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Designing and Implementing Smart Home Using Packet Tracing Tool

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ABSTRACT

Technology plays a major role in all daily activities of the present day. The necessity for the development of technology is to lead human life more comfortable. A home with up-to-date technology is known as smart home that uses currently released IoT for automation. Internet is used to connect this IoT device that allows distant monitoring and controlling of different home appliances like Air Conditioner, Sprinklers, Furnace, Smart Window etc. This can be implemented effectively using a packet tracing tool known as Cisco Packet Tracer as it offers a variety of network components that represent a real network and also allows us to configure the devices. The latest version 8.0 was used because it supports major programming languages like Python, Blocky Programming, Java Script and also supports home security features as well. The IoT smart devices are directly connected to the ports of home gateway and end devices are used for communication. This paper deals with designing and implementing smart home using Packet Tracer version 8.0.

Keywords: - IoT technology, home gateway, Internet of Things, IoT server, IoT monitor, Cisco Packet Tracer, Smart devices, DNS server, Smart home.

I. INTRODUCTION

A home that includes IoT smart objects to improve activities at home in advance and also performs automating activities without users involvement, such monitoring can be condition by different types of the sensors then ventilate based on the sensor information is called smart home, aimed to provide comfort, efficiency and to improve safety[1], [2]. Smart home provides different functions rather than providing safety, it mainly provides more automate security by using various alarm systems like siren, sending alert to the user if an issue is detected by the sensors[3]. By including various sensors in smart home system we can eliminate user involvement in tracking and operating home appliances. All smart devices are registered under the home gateway and are operated through end devices by a legitimate user[4].

The term IoT is the new Internet revolution. It was first announced in 1998 and Kevin Ashton coined the term IoT in 1999[5]. Haller et al[6] defined Internet of Things as "A place where physical things are integrated seamlessly into information network and the physical things can become active in the business process." The present Internet of Things has a capacity to depict various gadgets and sensors to interface with the web.

Fig 1.1 Concept of smart home

II. LITERATURE REVIEW

Alexandria Al-oisi in 2014 considered the connection among WSNs (wireless sensor network) and Internet of Things from ACOAP transport interconnection objects. This standard gives similarity among the interconnection of things and the remote sensing system. For doing this, the primary step is the familiarity on IOT and how sensors can be connected for collecting information taking into account of smart campus. For implementation it uses COAP (communication constrained protocol).

Ahmed Abdi conducted research on IoT in 2018 and initiated the proposal of smart university that uses technology in implementing a campus that can be simplified by replacing the campus components with the smart devices. Cisco packet tracer was utilized for designing the smart office that can be controlled by the staff with the help of their smart phones. Here the gateway allows the connection among the smart office and internet by using cloud. The main motive of this study is to enhance university in a smarter way and to enable sensors and link all devices to the network for controlling. It also permits association of sensors with devices for high standard and technology based architecture in the university (Abdi, 2018) (Marian, 2015).

Miluzzo Choudhury and A. T. Campbell carried a survey on sensors in mobile phones in 2010. The smartphone consist many built-in sensors like motion, GPS, light and sensors used for measuring pressure, humidity and temperature that can be used in many regions of IOT applications. Smart phones are mainly used for controlling IoT devices (Nicholas D. Lane, Emiliano Miluzzo, Hong Lu, Daniel Peebles, Tanzeem Choudhury, & Andrew T. Campbell, 2010) (ALFarsi, Jabbar, & ALSinani, 2018) (AlFarsi & ALSinani, 2017).

Yin Jie et al proposed the idea of smart home in 2013. He introduced architecture in which we can integrate many applications through the interface. RFID tags are used to ease the transmission among the devices. Primary issues correlated to smart home to be resolved are also involved in this research (Jie, Pie, Jun, Yun, & Wei, 2013).

Jetendra Joshi et al proposed an IoT based smart home that can access, control and monitor multiple devices by using web server from any location and at any time. For monitoring home appliances Arduino and Raspberry and was integrated with Nrf modules. The results and alarms of threats to the user are sent through web server (Jetendra , et al., 2017)

III. METHODOLOGY

For implementing smart home, Cisco Packet Tracer 8.0 variant is utilized that include IoT device with classically networking device [7] [8]. Smart home is created by using the test system which consists of brilliant gadgets, IOT server, DNS server, IOT cloud, cell tower, central office server, ISP server, switches, link modem and end devices. There are two servers Internet of Things server and Domain Name server. The IOT server stores all the recognized data from the working environment and gives customers an endorsed access to the advantages by entering username and password.

3.1 Conceptual Framework

The layout design of smart home prototype is designed on My Sweet Home 3D software based on the requirements. The prototype design includes master bedroom, bedroom 1, bedroom 2, toilet 1, toilet 2, kitchen, living room, and a porch.

Fig 3.1(a) Smart Home 2D Plan

Fig 3.1(b) Smart Home 3D View

Fig 3.1(c) Smart Home 3D Front View

Fig 3.1(d) Smart Home 3D Top View

Fig 3.1(e) Smart Home 3D Left Side View

Fig 3.1(f) Smart Home 3D Right Side View

3.1.1 Algorithm

Steps for implementing smart home are as follows:

Step 1: Start the project.
Step 2: Open the .pkt extension file and save the file.
Step 3: Add the required components to the work space.
Step 4: Connect all devices in work space using cables.
Step 5: Configure the device and setup internet service provider router.
Step 6: Add Home gateway to the network.
Step 7: Connect smart Devices to the home gateway.
Step 8: Add end user device to the network.
Step 9: Automate the activities in smart home.
Step 10: Test your simulation.
Step 11: Stop.

