Automated Smart Irrigation System using Raspberry Pi

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ABSTRACT
Water is the most essential contribution for upgrading agricultural productivity and therefore expansion of water system has been a key format in the improvement of farming in the nation. An Automated Sprinkler irrigation method distributes water to crops/plants by spraying it over the crops/plants like a natural rainfall. In this thesis we will develop an automated sprinkle system that will help a farmer/people to know about his field, and the status of his plant at his home or he may be residing in any part of the world. This work will helps the farmers to irrigate the farmland in a very efficient manner with automated irrigation system based on soil, humidity, weather .This sprinkler system will provide control for soil temperature, moisture sensing to ensure plants is watered when there is demand, live streaming and also provide the temperature, humidity sensing, forecast lookup from other weather services. Whenever there is a change in temperature, humidity and current status of rain of the surroundings these sensors senses the change in temperature and humidity and gives an interrupt signal to the raspberry pi. Water excess irrigation not only reduces plants production but also damages soil fertility and also causes ecological hazards like water wasting and salinity. In recent years the awareness of water and energy conversation has resulted in the greater use of sprinkler system .Currently the automation is one of the important roles in the human life. It not only provides comfort but also reduce energy, efficiency and time saving. Now a day the industries are using an automation and control machines which are high in cost and not suitable for using in a farm & garden field. So in this work we will design a smart irrigation technology based on IoT using Raspberry pi. The proposed sprinkler system will be low in cost and usable by the Indian farmers. Raspberry pi is the main heart of the overall system.

Keywords
IBM Bluemix; Internet of Things (IoT); Raspberry pi; Soil moisture sensor; Water motor;

1. INTRODUCTION
The importance of building an automation system for an office home or field is increasing day-by-day. Automation makes an efficient use of the electricity, water and reduces much of the wastage. Smart water sprinkler irrigation system makes an efficient use of water for the growth of plants. Heart of the system is Raspberry Pi 3 mini computer, shown in figure 1. Raspberry Pi model 3 has dedicated general purpose input outputs (GPIO) pins. These all GPIO pins can be accessed for controlling hardware such as LEDs, sensors, and relays, which are examples of outputs. Need of automatic Irrigation

- Simpler and easy to install and configure.
- Saving energy and resources, so that it can be utilized in appropriate way.
- Farmers would be able to spread the proper quantity of water at the proper time by automating farm or nursery irrigation.
- Avoiding irrigation at the incorrect time of day, reduce runoff from overwatering saturated soils which will enhance crop/plant's performance.
- Automated irrigation system uses shower to turn motor ON and OFF.

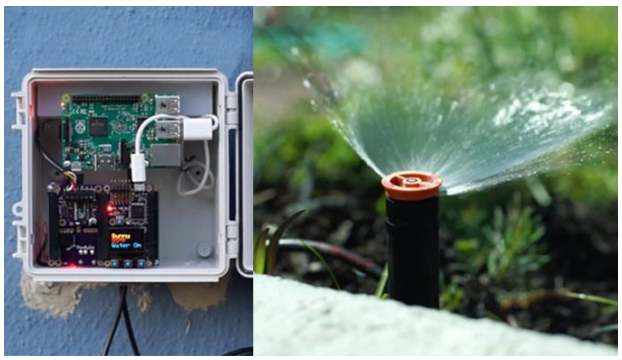


Fig. 1 Smart Sprinkler [10]

In this paper Raspberry pi 3 is used which was released in February 2016. Price is in between US 20$ to 35$. It has architecture of ARM v8(64/32 bit), Quad Core Broadcom BCM 2837 System on chip used along with the CPU of 1.2GHz 64/32 bit quad core ARM cortex A53. The memory of Raspberry pi 3 is 1GB and the storage is in the micro SDHC slot. It has an additional feature of Wi-Fi and Bluetooth as compared to other versions of Raspberry Pi.

