Implementing a Scalable Irrigation System using Cisco Packet Tracer

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***Abstract*—This paper proposes a smart Irrigation System to control the irrigation of farming fields. Irrigation is automated, thus reducing human intervention. The main objective is to make agriculture more efficient while also reducing the manpower and time required to maintain crops by automating most of the processes. This project also seeks to identify the different ways in which the usage of technology in more traditional domains impacts society. Numerous sensors, webcams, and other different electronic devices have been used to implement a smart irrigation system. This irrigation system has been simulated in Cisco Packet Tracer. Through such a system, farming can be made more convenient, especially in countries like India.**

Keywords*—*Cisco Packet Tracer, Smart Irrigation, Computer Networking

I. Introduction

Life on earth cannot exist without plants because they give us food for the existence of life. Without proper irrigation, care and cultivation of crops on a regular basis, we, humans would be unable to survive. the amount of food grains produced tells us more about the amount of food crops that is grown yearly and this poses to us, our problem, the care, and cultivation of such a large quantity of food crops requires a massive amount of manpower as well as constant vigilance to make sure that the crop is in proper condition. Irrigation plays a key role in increasing productivity. It is also a basic requirement for proper agriculture. Moreover, the last few decades have seen numerous changes in climate and resource utilization, strongly affecting water resources globally. The lack of freshwater, or water suitable for irrigation at the least has shown us that certain measures have to be taken to ensure proper water management. Smart irrigation is a method which involves the judicious use of water for irrigation. In agriculture, each crop has to be treated different throughout its various stages of growth. This implies that the irrigation requirements will also vary accordingly.

So, a customizable system, which can be remotely controlled works best here. This is made possible through IoT, which allow for remote control of devices.

Existing solutions include the usage of sensors and monitoring devices to control crop irrigation. This is made possible using sprinklers and other monitoring devices. It also extends to working as a security system through the various motion sensors present around the field.

II. NOVELTY

A. *Implementation of multiple access points*

Multiple access points have been implemented between the sensor devices and the DLC wireless gateway, the access points are segregated based on the use of the wireless devices that have been connected to them, this allows for reduced traffic at the gateway level, as all the data is aggregated into the access points before being sent to the gateway, which allows us to specify which data we specifically need. This allows for congestion control and scalability, both of which are important in implementing large scale farming.

B. *Data aggregation and processing*

The data accumulated from the network are aggregated at the server after being transmitted through the gateway, this data is stored for future use and access by the remote control devices, this data is also processed to allow for predictions of weather and crop yield, both of which can be used to decide the best irrigation method that can be controlled by the remote control devices.

III. METHODOLOGY

Utilizing the Cisco Packet Tracer software, we aim to implement a smart irrigation and crop maintenance system. With the increase in food demand and the shortage of farm workers, such a system allows for better management of crops and increases the efficiency of the farming industry.

In this paper, a simulation of a smart farm created using cisco packet traces is observed, a server, a wireless sensor network, sprinkler systems, and interfacing with mobile devices are all implemented with IP routing in place. Taking into account previously implemented projects under this field, the latency and transmission time observed through the implementation of this paper's novelties are noted, as shown in table (I).

As noted in previous implementation of this field, the solutions are not scalable, with large number of wireless sensors. This paper attempts to utilize multiple gateways as mentioned in section (II.A) to implement large scale farming with low latency conditions.

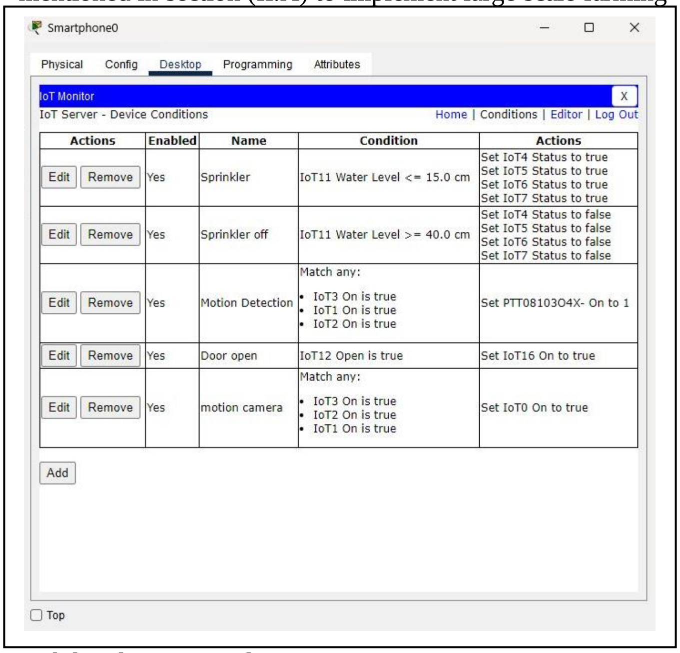


Fig. 1. Sensor interfacing with remote mobile device

A. *Device control using mobile device*

The wireless sensor systems are controlled through input from a remote mobile device, which allows for ease of access regardless of location, the best conditions for irrigation and crop management are analysed and the control of the devices are relegated to the user of the mobile device over a DLC wireless gateway that acts as an access point for both ends of the irrigation system.