3.1.2 Flow Chart

The flow chart is explained as follows:

3.1.2 Flow Chart Representation

3.2.1 Home Gateway

The IoT smart devices can directly register with the Home gateway IoT service or network database. It offers a wireless service on channel 6 that is provided with the SSID (service set identifier) and 4 Ethernet ports[9]. We can also setup WEP/WPA-PSK/WPA2 passphrase to wireless links for safer connections. The fig 3.2.1(a) indicates that the smart objects are associated to the home gateway by Wireless medium for local and remote control of smart devices. The home gateway is connected through WAN Ethernet port to the internet[10]. We can easily manage the IoT system with the help of home gateway and web interface. The internal IP address for the Home gateway is 192.168.25.10, can also be reached via its IP address in front of the Internet. Home portal can also be used as a DHCP server assigns IP addresses to any, connected smart device[11].

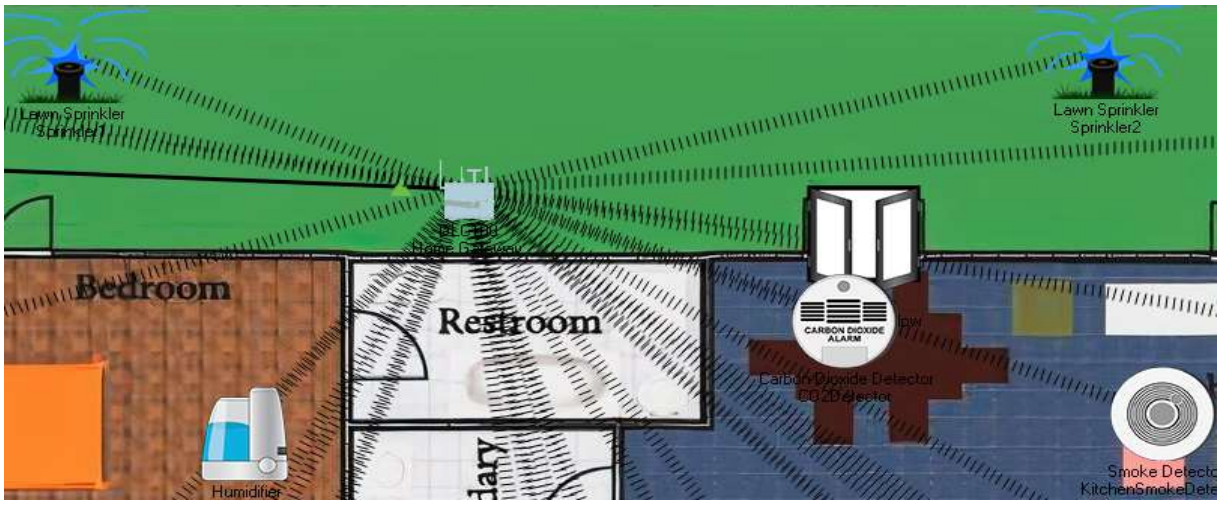

Fig 3.2.1(a) Home gateway with associated Smart objects

Fig 3.2.1(b) Home gateway ports

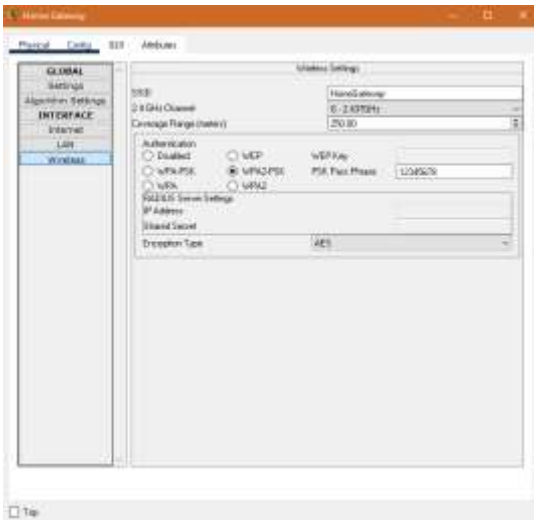

Fig 3.2.1(c) Home gateway Configuration

3.2.2 Smart Phone

In The Smartphone desktop we can found IoT Monitor icon fig 3.2.2(a). The IOT monitor displayed all IoT devices as we see in fig 3.2.2(c) and we can change IoT devices status as we see in fig 3.2.2(d).

