IoT Based Low Cost and Intelligent Module for Smart Irrigation System

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Abstract - The Internet of Things (IOT) has been denoted as a new wave of information and communication technology (ICT) advancements. The IOT is a multidisciplinary concept that encompasses a wide range of several technologies, application domains, device capabilities, and operational strategies, etc. The ongoing IOT research activities are directed towards the definition and design of standards and open architectures which is still have the issues requiring a global consensus before the final deployment. This paper gives overview about IOT technologies and applications related to agriculture with comparison of other survey papers and proposed a novel irrigation management system. Our main objective of this work is to for Farming where various new technologies to yield higher growth of the crops and their water supply. Automated control features with latest electronic technology using microcontroller which turns the pumping motor ON and OFF on detecting the dampness content of the earth and GSM phone line is proposed after measuring the temperature, humidity, and soil moisture.

I. INTRODUCTION

There are many techniques available for the precision agriculture to monitor and control, environment for the growth of many crops. Due to unequal distribution of rain water, it is very difficult to requirement needed farmer to manage the water equally to all the crops in whole farm it requires some irrigation method that suitable for any weather condition, soil types and variety of crops. Irrigation management is an important factor in agriculture allows the farmer to improve the cultivation in a way the plants need. According to the requirement of the crops the threshold will be set, if the any environmental condition like temperature, soil conditions and humidity goes below or above the threshold value, then IOT sense the changing in parameters are monitored simultaneously and all the data will be transmitted to farmers, according to that farmer will take the controlling decision and send to the system. The system will run the actuator and control the parameter. Types of sensor used and controlling action that are taken according to them Temperature control - Growth of plantation depends on photosynthesis methods that is depends upon the radiation from the sun. Humidity control -Water vapour is main problem that's affecting the growth of crops. Because of high humidity, chances of disease are increasing. Soil control- Soil water also affects the crop growth. Therefore, the monitor & control of soil condition have a specific interest, because the good condition of a soil provides the proper yield.

The Proposal of the project is to develop a smart irrigation monitoring system using Arduino. Focus area will be parameters such as temperature and soil moisture.

II. OBJECTIVE

The main objective of our project is to work for Farming where various new technologies to yield higher growth of the crops and their water supply. We are going to check the temperature, humidity, and soil moisture. The paper is all about automated control features with latest electronic technology using microcontroller which turns the pumping motor ON and OFF on detecting the dampness content of the earth and GSM phone line. It works automatically and hence reduces the man power. Irrigation is the artificial application of water to the land or soil. It is used to assist in growing of agricultural crops, maintenance of landscapes, and revegetation of disturbed soils in dry areas and during periods of inadequate rainfall. Watering systems will reduce the burden of getting water to plants when they need it. Knowing when and how much to water is two important aspects of watering process. To make the gardener works easily, the automatic plant watering system is created.

III. EXISTING SYSTEM

[1] has proposed a system ―Irrigation Control System‖. Their system includes a number of wireless sensors which are placed in different directions of the farm field. Each sensor is integrated with a wireless networking device and the data received by the

―ATMEGA-318‖ microcontroller which is on the ―ARDUINO-UNO‖ development board. The Raspberry pi is used to send various types of data like text messages and images through internet communication to the microcontroller process.

[2] proposed irrigation systems which are also automated through information on volumetric water content of the soil using dielectric moisture sensors. It is used to control actuators and save water, instead of irrigation schedule at a specific time of the day, with a specific duration and according to soil moisture.

[3] proposed an automated irrigation system. They have useda wireless sensor network and raspberry pi to control the activities of drip irrigation system.

[4] has proposed a paper on the water distribution system and gave result to decompose the original nonlinear optimal control problem (OCP).

Joauin Gutierrez et al. [5] used a wireless sensor network and GPRS module instead of the Raspberry pi for automated irrigation system.

[6] has Proposed Automatic Irrigation System Based on RF Module‖. A RF module (radio recurrence module) is a (normally) little electronic gadget used to transmit or potentially get radio flags between two gadgets. In an inserted framework it is frequently alluring to speak with another gadget remotely.

[7] proposed a Sensor based automatic irrigation system with IoT. This irrigation system used a rain gun pipe. The one end of the pipe is connected to the water pump and another to the root of plant. The limitation of their work is that their system doesn‘t provide water as a natural rainfall like sprinkler and only used a soil moisture sensor.

[8] has proposed an aurdino based on smart irrigation system using Internet of Thing, the researcher has not used Raspberry pi, but instead of raspberry pi the work is done using aurdino controller without use of soil moisture and other sensors.

[9] has proposed smart irrigation system based on raspberry pi, this system comprises the live streaming of crops using android phones and automatic motor on/off system, these two systems make the irrigation fully automatic. It can capture the live crop images on Wi-Fi. The entire system is monitored and controlled by the raspberry pi. The system has limited their functionality because of raspberry pi2 and also flow control over the irrigation not used.

Now days, water shortage is one of the biggest problem in the world. Many different methods are developed for conservation of water. We need water in each and every field. Water is considered to be basic need of all living creatures. Agriculture is one of the fields where water is required in massive quantity. Major problem in agriculture is every time excess of water is given to the fields. Many techniques are used to save or to control wastage of water from agriculture like Ditch Irrigation, Terraced Irrigation, Sprinkler System Rotary Systems.

An automatic Smart Irrigation Decision Support System, SIDSS, is determined to manage irrigation in agriculture. System estimates the weekly irrigations needs of a plantation, on the basis of both soil evaluation and climatic variables convoked by several autonomous nodes deployed infield. This enables a closed loop control scheme to adapt the decision support system to local perturbations and evaluation errors. Two machine learning approach, PLSR and ANFIS, are proposed as reasoning engine of our SIDSS. This approach is validated on three commercial plantations of citrus trees located in Spain. Performance is evaluated against decisions taken by a human expert. The main characteristic of system is the use of continuous soil measurements to complement climatic parameters to precisely predict the irrigation needs the crops, in contrast with previous works that are based only on weather variables or doesn't indicate the amount of water required by the crops. The use of real-time information from the soil specification in a closed loop control scheme allows to get used to the decision support system to local perturbations, avoiding the accumulative effect due to errors in consecutive weekly estimation, and/or detecting if the irrigation calculated for the SIDSS has been performed by the farmer. The analysis of the performance of the system is accomplished comparing the decisions taken by a human expert and the decision support component. Two machine learning techniques, PLSR and ANFIS, have been proposed as the basis of our reasoning engine and analysed in order to obtain the best performance.

