DEVELOPMENT OF IOT BASED SMART IRRIGATION FOR AGRICULTURE

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Abstract - Economic status of 70% of the Indian population is based on Agriculture. Due to the lack of rain and water scarcity, Irrigation being the vital part of agriculture has become a predicament which should be solved effectively by using smart technologies. Hence this paper is a study about monitoring the irrigation in the fields using the concept of Internet of Things (IoT). The humidity in the soil and the weather condition around the field are measured using the moisture and the temperature sensors respectively. These factors displayed by the LCD are communicated to the farmer by means of the Wi-Fi module. Thus, the project aims to irrigate the farm with appropriate quantity of water at accurate time thereby have a successful water supply management.

Keywords: - Internet of Things (IoT), Smart Irrigation, Data Analysis.GSM.

1. Introduction

Agriculture couldn't exist without Irrigation which being the artificial addition of water to the soil to dissolve the nutrients thereby promoting compound and biological activity. Since the water resources are been narrowing down without rain, an optimized solution for the application of water to the fields becomes imperative. This leads to the innovation of smart irrigation. Smart Irrigation assists in monitoring and managing the farms in an elegant way via sensor networks, precise techniques and the other electric automation. The Web applications revolve around the globe connecting people much fast and easier in spite of the time and the place through the Internet. Thus, Internet of Things (IoT) is the concept evolved to communicate anything to anyone at anytime from anyplace and to offer automated notifications with high security [1]. IoT is the network of devices transferring information of the objects and the surrounding atmosphere to the related people and the coordinated software and the machines [2]. This paper studies about the IoT based irrigation system by sensing the moisture level and the temperature presence in the particular farm with the respective moisture and the temperature sensors which are connected to the Microcontroller. The sensed facts are displayed by using a Liquid Crystal Display (LCD). The accumulated factors are conveyed to the user via the Wi-Fi module and can intimate the IoT system to pump the water by the motor to the fields.

2. Literature Review

Internet of Things (IoT) Based Smart Irrigation [3] by R. Hemalatha *et al.* has proposed an automatic irrigation system which checks the temperature, the humidity, the wetness and the pH level with their respective sensors connected to the Arduino Controller. From these parameters collected, stored and analyzed by the IoT system, the user discerns and remotely operates the system to pump the water to the crops.

The Arduino Microcontroller has connected to the sensors such as soil moisture, pH, pressure and an intruder detecting system (PIR) as **Arduino based Smart Irrigation System using IoT** [4] designed by Dr. S. Anila *et al.* works mechanically to provide a smart irrigation. When the facts go beyond the threshold, the GSM facility has been used to intimate the status to the user by the SMS service and thereby updating the web page also.

Dr. B. Sathish Kumar *et al.* has developed an **Automatic Irrigation System using Internet of Things** [5] via an android application. The RTC (Real-Time-Clock) works with the motor based on the scheduled intervals while the android system gains the temperature and the moisture levels through their relevant sensors. Whenever the sensed fractions surpass the permitted limit, the motor can be operated through the android application based on the SMS attentive received through the GPRS modem.

The paper **Sensor based Automated Irrigation System with IoT: A Technical Review** [6] by Sandip Delwadkar *et al.* has discussed about controlling the flow of water through the solenoid value via the microcontroller. The microcontroller works with respect to the moist level sensor by intimating the signal to the mobile for the activation of the buzzer. These connections are established through the GSM technology. They have also proposed a methodology of controlling irrigation to the field by using geo-referenced locations with GPS technology.

Dr. R.S. Kawitar *et al.* has studied the paper of **IoT based Smart Agriculture** [7], in which irrigation control has been considered as nodes of the system. Various sensor such as humidity, light, temperature and moisture are connected with the AVR microcontroller which represents the need for water consumption, according the water pumping been controlled automatically.

Dr S. Rathi. *et al.* nominates **An IoT based Smart Irrigation System** [8] using which the field is detect by the sensors to find the soil moisture, temperature and electrical conductivity of the soil. The factors consequently sensed are processed by the microcontroller to declare about the irrigation requirement. The users are reported through the GSM technology. Thus, the proposed system is a simple and effective method for monitoring and modernizing irrigation.