Fig 3.2.2(a) Smartphone desktop

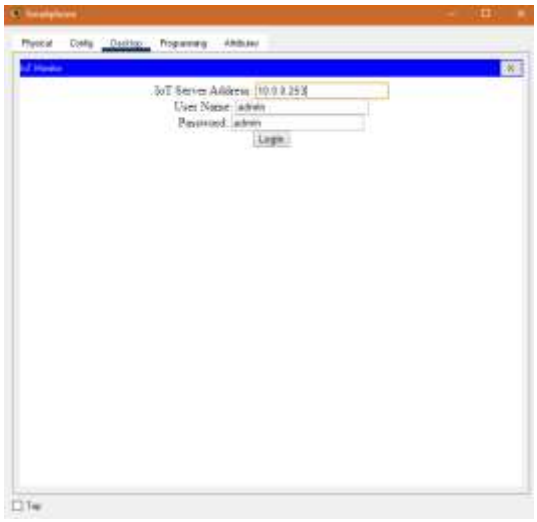

Fig 3.2.2(b) Smartphone IoT Login page

Fig 3.2.2(c) List of IoT Monitoring devices

Fig 3.2.2(d) Status of IoT devices

3.2.3 IoT Server Registration

To login into server we can create username and password figure 3.2.3(b), and we can display the username and password in Services – IoT as shown in the figure 3.2.3(d).

Fig 3.2.3(a) IoT server registration ports

Fig 3.2.3(b) Creating an account to register devices

Fig 3.2.3(c) User credentials verification

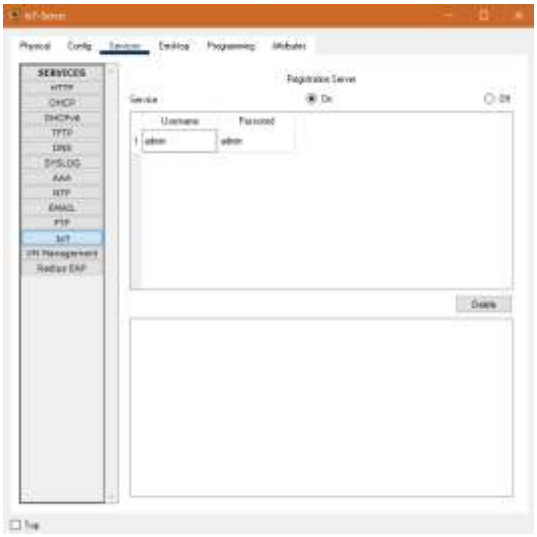

Fig 3.2.3(d) Registration Server for IoT services

3.2.4 IoT Device Registration

This server provides IOT services to the users present at remote. All the IoT smart devices are connected and registered to the the IoT server. To get the service and to control the devices, user needs to login the IoT server by entering username and password. Ip address (10.0.0.253) and its URL(www.ioe.org) of IoT server is entered in the DNS server(having ip address 10.0.0.254) of network. The smart devices were remotely connected to the IoT server sharing the same username and password credentials. Connection also was established by using the static IP of the IoT server hosted in the same IoT network as shown in figure 3.2.4(a) and figure 3.2.4(b).

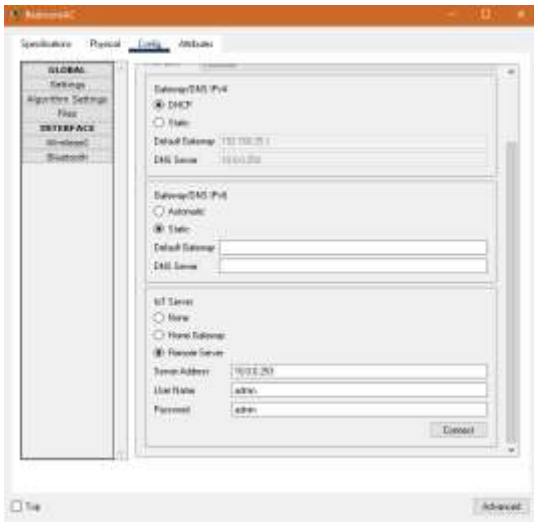

Fig 3.2.4(a) Registration of device

Fig 3.2.4(b) IoT monitoring in server

IV. IMPLEMENTATION

For implementing smart home I used different sensor, smart device and detector to make smarter. The following figure represents the home architecture that connected each other using wireless and wired medium.

