because of its lightweight and non-blocking nature. It is also a good choice JSON APIs based applications.
  - **Express.js:** It is a back-end web application framework for Node.js. Express helps building web applications and APIs built on top a Node server.
- **Front-end:**
  - **Flutter:** Flutter is a cross-platform SDK that gives the ability to develop application for multiple platforms based on a single code. Flutter grants access to native functionalities and native look without using frameworks such Apache Cordova or Capacitor. Flutter apps are easy and fast to code and do not require web development prior knowledge.

6 Architecture

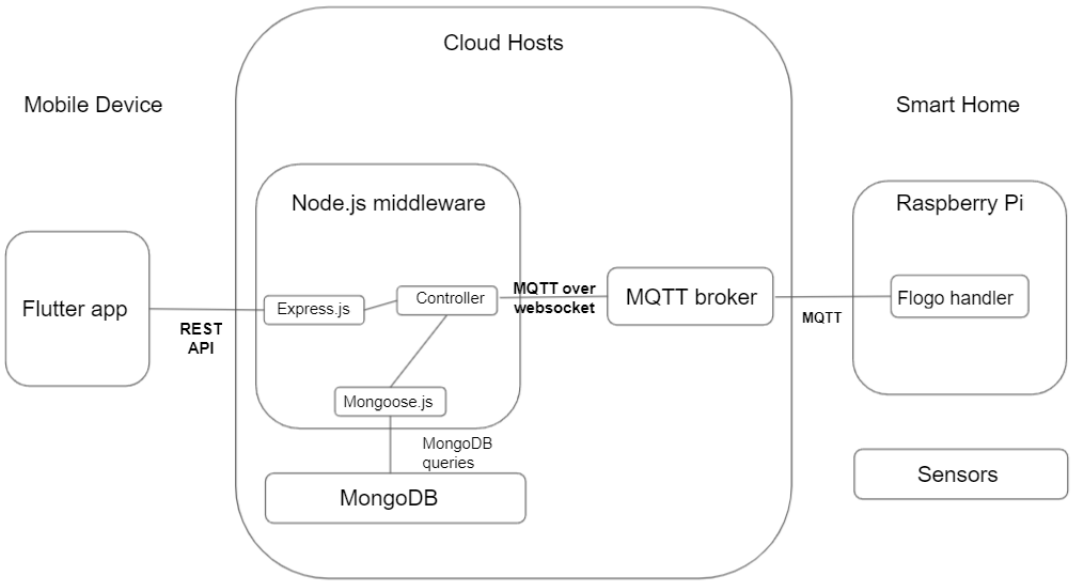

Figure 2: Home Automation application architecture

7 Timeline & Tasks

The project development will undergo different steps:

- Planning smart home architecture and connecting objects.
- Handling collected data and connecting to cloud MQTT broker
- Implementing database logic.
- Developing Express.js application, creating necessary APIs and connecting to database.
- Hosting Node.js on a cloud server.
- Developing Flutter mobile application and connecting to the web server endpoint.
- Creating a smart home prototype/simulation.
- Organize and update the project repository with a *Design Book*, *Full source code*, *Technical documentation* and a *Demo video*.

8 Deliverables

At the end of the project, the following items will be delivered:

- House automation mobile application.
- Source code for different project components on GitHub.
- Smart house prototype/simulation.

9 Assumptions

In this project, we assume that there will be no demonstration for the cooling and heating systems, instead we will mock them. We also assume that the home owner have full access to all the sensors and their addresses.

10 Assumptions & Constraints

In this project, we assume that there will be no demonstration for the cooling and heating systems, instead we will mock them. We also assume that the home owner have full access to all the sensors and their addresses.

