Wireless Data Networks 2021

Assignment

Monitoring Greenhouse Conditions

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Chapter 1: Introduction

Green houses are used to plant and grow selected plant varieties under controlled environments. Greenhouses monitor the extreme environmental conditions in favor of plant growth and helps maintain the environment necessary for optimal growth of plants. They can be a very useful not only to study and gather information on various plants but also to grow plants necessary for human consumption or use. With the growing needs of human's greenhouses can be considered a more productive way to produce and maintain plants which are required for specific purposes. IoT based Smart Greenhouses, primarily concerns the improvement of current agricultural practices by using modern technologies for better yield [1] and ease of maintenance. Today's technology can help us maintain these greenhouses using smarter and better techniques and technologies. Internet of Things (IoT) can be used to connect the surrounding environments to a network and build a smarter greenhouse system and automate the monitoring process of greenhouses. This will be beneficial in reducing costs, time consumption and also provide a easier control of the systems from any location on real time. Usage of different sensors as per the requirement can be used to monitor greenhouse and perform the actions according to the parameters sensed. The conditions can be predefined by the maintainer of the system so that the growth of the plant is not affected by environmental conditions.

Chapter 2: Objectives

This project is designed and implemented using Cisco Packet Tracer and a network will be formed by connecting the relevant sensors to monitor the reading of the environment. This system will have a temperature sensor to sense the environment temperature, a humidity sensor to check the humidity, a soil moisture sensor to detect the amount of water present in soil and CO_2 detector to check the concentration of Carbon dioxide present in air. Here a Solar cell is used to generate the required energy for the designed system and a smart door system is implemented to control the access to the environment [2].

The block diagram in the figure below shows the smart greenhouse based on IoT, it contains a temperature monitoring system, humidity monitoring system, fire detection system, CO_2 detection system, smart lighting system, moisture monitoring system, solar energy generator system and a smart door system. All the devices are connected using the internet and a smart phone can be used to monitor the devices in the greenhouse wirelessly.

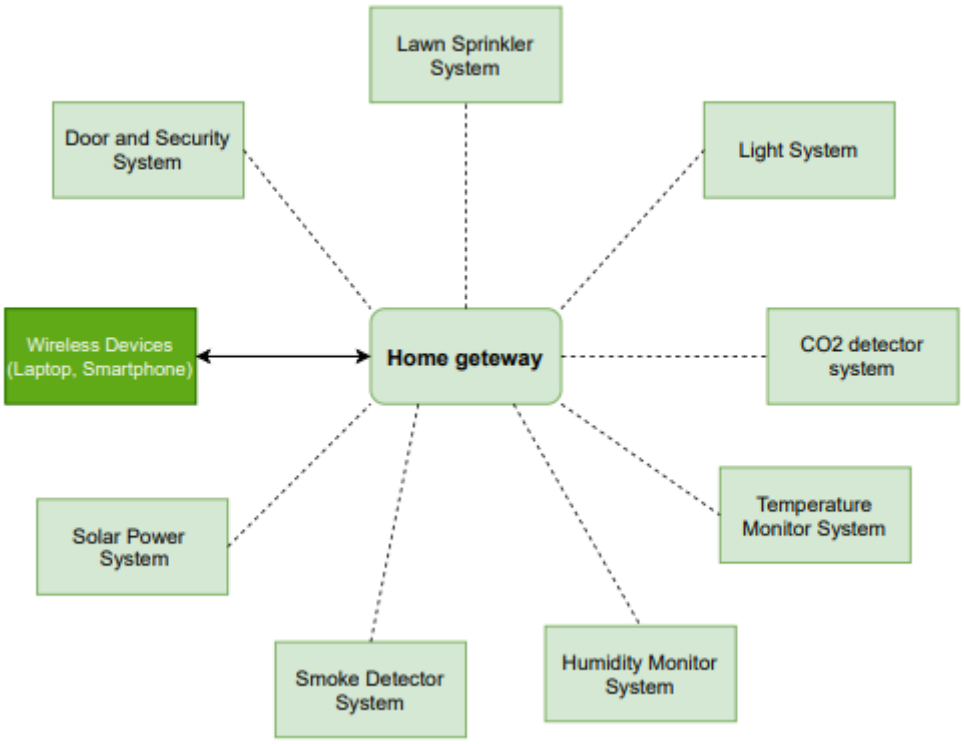

Figure 2.0.1: Block Diagram

The figure below (Figure 2) shows how the devices are monitored in the greenhouse using smartphones. The values read by sensors and the status of actuators can be monitored by the smart phones connected to the system through the home gateway.