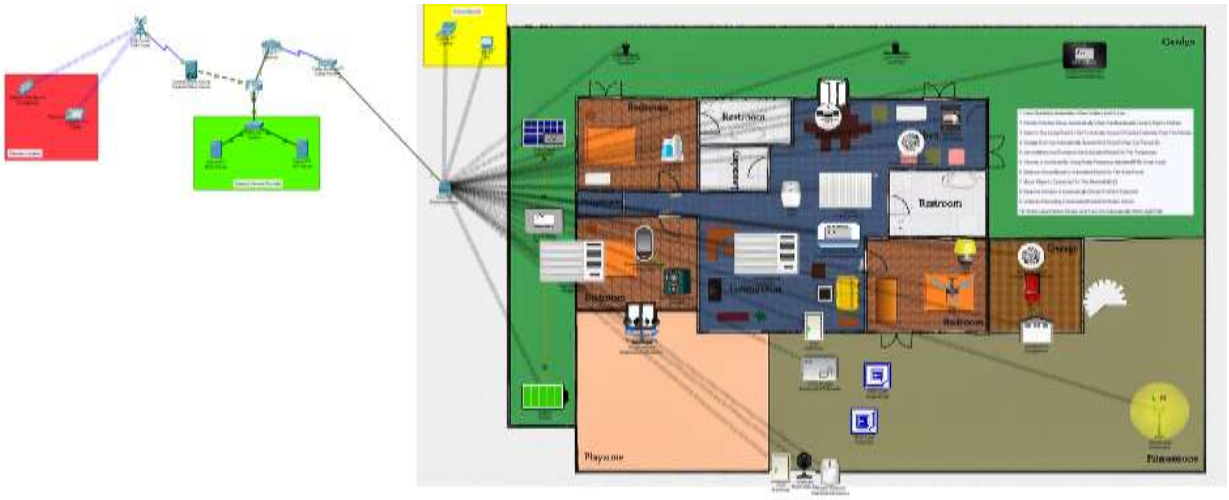

Fig 4 Smart home architecture

4.1 Device Configuration

Assigning hostname and Ip address for ISP router:

```
Router>
Router>enable
Router#conf term
Router(config-if)#int g0/0
Router(config-if)#ip address 10.0.0.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#int g0/2
Router(config-if)#ip address 209.165.201.225 255.255.255.224
Router(config-if)#no shutdown
Router(config-if)#int g0/1
Router(config-if)#ip address 209.165.200.225 255.255.255.224
```

Router(config-if)#no shutdown
Router(config-if)#exit

Configurating dhcp server for cell and Home Gateway:

Router(config)#ip dhcp excluded-address 209.165.201.225 209.165.201.229
Router(config)#ip dhcp pool CELL
Router(dhcp-config)#network 209.165.201.224 255.255.255.224
Router(dhcp-config)#default-router 209.165.201.225
Router(dhcp-config)#dns-server 10.0.0.254
Router(dhcp-config)#exit
Router(config)#ip dhcp excluded-address 209.165.200.225 209.165.201.229
Router(config)#ip dhcp pool WAN
Router(dhcp-config)#network 209.165.200.224 255.255.255.224
Router(dhcp-config)#default-router 209.165.200.225
Router(dhcp-config)#dns-server 10.0.0.254
Router(dhcp-config)#exit

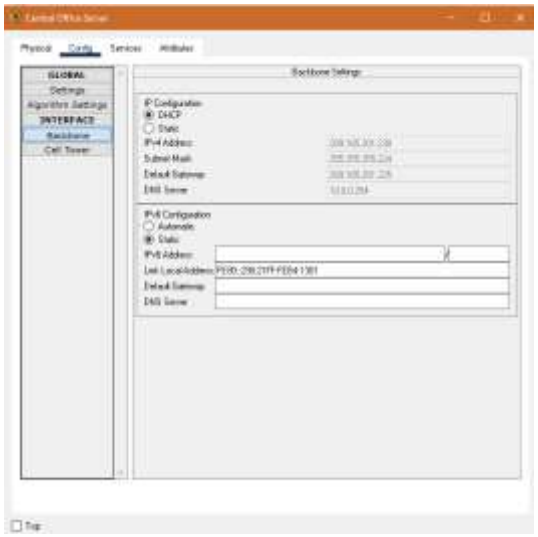

Fig 4.1(a) ISP server provides IP to Central office server

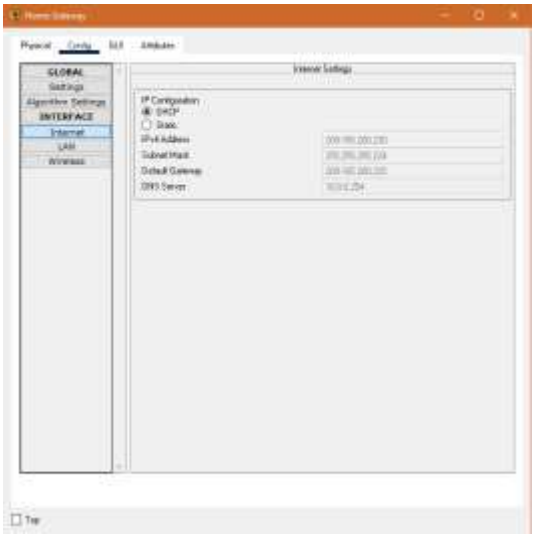

Fig 4.1(b) ISP server provides IP address address to Home gateway

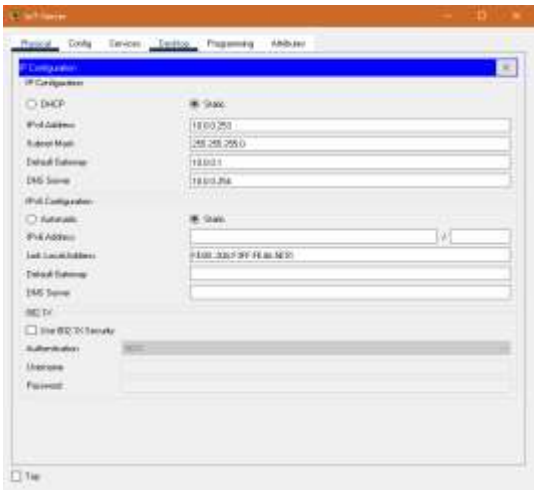

Fig 4.1(c) IP configuration of IoT server

4.2 Connect all IOT devices one by one to the home wireless

Steps for connecting IoT devices with home gateway wireless:

Step 1: Click on the IOT device.