The Raspberry Pi 3 will cost the same as its antecedent, but with an additional feature of Bluetooth and Wi-Fi. With its built-in wireless connectivity, the new Raspberry Pi 3 is clearly placed as a low-cost hub for Internet of Things(IOT) devices, or flexible, low-cost basis on new types of connected gadgets.

As for inputs, raspberry pi can read the status of buttons, switches, or different sensors.

- ✓ CPU: Quad-core 64-bit ARM Cortex A53
- ✓ GPU: 400MHz Video Core IV multimedia
- ✓ Memory: 1GB
- ✓ USB ports: 4
- ✓ Video outputs: HDMI via 3.5 mm jack
- ✓ Network: 10/100Mbps Ethernet and 802.11n Wireless LAN
- ✓ Bluetooth: 4.1
- ✓ Power source: 5 V via Micro USB
- ✓ Size: 85.60mm × 56.5mm
- ✓ Weight: 45g (1.6 oz)

In a Smart Irrigation System the Raspberry pi is combined with Cloud Computing to provide the communication between the person and the Sprinkler. Cloud is a service provider or a type of internet based computing that provides shared computers processing resource and other devices on demand.

Cloud provides services such as Infrastructure, Platform or Application:

IaaS (Infrastructure as a Service) provided to the consumer for processing, storage, network and other resources where the proofreading spelling and grammar:

User is able to deploy and run their software which can include operating system and applications.

PaaS (Platform as a Service) provided to the user to deploy onto the cloud consumer applications created using programming languages, libraries, services and tools supported by the provider.

SaaS (Software as a Service) provided to user to use the provider's application running on a cloud infrastructure .This paper presents a smart irrigation system for gardening purpose with the use of raspberry pi.

In this proposed work, we express such a kit based on IBM Blue mix with pre-installed analytic services IBM Watson IoT, Cloudant, dashboard and node-red.

Blue mix has all the trendy runtimes already installed and ready to go. And we don't see our favorite runtime, we can install our own, because Blue mix is based on Cloud Foundry technology. Bluemix has a bulky and growing catalog of services and facilities that are already installed and licensed for the platform, so they are easy to incorporate into our application. And they have usage-based pricing.

The Bluemix composable service approach lets you "a chance to kick the tires" of new technologies like Watson services. If the Bluemix runtimes and administrations aren't sufficient for your necessities, you can construct your own particular surroundings utilizing Docker-based holders. If we need control the entire software stack, Bluemix supports virtual machine deployments via OpenStack.

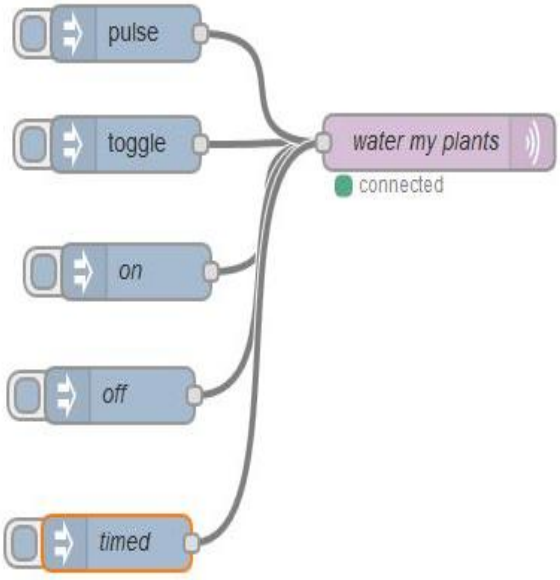


Fig. 2 Flow of sprinkler in node-red

By using Node-RED with our Raspberry Pi, WE will learn:

- How to set up Node-RED flows
- How to control GPIO pins with Node-RED
- How to use Node-RED inputs, outputs and a switch

The Raspberry pi interacts with the IBM Bluemix cloud. The cloud platform is used in our work is IBM Bluemix. This platform is an open standard, cloud based and easy platform for building, managing and running applications of all types (web, mobile, big data, new smart devices, so on). The developer using Bluemix for:

- To quickly bring products and services to market at lower cost.
- To continuously carry new functionality to their applications.
- To lengthen existing investment in IT infrastructure.