MOTIVATION

The inspiration for creating Smart Sprinkler originates from many reasons however most imperative are accommodation, vitality administration in extravagance. the inspiration of the agriculturists working in the ranch terrains are exclusively subject to the downpours and bore wells for water system of their territory. As of late, the agriculturists have been utilizing water system method through the manual control in which the ranchers inundate the land at customary interims by turning the water- pump ON/OFF when required. They may need to travel so far for SWITCHING ON/OFF the engine. They might experience the ill effects of hot Sun, rain and evening time as well. In the wake of achieving their ranch, they found that there is no power.

LIMITATIONS IN THE EXISTING SYSTEM

The Existing irrigation system does not make the efficient use of water. Water is not fed to the plant whenever there is need it leads to water scarcity. Quantity of water is not defined for each water supply in irrigation system.

IV. PROPOSED SYSTEM

The Proposal of the project is to develop a smart irrigation monitoring system using Arduino. Focus area will be parameters such as temperature and soil moisture. This system will be a substitute to classical farming method. We will develop such a system that will help a farmer to know his field status in his home or he may be residing in any part of the world. It proposes an automatic irrigation system for the agricultural lands. Currently the automation is one of the important role in the human life. It not only provides comfort but also reduce energy, efficiency and time saving. Now the industries are using automation and control machine which is high in cost and not suitable for using in a farm field. So here it also designs a smart irrigation technology in low cost which is usable by Indian farmers. Arduino is the main heart of the whole system. An automated irrigation system was developed to optimize water use for agricultural crops. Automation allows us to control appliances automatically. The objectives of this paper were to control the water motor automatically and we can also watch live streaming of farm on android mobiles by using wi-fi.

ADVANTAGES OF THE PROPOSED SYSTEM

The proposed system provides real time information on the field irrigation. Here the water is supplied based on the actual needs for the crops. This automated irrigation system is cost reduction and resource optimization. It improves the environment quality and increases the irrigation. It also reduces water logging and water shortages.

V. SYSTEM ARCHITECTURE

This archetype monitors the amount of soil humidity and temperature. A predetermine range of soil moisture and temperature is set, and can be varied with soil type or crop type. In case the moisture or temperature of the soil diverges from the specified range, the watering system is turned on/off. In case of dry soil and high soil temperature, it will activate the irrigation system, pumping water for watering the plants.

Dark Sky specializes in weather forecasting and visualization. The coolest aspect of Dark Sky is their weather API that we can use to retrieve the weather data from almost anywhere in the world. It's not just weather is rainy or sunny but temperature, dew point, wind gust, humidity, precipitation, pressure, UV index, and more, all easily available for wherever you want, whenever you want.

To retrieve all of the things prepared for this research work, need to clone the repository from GitHub. GitHub is a service that allows us to store, revise, and manage projects like this. we will want to run this script on a dedicated device. A Raspberry Pi is a perfect option to run applications like this tutorial.

To clone the repository all we need to do is go into Pi's terminal, or your computers terminal that is SSH'd into pi by typing this command:

```
$ git clone https://github. com/InitialState/darksky. git

Cloning into 'darksky'. . .

remote: Counting objects: 2, done.

remote: Total 2 (delta 0), reused 0 (delta 0), pack-reused 2

Unpacking objects: 100% (2/2), done.

Checking connectivity. . . done.
```

This command lists everything that's available in the directory that we are currently in. This list shows that our GitHub Repo has been successfully cloned into our directory under the name "darksky. " Let's take a look at what's in that directory. To move to a directory, need to do is type "cd" and then type the name of the directory that you wish to go to.

```
$ cd darksky
```

Once hit enter, we will l see that we're now in the darksky directory. Let's type "ls" again to see what files we've installed on our pi.

```
README. md darksky. py . . .
```

Here we see the we've got our readme document and python files. Let's take a look at darksky. py using the "nano" command. The nano command allows us to open up the nano text editor where we have all of our python code for each segment of this project. Go ahead and type:

```
$ nano darksky. py
```

Here we can see all of the code we've prepared for you for this project. We're not going to make any changes to this document just yet, but feel free to scroll around and see what we're going to be doing later in this tutorial.

Step 2: Using the Dark Sky API

In order to use the Dark Sky API, you first need your own

This limit automatically resets each day at midnight UTC.

The Forecast Request returns the current weather forecast for the next week.

The Time Machine Request returns the observed or forecast weather conditions for a date in the past or future.

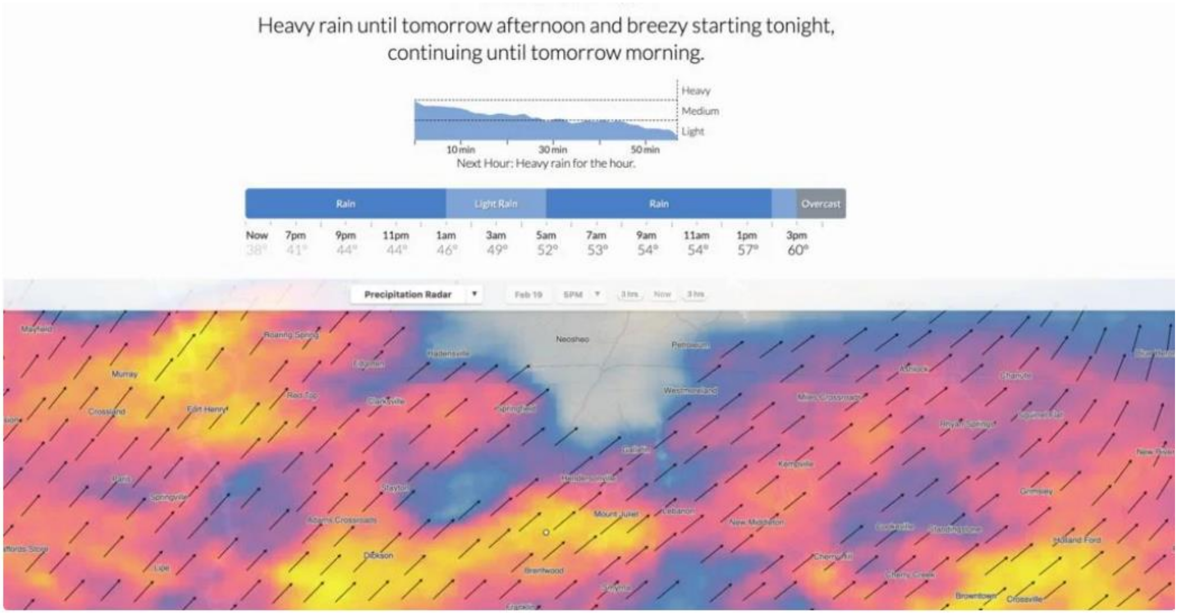
Your secret Dark Sky API key will look something like this: 0123456789abcdef9876543210fedcba.

