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IoT - Smart Home Automation

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Comments:	**Date:**

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Chapter 1

Introduction

1.1 Overview

The rapid advancement of technology has prepared the way for IoT (Internet of Things) systems as well as transformed traditional homes into smart, automated environments. A smart home integrates various IoT devices, enabling automation and remote control of home systems, such as lighting, security, climate control, and appliances. This project, "IoT-Smart Home Automation," aims to create a cost-effective and user-friendly smart home system that enhances security, saves energy, and provides convenience. By leveraging IoT devices and advanced network protocols, homeowners can monitor and control their homes from anywhere in the world using their smartphones. [1] [2] [3] [4]

Figure 1.1: IoT - Smart Home

1.2 Motivation

The motivation behind this project arises from the increasing demand for smarter, safer, and more energy-efficient homes. Traditional home systems often lack automation and require manual intervention, which leads to inefficiencies and increases energy consumption. Additionally, security is a greater concern in modern homes. The ability to remotely monitor and control home devices is an appealing solution to these challenges. This project combines innovation and practicality to simplify daily tasks, reduce energy waste, and provide peace of mind through enhanced security.

1.3 Tools & Technology

We use these tools and technologies in online and IoT systems:

1. Server
2. Access Pointer
3. Router
4. Smart Phone
5. IoT Devices: **Webcam, Street Lamp, Fan, Light, Coffee-Maker, Sensor, etc.**
6. Motion Detector
7. Switch
8. Lawn Sprinkler
9. Water Drain
10. Wind Detector
11. Smart Car
12. Air Conditioner
13. LED Light

1.3.1 Simulator

- Cisco packet tracer.

1.4 Problem Definition

1.4.1 Problem Statement

Traditional home setups are inefficient and often fail to address modern needs for security, convenience, and energy management. Homeowners have limited control over their homes when away, and manual processes increase time and energy consumption. This project seeks to solve these issues by developing an IoT-based smart home system that automates tasks, improves security, and allows remote control of home devices.

1.4.2 Complex Engineering Problem

The project addresses a complex engineering problem, as summarized in Table 1.1 below:

Table 1.1: Summary of the attributes touched by the mentioned project

Name of the Problem Attribute	**Explanation of How It is Addressed**
P1: Depth of knowledge required	Requires understanding of IoT devices, networking protocols (DHCP, EIGRP), and automation logic.
P2: Range of conflicting requirements	Balancing energy efficiency, cost, and user convenience.
P3: Depth of analysis required	Requires extensive analysis of network configurations and device interoperability.
P4: Familiarity of issues	Tackles common issues like security, energy management, and automation in home systems.
P5: Extent of applicable codes	Adheres to IoT communication protocols and security standards.
P6: Extent of stakeholder involvement and conflicting requirements	Incorporates homeowner preferences and addresses conflicting requirements like low cost vs. high functionality.
P7: Interdependence	Integrates multiple systems like lighting, HVAC, and security for seamless automation.

1.5 Design Goals/Objectives

The design goals of this project are:

Automation

To create a fully automated home environment where devices operate based on real-time sensor inputs and predefined conditions. This includes automating:

- Lighting systems based on occupancy.
- Climate control based on room usage.
- Security systems such as motion detectors and webcams.

Security

To enhance home security by integrating smart monitoring systems, including:

- Motion detectors and cameras for real-time surveillance.
- Automated alerts and notifications for suspicious activity.

- Remote access for monitoring and controlling security devices.

Energy Efficiency

To optimize energy consumption and reduce costs through intelligent device management, such as:

- Automatically turning off unused appliances.
- Adjusting heating, ventilation, and air conditioning (HVAC) systems based on environmental conditions and occupancy.
- Using energy-efficient IoT devices like LED lights.

1.6 Application

The IoT-Smart Home Automation project has a wide range of real-world applications, as outlined below:

Residential Homes

Smart homes provide convenience, security, and energy savings. Automation of lighting, HVAC systems, and security enhances the quality of living by reducing manual intervention and energy costs.

Rental Properties

Landlords can remotely monitor and manage properties, ensuring tenant safety and energy efficiency. Smart locks and monitoring systems provide better control over property access.

Healthcare and Elderly Care

Smart homes assist in healthcare by enabling remote monitoring of elderly or disabled residents. Automated reminders for medication, fall detection, and emergency alerts can improve their quality of life and safety.

Commercial and Office Spaces

In offices, smart IoT systems optimize energy usage, control lighting, and monitor security, leading to reduced operational costs and enhanced workplace safety.

Environmental Impact

By enabling precise control of energy consumption, smart homes contribute to environmental sustainability. Automated systems reduce unnecessary energy use, aligning with green energy initiatives.

Smart Cities

IoT-based smart home systems can integrate with smart city infrastructure, improving resource management, traffic control, and overall urban efficiency. Homes equipped with IoT can communicate with city systems for coordinated energy and water usage.

Disaster Management and Safety

Smart homes can provide real-time alerts for environmental hazards such as fire, gas leaks, or floods. Integration with local authorities ensures timely response and evacuation, reducing casualties and damage.