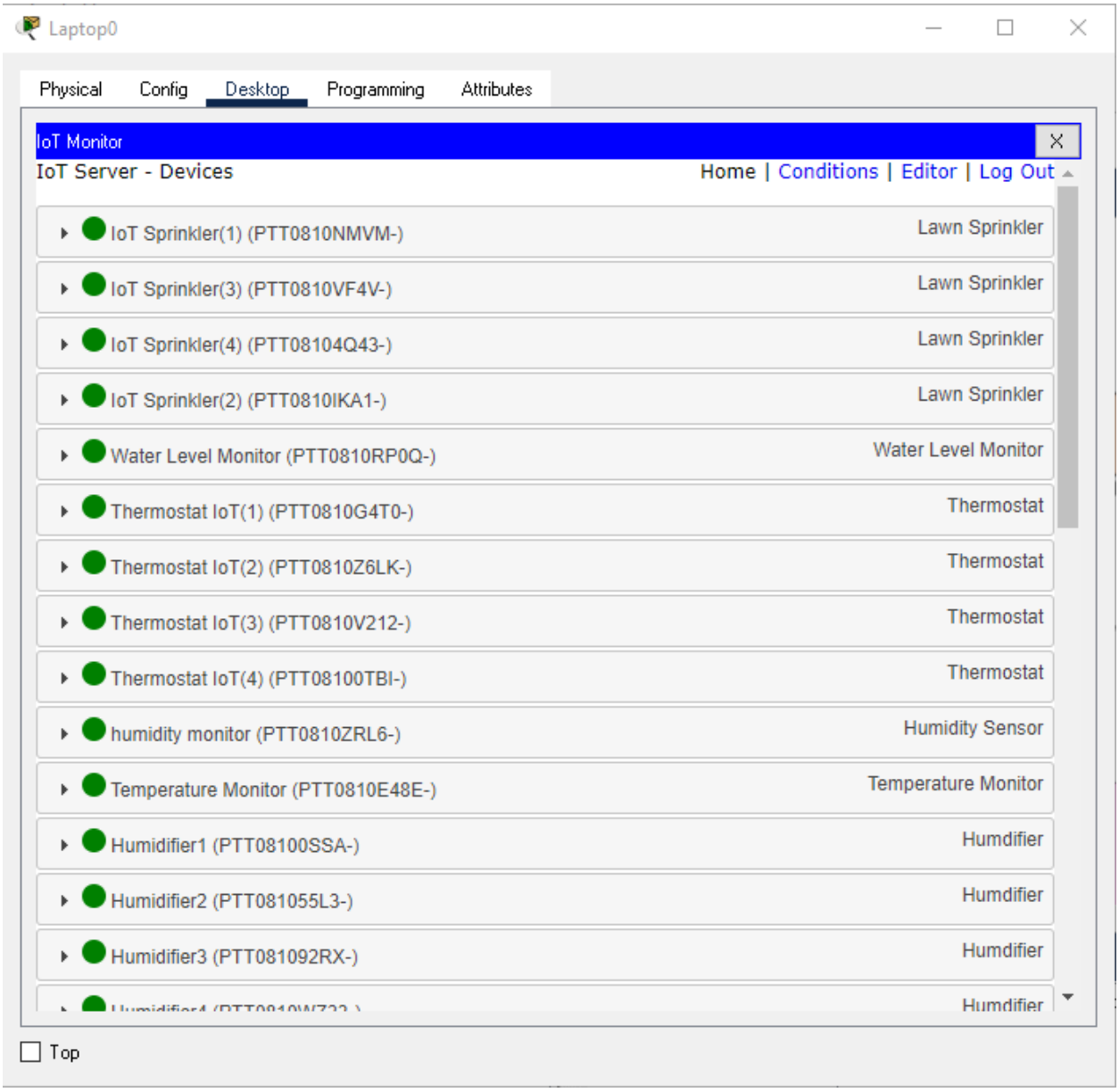

Figure 2.0.2: IoT monitoring via Laptop

2.1 Technologies Used

2.1.1 Temperature Measuring System

The temperature measuring component consists of sensors, thermostats, heating elements as well as cooling elements. The temperature sensor keeps track of the temperature of the environment and displays the reading on a connected LED display or monitor. The temperature read by the sensor is converted into appropriate form and is given as input to the thermostat which is used to control temperature in a greenhouse based on the temperature sensed by the temperature sensor. Depending on the temperature the heater is activated when the temperature falls below the preset value and the cooler is activated when the temperature is greater than the present value. The thermostat will be in the off state when the temperature inside the greenhouse is in the optimum range for the positive growth of plants within the greenhouse.

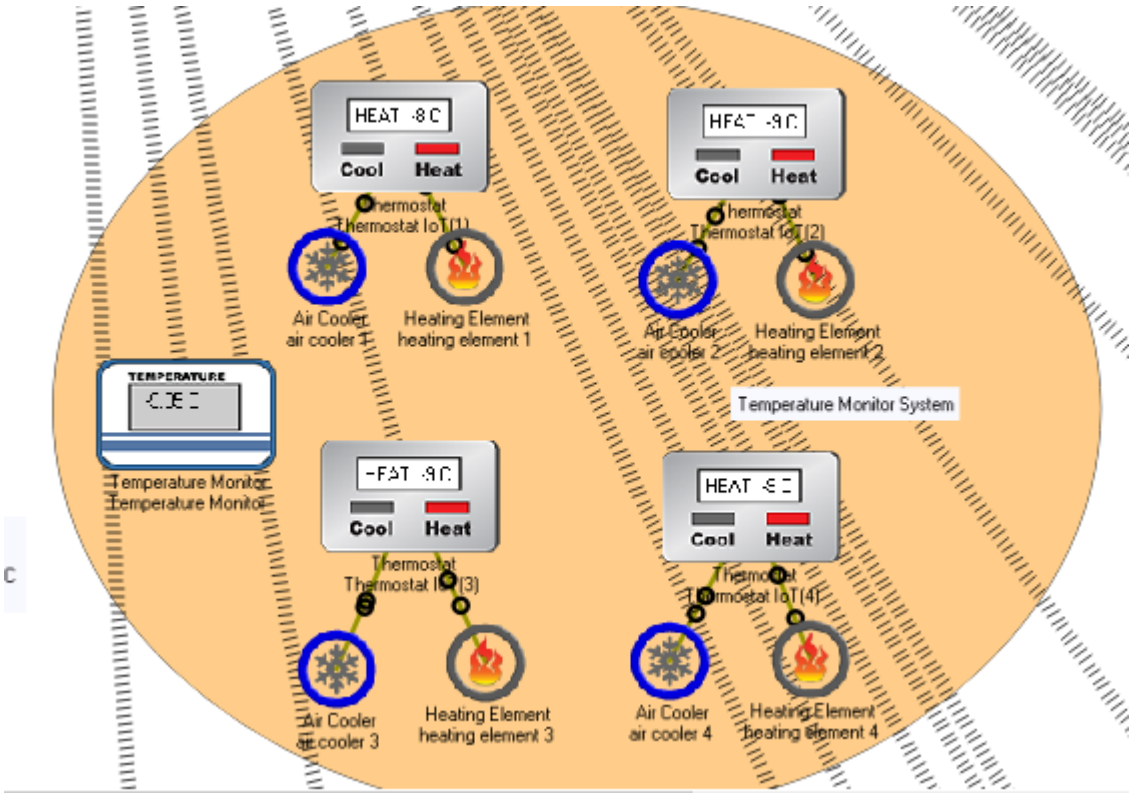

Figure 2.1.1: Temperature Measuring System

2.1.2 Humidity Monitoring System

Humidity monitoring systems consists of humidity sensors and humidifiers. The humidity sensors measure the amount of water (humidity) content present in the air within the greenhouse. The humidifier is used to maintain the moisture content in the air and is activated when the percentage of humidity within the greenhouse falls below the desired optimum values.

