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Research Article

Internet of Thing (IoT) Based Mobile Plant Irregation Application

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Abstract – Nowadays, the use of high-tech devices that make the lives of societies easier has gained importance. Thanks to Internet of Things (IoT) technology, devices communicate with each other and create a smart communication ecosystem. IoT means that not only computers but also smart devices can be connected to the internet. Large amounts of sensor data coming from physical environments are evaluated and converted into information and transmitted to operators or relevant persons, or an activity is carried out through the systems. For example, automatic irrigation projects such as plant watering are designs that aim to ensure healthy growth of plants and plants and to beautify the environment. Automatic irrigation system reduces time and effort in terms of practicality and helps to use water resources efficiently. It also saves water in water-scarce areas. In this project, a remote control and monitoring system was implemented using Arduino IDE, Firebase and MitAPP. Components such as Esp8266 Wifi card, submersible pump, L9110 Dual Motor driver, soil moisture sensor are used. The application was converted into an Android application via MitAPP Inventor and communication was established with the Firebase database. In this way, plant moisture measurements can be displayed in real time and manual or automatic watering can be done at any time. With the successful operation of this work, sufficient and correct amount of water is provided to the plants. Thanks to the technologies and components used in this study, it is aimed for the healthy growth of plants.

Keywords – Internet of Things (IoT), Computer and Communication Networks, Computer Software, NodeMCU, FireBase, MitAPP

I. Introduction

Agriculture stands as the primary source of sustenance, while simultaneously being accountable for a substantial 70% of total water resource utilization [1]. This significant allocation of water resources has spurred researchers' growing interest in exploring avenues to curtail irrigation water consumption [2]. Several key concepts have arisen in this domain, with "sustainable irrigation" taking the forefront. Sustainable irrigation entails the implementation of judicious water consumption policies to safeguard water resources [3].

Conversely, inefficient irrigation practices yield various adverse consequences, the most prominent being the inefficient use of water and a decline in crop quality. This issue is particularly pronounced in cases of irregular irrigation, where the individual water requirements of each plant or crop are not meticulously considered. Frequently, agricultural fields comprise multiple plant species, each with distinct water needs [4]. In many instances, farmers tend to over-irrigate, pumping more water than necessary. This practice not only diminishes crop yields but also results in the wastage of both water and energy resources [5].

Conversely, the utilization of Internet of Things (IoT) technology has witnessed substantial growth in recent years, resulting in a continuous proliferation of internet-connected devices. This surge can be attributed to the escalating demand for data collection from these devices to serve various internet-related applications [6]. Projections suggest that the number of connected devices is poised to reach a staggering 25.1 billion by the year 2025 [7].

Within the realm of irrigation, IoT technology presents a myriad of applications aimed at monitoring crop growth and facilitating informed irrigation decisions [8]. This renders IoT an apt choice for the implementation of smart water management solutions. However, despite the widespread adoption of IoT, several challenges persist, impeding its broader utilization for precision irrigation. These challenges encompass the necessity to develop software tailored for IoT-based smart applications, as well as the imperative to automate irrigation processes using specialized platforms that are not yet fully realized [9], among other considerations.

The existing research on smart irrigation systems has been conducted in the literature [10-14]. Within the scope of irrigation systems, software for irrigation systems [15], pivot center-specific irrigation systems [16] or irrigation systems for greenhouses [17] are used in precision agriculture [18-23], There are studies focusing on monitoring crops [24] and studies on agro-industrial and environmental areas of agriculture [25].

Smart irrigation systems with the Internet of Things are needed hardware (sensors, circuit equipment, etc.), controllers (circuit kits that detect sensors and provide control with embedded software) and software platform (embedded system software, cloud systems, application platforms, etc.).

In the study, a prototype application was made to the smart irrigation system. In this application, the data received from the sensors was controlled with the embedded system software, data was processed to the database in the cloud system with the help of the communication module, the data was monitored with the interface application and the irrigation need was provided through the interface. Working hardware, embedded system software, cloud platform and has a working feature that integrates the Android interface application.

In the remaining part of the study, tools and technologies used in application and the screen prints and results of the study are explained.

II. Materials and Method

Automatic plant watering system, which is a design designed to use water resources economically, prevent plants from drying out, grow crops planted in agricultural areas more healthily, and decorate the environment, aims to reduce time and labor in terms of being practical.