Step 2: Go to advanced setting.

Step 3: Go to the I/O config.

Step 4: Select PT-IOT-NM-1W(for wireless connection).

Step 5: Go to config.

Step 6: Select wireless(in wireless connection).

Step 7: Enter passkey of the wifi network.

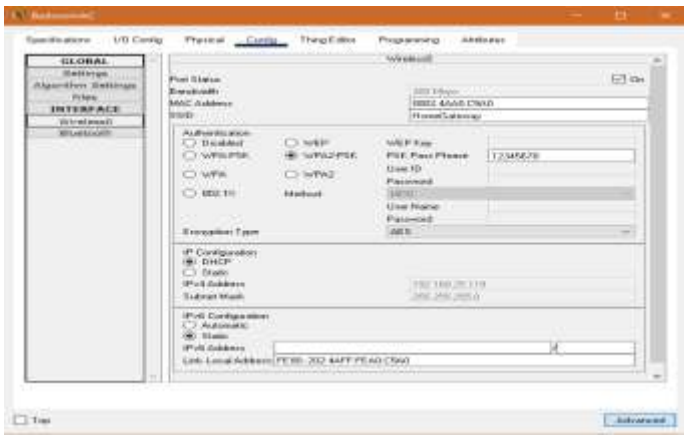

Fig 4.2 Connection of devices through home gateway

4.3 Register all IOT devices in IoT server

Steps for registering IoT devices in IoT server:

Step 1: Click on the IoT devices.

Step 2: Click on the config.

Step 3: Enter IOT server IP address, username, password.

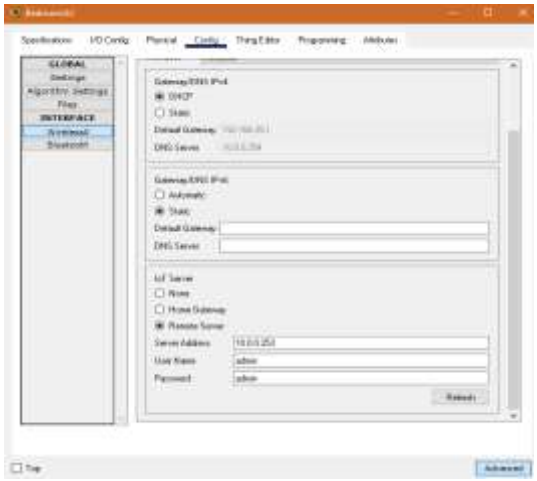

Fig 4.3 Registration of IOT devices in IoT server

4.4 Enable DNS services like HTTP, DNS

Steps for enabling DNS services like HTTP, DNS:

Step 1: Click on the DNS server.

Step 2: Click on the service.

Step 3: Enable different services like HTTP, DNS etc.

Fig 4.4 Enabling DNS service

4.5 Assign IP addresses to DNS and IoT server statically

Steps for assigning IP address to DNS server statically:

Step 1: Click on the DNS server.

Step 2: Click on the config.

Step 3: Select static.

Step 4: Assign IP address to DNS server.

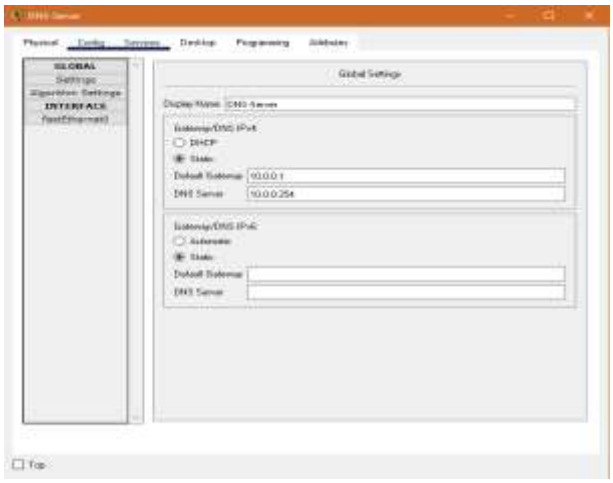

Fig 4.5(a) Assigning IP address to DNS server

Steps for assigning IP address to DNS server statically:

Step 1: Click on the IoT server.

Step 2: Click on the config.

Step 3: Select static.

Step 4: Assign IP address to IoT server.

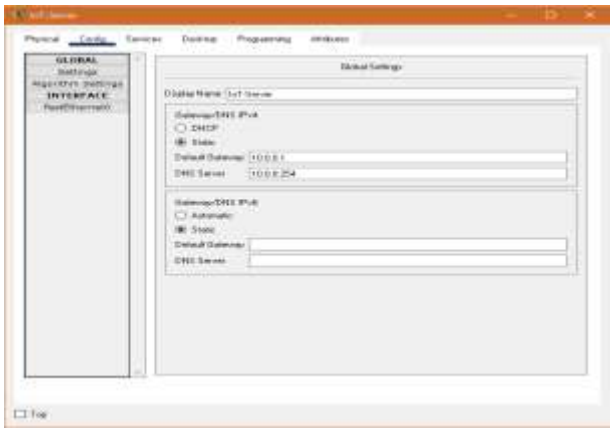

Fig 4.5(b) Assigning IP address to IoT server

4.6 Monitoring and controlling IoT devices through remote devices

Steps for controlling and monitoring IoT devices:

Step 1: Click on the remote device like smartphone, laptop, tablet or PC.