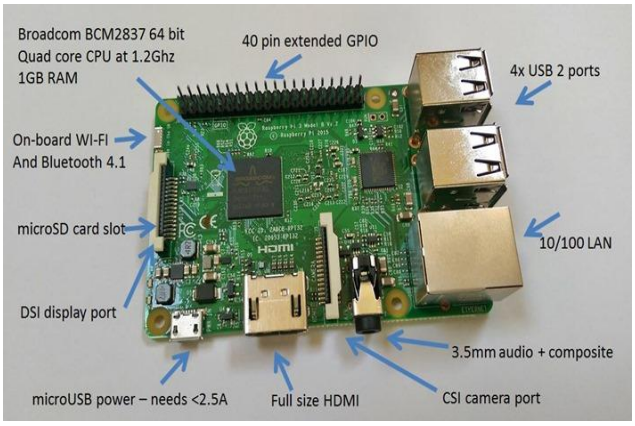


Fig. 3 Raspberry pi 3

The rest of the paper being presented as follows: Section II provides a literature review of the paper and section III Provides the Proposed system and section IV contain Methodology of the System and Section V contain Conclusions. The paper concludes by looking as the future

2. LITERATURE REVIEW

After extensive research in the agricultural field, many researchers found that the agriculture area and its productivity are decreasing by the day. With the Use of different technology in the field of agriculture we can increase the production as well as reduce manual efforts.

This paper shows the sprinkler enabling techniques, protocols and architecture for sprinkler which is widely used for agricultural, gardening, home and office purpose.

Chandankumar Sahu et al. proposed a system on "A Low Cost Smart Irrigation Control System". It 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 [1]

K S. Nemali et al. 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 [2].

Supraha Jadhv et al. proposed, automated irrigation system using wireless sensor network and raspberry pi that control the activities of drip irrigation system efficiently [3].

Sebastian Hentzelt et al. proposed a paper on the water distribution system and gave results to decompose the original nonlinear optimal control problem (OCP) [4].

Joauin Gutierrez et al. attempted a paper that research automated irrigation system using a wireless sensor network and GPRS module instead of the Raspberry pi [5].

Ms. Deweshvree Rane et al. Proposed "Review paper based on Automatic Irrigation System Based on RF Module" it is based on the RF module, this device is used to transmit or received radio signal between two devices. It's design is complex because of the sensitivity of radio circuits and the accuracy of the components [6].

Karan Kansara et al. proposed "Sensor based automatic irrigation system with IoT", this irrigation system is used a raingun pipe, one end connected to the water pump and another to the root of plant. It doesn't provide water as a natural rainfall like sprinkler and also it uses only soil moisture sensor.[7].

G. Parameswaran et al. proposed "Aurdino based smart irrigation system using Internet of Things", the researcher has not used Raspberry pi instead the work is done using aurdino controller without use of soil moisture sensors [8].

3. PROPOSED SYSTEM

The block diagram of the proposed system as shown in Fig. 2 consists of different types of sensing unit such as Soil Moisture Sensor to measure water content of the soil, Temperature Sensor detects the temperature, Humidity Sensor to measure the presence of water in the air.