In the study, a moisture sensor was connected to the determined soil and irrigation was carried out automatically or manually via a remote application when necessary, with the help of a submersible pump from the water tank. In this system, a remote control and monitoring system was implemented using the NodeMCU[26] card and Arduino IDE[27] Firebase[28] and MitAPP[29]. The materials and technologies used in the study are explained below.

A. *Tools and Technologies Used in Study*

In the study, as technology; software via Arduino IDE, a Firebase database to ensure and monitor communication, MitAPP inventor for the Android application and NodeMCU development card will be used to remotely control and upload our software to the system.

The materials used for circuit design are as follows;

1. Esp8266 Wifi card (NodeMCU LoLin Esp8266)
2. Submersible Pump
3. L9110 Dual Motor driver
4. Soil Moisture Sensor
5. BreadBoard
6. Adapter
7. Jumper Cable.

B. *Controller-NodeMCU*

The NodeMCU platform is an open source programmable physical platform based on ESP8266. This platform was produced to realize internet of things applications at low cost and has a structure similar to the Arduino Nano platform. Input/Output units offer PWM outputs and communication support. In addition to the Arduino Nano platform, it can provide WiFi connection[30]. The pin view of the NodeMCU platform is shown in Fig.1.

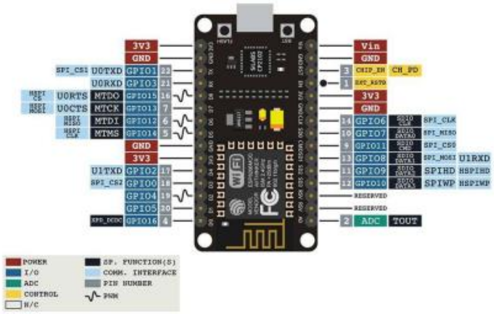

Fig. 1 NodeMCU Microcontroller

Despite its cost-effectiveness, this card exhibits remarkable stability, rendering it suitable for a broad spectrum of applications. Notably, its integration with the ESP8266[31] Wi-Fi module facilitates seamless internet connectivity, making it a popular choice for remote control and Internet of Things (IoT) ventures. Moreover, its low power consumption renders it highly preferable in projects where energy efficiency is a paramount concern. Typically, it employs script as its primary programming language, although it offers compatibility with the Arduino IDE, enabling programming in the same language as Arduino. The micro USB input further simplifies the programming process via the Arduino IDE.

C. Communication Unit-Esp8266

ESP8266 is a low-cost Micro Control Unit (MCU) with TCP/IP stack. Thanks to this module, TCP/IP connections to the Wi-Fi network can be made.

D. Hardware

The hardware materials used in the study are shown in Fig.2 and briefly explained below.

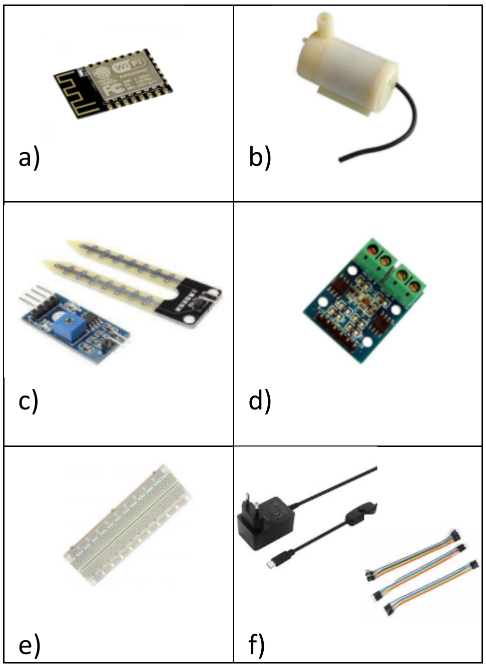

Fig. 2 Communication Unit and Hardware a) Esp8266-Wi-Fi Card b) Mini submersible pump c) Soil moisture sensor ,d) L9110 dual motor driver, e) Breadboard, f)Adapter and jumper cable

Waterproof water engine that operates silently and has low power consumption It can transfer liquids such as oil and water up to 120 liters per hour. This product, which has an IP68 standard, is water and dust proof.