Step 2: Select IoT monitor application from the device desktop.

Step 3: Register if new user and enter IP address and login credentials.

Step 4: Control and monitor your IoT devices.

Fig 4.6(a) Applications on PC desktop

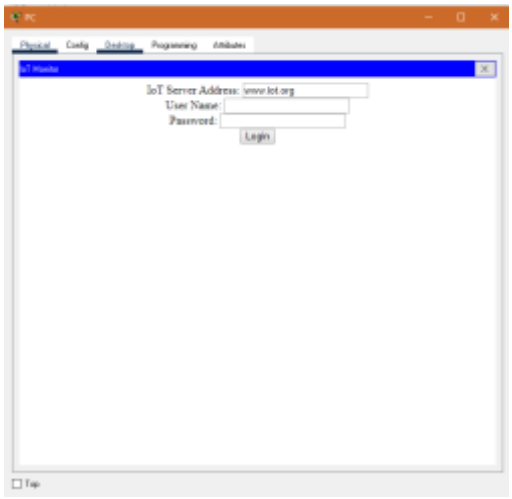

Fig 4.6(b) IoT server login through PC

Fig 4.6(c) IoT Server Web page

Fig 4.6(d) IoT server login with user credentials

Fig 4.6(e) Monitoring, controlling IoT devices

Fig 4.6(f) Conditions for automation

4.7 List of components used for implementation

S.no	Device	Function
1	Central office server	Used for connecting cellular system to the router.
2	Router	Used to interconnect home with cellular network.
3	Cable modem	Used for connecting home with internet.
4	IoT server	To control registered smart IoT devices.
5	End devices	Connect to home getaway to access smart object.
6	Home Gateway	Used for registering and providing IP address for IoT devices.
7	Fan	Used for ventilation.

8	Webcam	Records the environment.
9	Siren	Alerts for an event in home.
10	Light	Provide light.
11	Motion detector	Detects a motion.
12	Smart door	Connect to home gateway and provides function based event.
13	Cell tower	Provide coverage for user to control home appliance from remote area.
14	Co2 detector	Detects level of co2 in the home.
15	Water level monitor	Used for detection of water level.
16	Lawn sprinkler	Used to sprinkle water.
17	Smoke sensor	Used for sensing the level of smoke.
18	Bluetooth speaker	Used to simulate when connected to bluetooth supported device.
19	Temperature sensor	Used for sensing the temperature.
20	Old car	Used to simulate different scenario in home design since it affect, co, co2 and smoke level.
21	Air Conditioner	Used to cool the home.
22	Smart window	Controlling the window remotely.
23	Wind detector	Detects wind in the environment.
24	Music player	Plays music through Bluetooth capabilities.
25	Humidifier	Controls humidity in the atmosphere.
26	Power meter	Read the power being transmitted on a line.
27	Battery	Send power to other devices.
28	Furnace	Produces hot temperature inorder to reduce cold temperature
29	RFID Reader	Read the ID of an RFID Card.
30	RFID Card	Interacts with the RFID reader.
31	Solar Panel	Generates power when exposed to sun rays.

V. RESULTS

The smart home environment offers automation along with smart control and monitoring of smart devices:

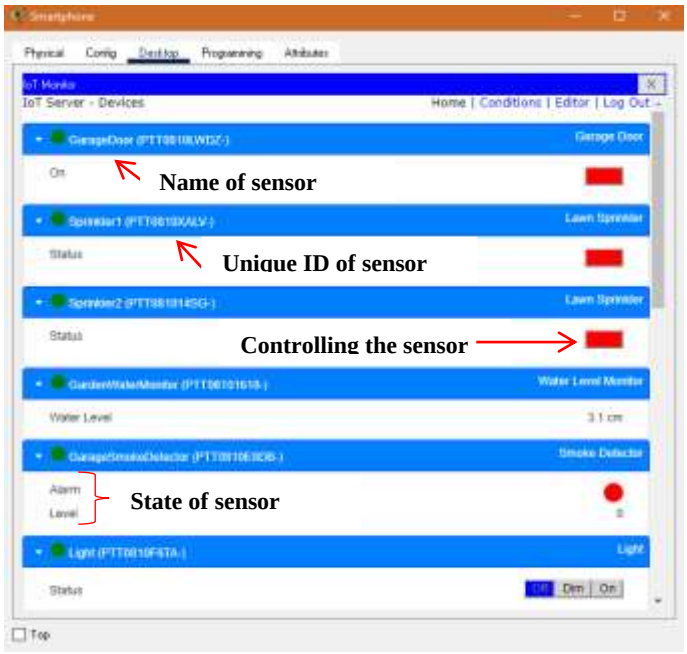

Fig 5 Monitoring and controlling smart devices

1. Lawn sprinklers automation when water level is low.

Fig 5.1 Lawn sprinkler on and off based on the water level

The fig 5.1 shows the lawn sprinkler is set to on based on the condition made on Home gateway that is if water level is more than 5 cm the lawn sprinkler on else off.