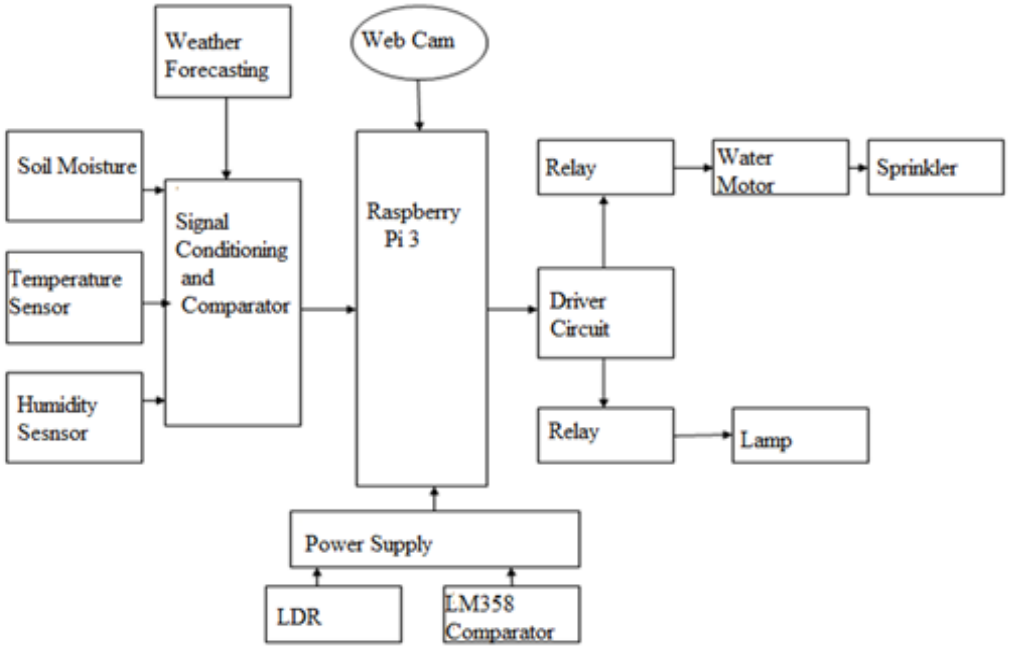


Fig. 4 Proposed System Design

4. METHODOLOGY OF THE PROPOSED SYSTEM

In this work, webcam is interfaced with Raspberry Pi 3 via Wi-Fi Module. Raspberry Pi is the heart of the overall existing system. The Raspberry Pi Model 3 incorporates a number of enhancements and new features. Improved power consumption, enlarged connectivity and greater IO are among the improvements to this powerful, small and lightweight GPIO(General Purpose Input Output) pins.

The Raspberry Pi cannot directly drive the relay. It has only zero volts or 3.3 V. We need 12V to drive electromechanical relay. In that case we need a driver circuit .The driver circuit takes the low level input and gives the 12V amplitude to drive the relay which operates at 12V .We are using here 2 relay to switch on Water motor , sprinkler.

Soil moisture sensor, humidity sensor, temperature detection sensor are connected to Raspberry Pi board through comparator circuit. Soil moisture sensor gives a resistance variation at the output. That signal is applied to the comparator and signal conditioning circuit. The signal conditioning circuit (LDR) has potentiometer to make a decision the moisture level above which the output of comparator goes high. That digital signal is given to the raspberry pi board. If the soil moisture value is above the moisture level and humidity is high at the given value and also if the temperature is high then the water motor will be on, whereas if the moisture level, humidity, temperature is low the motor will be off through the relay. With all the parameter's, it also check is it rainy? If yes so water motor will not on for 30 minutes and again after 30 minutes it will recheck the status of rain through weather forecasting report if rainy so water motor will on only for 10 minutes otherwise not rainy on that condition water motor will on for calculated time.LDR is used for controlling light automatically, at night light will be ON automatically so that we can observe our farm at night also using mobile phones.

The android app will have a GUI which will show all the data to user. The modes as specified can be selected by the user on the app itself.

Fig 5 & 6 shows the simulation of lawn sprinkler in Packet Tracer 7.0.