It is a sensor that you can use to measure the amount of moisture in the soil or the level of a liquid on a small scale. Moisture meter probes are used by being immersed in the environment to be measured. Due to the resistance caused by the soil or the liquid immersed in it, a voltage difference occurs between the probe tips.

There is an L9110 motor driver integrated on the card. The driver, which operates at an input voltage between 2.5-12V, uses two separate DC motors in both directions. motor or 4-wire 2-phase stepper motor can be controlled.

It is the tool with which we test our circuits on the breadboard. It allows us to easily test the circuits we have built without soldering them to each other. It allows us to test the circuits we design before transferring them to printed circuit boards or perforated plates.

E. Software and Cloud

The Integrated Development Environment (IDE) for Arduino is a cross-platform application (for

Linux, macOS, Windows) written in C and C++ languages. It is used to write and upload programs to Arduino compatible cards. Arduino IDE basically processes the executable code into a text file with hexadecimal format. The Arduino IDE used transfers this text file to the connected Arduino card with the firmware loader program.

Firebase is a platform developed by Google for creating mobile and web applications. It is a partially free online database. Firebase real-time database is a cloud-based NoSql (Not Only Sql) database system. They can be managed with json parameters without the need for any SQL queries [7]. In addition to data storage, it allows instantaneous monitoring of data changes with its asynchronous operation.

Firebase Realtime Database keeps all data as a JSON object. Firebase Realtime structure can generally be thought of as a cloud-based json tree structure. When data is added to the Json tree, your data becomes a node in JSON format. Nodes have a key-value structure. Keys such as User ID can be created. Key values in the JSON structure are of String type and unique. The values that the key takes can be of various types such as String, Integer, Boolean.

MIT App Inventor is a free application development tool introduced by Google and later developed by the Massachusetts Institute of Technology (MIT). It allows application development for the Android operating system using the block coding method. Its most important feature is that it can be programmed as drag and drop. With this easy method, we extract data from the database, whose keys we enter, transfer it to the application, and send data to the database and change it.

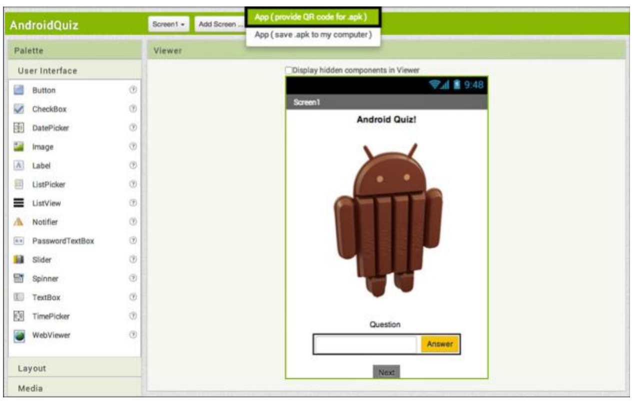

Fig. 3 Mitapp Development Application

III. EXPERIMENTS

The circuit design prototype used in the study is shown in Figure 4. The points to be considered in circuit design and coding application are listed below:

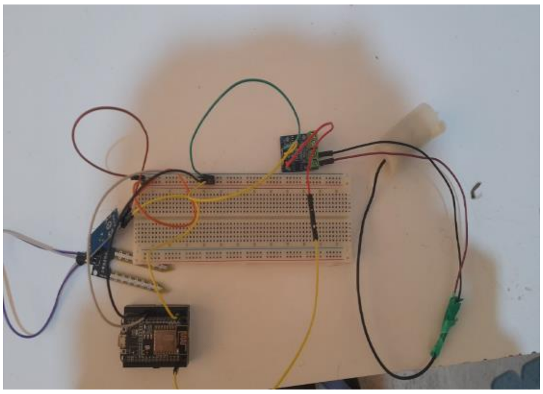

Fig. 4 Prototype of Circuit Design

A. *Circuit Design Setup*

1. We connect the soil moisture sensor to the analog board with a female jumper cable.
2. Connect the A0 end of the analog card to the A0 end of the Esp card. GND(-),VCC(+) terminals are connected to -,+ of the breadboard.
3. After connecting the GND(-), VCC(+) pins of the Motor Driver board to the breadboard, connect the A1-1 pin to the D0 (GPI 16) pin input with the female jumper of the board end and the male jumper of the board end.
4. Mount 2 cable ends to the A MOTOR control part of the Motor Driver Card with the help of a screwdriver.
5. Motor driver output cables are connected to the mini submersible pump.
6. The soil moisture sensor is immersed in the soil of the plant pot.
7. By attaching a straw or a mini hose to the mouth of the submersible pump, it is immersed in the water tank located near the flower pot.
8. The hose end is positioned towards the soil for irrigation.
9. The program written with the Arduino IDE software is uploaded to the development board and the circuit is ready.
10. The development board and project circuit are plugged into the power supply and operated with the help of a battery or adapter.

B. *The Most Important Parts in the Code*

1. Install the relevant libraries (ESP, Firebase and sensors) for Arduino IDE. For example:
   #include <ESP8266WiFi.h>
   #include <FirebaseArduino.h>
2. Set the mini submersible pump as output to operate the data coming from inside, and set the humidity sensor as input to transfer the data coming from outside. For example:
   pinMode(pump,OUTPUT);
   pinMode(sensorPin,INPUT);
3. The variable used in Firebase must be the same as in the code. For example:
   String mtr = Firebase.getString("mtr");
4. When you want to transfer data to Firebase (it could be a text or a variable), use the relevant commands. For example:
   Firebase.setString("m1", "Welcome");
5. If you encounter any error while pulling data from the database, you can use the line of code to output the error. For example:
   if(Firebase.failed())
   { Serial.print("setting /data failed:");
   Serial.println(Firebase.error()) ;
6. Since Servo Motor L9110 is a reverse-connected card, Low and High commands work in reverse logic. For example:
   digitalWrite(16, LOW);
7. If your pot is not large, keep watering regularly; It may leave the soil too moist. To prevent this, you can make an open, close, measure cycle with delay. For example:
   You can also write it in a for loop.
   digitalWrite(16, LOW);
   delay(1000) ;
   digitalWrite(16, HIGH);

IV. RESULTS

The output obtained when the Arduino IDE is compiled with the serial port can be seen. The program is connected to the internet, input, output etc. shows the desired values.Serial port output is showed in Fig. 5.

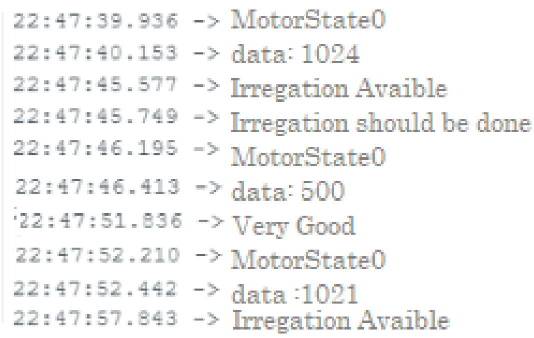

Fig 5. Serial Port Output

It produces output with the expression "Very Good" for values of 600 and below in the sensor data, "Irrigation Avaible" for values above 600, "Irrigation should be done" for values above 1300. “MotorState0” indicates that the engine does not work due to water.

There may be problems sending real-time data in the Firebase application. It is necessary to have an up-to-date Fingerprint in the application and replace it with the up-to-date Fingerprint from the Ardunio library > Firebase-master > firebasehttp.h. For example:

"03:D6:42:23:03:D1:0C:06:73:F7:E2:BD:29:47: 13:C3:22:71:37:1B"; // 2020-02 "93:49:BD:13:3F:AD:AE:EB:44:9B:DA:EA:6E:7F :27:A3:2E:D1:73:7B"; //2022-01 //valid date: 21-02-2022#endif // FIREBASE_HTTP_CLIENT_H

The output of the firebase application shows in Fig. 6.