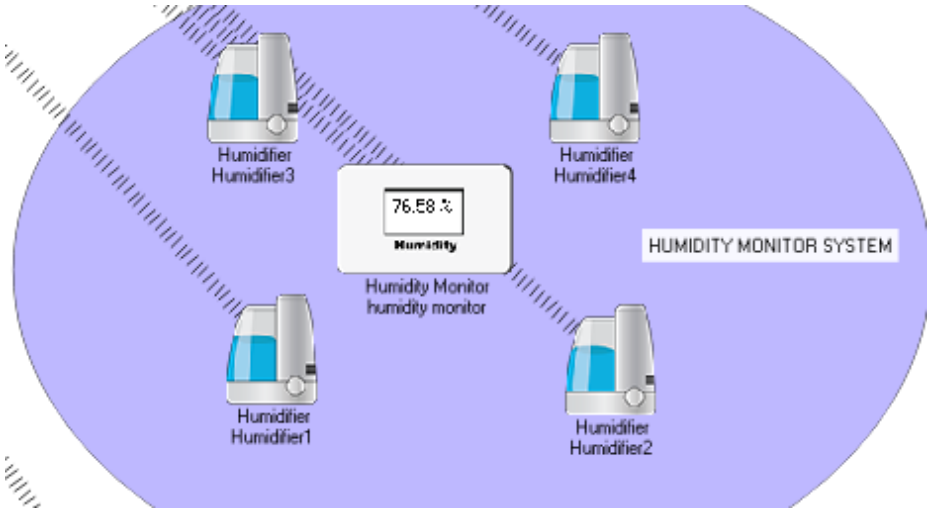

Figure 2.1.2: Humidity Monitoring System

2.1.3 Fire Safety System

The fire safety system for this greenhouse uses a smoke detection system consists of a smoke detector, fire sprinkler and a siren. A smoke detector is a device that senses the presence of smoke from a fire. As soon as the fire is detected a message is sent to the security panel and the fire alarm is activated. If there is any emergency due to fire, the sprinklers will be activated automatically as soon as the smoke detector detects any smoke.

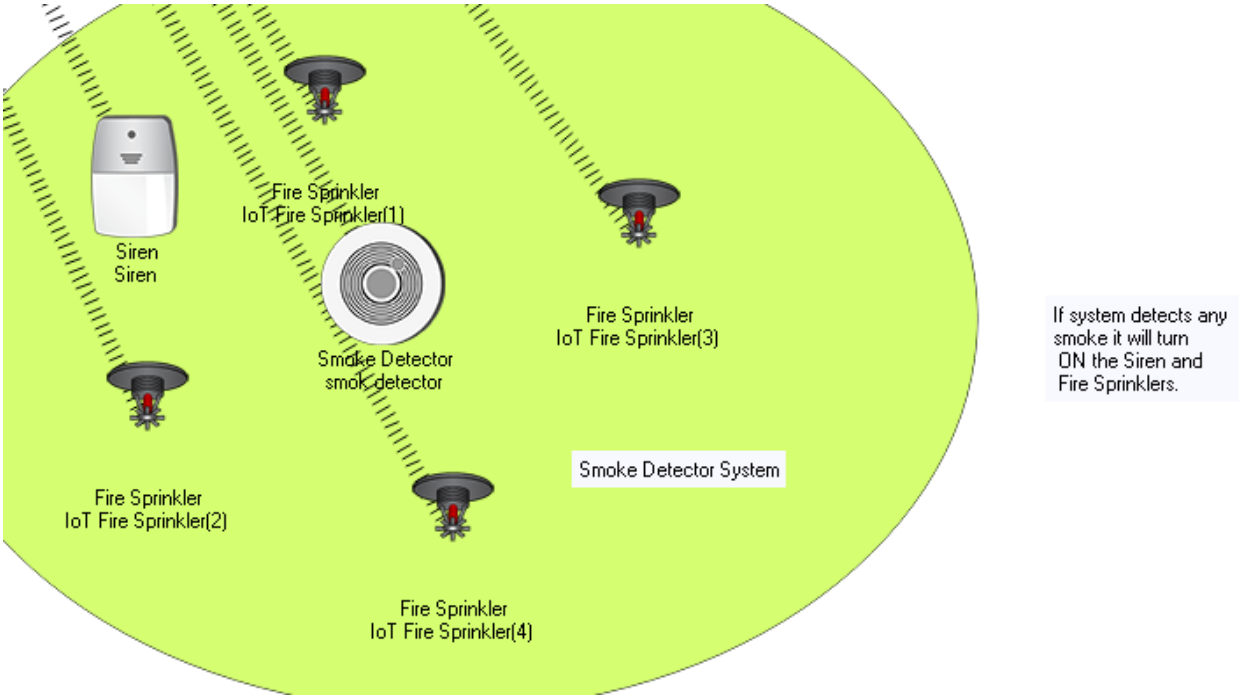

Figure 2.1.3: Fire Safety System

2.1.4 Carbon Dioxide detecting system

The Carbon Dioxide detecting system contains a CO_2 detector and an exhaust fan. A Carbon dioxide detector is a device which senses the concentration of carbon dioxide available in the atmosphere. There are basically two types of CO_2 detectors, IR and chemical sensors. CO_2 plays a major role in the growth of plants and it is essential to maintain the CO_2 concentration within the greenhouse. Hence the CO_2 sensor is used to monitor the CO_2 levels and when the detected CO_2 levels are high within the greenhouse, the exhaust fan is operated at high speed to remove the CO_2 and when CO_2 values detected with respect to acceptable value is moderate, the exhaust fan is operated at low speed and when CO_2 level is within the acceptable the range exhaust fan is turned off.