You can make an API call to Dark Sky by typing in a URL into your browser in the following format:

https://api. darksky. net/forecast/[key]/[latitude],[longitude]

Replace "key" with your Dark Sky API key and longitude/latitude with whatever you want. You can find your longitude and latitude by going to Google Maps and searching your location. Those values will be in the URL.

Copy and paste the above dark sky URL with your access key and values added into an address bar.



Once you do that you will see something like this:

{"latitude":37. 8267, "longitude":-122. 4233, "timezone":"America/Los_Angeles", "currently":{"time":1550615286, "summary":"Clear", "icon":"clear-

day", "nearestStormDistance":57, "nearestStormBearing":15, "precipIntensity":0, "precipProbability":0, "temperature":53. 9, "apparentTemperature":53. 9,

"dewPoint":29. 59, "humidity":0. 39, "pressure":1022. 45, "windSpeed":3. 87, "windGust":9. 25, "windBearing":259, "cloudCover":0. 01, "uvIndex":3,

"visibility":7. 8, "ozone":309. 71}, "minutely":{"summary":"Clear for the hour. ", "icon":"clear-day", "data":[

{"time":1550615280, "precipIntensity":0, "precipProbability":0}, . . .

It can be a little overwhelming and hard to read so what I recommend doing is using a JSON Formatter to help make the data more readable. When you do this it will look something like this:

object {9}

latitude: 37. 8267

longitude: -122. 4233

timezone: America/Los_Angeles

currently {19}

time: 1550615286

summary: Clear

icon: clear-day

nearestStormDistance: 57

nearestStormBearing: 15

precipIntensity: 0

precipProbability: 0

temperature: 53. 9

apparentTemperature: 53. 9

dewPoint: 29. 59

humidity: 0. 39

pressure: 1022. 45

windSpeed: 3. 87

windGust: 9. 25

windBearing: 259

cloudCover: 0. 01

uvIndex: 3

visibility: 7. 8

ozone: 309. 71

You've just made an API call! See how easy that was? You didn't even have to write a single line of code. Now that you've mastered API's we can move on to the data streaming portion.

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Step 3: Initial State

We want to stream all of our weather data to a cloud service and have that service turn our data into a nice dashboard that we can access from our laptop or mobile device. Our data needs a destination. We will use Initial State as that destination.

Step 1: Register for Initial State Account

Go to https://iot. app. initialstate. com and create a new account. You get a 14 day free trial and anyone with an edu email address can register for a free student plan.

Step 2: Install the ISStreamer

Install the Initial State Python module onto your Raspberry Pi. In the command prompt, run the following command:

$ cd /home/pi/
$ \curl -sSL https://get. initialstate. com/python -o - | sudo bash

Step 3: Make some Automagic
After Step 2 you will see something similar to the following output to the screen:

pi@raspberrypi ~ $ \curl -sSL https://get. initialstate. com/python -o - | sudo bash
Password:

Beginning ISStreamer Python Easy Installation!

This may take a couple minutes to install, grab some coffee :)

But don't forget to come back, I'll have questions later!

Found easy_install: setuptools 1. 1. 6

Found pip: pip 1. 5. 6 from /Library/Python/2. 7/site-packages/pip-1. 5. 6- py2. 7. egg (python 2. 7)

pip major version: 1

pip minor version: 5

ISStreamer found, updating. . .

Requirement already up-to-date: ISStreamer in /Library/Python/2. 7/site-packages

Cleaning up. . .

Do you want automagically get an example script? [y/N]

Where do you want to save the example? [default: . /is_example. py]

Please select which Initial State app you're using:

1. app. initialstate. com

2. [NEW!] iot. app. initialstate. com

Enter choice 1 or 2:

Enter iot. app. initialstate. com user name:

Enter iot. app. initialstate. com password:

When asked if you want to automagically get an example script put "y" for yes and press enter to save your script in the default location. For the question about which app you are using, select 2 (unless you signed up before November 2018) and enter your username and password.

Step 4: Run the Example Script

Run the test script to make sure we can create a data stream to your Initial State account. Write the following command:

$ python is_example. py

Step 6: Example Data

Go back to your Initial State account in your web browser. A new data bucket called “Python Stream Example” should have shown up on the left in your log shelf (you may have to refresh the page). Click on this bucket to view your data.

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Step 4: Dark Sky Weather Dashboard

Now for the fun part. We are ready to start using the Dark Sky API to create a weather dashboard and capture the weather history for the location we choose. To do this, we are going to use the Python script: https://github. com/initialstate/darksky/blob/master/darksky. py. This script simply calls the Dark Sky API using your API key and retrieves the weather information on a specified time interval. It also streams that data to your Initial State account, which will allow you to create a Dark Sky weather dashboard.

You can either copy this script to your Pi, or access it through the GitHub repository that we cloned earlier. You can do this by changing into your darksky directory by typing:

$ cddarksky

From here, you'll be able to access the python file that we'll run to create our weather dashboard. Before you run it, you need to set your desired parameters and insert your keys. Nano into the darksky. py file by typing:

$ nano darksky. py

Then edit the section near the top of the script:

--------- User Settings ---------

CITY = "Nashville"

GPS_COORDS = "36. 1628414, -86. 780199"

DARKSKY_API_KEY = "PLACE YOUR DARK SKY API KEY HERE"

BUCKET_NAME = ":partly_sunny: " + CITY + " Weather"

BUCKET_KEY = "ds1"

ACCESS_KEY = "PLACE YOUR INITIAL STATE ACCESS KEY HERE"

MINUTES_BETWEEN_READS = 15

You need to set the desired GPS coordinates and city name. You also have to insert your Dark Sky API key and your Initial State account access key or your data isn't going to go anywhere. The MINUTES_BETWEEN_READS parameter will set how often your script will poll the Dark Sky API for weather information. 15 minutes provides a nice interval long-term. For the sake of short-term testing, you can set this to 0. 5 minutes. Make your changes then enter control+X to exit and save.

Once you have your parameters set, you are ready to run your script:

$ python darksky. py

If you are ssh'ing into your Pi and want to leave this script running uninterrupted for a long time, you can use the nohup command (no hang-up) as follows:

$ nohup python darksky. py &

This script is going to do a bit more than just read the weather data and send it to Initial State. This script is going to take advantage of the emoji support built into Initial State's tools to make the dashboard a bit more cool. You can see the logic used to take the weather status from the currently -> icon and convert it to an emoji token in the weather_icon function. Something similar happens for the moon phase in the moon_icon function and wind direction in the wind_dir_icon function.