Chapter 2

Design, Development, and Implementation of the Project

2.1 Introduction

The design and implementation of the IoT-Smart Home project focus on integrating IoT devices with network configurations to create a fully automated and remotely accessible home system. The project leverages advanced protocols, sensors, and user-friendly interfaces to enhance convenience, security, and energy efficiency.

2.2 Project Details

The project comprises multiple components and subsystems working together to automate various aspects of a home. The detailed structure is outlined below:

2.2.1 System Overview

The IoT-Smart Home system includes sensors, actuators, cameras, routers, and a server. It connects all devices via a network, allowing remote monitoring and control using a smartphone application.

2.2.2 Key Functionalities

- **Lighting Automation**: Lights turn on or off based on motion detection.
- **Security**: Motion detectors and webcams provide real-time surveillance and notifications.
- **Climate Control**: HVAC systems adjust based on room occupancy.
- **Device Control**: Appliances like fans and coffee makers can be controlled remotely.

- **User Accessibility**: All features are accessible via a secure smartphone application, allowing homeowners to monitor and control their home from anywhere in the world.

2.3 Implementation

The implementation involves configuring hardware and software components to realize the smart home's functionalities.

2.3.1 The Workflow

The implementation follows these steps:

1. Configuring routers and switches for network communication using DHCP and EIGRP protocols.
2. Integrating IoT devices like motion sensors, webcams, and smart appliances.
3. Developing automation logic on the server for device behavior.
4. Enabling remote access through a smartphone app.

2.3.2 Tools and Libraries

- **Hardware**: routers, IoT devices (motion sensors, webcams, smart lights), and switches.
- **Software**: Cisco Packet Tracer for simulation, server-side scripting, and mobile app interfaces.
- **Protocols**: DHCP for IP configuration and EIGRP for dynamic routing.

2.3.3 Implementation Details

The server was programmed to handle all automation logic, including:

1. Taking servers, IOT devices, routers, switches, smart phones, wires, etc. for making IOT-Smart Home.
2. We will connect all the routers. After that, we will connect the routers with the switches. Then we will connect all the switches, & then all switches will connect with the all IOT devices/home devices, server, & smart phone.
3. Now we will configure router 0 for giving dynamic IP addresses by using the DHCP protocol in figure 2.1 & figure 2.2.

```
Router(config)#ip dhcp pool 10network
Router(dhcp-config)#network 1.1.1.0 255.0.0.0
Router(dhcp-config)#dns-server 1.1.1.2
Router(dhcp-config)#defa
Router(dhcp-config)#default-router 1.1.1.1
Router(dhcp-config)#exit
```

Figure 2.1: Configuration of DHCP protocol in router 0

```
Router(config)#ip dhcp pool 20network
Router(dhcp-config)#network 10.0.0.0 255.0.0.0
Router(dhcp-config)#dns-server 10.0.0.2
Router(dhcp-config)#defa
Router(dhcp-config)#default-router 20.0.0.1
Router(dhcp-config)#exit
Router(config)#
```

Figure 2.2: Configuration of DHCP protocol in router 0.

4. Now we will configure router 1 for giving dynamic ip addresses by using the DHCP protocol in figure 2.3 & figure 2.4.

```
Router(config)#ip dhcp pool 30network
Router(dhcp-config)#network 20.0.0.0 255.0.0.0
Router(dhcp-config)#defa
Router(dhcp-config)#default-router 20.0.0.1
Router(dhcp-config)#exit
Router(config)#
```

Figure 2.3: Configuration of DHCP protocol in router 1.

```
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#ip dhcp pool 30network
Router(dhcp-config)#network 10.0.0.0 255.0.0.0
Router(dhcp-config)#dns-server 10.0.0.2
Router(dhcp-config)#defa
Router(dhcp-config)#default-router 10.0.0.1
Router(dhcp-config)#exit
Router(config)#
```

Figure 2.4: Configuration of DHCP protocol in router 1.

5. Now we will configure routing protocol EIGRP in router 0 so that the owner of the house can access his home from anywhere in the world over the internet by using his smart phone in figure 2.5.

```
Router>en
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#router eigrp 1
Router(config-router)#network 1.1.1.0
Router(config-router)#network 10.0.0.0
Router(config-router)#
```

Figure 2.5: Configuration of the EIGRP routing protocol in router 0.

6. Now we will configure routing protocol EIGRP in router 1 so that the owner of the house can access his home from anywhere in the world over the internet by using his smart phone in figure 2.6.

```
Router(config)#router eigrp 1
Router(config-router)#network 20.0.0.0
Router(config-router)#network 10.0.0.0
```

Figure 2.6: Configuration of the EIGRP routing protocol in router 1.

7. Smart phone accessing the server by using the EIGRP routing protocol in figure 2.7.

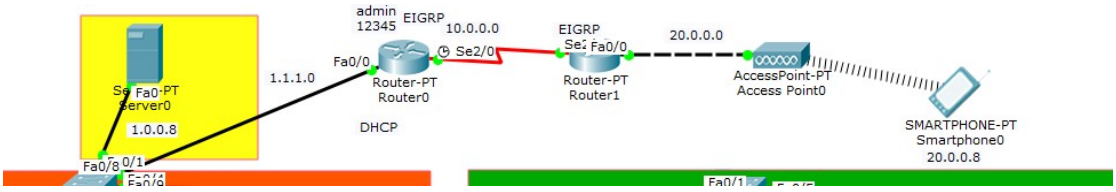


Figure 2.7: Phone accessing the server by using EIGRP routing protocol.