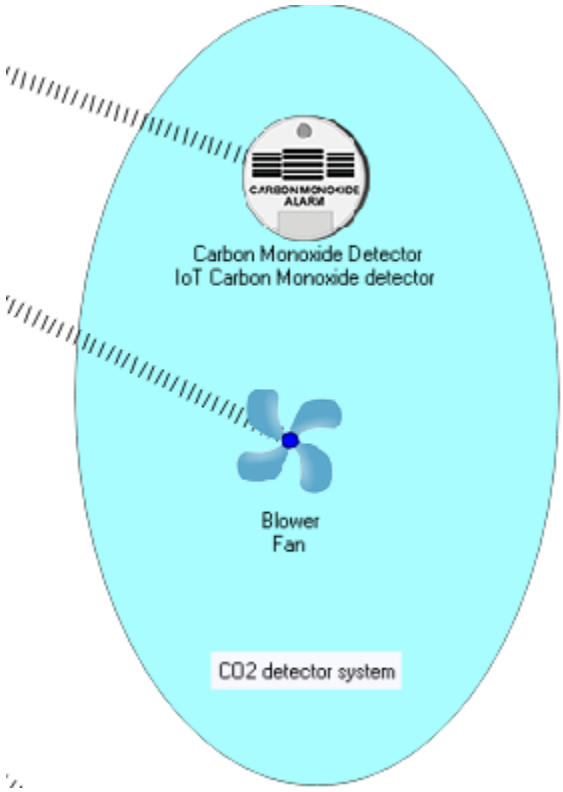

Figure 2.1.4: Carbon Dioxide detecting system

2.1.5 Soil Moisture Monitoring System

The soil moisture monitoring system consists with a water level monitor and a lawn sprinkler. The water level monitor measures the water levels present in soil within the greenhouse, and this will be used as the indication for moisture content in soil. The amount of moisture must be maintained in the soil for healthy plant growth. Therefore, when the moisture levels fall below the preset value water sprinkler is activated to moisten the soil.

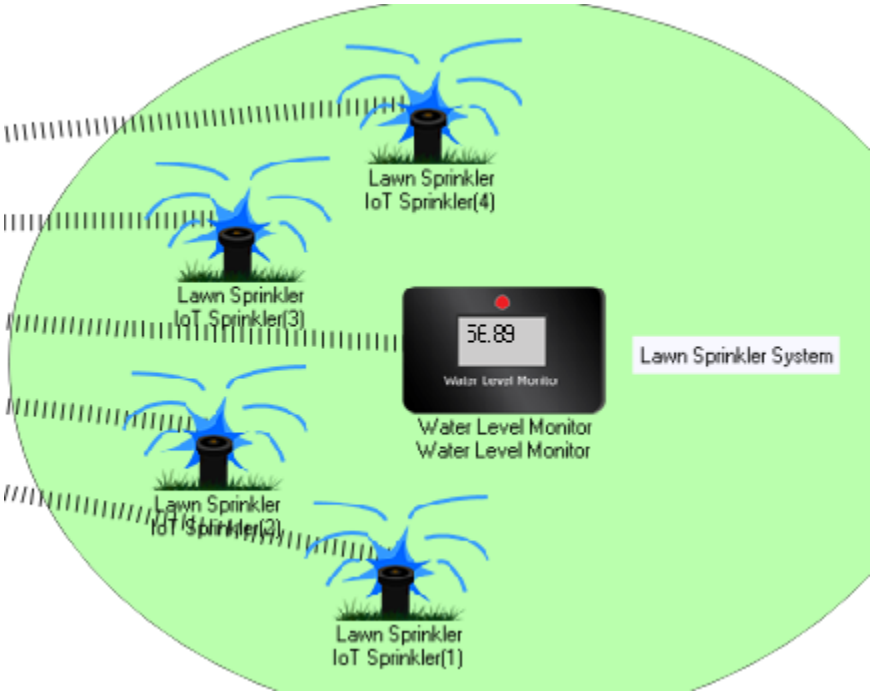

Figure 2.1.5: Soil Moisture Monitoring System

2.1.6 Solar Cell

The Solar Power System consists of a solar panel, power meter and a battery. Solar panels convert sunlight into electricity and the power produced by the solar panel can be converted and stored in a battery which is connected to all the devices. Since solar cells are used to supply energy for all the devices within the system, the proposed system will be eco-friendly and easily be automated as well.

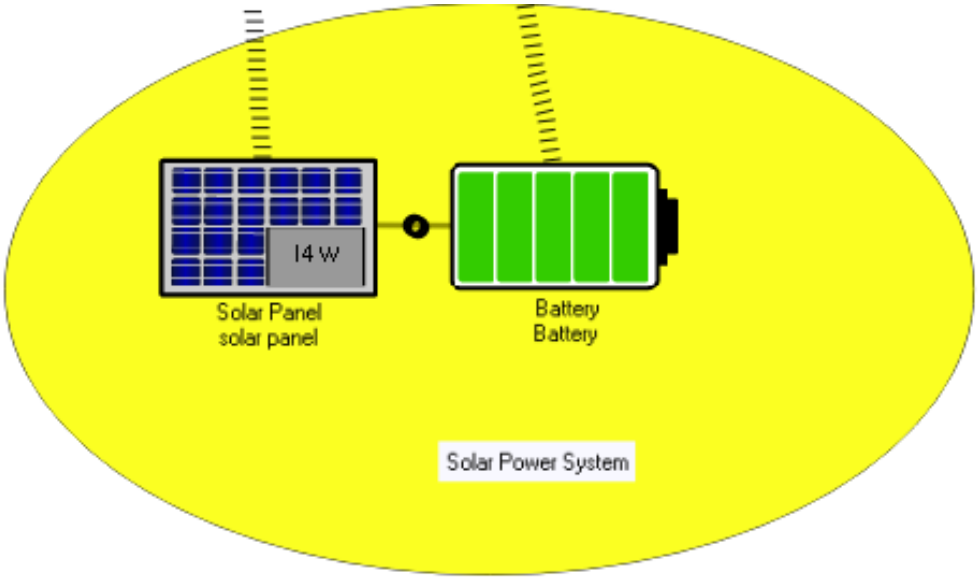

Figure 2.1.6: Solar Cell

2.1.7: Smart Door System

Smart door system uses e-card technology to open. The doors and windows can be controlled using the IoT monitor or website as well. The webcam and motion sensor will also be activated throughout the entire time.