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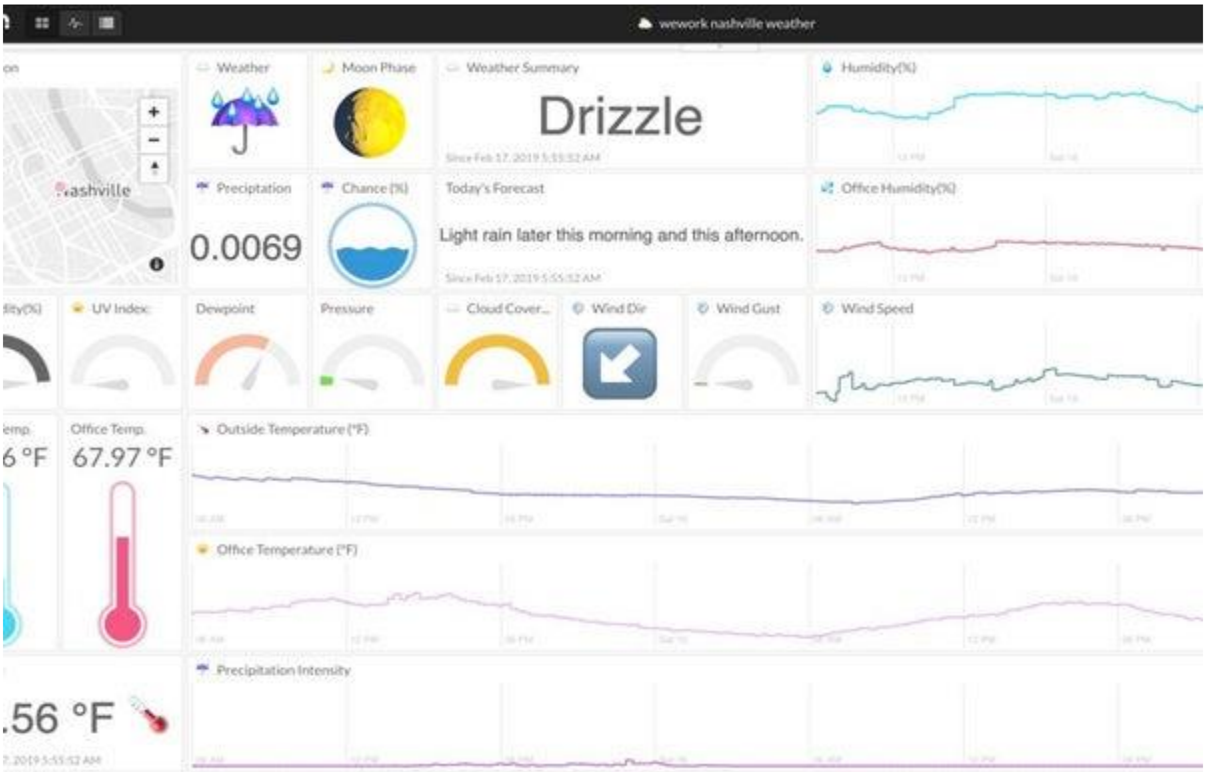
Step 5: Conclusion



4. 1CISCO Packet Tracer 7. 0

- the Basic concept of smart irrigation system is given in Cisco Packet Tracer, where an IoT projects simulation is performed, one of them a Lawn Sprinkler is simulated over the Packet tracer. Packet Tracer 7. 0 introduced dynamic environment management (temperature, gas, pressure, and light,) to make IoT device simulation more realistic.

- Many devices or Things affect or respond to the environment in Packet Tracer: a Fire Sprinkler will raise the water level and humidity in a container, a Lawn Sprinkler,

- Floor Sprinkler will Affect Water Level at a rate of 0. 1 cm per second.

Temperature Sensor will Detect Ambient Temperature.

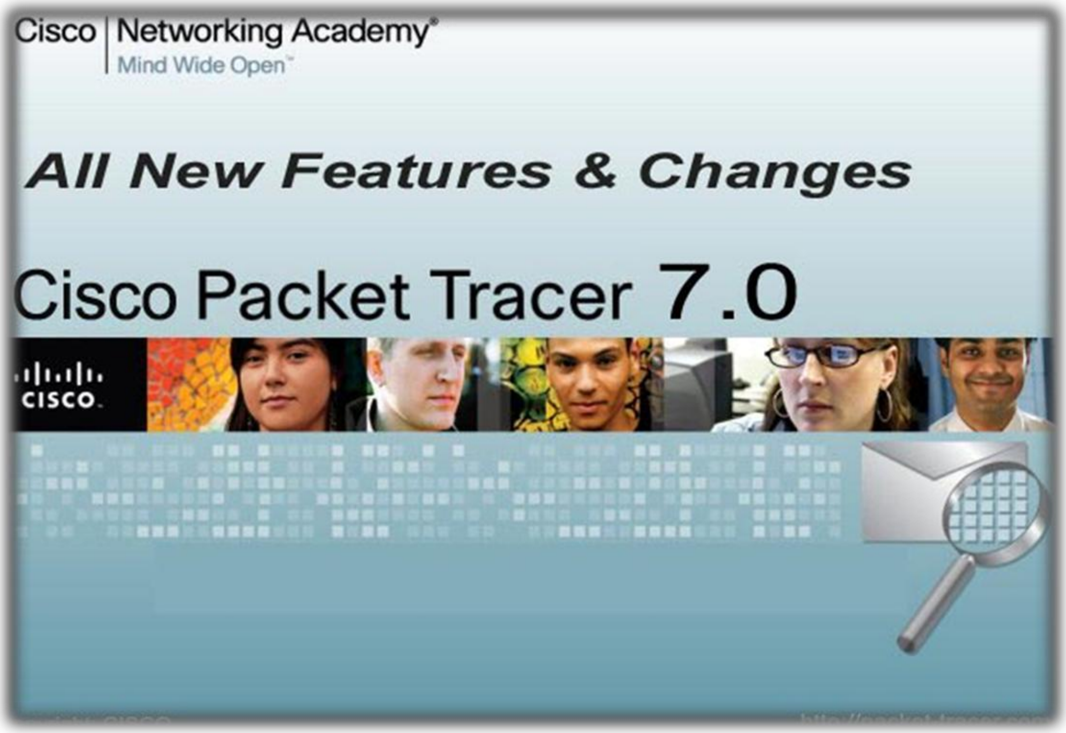


Fig. 4. 1CiscoPacketTracer7. 0

4. 2 Things and Components available in Packet Tracer 7. 0

Things interacting with Packet Tracer7. 0 simulated environment

- Packet Tracer 7. 0 Network Component Box now contains a wide range of Smart

Things and segments :

