Improving Irrigation by Using a Cloud Based IoT System

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Abstract—**Palestine is a fertile country, and the agriculture system is a significant part of its economy. In Palestine, farming depends on rainfall, however, the rainfall amount has been decreasing over the years and springs are drying out. Therefore, the irrigation system is considered one of the most used systems in the agriculture field. However, there are many factors that should be taken into consideration to control the right amount of water that should be provided to the plant when using the irrigation system, like the soil type, the fertility of the soil, the moisture level, humidity, and temperature of the soil. Our proposed irrigation system takes into account those factors to automate the amount of water dispensed to the plants. The project employs a microcontroller module (ESP8266) which connects the system to the internet by WiFi. This module controls two relays for supplying water to the field, and triggers the fans based on the information obtained from the soil moisture and temperature humidity sensor. This entire system is monitored and controlled by a Blynk server.**

Keywords- Internet of Things (IoT); soil moisture sensor; IoT in agriculture; irrigation system

I. INTRODUCTION

The Internet of things (IoT) ecosystem consists of a group of hardware boards, software systems, web APIs, and protocols, which work together in a harmonious environment that enable smart embedded devices that will connect to the internet network. The principle of IoT is that it enables the sensing and controlling remotely through network infrastructure, in a way that it creates more chances for direct merge of the physical world and computer based systems. The outcome of this action is improved efficiency, accuracy, and economic proficiency. When IoT is augmented with sensors and actuators, the system instantly becomes more common cyber systems, that will include technologies like smart homes [1], smart grids, intelligent transportation, smart cities, and smart agriculture (such as irrigation system, and monitoring the color of leafs). Everything is individually recognized via its embedded computing system. This sensory data can be accessed and controlled directly over the internet network. Additionally, the devices are connected to the internet using different ways such as Ethernet, WiFi or 3G technology. There is no need for the devices to be connect to the internet independently, instead they can be connected as a group of components like a sensor network and the base station. Each component has a unique IP address. Due to the huge number of IoT devices and the depletion of the IPv4 address space, IoT devices typically have IPv6 addresses. Often, IoT devices are connected to the Internet via gateways that are dual stack (having both IPv4 and IPv6). Advanced technologies, hardware and software together will enable the IoT to found and tally everything, which can incredibly decrease the cost, grain losses, and save time. The information of parameters of interest can essentially gotten at fingertips utilizing electronic devices which ease the client to require future activity.

The IoT transforms the agriculture industry and enables the farmers to perform their work more efficiently. Such systems can help improve production, improve quality, and reduce cost.

This paper is structured as follows: section II, introduces the problem statement. Section III, discusses the background of the research work. Section IV is highlighting on proposed system and components. In section V, the cloud platform and in section VI, the user interface are described. Section VII, discusses future work. Section VIII concludes this paper.

II. PROPLEM STATEMENT

Rainfall levels have been dropping in Palestine over the last few years and spring water flow has been decreasing and unpredictable (Fig. 1) and some are drying out [2]. The local and global markets are growing, and there is an increasing demand for more food supplies. Agriculture industry is the only source that provides food for human societies. Agriculture has always been an important factor in the economy and it had been developed in many ways to reduce the cost and extra expense for extra workers. Technology has helped reduce the number of workers needed to cover a large area of a farm, and limited the time required to accomplish many tasks. IoT enables the workers to monitor and control the large fields from a distance, in addition to controlling the time, especially at nights, weekends, and emergencies like Corona viruses crises. The farmer can monitor the humidity level and the soil moister, and then pump water into the fields accordingly. In addition, to overcoming the restrictions of the water system framework in cultivating routine and due to water scarcity, IoT will help in using the right amount of water depending on the moisture of soil, besides the plants type. The system helps conserve value water, reduce the cost of irrigation, and save a lot of the farmers time. The cost of the system is low due to the use of inexpensive parts.