8. Now we will register an account on the server for connecting all the IOT devices/home devices by giving the user name & password in figure 2.8.

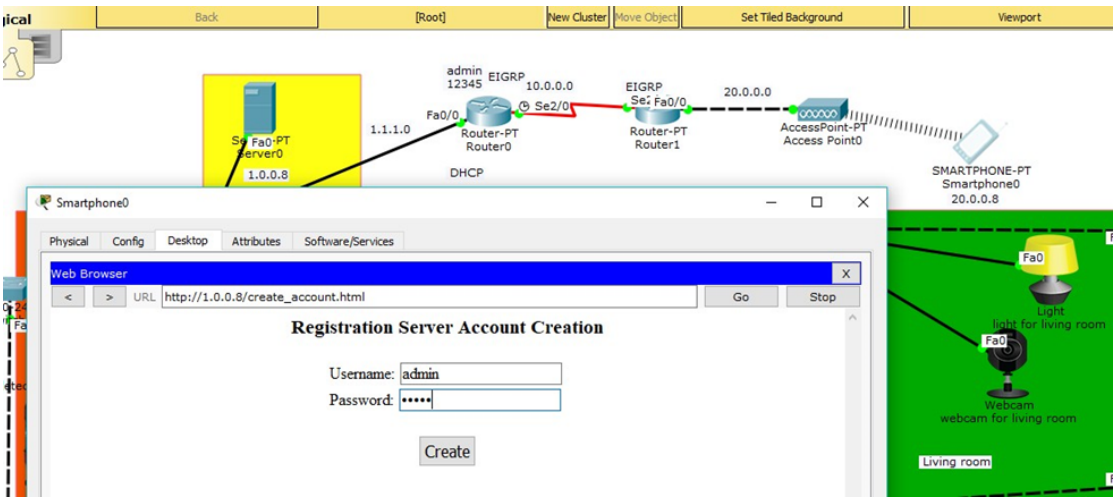


Figure 2.8: Registration of an account in the server.

9. Smart phone accessing the home by signing in to the server in figure 2.9.

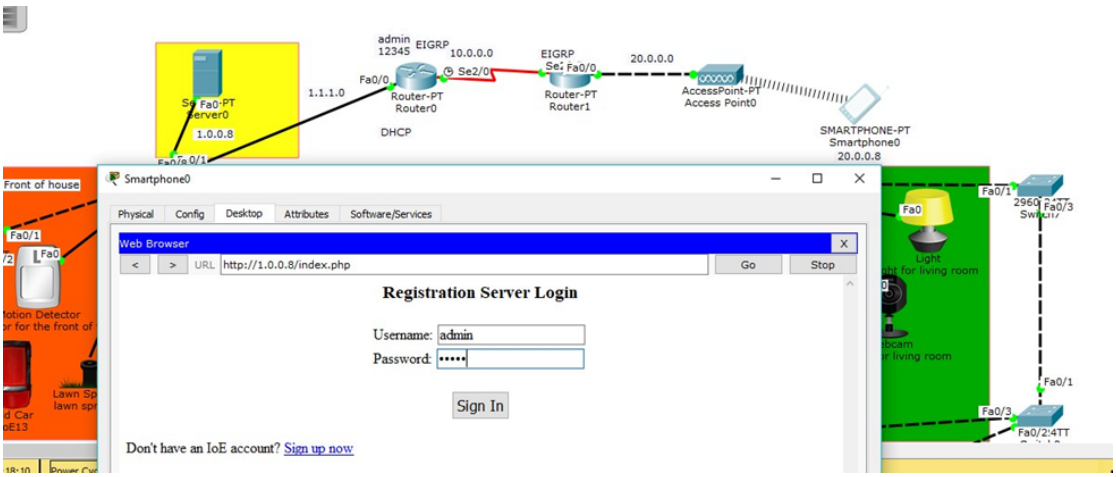


Figure 2.9: Smart phone accessing the home by signing in to the server.