- Smart Things are physical articles that can associate with the Registration Server or Home Gateway through a system interface. Theyareisolatedinto4subcategories: Home, Smart City, Industrial, and Power Grid.
- Components are physical articles that interface with the microcontroller (MCU-PT) or single boarded PCs(SBC-PT). They normally don't have a system interface and depend on the MCU-PT or SBC-PT for arranging to get to. These are simple devices that only communicate through their analog or digital slots.
- There are three subcategories for Components:
- Boards: microcontrollers (MCU-PT), single boarded computers(SBC-PT), and a special device called Thing which are used to create self-contained physical objects like coffeemakers or smoke alarms.
- Actuators: these components operate the Environment, themselves, or the region around them.
- Sensors: these components sense the surroundings (photo detectors, temperature sensor), the area around them(RFID, metal sensor), or interactions(potentiometer, push button).

4. 3 NEW Features in the CISCO new Packet Tracer 7. 0

Some new device and technology will support in the new PT and it‘ll upgrade the using

Capacity as network simulator like…

- Switched Port Analyzer(SPAN)and Remote SPAN(RSPN) will support in the new PT 7. 0
- Resilient Ethernet Protocol (REP) is the new technology in the PT 7. 0 by CISCO.
- Layer 2 Network Address Translation(L2NAT)Will support in the new features

Packet Tracer

- Precision Time Protocol (PTP) will support in the PT 7. 0

Link Layer Discovery Protocol (LLDP) will now support in the new Packet Tracer

7. 0

New Packet Tracer 7. 0will support IoT.

Power over Ethernet (PoE) will support with improvement way.

Improved support for Copy and Paste.

Dynamic Host Configuration Protocol (DHCP) will support in the new PT which means port-based address allocation support.

Internet of Things (IoT) switches protocol support.

Modifiable Environment demonstrating IoT (Internet of Things') changes.

Python, JavaScript, Blocky programming added for IoT (Internet of Things) usage.

4. 4 simulation of Home Lawn during packet transmission operation:

Use the real-time/ simulation tab to switch to the simulation mode. Click on the Auto Capture

/Play button to begin packet capture. Try a Simple PDU, and the event list will be populated with three entries, indicating the creation of an ICMP packet, ICMP echo sent, and ICMP reply received:

If we click on a packet (the envelope icon), we will be presented with the packet information categorized according to OSI layers. The Outbound PDU Details tab information in a packet format:

Step1Design the topology in the Cisco Packet Tracer, assign the IP addresses to PCs and noted down the MAC addresses as shown in the below-given figure:

Step2Check the ARPtableofPC-1, PC-2, andPC-3with the help of arp–a command on the _Command Prompt'. If you find any entry in it, then use the command arp–d to clear the entry or entries of ARP table.

Step3In this step, we will ping the PC-1 from PC-3. On the PC-3 open the _Traffic Generator'.

Fill the following information in the Traffic Generator:

Destination IP Address: 192. 168. 1. 1

Source IP Address: 192. 168. 1. 3

Sequence Number: 1 and then click on _Send'

Traffic Generator will send the traffic(ping) to the destination. From Step-4to Step-10, we will observe that --how the ARP is working actually.

Step4Toobserve the traffic closely, select the _ simulation Mode' and in the simulation Panelclick on_Capture/Forward'button. Observe the main window of Packet Tracer and the Event List of simulation Panel.