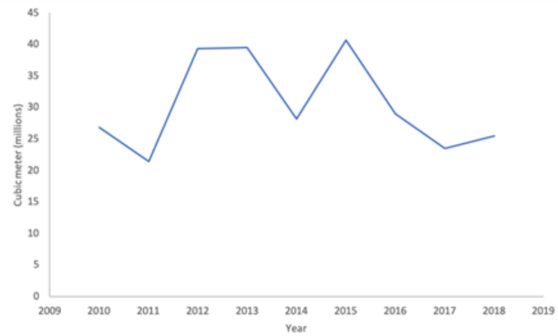

Figure 1. Amount of water flow from springs in millions of cubic meters

III. RELATED WORKS

Numerous related IoT systems are proposed in the literature. The authors of study [3] used an Arduino based system with sensors for pH and YL-69 soil moisture for precision farming. They implemented a central server that receives data from the sensors, summarizes the data and forwards the messages to the farmers. The system is customizable, where farmers can adjust the threshold values to control the amount of water for the plants. Moisture level dropping below a certain threshold will trigger the system motor to start the irrigation system.

Authors of study [4] proposed an irrigation system that conserves water. They used the PIC16F877A equipped with an RTC DS1307, a ZigBee radio modem and a GSM module. The microcontroller receives data from soil moisture and temperature sensors and displays these data on LCD displays. Data from the temperature and soil-moisture are used to control the water pump. The users can monitor the sensors via Android application.

In [5], authors deployed Arduino to read data from water level and soil moisture sensors. The collection was then forwarded into Raspberry Pi running a NodeJS application and AWS IoT SDK for JavaScript. The backend is powered by AWS Dynamo database and AWS IoT platform for remote plant watering and monitoring systems. On the other hand, they designed the web application to visualize the data from Dynamo database and to permit users to control the water pump.

The authors of [6] used heterogeneous sensors to predict and define the irrigation system such as atmospheric temperature, humidity of lemon tree area, and soil moisture. Additionally, using intelligent decision by automating the system. The system is made by WIFI modules and Arduino processor

In [7], the researchers build an automation irrigation system based on IoT technologies for transfer data from sensors and store it in a NoSQL database system according to the Plant profile, which is defined by the user.

Compared to other approaches, my proposed approach is simplistic, does not require configuration and IoT knowledge. It also provides simple to use interface to customize different aspects of the system.

IV. THE PROPOSED SYSTEM AND COMPONENTS

Our system is programmed and connected in a star topology, two sensors send the extracted data to the server at predefined time intervals in minutes depending on many factors such as weather, the type of plants. The information is sent by Wi-Fi to a Blynk server. The information is summarized and displayed to the user through an application interface, the users can take various actions such as controlling the irrigation system via the application interface. Fig. 2 shows our proposed IoT based system architecture.

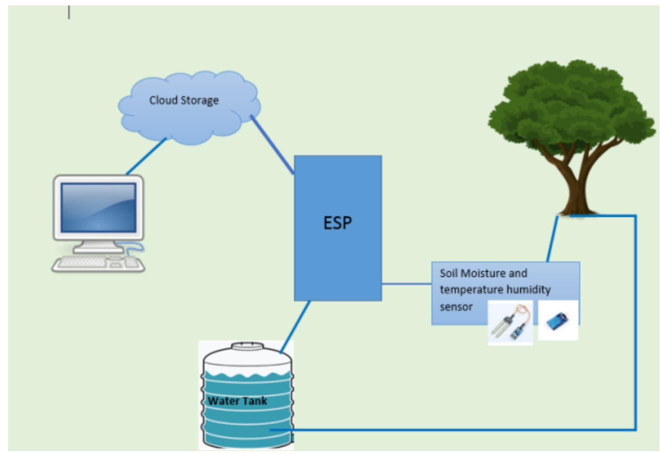

Figure 2. System architecture

A. Data Flow diagram

Fig. 3 describes the overall process of the system. The systems starts with the ESP Wi-Fi controller, which collects the information from the soil moisture and temperature in real time. The data is then uploaded to the cloud. The user then can login to the web portal to monitor the data and can control the water pump and fans based on the sensor values and thresholds.