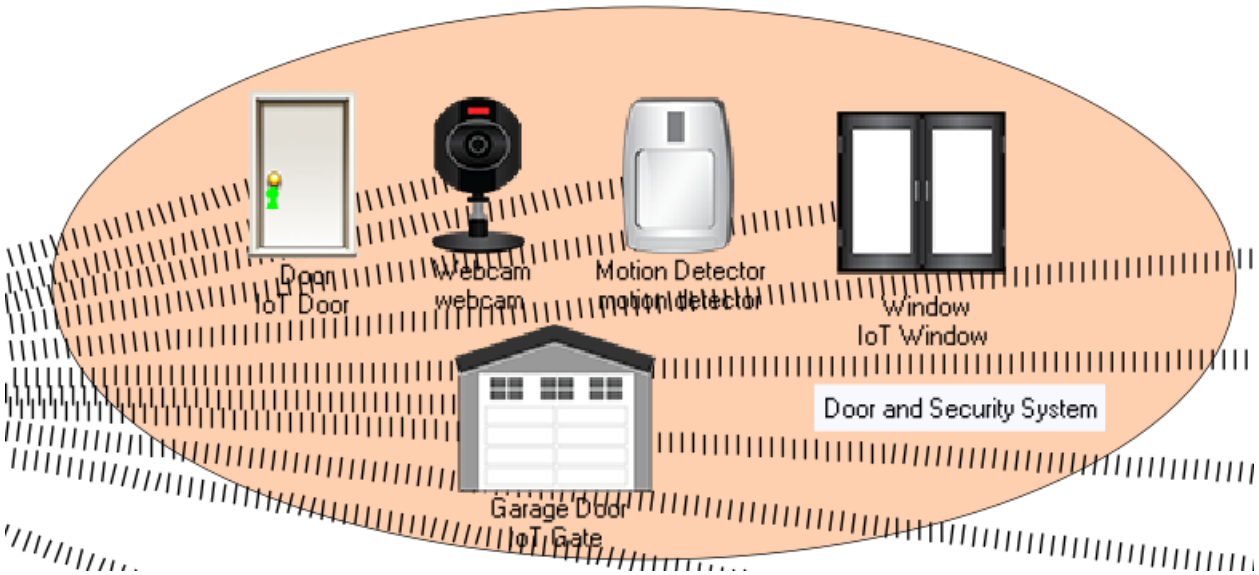

Figure 2.1.7: Smart Door System

2.1.8: Smart Light System

This project makes use of a smart lighting system to maintain the proper lighting arrangements required for the environment. The lights can be activated or controlled easily by using a smartphones or laptops by simply connecting to the IoT monitor or through the greenhouse website. Smart lighting systems for greenhouses has advance and gained popularity over the Internet, Internet of Things (IoT) becomes one of the most popular technologies in recent decade [3]

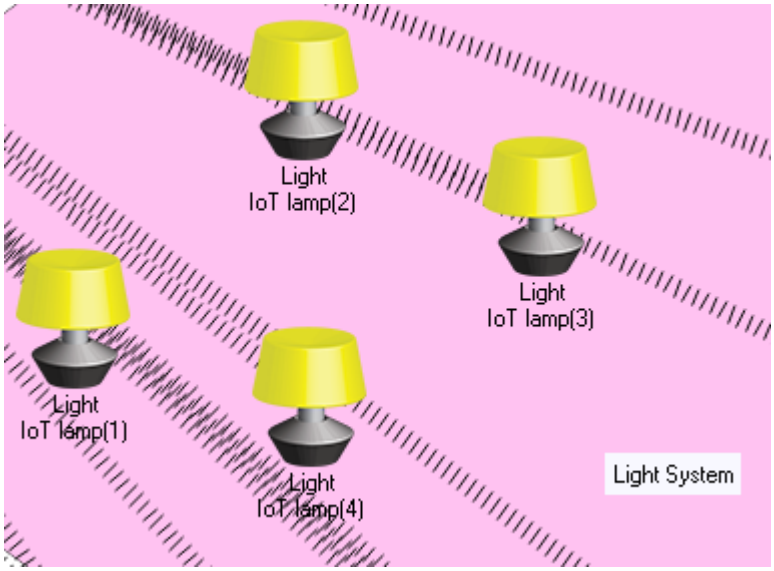

Figure 2.1.8: Smart Light System

2.2 Methodology

This section will discuss the methodologies of the project including the business model, sensing parameters and actuators, connections, IP addressing. This project has been designed and built considering the 6 pillars of Cisco IoT. It consists with Network connectivity via wireless products, Fog computing capabilities, Security features which ensure both physical security features such as smart doors and surveillance and cyber security features as well. Data analytics, management and automation, and application enablement platforms have also been considered when designing and building this system, which ensures all 6 pillars of Cisco IoT are used. The following business model depicts the relevant information for the required system. It includes the key partners and activities of the system, value propositions, customer relations, customer segments, key resources, channels, cost structure and revenue streams.