10. After signing in to the server by using a smart phone in figure 2.10.

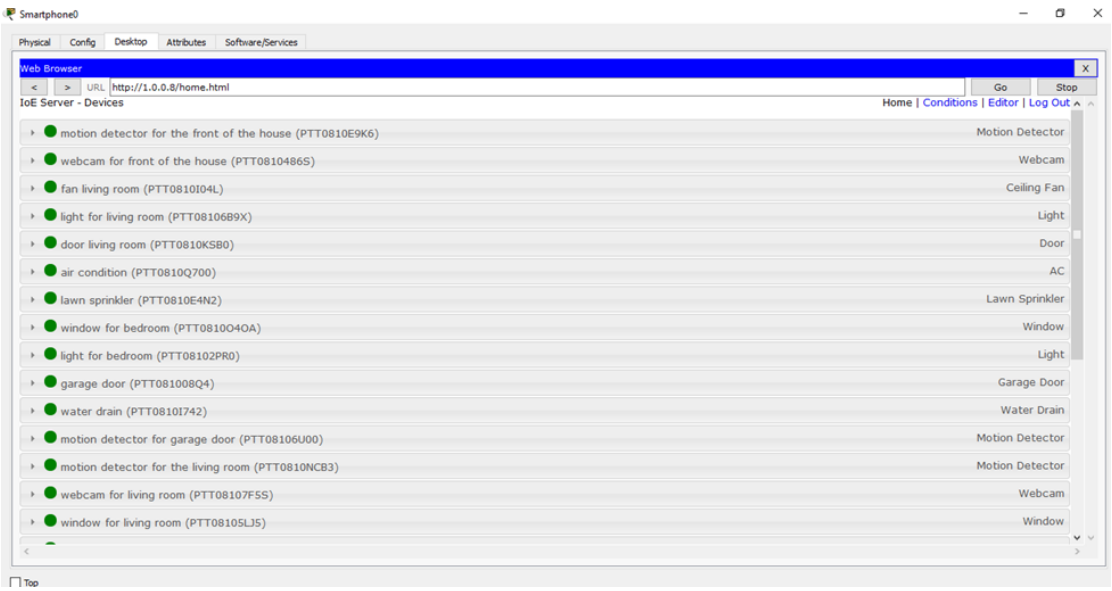


Figure 2.10: After signing in to the server by using a smart phone.

Logic/Conditions

Now we will implement all the logic and conditions in the server for making an automated house:

1. In front of the house, when there will be someone, a motion detector will detect that, and the webcam will be automatically on.
2. In front of the house when there will be nobody, the motion detector will be off, and also the webcam will be automatically off.
3. In front of the house, when the lawn sprinkler is on, then automatically the water drain will be on.
4. In front of the house, when the lawn sprinkler is off, then automatically the water drain will be off.
5. In front of the house, when the wind detector detects high wind, then all the windows of the house will be off.
6. When there will be someone in front of the door of the living room, then the motion detector will detect that, & the door of the living room will automatically be on.
7. When there will be nobody in front of the door of the living room, then the motion detector will be off & the door of the living room will automatically be off.
8. When there will be someone in the living room, the motion detector of the living room will detect that, & all the fans, lights, windows, & webcams of the living room will be automatically on.

9. When there will be nobody in the living room, then the motion detector of the living room will be off, & all the fans, lights, windows, & webcams of the living room will be automatically off.

10. When there will be someone in front of the door of the bedroom, then the motion detector will detect that, & the door of the bedroom will automatically be on.

11. When there will be nobody in front of the door of the bedroom, then the motion detector will be off, & the door of the bedroom will automatically be off.

12. When there will be someone in the bed, the motion detector of the bedroom will detect that, & all the fans, lights, & windows of the bedroom will be automatically on.

13. When there will be nobody in the bedroom, then the motion detector of the bedroom will be off, & all the fans, lights, & windows of the bedroom will be automatically off.

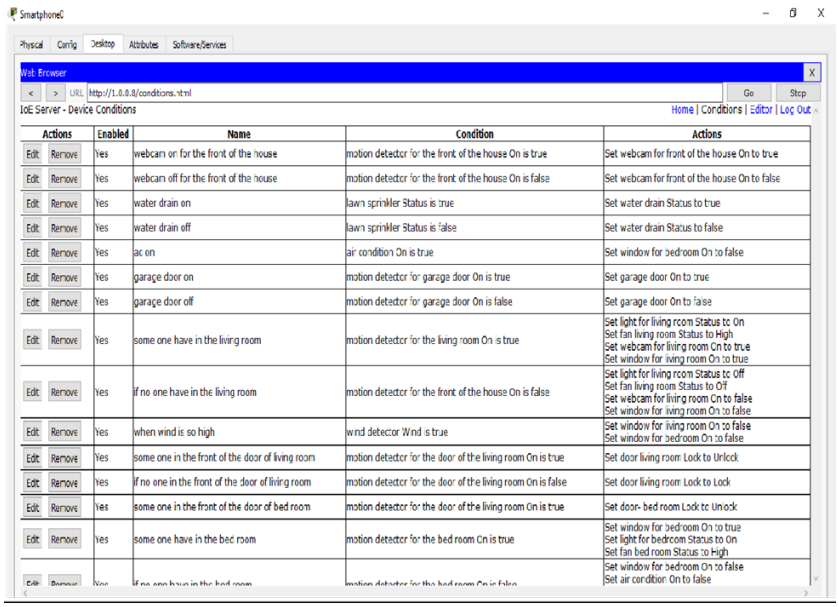
14. When the air conditioner of the bedroom is on, then the window of the bedroom will be automatically off.

15. When there will be any car or anyone in the front of the garage, the motion detector will detect that, & the garage door will automatically be on.

16. When there will be no car or nobody in the front of the garage, then the motion detector will be off & the garage door will automatically be off.

17. When there will be someone in front of the door of the kitchen, then the motion detector will detect that, & the door of the kitchen will automatically be on.

18. When there will be nobody in front of the door of the kitchen, then the motion detector will be off, & the door of the kitchen will automatically be off.