2. Kitchen window opens automatically when carbondioxide level is high in kitchen.

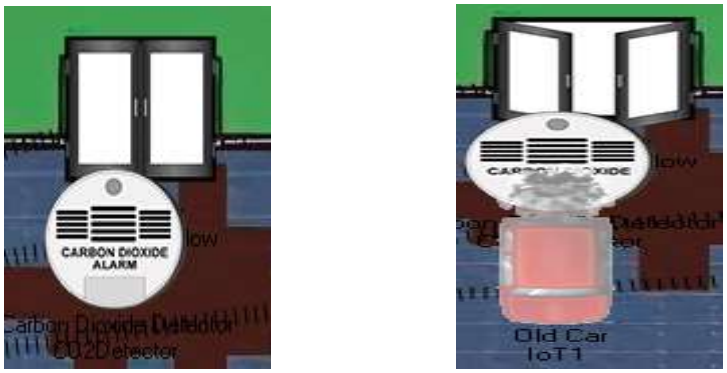

Fig 5.2 Kitchen window open and close based on the co2 level

The figure 5.2 shows the window is opened when the carbondioxide is detected. To detect carbon dioxide, carbon dioxide detector is used. For the simulation scenario an old car is used due to lot of problem by increasing the co2.

3. Siren in the living room is set to activate incase of smoke detection from the kitchen.

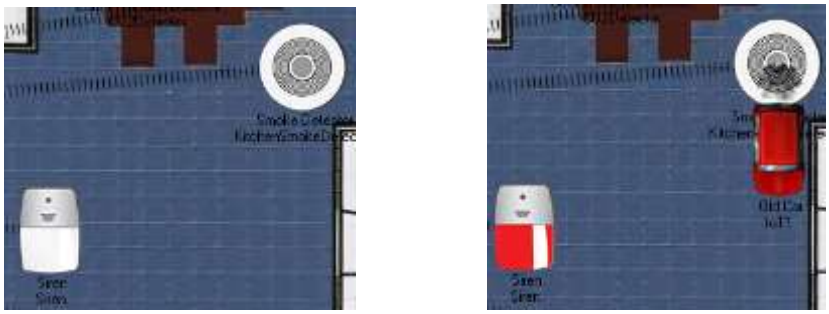

Fig 5.3 Siren in the living room is set to on when smoke level is increased in the kitchen

The figure 5.3 shows the siren is on when the smoke level in the kitchen increases to prevent the fire accidents. To detect smoke, smoke detector is used. For simulation scenario an old car is used.

4. Garage door is automatically opened and closed when car passes.

Fig 5.4 Garage door automation based on the smoke level

The figure 5.4 shows garage automation when the smoke level is 0.01 .When the smoke level reaches to its extent the garage door automatically opens.

5. Air Conditioner and Furnace are automated based on the temperature.

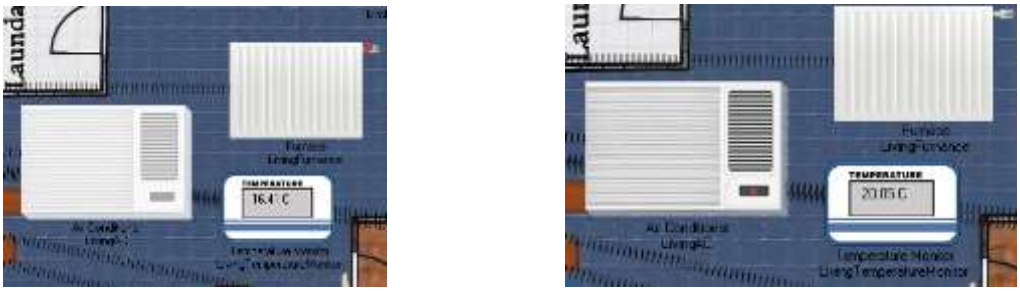

Fig 5.5 Automation of Air conditioner and Furnace based on the temperature

In figure 5.5 when the living room temperature is above 20 C air conditioner is automatically power on and when the temperature is below 20 C furnace is switched on.

6. Security is increased by using Radio Frequency Identifier(RFID) smart cards

In figure 5.6 I have used RFID reader for extra security. If the RFID card is original only we can access the main door. A fake RFID card does not permit inside the main door.

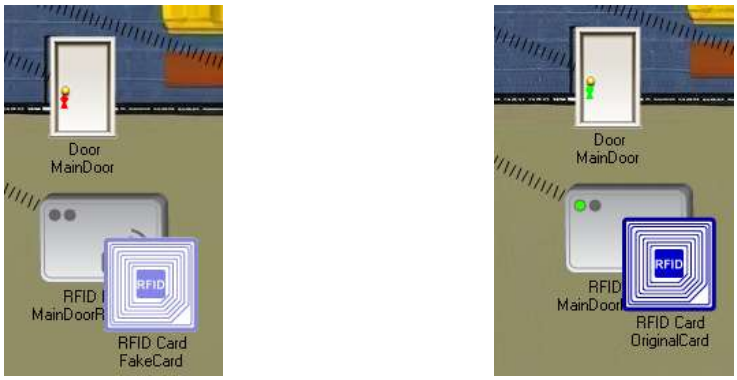

Fig 5.6 Automation of Air conditioner and Furnace based on the temperature

7. Bedroom Air Conditioner is automated based on the solar power.

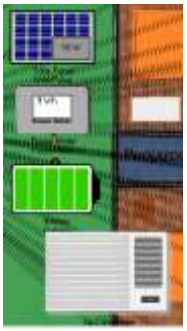

Fig 5.7 Bedroom Air Conditioner is power on based on the solar power generated through solar panel

In figure 5.7 if the battery level is greater than 20% the Air Conditioner switches on. Here the solar power is transmitted to the battery.