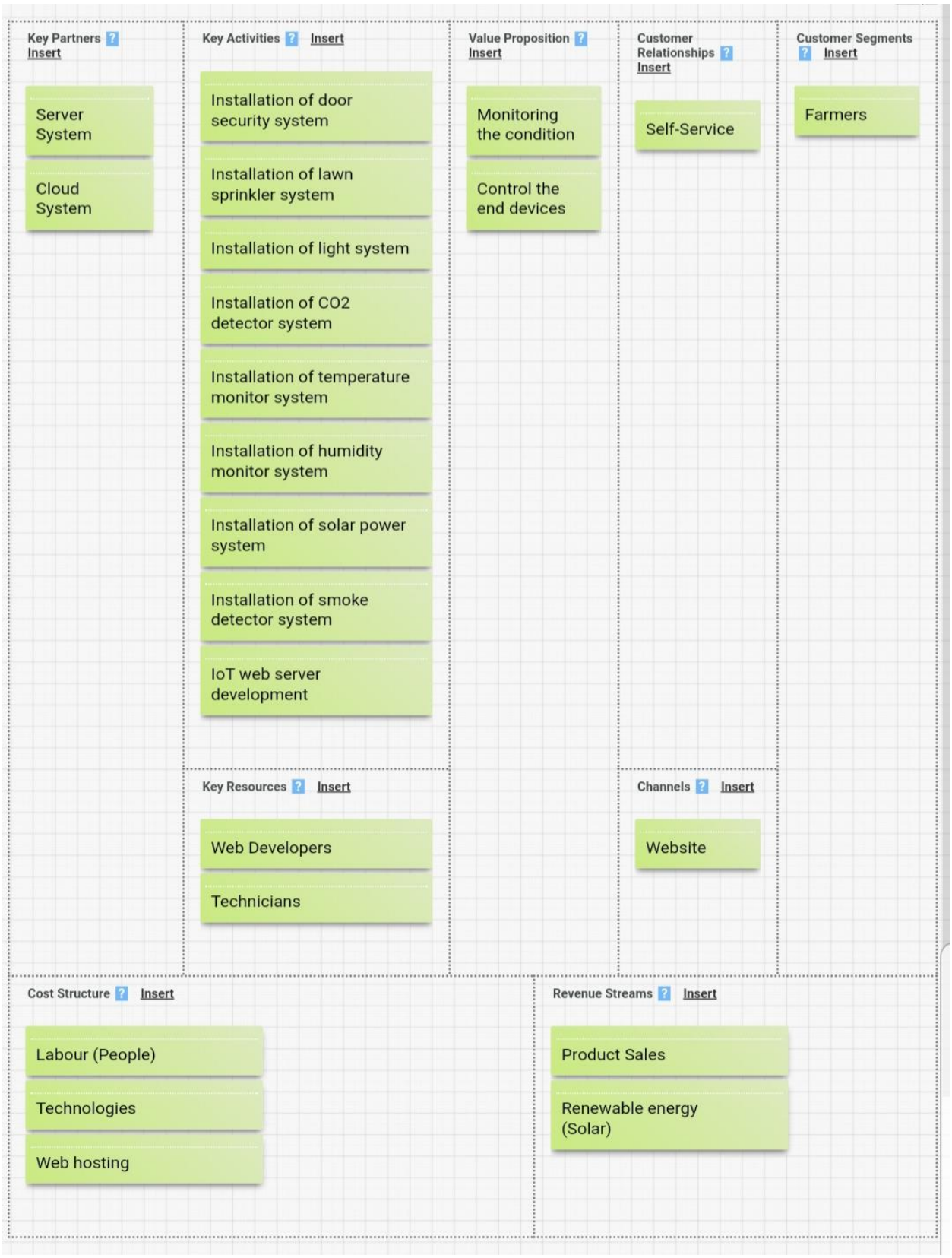

Figure 2.2.1: Business model for the project

The key partners for this project will be the server system and the cloud system that will be used for the key activities mentioned in the document. The key activities for this project are, installation of door security systems, lawn sprinkler systems, lighting systems, Carbon dioxide detection system, temperature and humidity monitoring systems, solar power systems and smoke detection systems. Also, the development of the IoT web server is one of the key activities.

Monitoring the conditions within the greenhouse and control over the devices and sensors within the system can be considered as value propositions for this project.

The customer relations associated with this project will be self service and the customer segments considered here are mainly farmers.

Web developers and technicians, specializing in IoT design and concepts will be the key resources for this project and the channel considered here would be the website. This is because when we access the greenhouse website through the web portal the devices can be controlled from there as well therefore web developers are a main key for this project. The cost structure san mainly be broken down to the labor of people and expenses towards the purchase and maintenance of the devises required for the system. The hosting charges and other expenses related to maintenance of the website can also be considered here. The main revenue streams for this project will be the sales in products and the use of solar energy can also be considered here as well.

The figure below shows the general flow chart of the methodology used in this project. The same procedure is used for all the systems which are used in this design. First the sensors read their respective parameters and the values obtained are converted into the appropriate format which are then fed to the actuators. The actuators are activated based on the input given following predefined conditions set for each device.

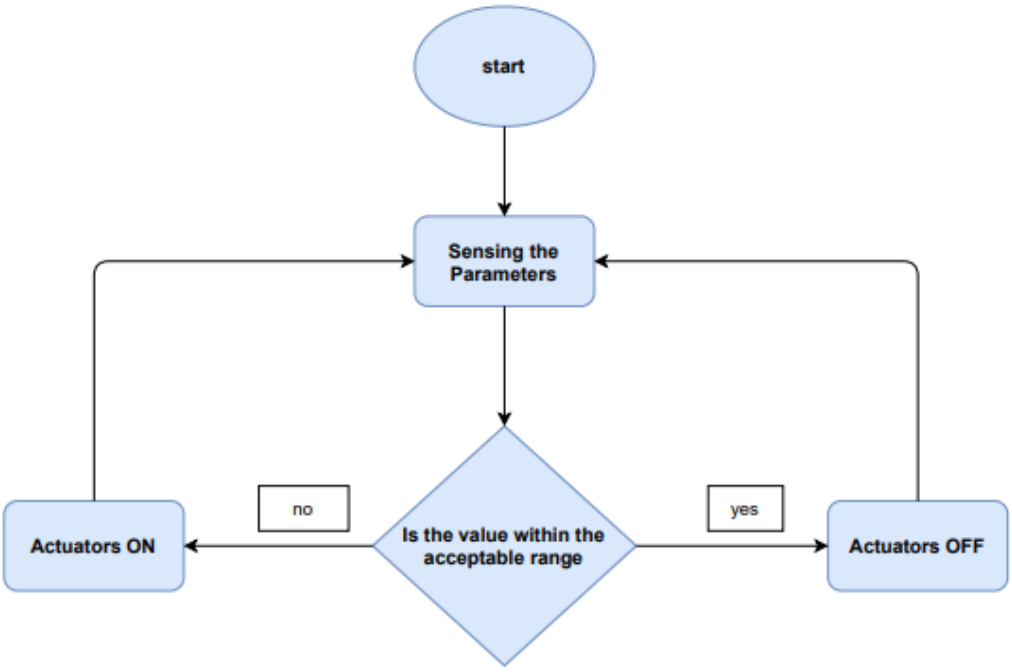

Figure 2.2.2: Flow Chart

This system can be accessed and controlled through the internet as well. This can be done by using the web browser in the Cisco Packet Tracer file used for this project. The IoT monitor can then be accessed by using the following steps.

1. Open the Cisco Packet Tracer File for this project
2. Open the web browser and enter the site www.greenhouse.com
3. Provide the details below to access the IoT monitor
   Username: admin
   Password: admin

The smartphone connections with the home gateway, Assigning IP address to the IoT Server and DNS server are shown below.