Actions	Enabled	Name	Condition	Actions
Edit Remove	Yes	webcam on for the front of the house	motion detector for the front of the house On is true	Set webcam for front of the house On to true
Edit Remove	Yes	webcam off for the front of the house	motion detector for the front of the house On is false	Set webcam for front of the house On to false
Edit Remove	Yes	water drain on	lawn sprinkler Status is true	Set water drain Status to true
Edit Remove	Yes	water drain off	lawn sprinkler Status is false	Set water drain Status to false
Edit Remove	Yes	ac on	air condition On is true	Set window for bedroom On to false
Edit Remove	Yes	garage door on	motion detector for garage door On is true	Set garage door On to true
Edit Remove	Yes	garage door off	motion detector for garage door On is false	Set garage door On to false
Edit Remove	Yes	some one have in the living room	motion detector for the living room On is true	Set light for living room Status to On Set fan living room Status to High Set webcam for living room On to true Set window for living room On to true
Edit Remove	Yes	if no one have in the living room	motion detector for the front of the house On is false	Set light for living room Status to Off Set fan living room Status to Off Set webcam for living room On to false Set window for living room On to false
Edit Remove	Yes	when wind is so high	wnd detector Wnd is true	Set window for living room On to false Set window for bedroom On to false
Edit Remove	Yes	some one in the front of the door of living room	motion detector for the door of the living room On is true	Set door living room Lock to Unlock
Edit Remove	Yes	if no one in the front of the door of living room	motion detector for the door of the living room On is false	Set door living room Lock to Lock
Edit Remove	Yes	some one in the front of the door of bed room	motion detector for the door of the living room On is true	Set door- bed room Lock to Unlock
Edit Remove	Yes	some one have in the bed room	motion detector for the bed room On is true	Set window for bedroom On to true Set light for bedroom Status to On Set fan bed room Status to High
				Set window for bedroom On to false Set air condition On to false

Figure 2.11: All the conditions.

Chapter 3

Performance Evaluation

3.1 Simulation Environment/Simulation Procedure

The simulation was performed using Cisco Packet Tracer to model the IoT-Smart Home system. The simulation included:

- Setting up routers and switches with DHCP and EIGRP configurations.
- Connecting IoT devices to the network.
- Testing device behavior based on automation logic.

3.1.1 Testing Scenarios

- Motion detection triggers lights and cameras.
- Smartphone app controls device states.
- Network stability and speed under varying loads.

3.2 Results Analysis/Testing

In our smart home we are taking the front of the house, living room, bedroom, garage, and kitchen and also making them automated. We are using the server for the main connection, and to connect the smartphone, we are using the router for routing.

Front of the House: In the front of the house we have:

- Motion sensor
- Webcam
- Wind Detector
- Street Lamp

- Lawn Sprinkler
- Water Drain
- Car

Initially all things are off.

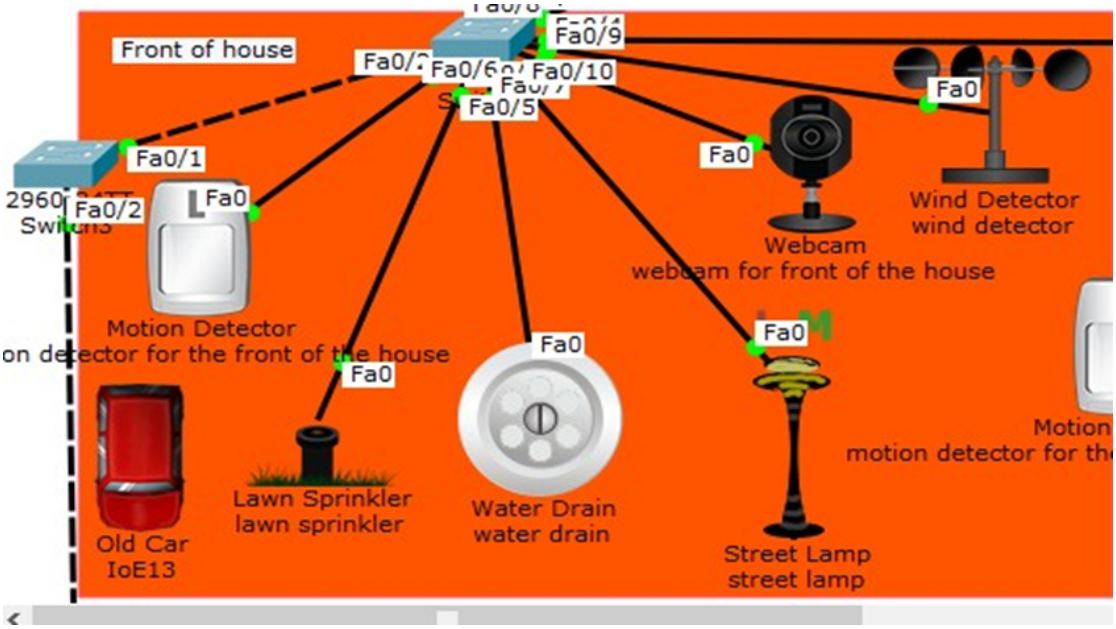


Figure 3.1: Front of the house before turned on

Living room: In the living room we have,

- Motion sensor
- Door
- Webcam
- Fan
- Window
- Light

Initially all things are off .