11 Business Study

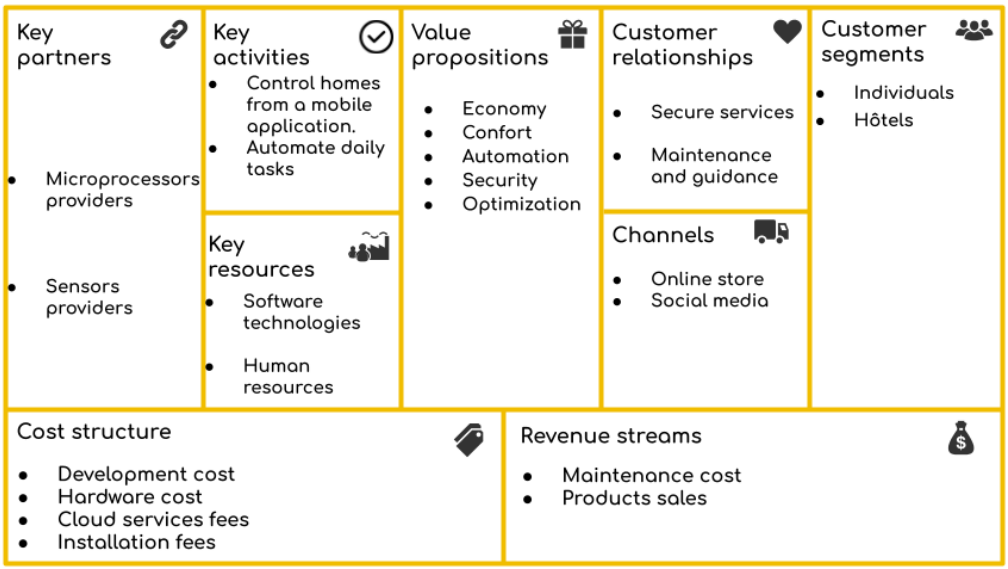

Figure 3: Home Automation Business Model Canvas

12 Marketing Study

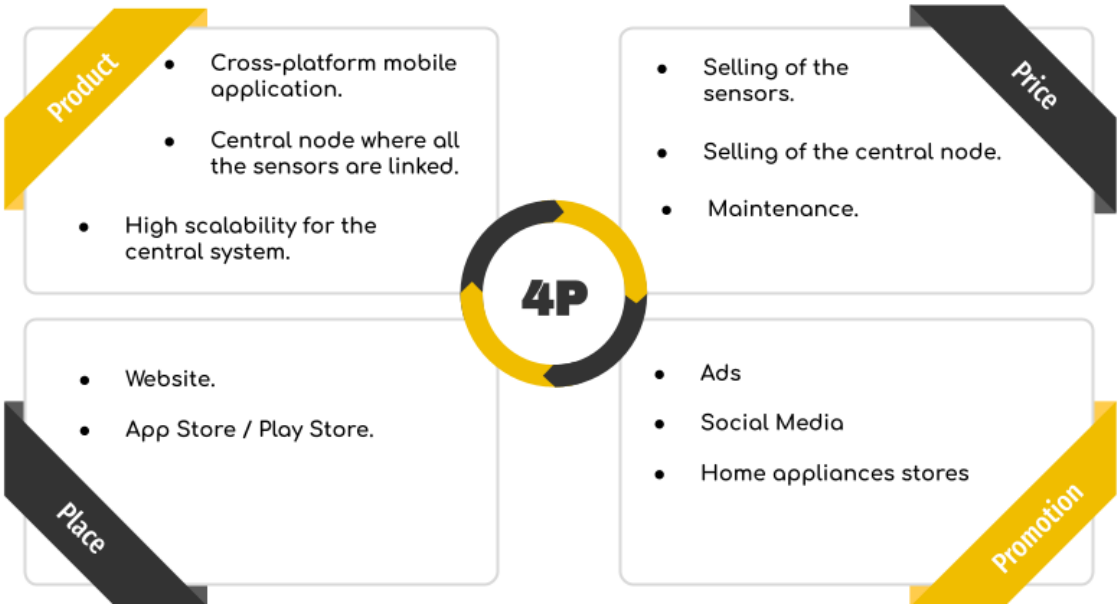

Figure 4: 4P Marketing Mix

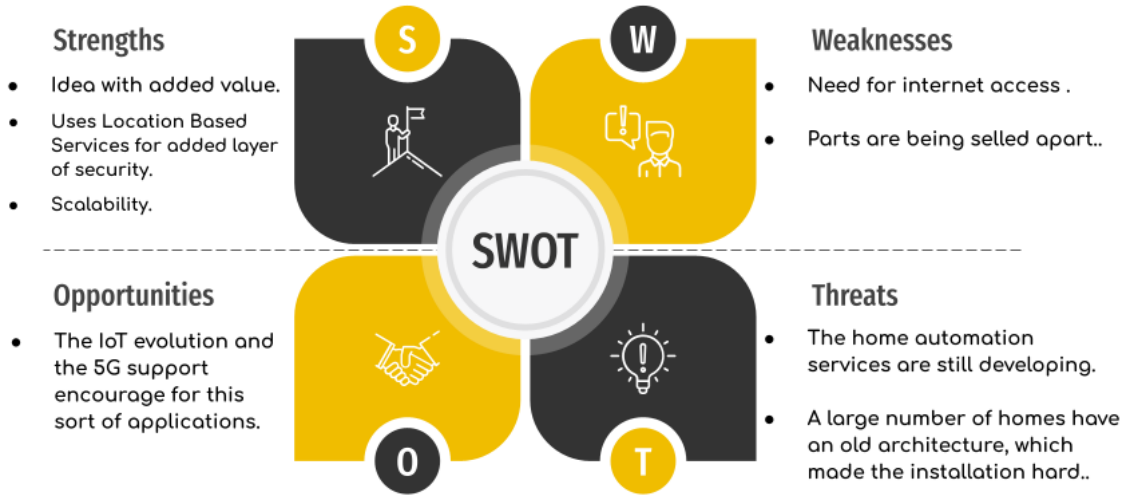

Figure 5: SWOT Analysis