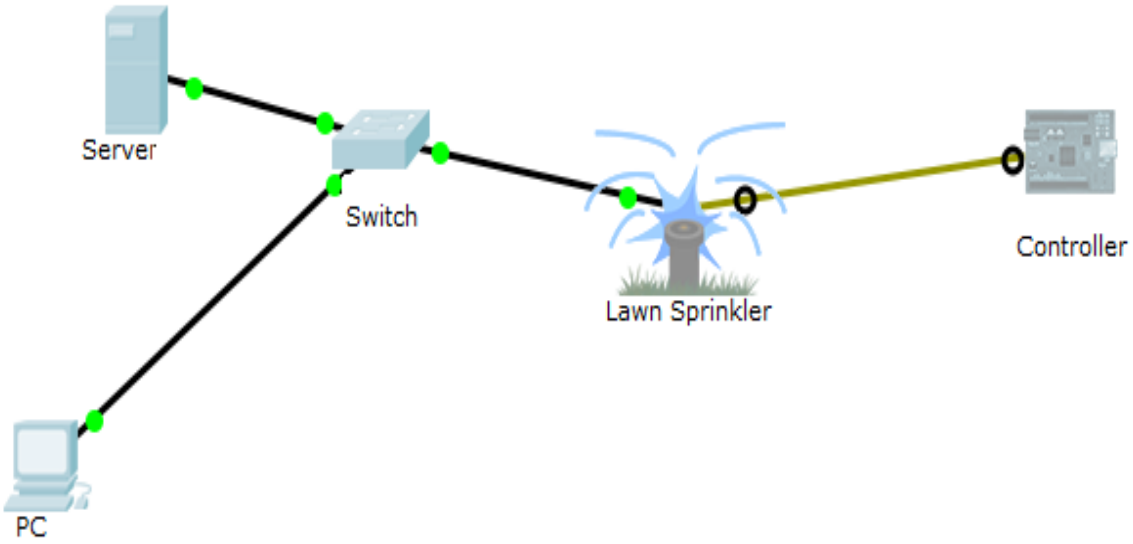


Fig. 5 OFF Sprinkler Simulation

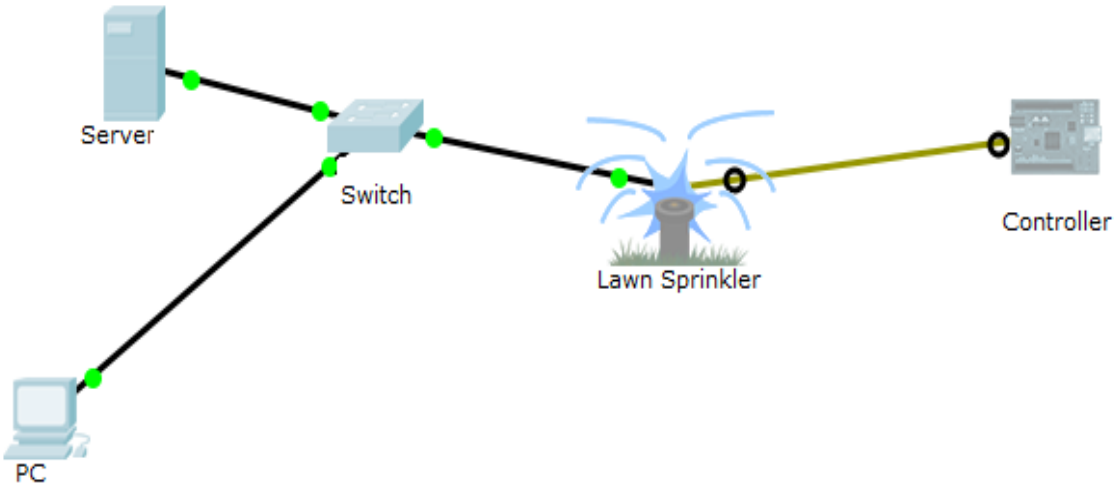


Fig. 6 ON Sprinkler Simulation

4.1 Steps of System implementation:

There is different irrigation actions are implemented in system

1. Irrigation performed manually with the on, off buttons.
2. Irrigation performed at a given date and time through web or mobile application.
3. Automated irrigation with a fixed duration, when soil moisture, humidity sensors value get low at the programmed threshold level.

Manually performed the irrigation: During the season when we do not need to water your plants daily at a given time of interval that time manually on/off the sprinkler needed.