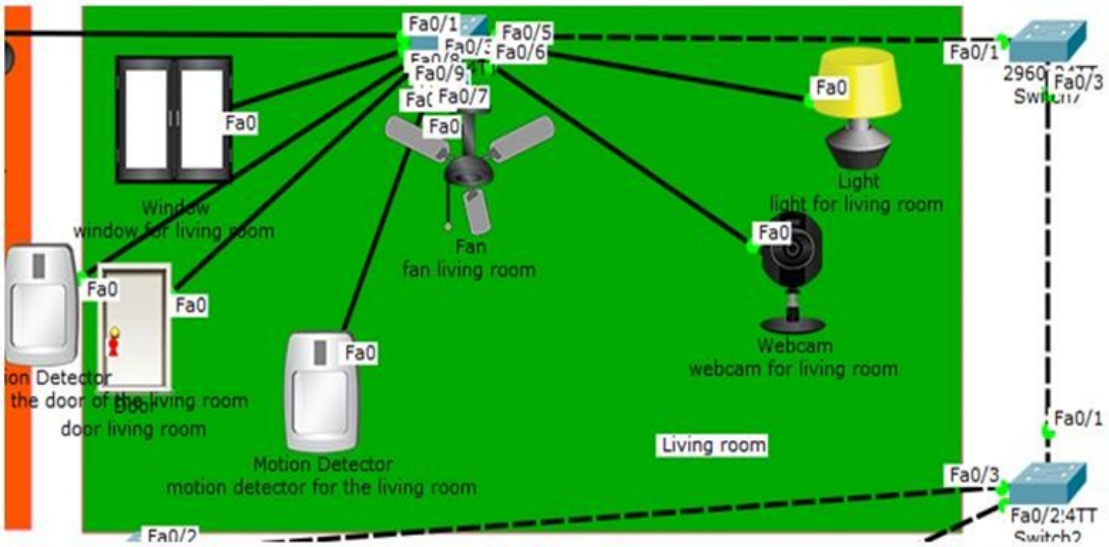


Figure 3.2: Living Room

When the motion happens in front of the door of the living room, the door itself is open automatically. After entering the room, the light, fan, webcam, and window will run. If it needed, then the user can control light, fan by his smart phone. When we will be out of the room, the lamp, fan, window, and webcam will then turn off themselves.

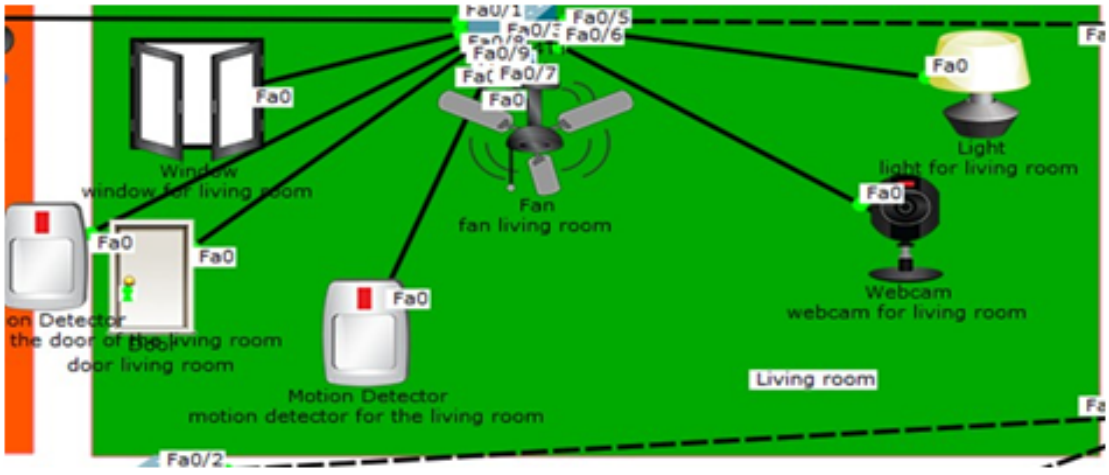


Figure 3.3: Living room fan, light, webcam is running and window is open

Bedroom: In the bedroom we are taking,

- Motion detector
- Door
- Window
- Light
- Fan

- Air conditioner

At the first point, all the IOT devices will remain turned off.

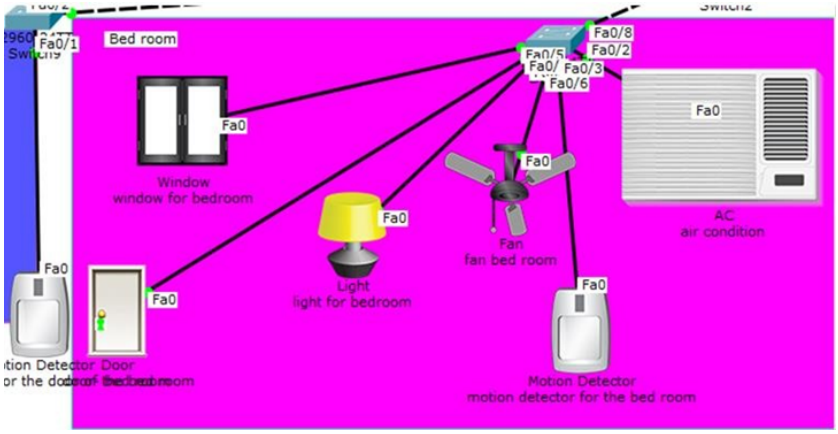


Figure 3.4: Bedroom, initial state

When the motion occurs in front of the door of the living room, the door itself is open automatically. After entering the room, light, fan, and window will run.