This implementation can also be used as a monitoring system to analyse the state of the farm that the irrigation system is operating on, showing the health of the crops and other statistics that allow for better analysis of crop production.

B. *Cloud interfacing*

The system is interfaced to a cloud server which acts an intermediary between the remote mobile device and the wireless sensor systems. The cloud server aggregates the data from the sensor network and allows access of the data from the remote mobile device.

The cloud server is also utilized to process the data and use the collected information to create a machine learning model that provides with predictions of water requirements for each plant type as well as a rainfall prediction algorithm.

The processing done at the cloud server can also be utilized to predict the best water level for each day based on humidity and moisture content data that has been gathered through the wireless devices.

C. *Home and field security system*

The remote monitoring system as mentioned in section (III.A) is also utilized to implement a security system using camera modules and motion detectors, the data is processed at the cloud server and in the case of any unfamiliar movements, the siren alarm is triggered, alerting the user.

The security system can also be interfaced with the food storage to automatically lock it remotely through the mobile device that has been interfaced with the system.

IV. OTHER RELATED WORKS

A. *WSN based Irrigation*

With the advancement in WSN technologies, many smart irrigation systems involve the utilization of such networks to improve the efficiency of the farm. However, the implementation of WSN is not applicable to large scale systems and/or multiple fields, with the short range of data transmission as it operates through ZIGBEE, it also suffers from a communication range issue between server and node.

B. *IOT based irrigation*

Applying IoT to modernize irrigation has also been considered, while feasible in a lab scale experiment, in large scale implementations, or even in real life deployment of such a system is largely improbably mainly due to the fact that the cost of implementing a large scale IoT based system is not feasible for most farms and the cons outweigh the pros.

V. RESULTS AND ANALYSIS

From this paper, the smart irrigation system implemented through the Cisco Packet Tracer software aims to make agriculture more efficient to keep up with modern day demands, while reducing the maintenance cost of the crops. While various other methods have been implemented as mentioned in section (IV) this method aims to reduce the delay and transmission time between the nodes and the server. With the help of table (I) we can note that the implementation of this paper's novelties allows for better latency and reduces the packet loss between the two ends of the system, implementing a security system and a monitoring system on top of this project also allows for a more secure agricultural field that allows for quick and easy maintenance.

The ping command is a very common method used to troubleshoot accessibility of devices. It uses a series of Internet Control Message Protocol (ICMP) Echo messages to determine:

- Whether a remote host is active or inactive.
- The round-trip delay used to communicate with the host.
- Packet loss.

The ping command first sends an echo request packet to an address, then waits for a reply. The ping is successful only if:

- the echo request gets to the destination, and
- the destination can get an echo reply back to the source within a predetermined time called a timeout. The default value of this timeout is two seconds on Cisco routers.
- the TTL value of a ping packet cannot be modified.

From calculating the latency using the above-mentioned ping command, we can note a 74.1% percentage increase in the transmission time utilizing the novelties mentioned in this paper as compared to the initial paper's implementation of the same.

TABLE I.

S. No	Latency Comparison		
	Transmission from and to	***Base implementation (ms)***	***Implementation utilizing paper novelties(ms)***
1	From mobile device to server	48	14
2	From cloud to router	42	12
3	From router to wireless sensors	41	11
4	From sensors to router	45	12
5	From router to server	44	13
6	From server to mobile device	56	20

[a] Based on real time analysis and usage of traceroute on Cisco packet tracer

Fig. 2. Comparision table of latency between initial implementation and implementing with multiple access points