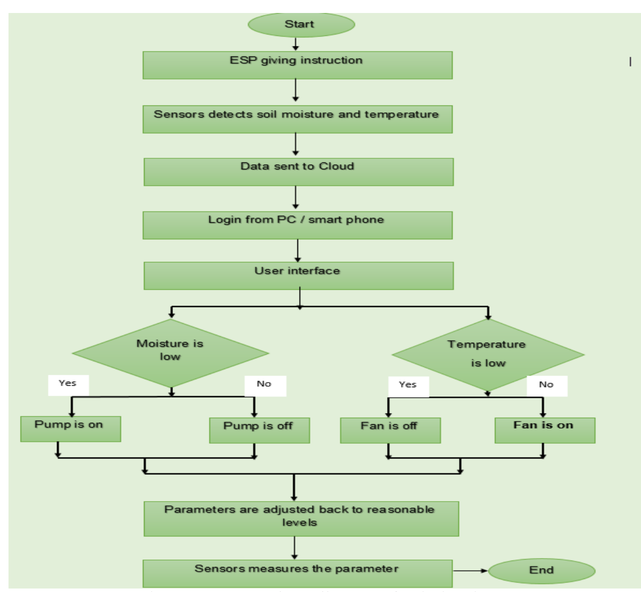

Figure 3. Data Flow diagram for irrigation system

B. Block Diagram

The block diagram (Fig. 4) shows how the systems components are interconnected. The main hub is the ESP Wi-Fi controller. The ESP takes input from moisture sensor and temperature sensor. It is also connected to the cloud from which a web portal can be accessed by the user. ESP is also connected to the pump and fan that can also be controlled by the user.

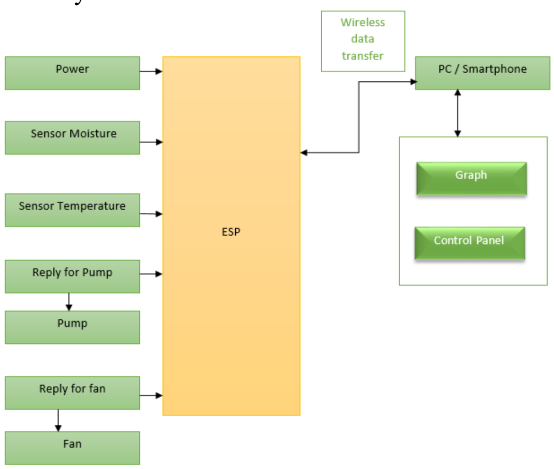

Figure 4. Block Diagram for irrigation system

C. Electric circuit diagram

This project is designed based on ESP8266 WiFi [9] microcontroller module and uses two sensors (Soil Moisture [10] and DHT22 sensor), two relay switches, a DC motor pump, and a DC Fan which used in plastic houses plants. The main role of the fan is to harmonize the temperature and humidity of the air as it works on generating an internal air stream. Unlike when not using a fan, and with the presence of an air stream, the air humidity will be reduced, and this will also reduce the occurrence of fungal diseases. This will also increases the gas exchange on plant leaves, so that it reduces the accumulation of carbon dioxide during the morning and in the night it reduces the accumulation of oxygen. The selection of these components makes the system power effective and inexpensive. The experiment run on an Arduino C. Fig. 5 present a graphical representation of the electrical circuit.

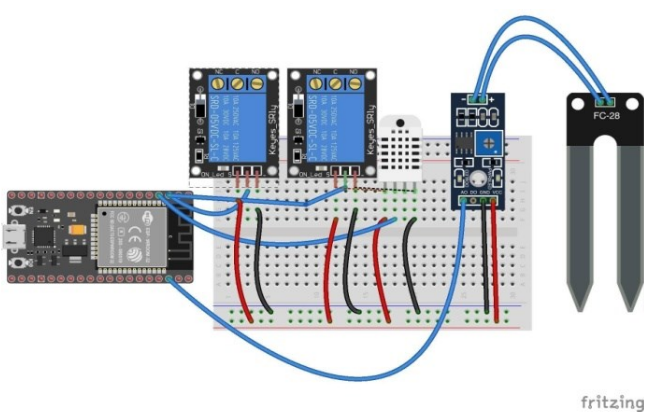

Figure 5: Circuit Layout for Irrigation System

V. Cloud Platform

Blynk server [11] is used for building web applications and mobile applications using an open source in Java server. It is considered as an appropriate platform for IoT applications to send and receive messages between Blynk mobile application and different microcontroller units (MCUs) such as Arduino, ESP32, ESP8266, and Raspberry Pi, and drag-n-drop IoT mobile applications for Android and IOS. To enhance security, Blynk communicates using Secure Sockets Layer (SSL) or Transport Layer Security (TLS) for server connection, and there is authentication code put on pseudo-code and send through the email.