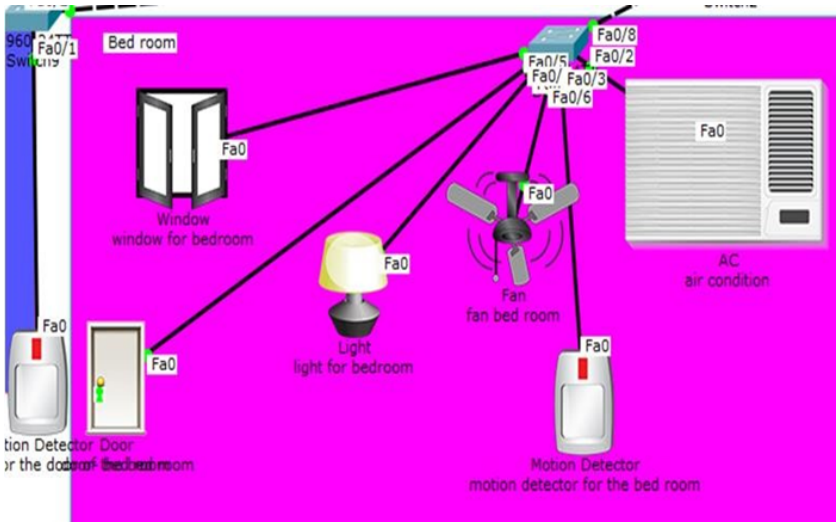


Figure 3.5: Bedroom light, fan, window ON

But when the users turn on the air conditioner, the bedroom fan and window will automatically turn off.

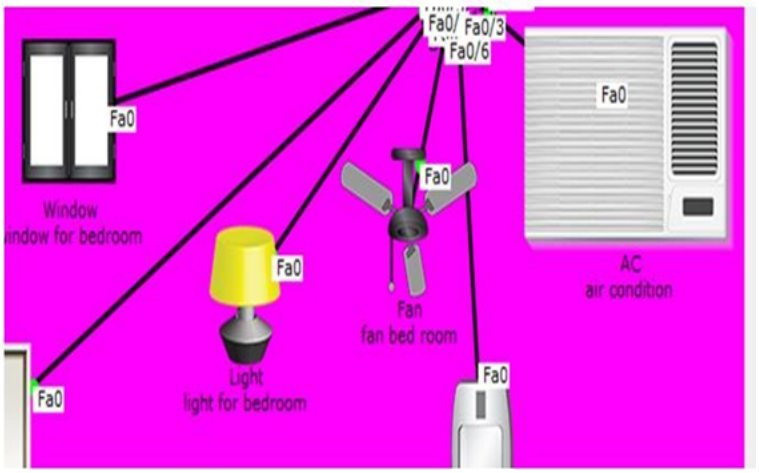


Figure 3.6: Bedroom AC on and fan, window OFF

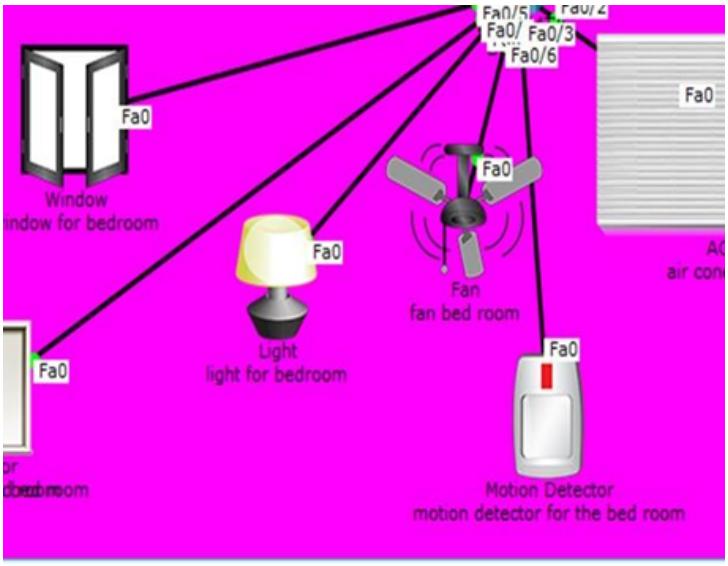


Figure 3.7: Bedroom AC OFF, fan, window ON

Garage:

- Car
- Garage Door
- Motion Detector

If the car stays in front of the garage door, the garage door will open itself.