Fig. 3. Cisco packet tracer model of smart irrigation system

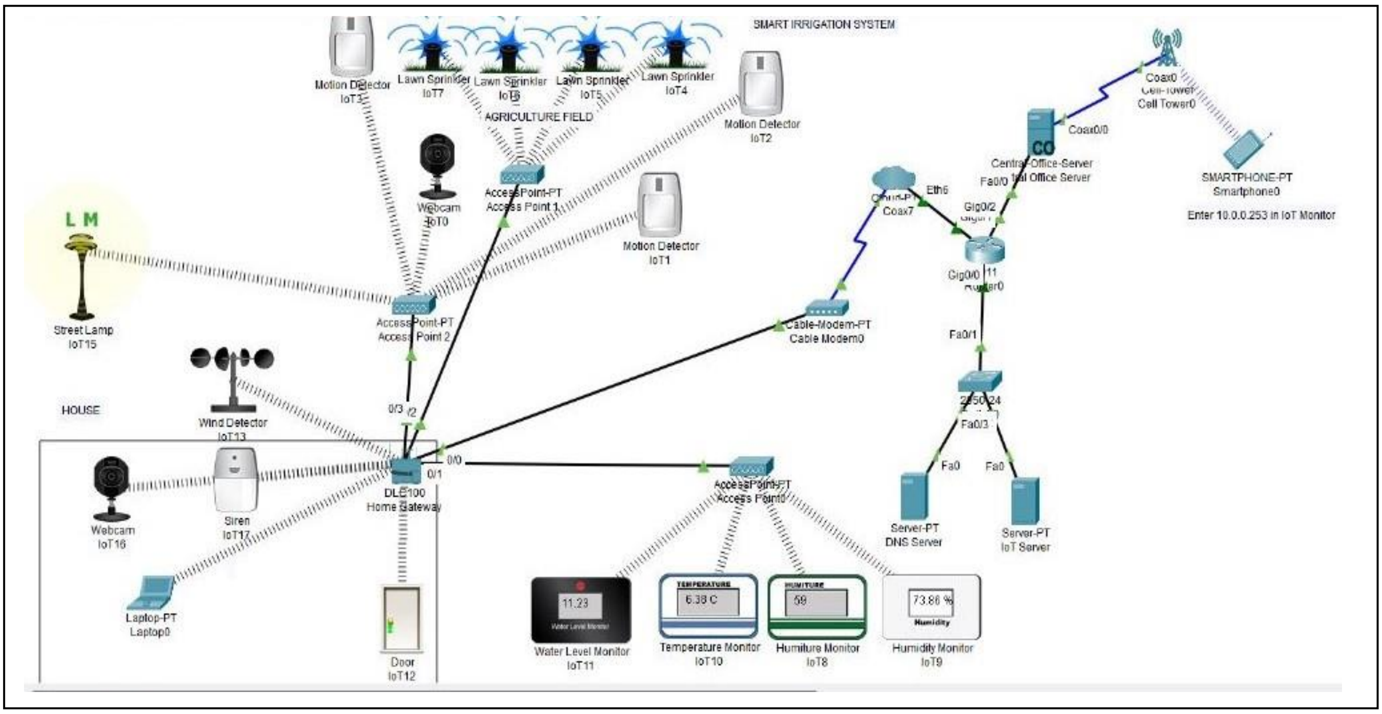
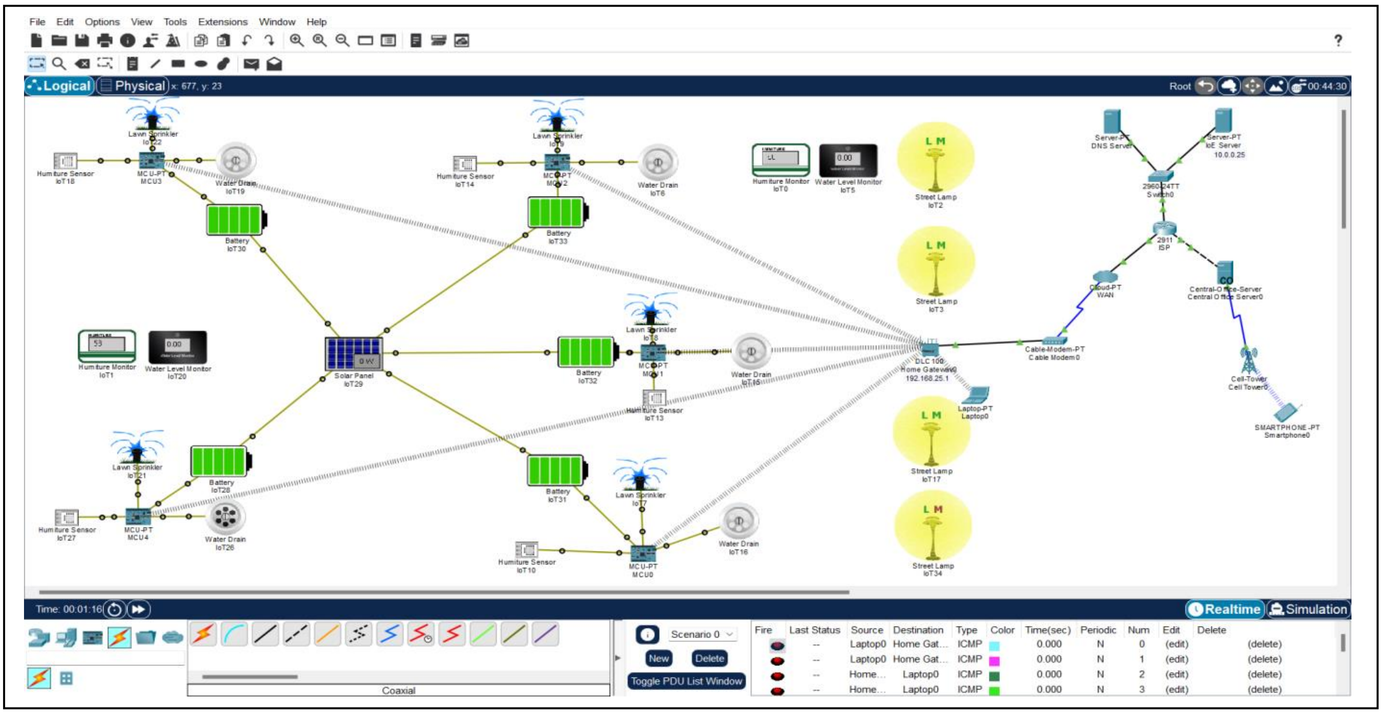


Fig. 4. Cisco packet tracer model of WSN-based smart irrigation system



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