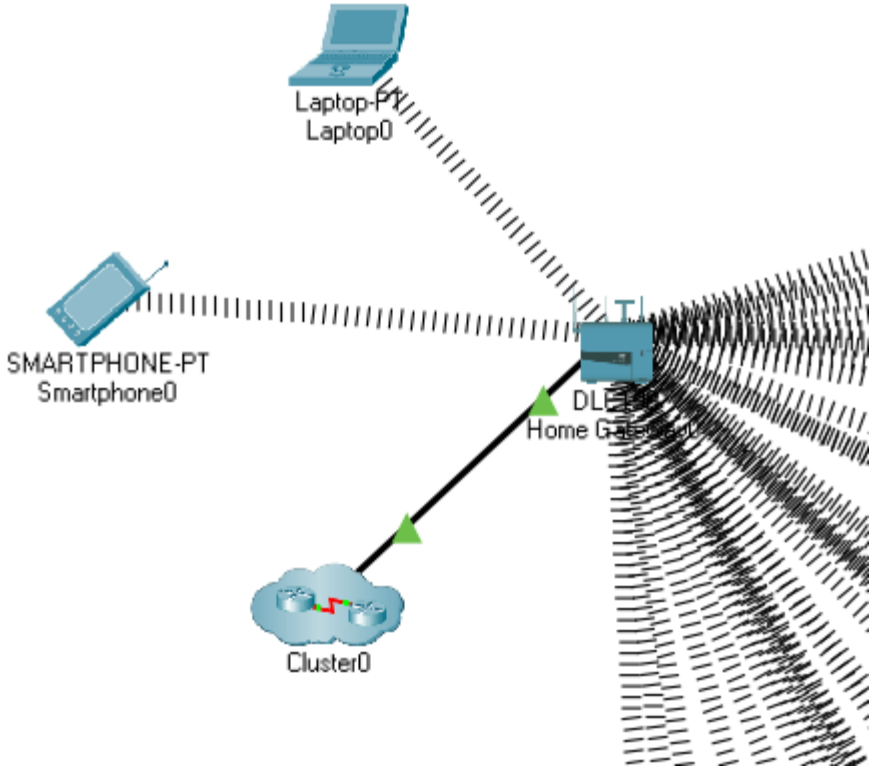

Figure 2.2.3: Smartphone connection with home gateway

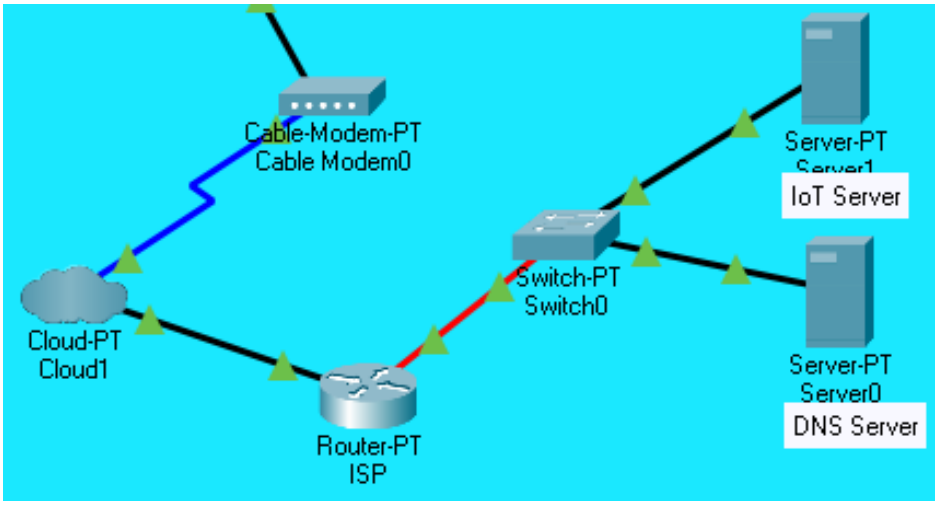

Figure 2.2.4: Cluster

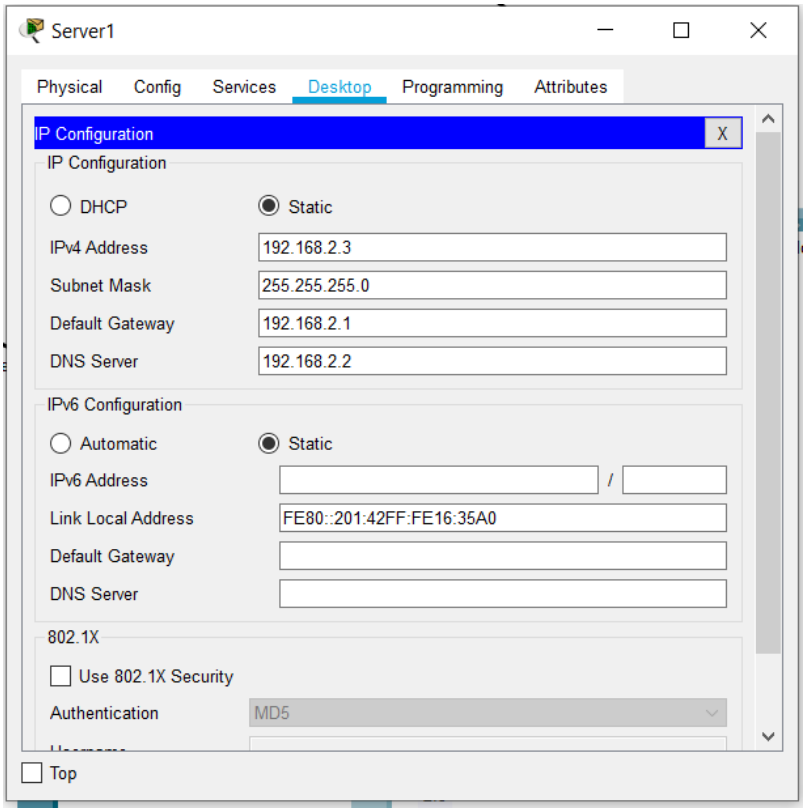

Figure 2.2.6: Assigning IP address to IOT Server

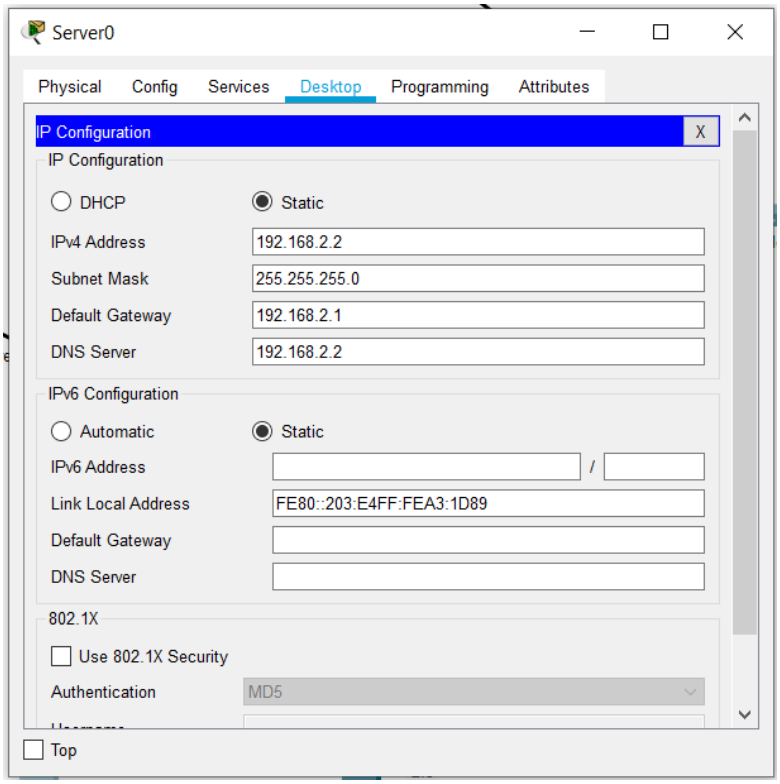

Figure 2.2.7: Assigning IP address to DNS Server

The figure below shows how the system can be acessed by using a web browser and signing in as an administrator of the system

Figure 2.2.8: Sign in through website

Chapter 3: Six Pillars of IoT Design

This system is designed considering the six pillars of Cisco IoT systems. One of the main things under consideration when designing this project is the first pillar of Cisco IoT which is network Connectivity. This design must have a seamless connection with all the devices connected to the system and must be flexible to add connections considering scalability as well. The system must also be highly ruggedized in order to match the conditions within the greenhouse. The temperature factors and humidity are the major factors that effect the need for a ruggedized system and since there may be water as well these devices must be able to withstand these conditions.

Fog Computing is another pillar of the Cisco IoT System that has been considered here. This system requires low latency in certain devices for example the certain Systems such as CO_2 detection system, fire safety system, temperature and humidity monitoring systems rely on fog computing. These systems gather data during certain time intervals and alert or perform tasks if a certain preset value for a variable is exceeded or below required levels.

The security factor has also been considered here and this includes both cyber and physical security as well. The greenhouse will be monitored by cameras and there will be motion detectors installed as well. The IoT monitors will be password protected to only allow system administrators to access the devices.

The data analytics process which is another pillar of cisco IoT is considered here. The data collected form the Sensors are processed and then fed into actuators which carryout the tasks. They measure and compare data to preset values in real time and carry out their tasks when the preset values are reached. Such devices in this system include CO_2 detectors, humidity and temperature detectors and more.

Management and automation is also considered here since the entire system is automated and can be controlled easily. The conditions within the greenhouse such as Temperature, humidity levels, soil moisture levels, CO_2 levels are monitored automatically thereby making management easier. Other systems such as security systems and fire detection systems are also automated in order to provide safer environments. The system can be managed easily from any location on real time by easily connection to the IoT monitor or website by providing login credentials which are required.

Application enabled platform can be considered here as well. Currently this system is accessible through the website (www.greenhouse.com) on laptops or smartphones or can be connected to the IoT monitor wirelessly as well.

Chapter 4: Other Requirements