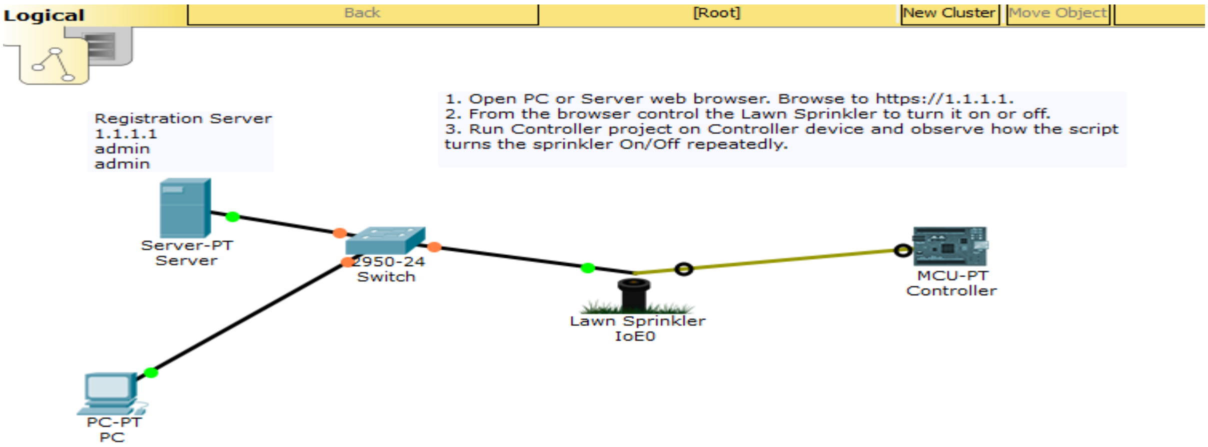


Fig. 4. 2HomeLawnIoT Project in Packet Tracer

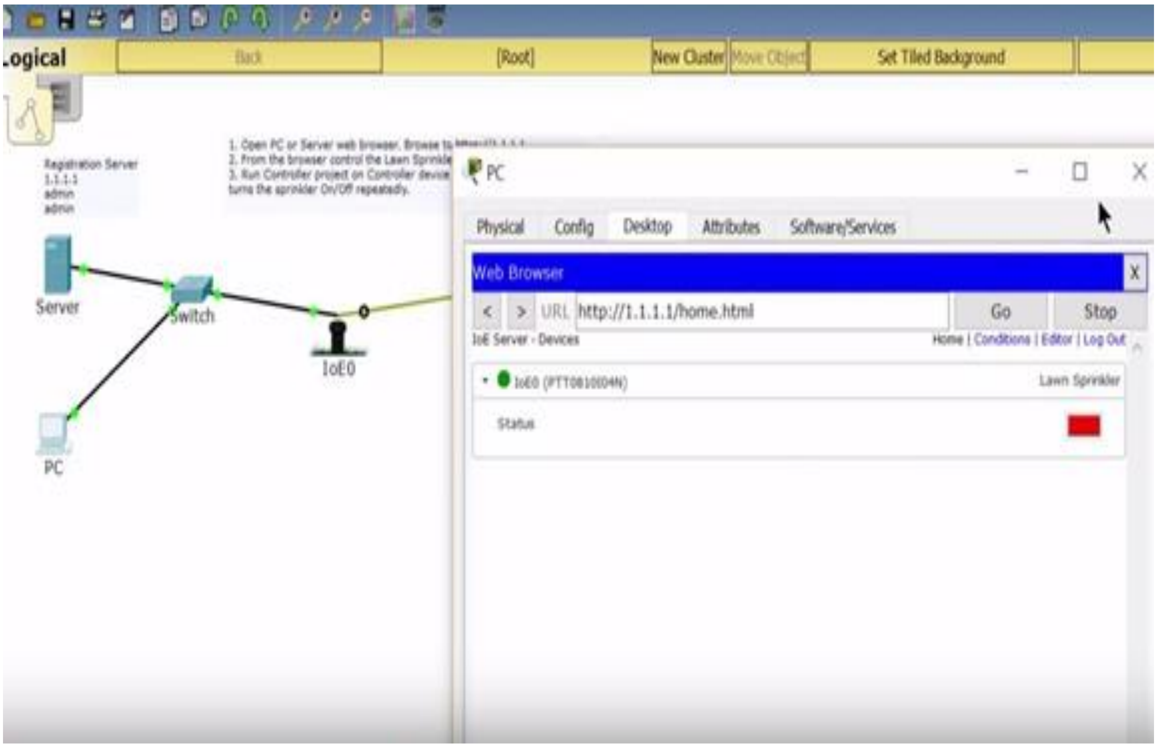


Fig. 4. 3 Home Lawn Project, Running stage

Step5

Now we will click on Capture/Forward & button to send ARP traffic fromPC-3 to Hub-1. When the Hub will receive the ARP frame, it actually stops here. In order to broadcast it on all ports, we will continue to click on the same & Capture/Forward & button. As a result, it

Will broad cast it on all the ports, except the port from which it receives this frame. On the Hub-1 the Inbound and Outbound PDUs are same, we can see in the figure:

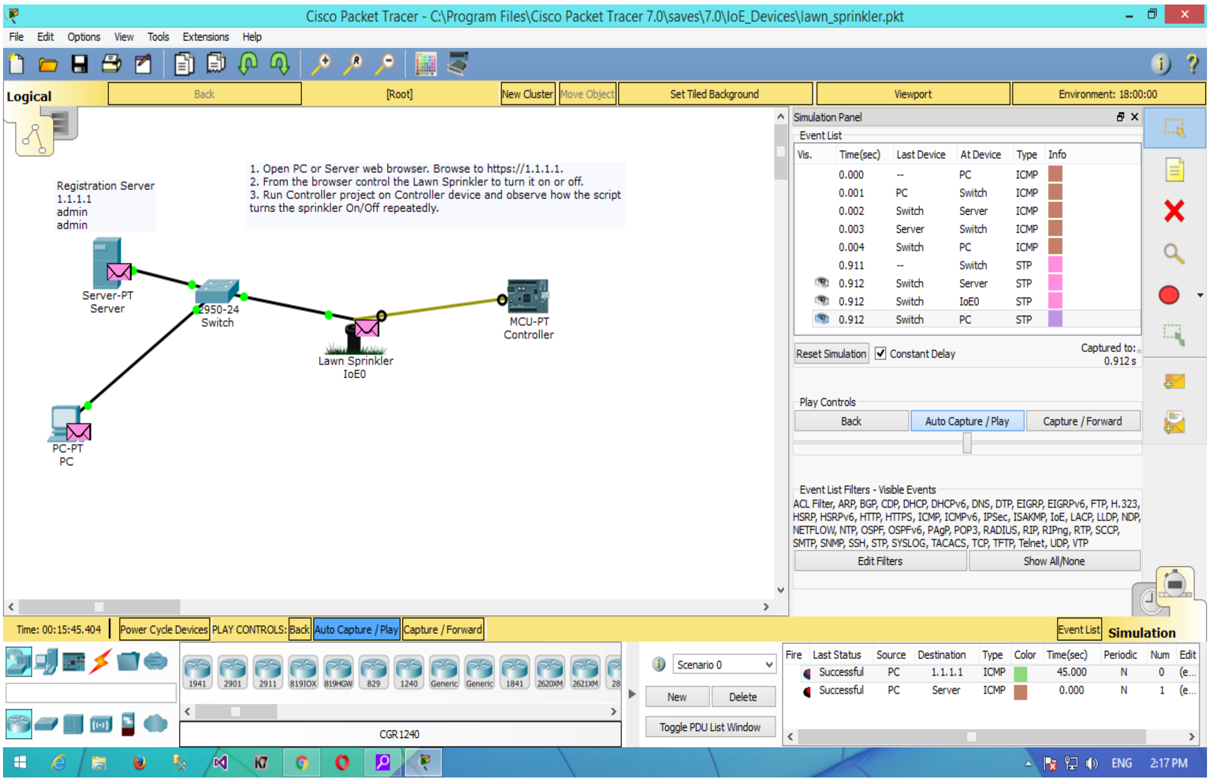


Fig. 4. 4 Capture & Forward the Packets

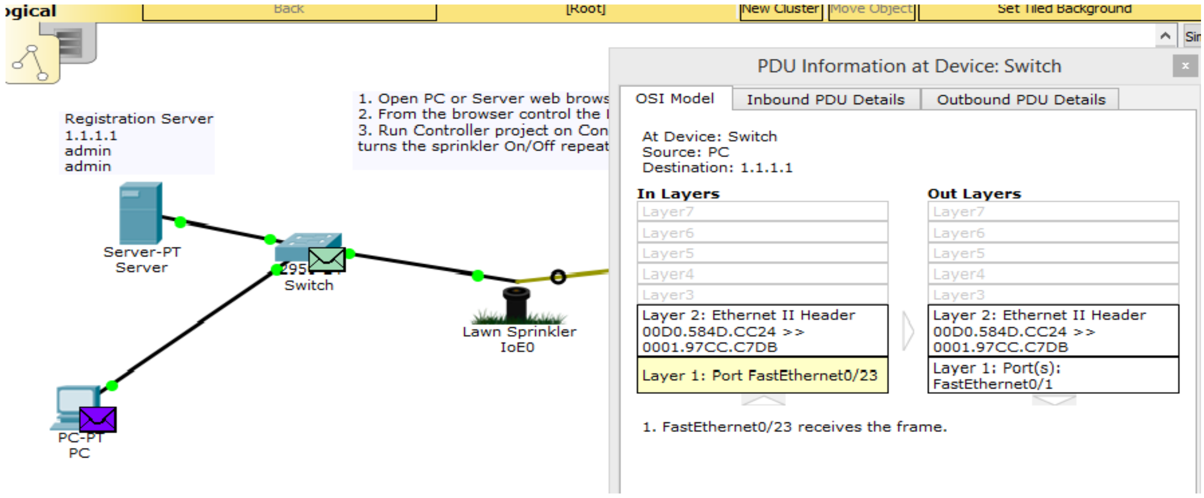


Fig. 4. 5 Inbound & Outbound Details

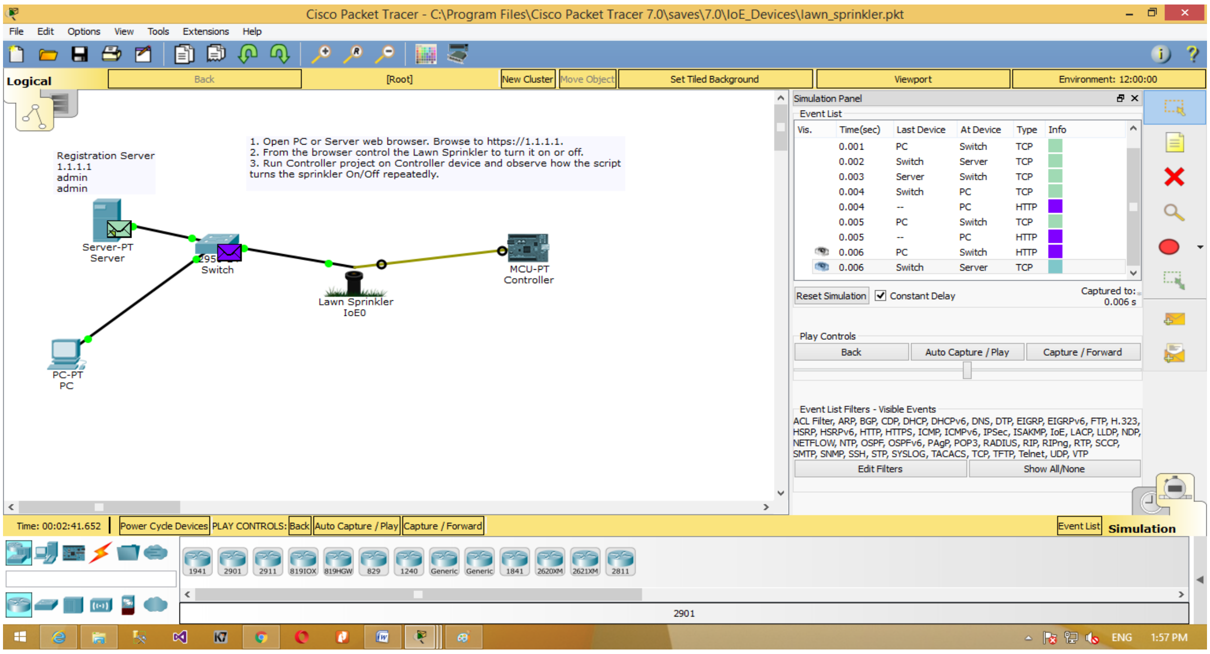


Fig. 4. 6 Home Lawn Project, Running stage

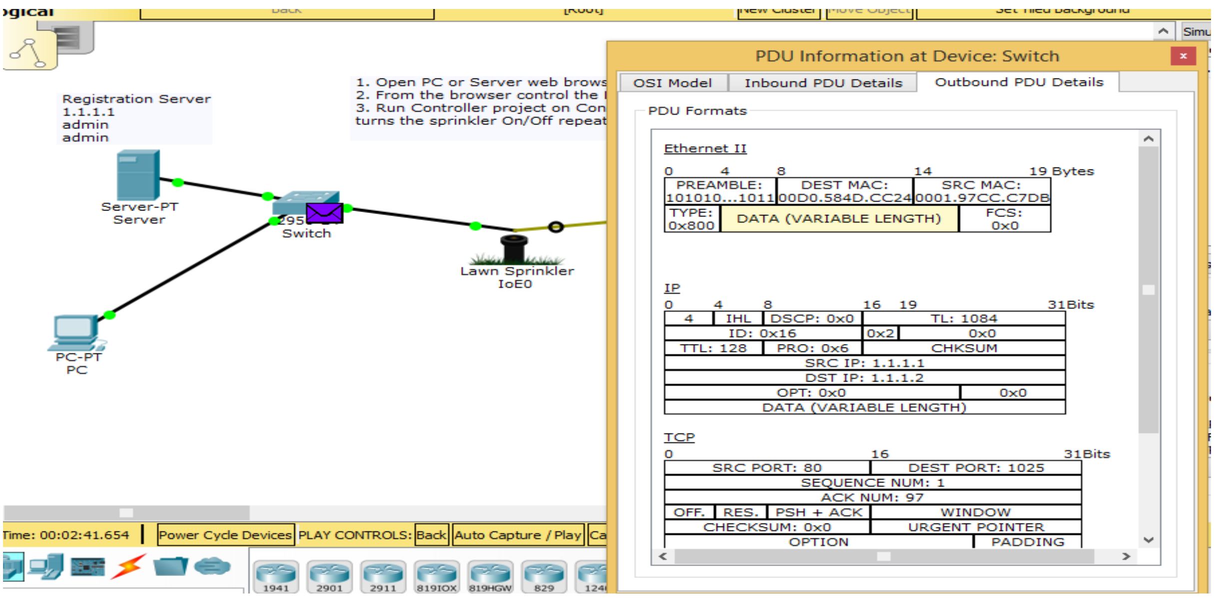


Fig. 4. 7 PDU Format

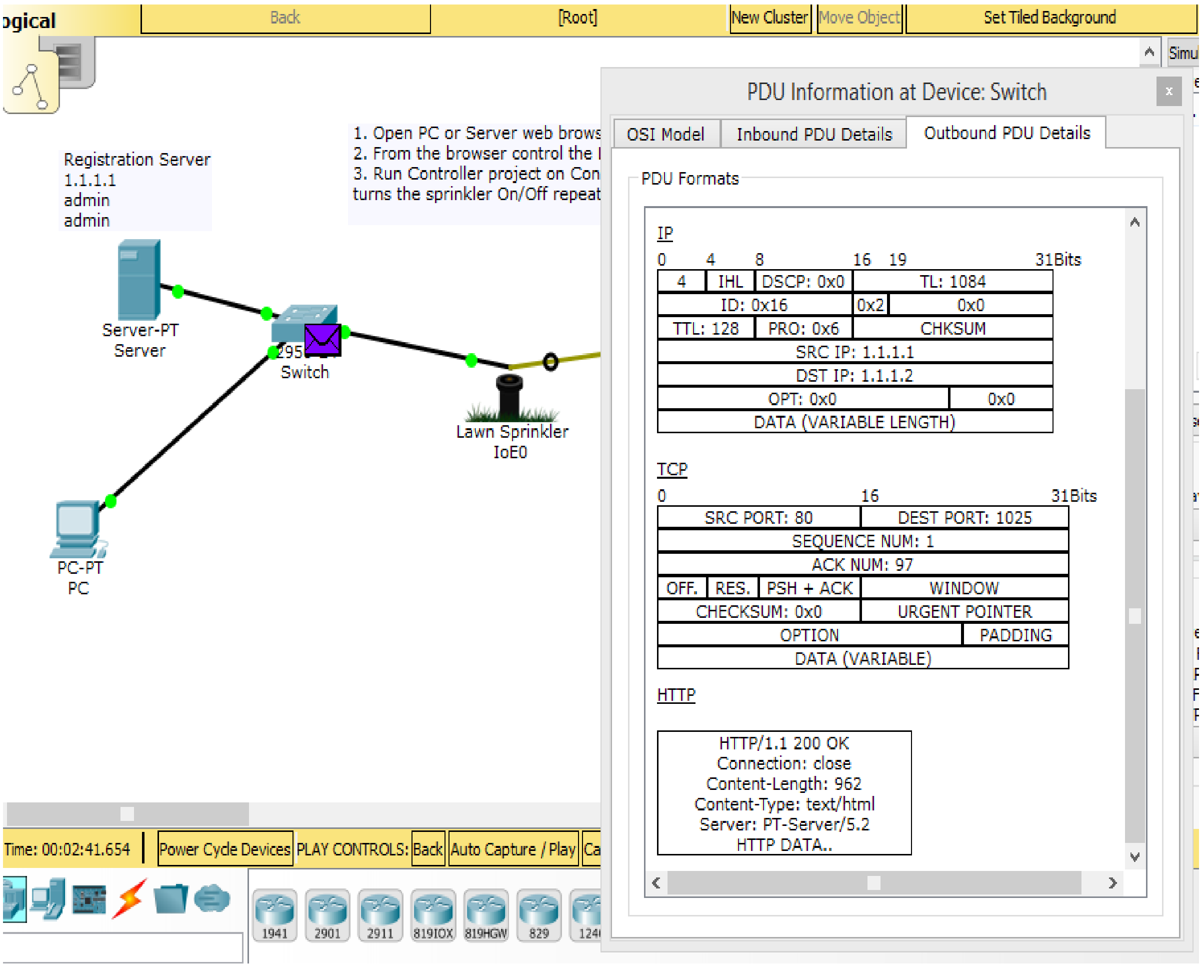


Fig. 4. 8 TCP & IP Header Format

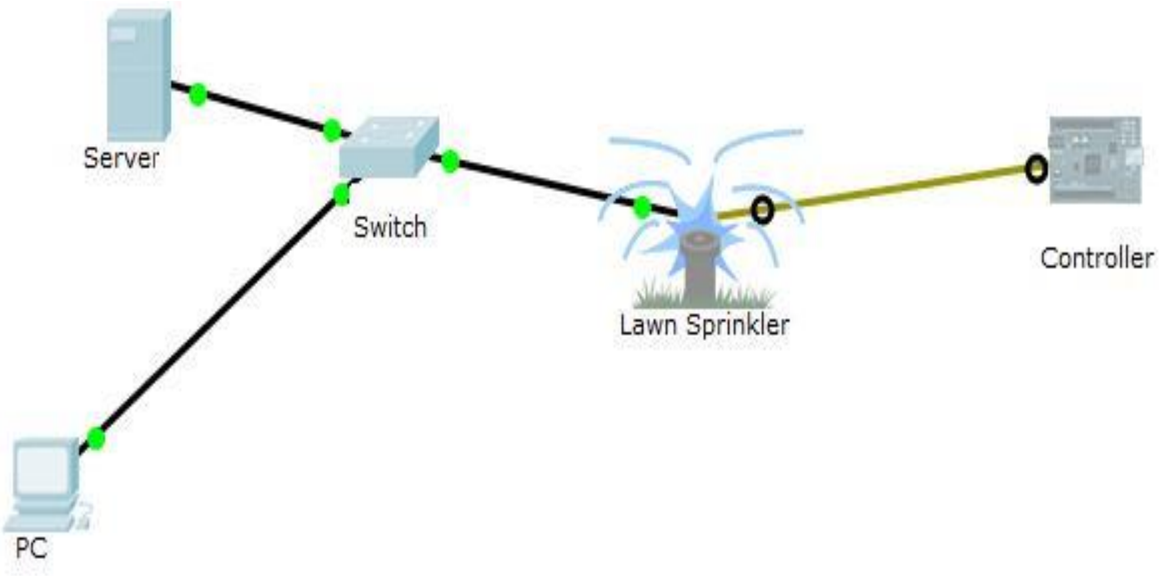


Fig. 4. 10 ON Sprinkler simulation

Result and Comparison

Technical Specifications: According to our work we had studied that our proposed approach is good the nearlier method present in IOT. The specification of result compared in terms of system's ease of use, its simplicity and many other as shown in table.

TABLE : Relevance of Proposed System as per User Specification

SNo.	User Oriented Metric	Earlier Method	Proposed Approach
1.	Ease of Use	Complex	Moderate
2.	Simplicity	Low	High
3.	Resource Requirements	More	Less
4.	Speed	Low	High
5.	Understand ability	Complex	Moderate
6.	Security	Less	Moderate

As per Technical specification of current proposed approach, we can see their impact:

TABLE: Relevance of Proposed System as per Technical Specification

SNo.	Technical Specification	Earlier Method	Proposed Approach
1.	Hardware Complexity	Complex	Moderate
2.	Code Complexity	Complex	Moderate
3.	Delay	High	Low
4.	Flexibility	Very Limited	Available
5.	Reliability	Moderate	High
6.	Cost	Very Costly	Less
7.	Portability	No	Yes

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