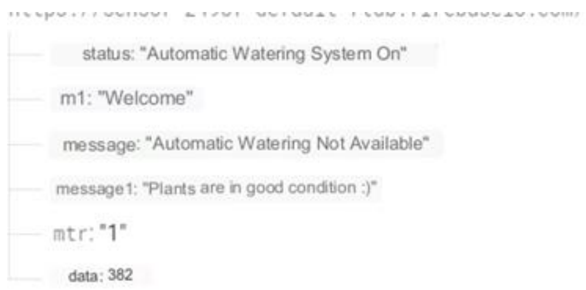

Figure 6. FireBase Output

With the help of MitAPP Inventor 2 the project can be converted into Android Application. In order to do this, the Firebase database must be transferred to Inventor. In this way, communication between the database and the application is ensured. First of all, after establishing communication between Firebase and Mit Inventor, Blocks are created by selecting the components that you want to appear in the application. The output of the MIT Inventor Screen shows in Fig. 7.

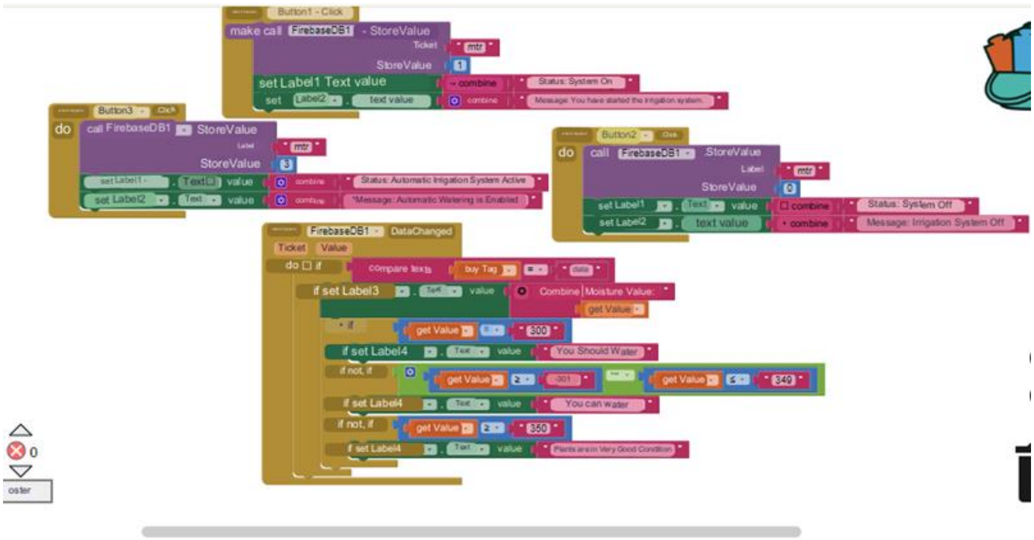

Fig 7. MIT Inventor Screen Output

The mobile application screen shows in Fig. 8. There are manual on/off and automatic watering options in the interface of the application. In addition, information is provided about the current status of the plant and the amount of moisture.

Fig 8. Mobile Application Screen

The project is running successfully. An android application that can be controlled remotely has been developed. It can be turned on and off manually whenever desired, depending on the humidity of the plant. Automatic mode can be activated if desired. Thus, the water needs of the plant can be met proportionally and properly. The circuit image for proposed model shows in Fig. 9.

Fig 9. Circuit image for proposed model

V. DISCUSSION AND CONCLUSION

It leads to an intelligent communication ecosystem through the use of Internet of Things (IoT) technology in devices. In the field of Internet of Things, significant amounts of sensor data from the physical environment are subjected to comprehensive evaluation, converted into actionable information and distributed to operators or relevant stakeholders. Such data-driven processes can also trigger automated activities through specialized systems. Automatic irrigation works, which aim to promote the healthy growth of plants and improve environmental aesthetics, exemplify the practicality of IoT-focused projects. These automatic irrigation systems encourage rational use of water resources by providing efficiency in terms of time and labor. It contributes to water saving, especially in areas where water is scarce. Within the scope of this project, a remote monitoring and control system prototype was implemented using Arduino IDE, Firebase and MitAPP. This system includes components such as Esp8266 Wifi module, submersible pump, L9110 Dual Motor driver and soil moisture sensor. MitAPP Inventor was used to convert the application to an Android-based platform; It provided real-time viewing of plant moisture measurements and facilitated manual or automatic watering at any time. The irrigation system prototype presented in this study was designed to meet the water needs of plants while ensuring efficient use of water resources. It is thought that the study will be expanded by using various development modules, different sensors and cloud-based applications in future studies. Additionally, a mobile application suitable for a wide range of mobile devices can be developed.

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