So we need to setting the time:

1. Use the "+" and "–" the buttons to adjust the minutes.

2. Press SET to continue.

4.2 Flow Chart of automated irrigation methodology:

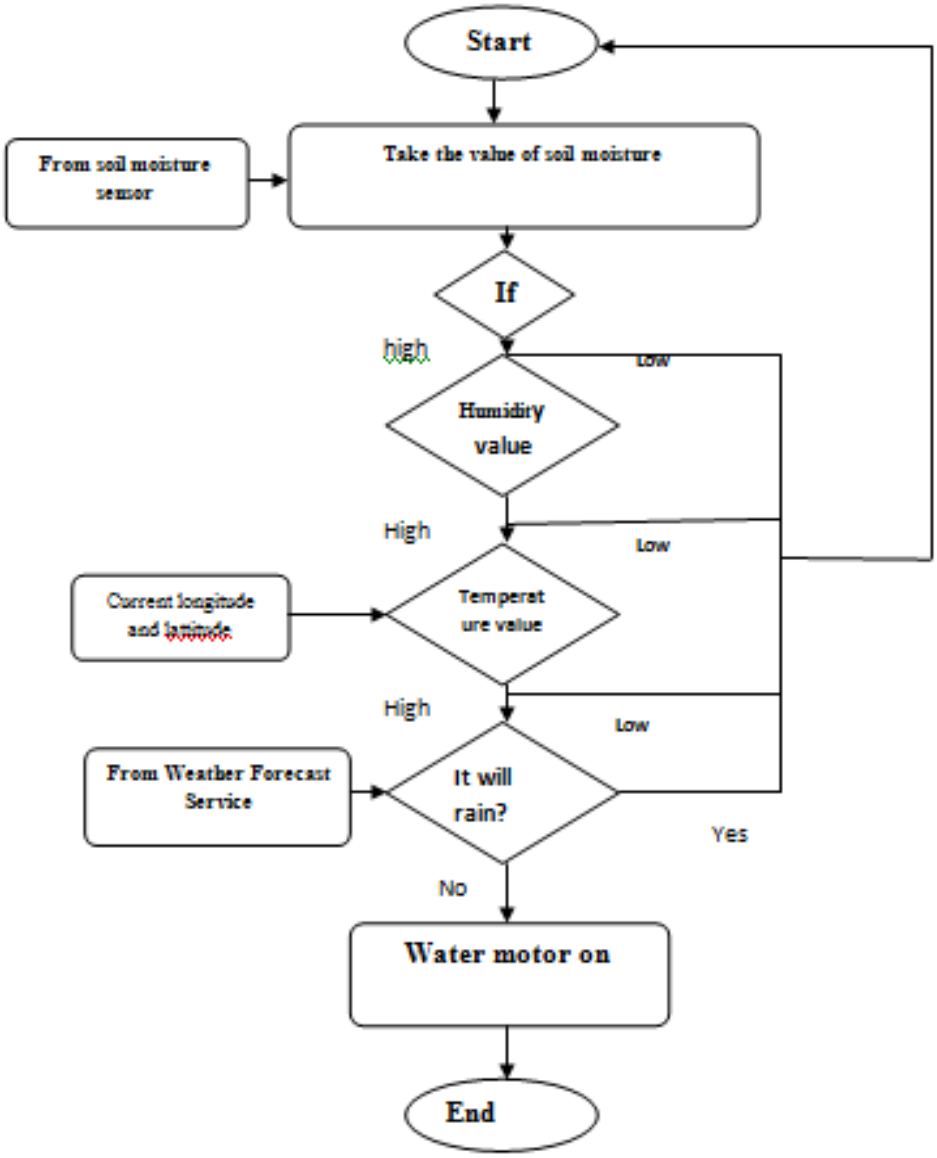


Fig. 7 Flow diagram of sprinkler system

4.3 How Modules Work:

There are two modules in our system:

Scheduled (Automated) & Manual

Step 1: Start.

Step 2: Initialize the system on Raspberry Pi.