Other than the main requirements for a greenhouse this proposed system has certain additional features and requirements as well. These features also include smart technologies and can be controlled wirelessly or automated as well. This greenhouse has a fire safety system which is activated when smoke is detected within the greenhouse and activates a siren to alert the people. Additionally, it automatically activates water sprinklers to extinguish the fire.

The greenhouse has security features enabled such as motion detection and surveillance via cameras too. The lighting is also automated and can be controlled automatically as well. The power which is required can be produced via the solar panels and the produced energy can be stored in a rechargeable battery. Therefore, energy efficiency is a required factor.

Some other requirements include suitable uninterrupted Internet connection so that devices can communicate, or users can connect to the system via their wireless devices (Laptops/Smartphones). Also, ample sunlight is also a requirement since solar power is used in energy generation.

This system also targets to reduce costs of managing a normal green house. This includes reducing labor costs and maintenance costs and reduce power and energy consumption as well. This system is also required to have more security since valuable smart devices are placed within the system. Therefore, surveillance via cameras and password protected access to the IoT monitors are required.

Since the entire system is automated there must be safety features in case of fires, therefore a fire prevention system is a requirement. The system used here detects smoke and activates sprinklers to extinguish the fires while sounding the alarms.

Time management is also considered here and since this system is automated a great deal of time can be saved compared to manually testing for each environmental factor and tending to them.

Chapter 5: Conclusion

Green houses are used a lot at present times and there are large farms and that have large number of greenhouses. Greenhouses are beneficial in production and maintenance of plants that need to be grown in a controlled environment. With developing technology, a IoT based system such as this could make maintenance of such greenhouses easier. This helps increase productivity, reduce operational costs, and time wastages as well. This also helps reduce the required labor force and automates the entire process making it easier to manage the farms from any location at real time by easily connecting to the system through smart devices. Using the sensors and actuators with pre-defined values will ease the work and help automate the entire process of manually testing everything. Using solar energy for the generation of electricity and storing it for usage of devices is also an advantages factor and can be considered a step toward maintenance of greenhouses through renewable energy sources

Chapter 6: References

[1] Yung Sheng Chang, Yi Hsiung Chen, Sheng Kai Zhou “A smart lighting system for greenhouses based on Narrowband-IoT communication “IEEE IMPACT on International MicroSystem, 2018.

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