8. Music player is connected to the bluetooth(BLE)

Fig 5.8 The portable music player is connected to the Bluetooth speaker, plays music through Bluetooth speaker

In figure 5.8 we had a bluetooth connectivity to the bluetooth speaker from the portable music player.

9. Bedroom window is automatically closed if wind is detected.

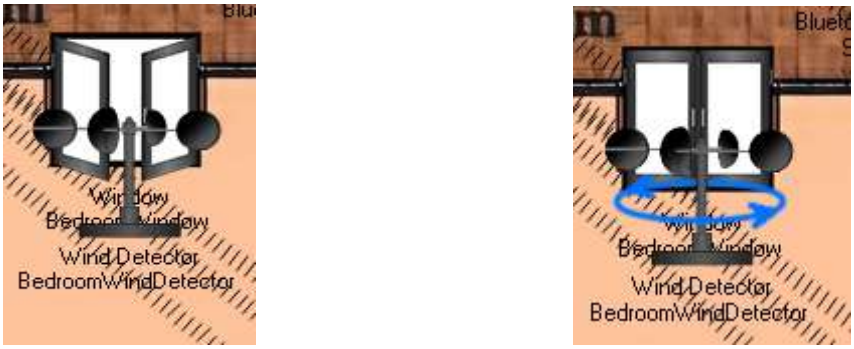

Fig 5.9 Bedroom window automatically closes if wind is detected by the wind detector

The figure 5.9 shows the bedroom window is closed when the wind detector placed at the window nearby detects wind flow.

10. Webcam recording is automated based on motion sensor.

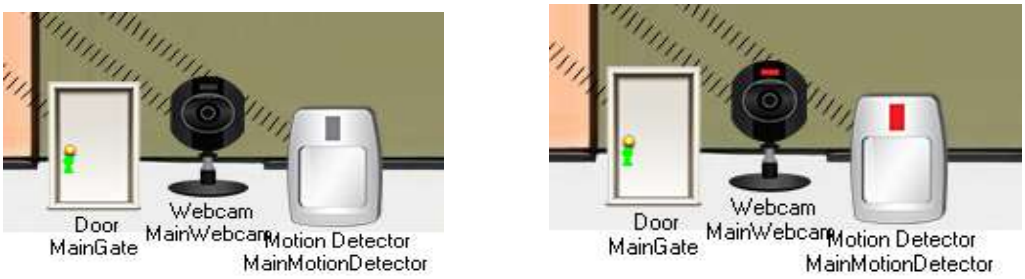

Fig 5.10 Webcam started recording when motion is detected

The figure 5.10 for intruder detection, the web cam automatically starts recording when motion is detected.

11. Street lamp detects motion and turns on automatically when light falls

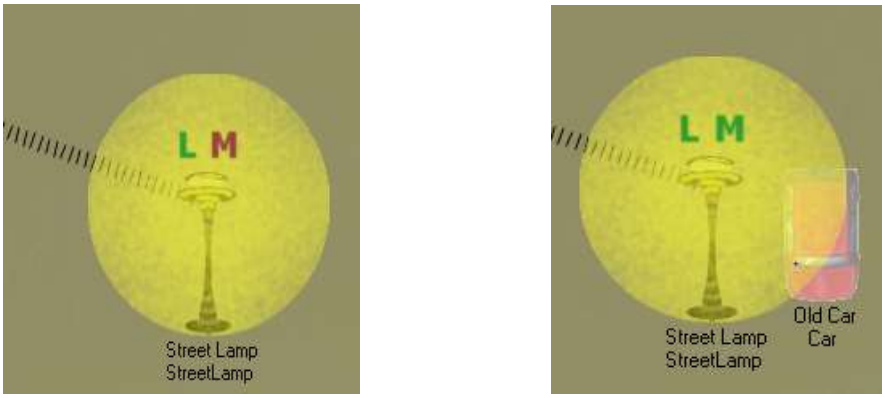

Fig 5.11 Street Lamp that has both light and motion detection

The figure 5.11 the street lamp automatically goes on when the light falls and also capable of motion detection.

VI. CONCLUSION AND FUTURE WORK

The main aim of this paper was to design and implement IoT based home automation system. The motivation behind the work is due to the innovative technology and hike in smart device usage. The security measures are very expository and IoT technology makes our surroundings more smart. In this paper cisco packet tracer is utilized provides various opportunities for making simulation easy. The netcad sessions and previous research analysis are very beneficial for the implementation process of smart home. From the outcome of the paper we can convey that the IoT devices can be monitored and controlled through end devices of the user and there is a chance to apply this smart home model in real life.

Cisco packet tracer also includes microcontroller that can be used to make communication between devices. We can use python or java script language to program the microcontroller. in this way if a microcontroller is used in the IOE system then work will be more faster and reliable.

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