A. How Blynk Works

The Blynk platform consists of three main components as follow and shown in Fig. 6:

- Blynk Application: to create an interface for the project by using varied widgets.
- Blynk Server: the main job for Blynk Server to communicate between the smartphones and hardware. The user could use Blynk Cloud, which is provided by Blynk for free and open source or run his particular Blynk server locally.
- Blynk Libraries: available for whole common hardware platforms, that execute all communication with the server and process all the incoming and out coming commands.

The Blynk application proves the user interface supported by the Blynk Cloud. The application has the ability to control Arduino and Raspberry Pi over the internet. The data flow works in both directions, meaning from the Blynk app to the IoT devices and vice versa.

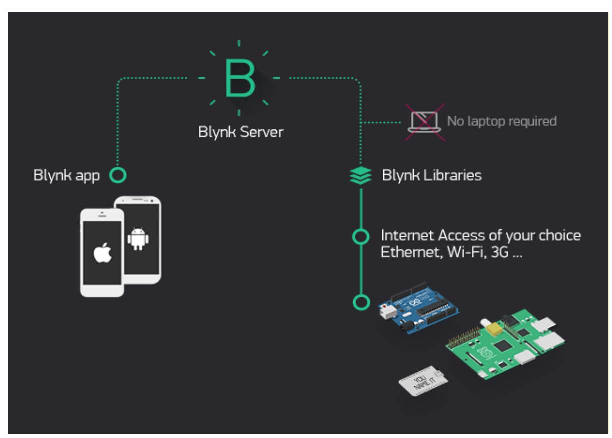

Figure 6. How Blynk Works [9]

VI. Project Interface

As shown in Fig. 7 (the monitoring interface), the user can run/stop the fan or pump according to the sensors reading data. If the statues are switched to on, the pump will work directly and the pump will be opened and the water will flow to the crops, and when switched to off the pump will stop working, and the user can switch them manually.

Figure 7. Project Interface for Irrigation System

VII. Discussion and Future Work

There are many challenges in building automation systems, depending on many factors as collected by farmers such as soil type, weather, humidity, transplant type like (citrus fruit, seasonal fruit, and vegetable), irrigation time, as it is recommended to thrives the plant at the time of budding. In the future, we recommended to build a database including all information about all the above-mentioned factors for the crops in Palestine, by classifying the plant into many categories such as mentioned above. That will make the farmer feel safe in using the automation irrigation system. There are some limitations on such systems as security and privacy [13].

VIII. Conclusion

The most important goal of the irrigation system is to give and maintain the ideal environment in concepts of soil moisture and temperature for the optimum growth of crops using electronic devices like smart phones and remote computers, users can log in to the cloud storage to extract the sensor data use. Users also can monitor the products and control the water pump and fans from the control panel of the user interface. There are some advantages that can be highlighted in this system, firstly it can save time and water as you do not have to go to the farm to do the watering. The irrigation system supplies the right amount of water to the plants as excessive watering may affect the growth of the plants and sometimes the water from rainfall is not sufficient for the plants. So, this system makes use of the sensor to detect the soil moisture level and do watering by using the water pump. Then since the water is supplied to the roots of the plants, it can actually prevent weeds from growing around the plants. This may also save the farmer from spending money and energy to do the weeding process. Soil temperature also has a big effect on the plant growth. If the temperature is too high, the soil will become dry and lose its nutrients. Hence, by knowing the soil temperature from the sensor, electric fans will be switched on remotely when the soil temperature is above the ideal level. Other than that, the irrigation system will in fact reduce human effort as the sensor will be the one who collects all the data directly from the farm to the user's electronic devices. Users do not have to go on site to monitor the environment of the plantation, which is impractical if the area is too wide. All this work can be done with fingertips, when introducing the Internet of Things to the agriculture field. By giving and keeping up the ideal environment for the growth of crops using innovation applications of IoT, we believe that productivity of the crops can be increased and it will be sufficient to provide food for an estimated world population of 9 billion humans by the year 2050 [12].

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