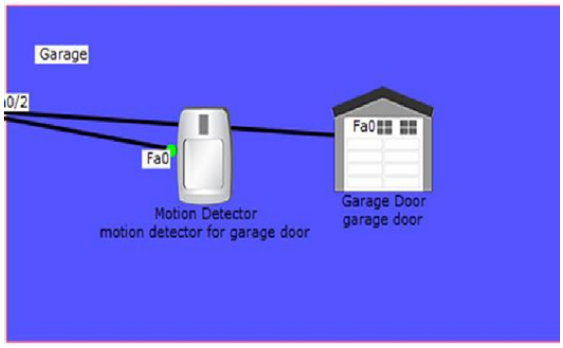


Figure 3.9: Garage door CLOSED

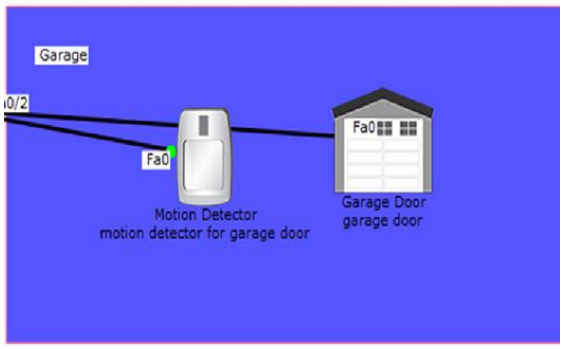


Figure 3.8: Garage door OPEN

Kitchen:

- Motion detector
- Kitchen Door
- Coffee Maker
- Other IoT devices

As in other rooms, the kitchen door will open itself. And after entering the kitchen, the coffee maker and other IOT devices will turn on as well.

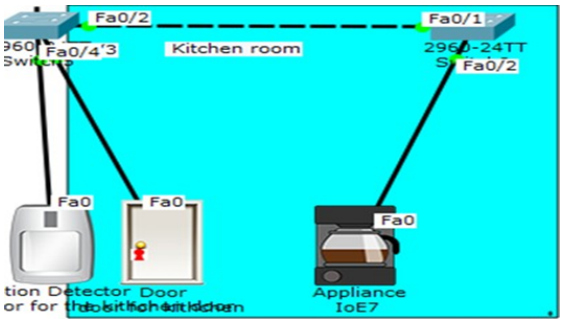


Figure 3.10: Kitchen: initial state

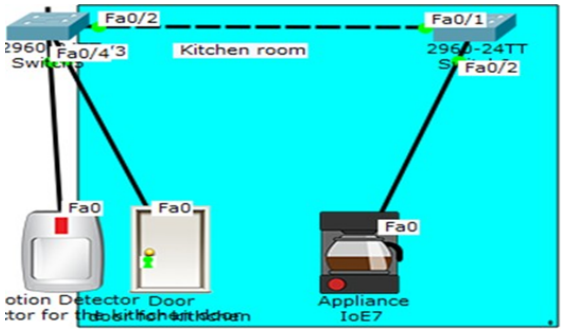


Figure 3.11: Every device of the kitchen is turned ON

3.3 Results Overall Discussion

The system achieved all its objectives with efficient automation, security enhancement, and energy optimization. Minor latency was observed in network communication under high loads. Further optimization of network configurations could address the latency issue and improve efficiency under heavy loads.

Chapter 4

Conclusion

4.1 Discussion

This project successfully showed a properly working Internet of Things (IoT)-based smart home system that combines several devices to automate different tasks, improve security, and minimize energy use. The implementation showed how easily IoT devices and network configurations can work together to give users simplicity and manage them via a smartphone application. During testing, the system's reliability and flexibility of use were shown, making it an acceptable choice for modern-day life. These results also point to a great deal of promise for improving home security and energy efficiency in practical applications.

4.2 Limitations

While the project successfully met its objectives, it also highlighted certain limitations:

- **High Initial Setup Costs:** The cost of IoT devices, sensors, and networking hardware is substantial, making the system less accessible for budget-conscious users.
- **Limited Scalability:** The system is currently dependent on specific hardware configurations, which limits its capacity to easily connect new devices or adapt to a variety of situations.
- **Network Latency:** During testing, minor latency was observed under heavy device loads, which could impact the performance of time-sensitive applications, such as real-time surveillance or critical automation tasks.
- **Power Dependence:** The system relies heavily on continuous power supply and internet connectivity, making it vulnerable to outages or disruptions.
- **Security Risks:** Even with the implementation of basic security measures, IoT systems are still vulnerable to cyberattacks, requiring the use of stronger defenses.

4.3 Scope of Future Work

To enhance the system's capabilities and address its limitations, future developments could focus on the following areas:

- **Expanding Device Compatibility:** Integrate support for a broader range of IoT devices and platforms to make the system more flexible and adaptable for diverse use cases. This could include devices from various manufacturers and emerging IoT standards.
- **Improving Security:** Implement advanced security measures, such as end-to-end encryption, multi-factor authentication, and anomaly detection systems, to protect user data and devices from cyberattacks.
- **Cost Reduction:** Develop cost-effective solutions by exploring the use of affordable and low-power IoT devices, along with optimizing the network infrastructure for efficiency without compromising functionality.
- **Voice and AI-based Control:** Introduce AI-driven automation and voice recognition technologies, allowing users to control and interact with the system naturally and intuitively.
- **Improved Scalability:** Redesign the architecture to allow easy integration of additional devices and functionalities without significant reconfiguration, allowing the system to grow with user needs.
- **Resilience to Outages:** Incorporate backup power options and offline operational capabilities to ensure continuous functionality during power or internet outages.
- **Environmental Monitoring:** Add features for monitoring air quality, humidity, and temperature to enhance comfort and safety within the home.
- **Integration with Smart City Infrastructure:** Expand the scope of the system to communicate with smart city frameworks, enabling coordinated energy management, traffic control, and emergency response systems.

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