Step 3: The soil moisture sensor checks the soil moisture level constantly.

Step 4: The USB camera installed with the Raspberry Pi gives the complete surveillance of the field and this can be monitored in the internal network system.

Step 5: The DHT11 sensor constantly senses the temperature and humidity of the field and updates the date in the web server.

4.4 Result Analysis

Node-Red implementation of automated irrigation system is shown below:

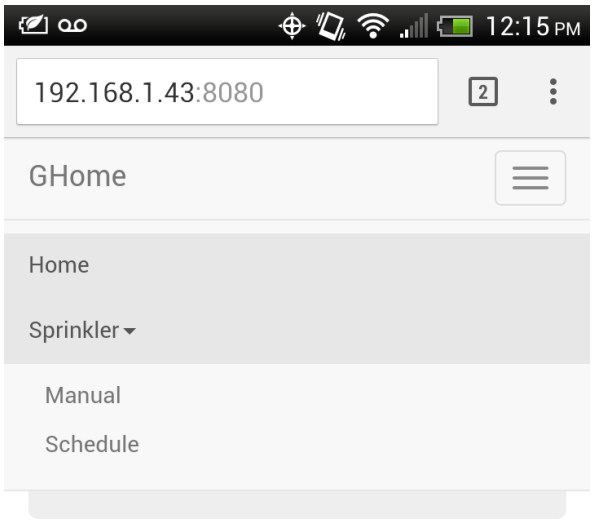
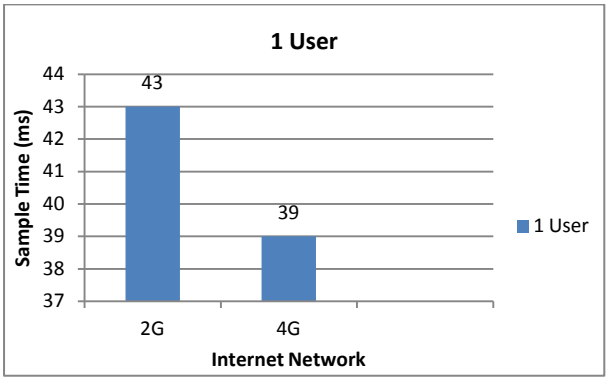


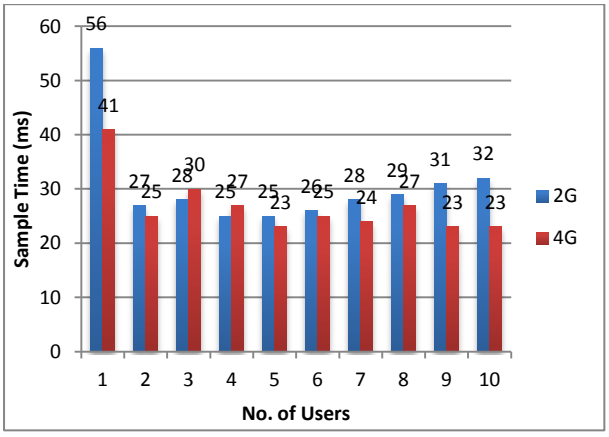
Fig. 8 Graphical User Interface Using Node-Red

Very first all the required nodes taken in node-red dashboard and then we added a function with coding and after all codings we deployed our flow, output of our flow is as fig. 8

4.4.1 Comparison of sample time when no. of user is 1



4.4.2 Comparison of sample time when no. of users are 10



5. CONCLUSION

In the present era, people use various irrigation techniques through manual control, in which a person has to irrigate a garden/land at regular time intervals. This process seems to consume more water and results in water wastage. Moreover in some garden areas where there is inadequate rainfall or watering plants, irrigation becomes difficult. Hence we require an automated system that will precisely monitor and control the water requirement in the garden .Installing smart irrigation system in smart garden saves time and ensures efficient use of water. Moreover this architecture uses Raspberry pi which promises many features for growing plants perfectly.

6. REFERENCES

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