Smart Irrigation: IoT based irrigation Monitoring System [9] by Shaif Choudhury *et al.* is an automatic system integrated with several sensors and a microcontroller to detect the water level present in the fields. The sensors such as

temperature, moisture, pollutant and ultrasonic are used to read the air temperature, humidity, and presence of polluting agents and monitor the pests respectively. These information are gather by the microcontroller and are analyzed based on the past data references, then the decision about the irrigation has been made. The system uses Wi-Fi module and the GSM modem to transmit and communicate the user correspondingly.

A. Ramakrishna *et al.* promote an **Automatic Irrigation System using Embedded System and GSM Technology** [10], with sensors such as humidity, temperature, moisture and Light Dependent Resistor (LDR). The LDR has used to measure the light intensity, and the value varies from day to night. These sensors are attached with microcontroller which generates the signal for the electromagnetic relay to pump water. The user acknowledgement has been delivered by a message through the GSM modem.

B.

Intelligent IoT based Automated Irrigation System [11] recommended by Suresh Sankaranarayanan *et al.* deals with temperature and moisture sensors to sense the soil condition and carries to the microcontroller. A machine learning classification algorithm, K- Nearest Neighbor (KNN) has been used for the father analysis. This classification has been held in the media center Raspberry Pi3. The algorithm works accordingly with the preset training dataset and analyses the present data. The simpleton algorithm upgrades the proposed system to automatic predict the irrigation requirement.

V. Vinoth kumar *et al.* put forward a paper on smart irrigating technique with various sensors and a microcontroller. **Implementation of IoT in Smart Irrigation system using Arduino Processor** [12] deals with four various sensors such as soil moisture, humidity, temperature and ultrasonic among which only the soil moisture sensor is connected to the microcontroller while the remaining three are directly connected to the Wi-Fi module. The parameters are thus collected and transmitted to the user via IoT server technoartista, thereby the user can take priest decision about irrigation.

Design and Implementation of Automatic Irrigation System using ARM7 [13] submitted by Mamta Patidar *et al.* is a network of moisture sensor, temperature sensor and humidity sensor with a water level indicator. The plant's atmospheric parameters are resolved through these sensors and conducted to the ARM7 where the system advocates on irrigating the crops. These computational factors are broadcasted to the external users via zigbee and GSM technologies.

Water Saving-Irrigation Automatic Agricultural Controller [14] presented by Prof. V. V. Dixit *et al.* has contributed by a serial of sensors such as soil moisture, temperature, humidity, wind speed and direction, radiation and sunshine and rainfall connected with a microcontroller influence the requirement of irrigation. The report about the surveillance has been send to the user through the GSM technology.

Authomatic Soil Moisture sensing Water Irrigation System with Water level Indicator [15] contributed by Edmond B. Ecjia *et al.* has been proposed to maintain stable water content in the soil. The soil moisture sensor implanted in the field detects the moisture content of the soil constantly and connect to the microcontroller. According to the soil moisture content and water level of the tank, the microcontroller predicts the obligation of the irrigation and initiates the relay switch. The Real Time Clock (RTC) is also attached to the system to irrigate the field at considerable time intervals.

Srishti Rawal intended a paper **on IoT based Smart Irrigation System [**16] to irrigate the farms without human interruption by using moisture sensors to analyze the moisture content of the soil. The data interpreted by the microcontroller directs the water pumping system. The GSM GPRS SIM modem has been used to transmit the data from and to the cloud server of THINGSPEAK. The THINGSPEAK is an IoT open sources program which disrupts the gained data to generate a graphical pictogram. Thus, the paper enhances a better understanding of the field to the user and the working status of the system.

A Smart Irrigation and Monitoring System [17] introduced by Dishay Kissoon *et al.* has been upgrade with Microsoft Azure machine learning. The references such as soil moisture, temperature and humidity are determined by the respective sensors are channelized to the WeMos board. From the board, the data are carried to the Azure hub where stream analysis of the data takes place. The wireless communication technologies such as Universal Asynchronous Receiver/Transmitter (UART) and GSM are used to convey data to the Azure platform and acknowledge the user.

M.S. Srinath *et al.* demonstrated on a system on **GSM based Automatic Irrigation Control System for Efficient Use of Resources and Crop planning by using an Android Mobile** [18].To control over-irrigation, the ARM7 microcontroller has been used to monitor the field aided by temperature and moisture sensors. According to the data revealed, GSM mobile technology has been used by the application to communicate the user via an android mobile phone. The Universal Asynchronous Receiver/ Transmitter (UART), the physical device which promotes effective and continuous communication has been implemented to manage transactions between the micro controller and the GSM Module.

Prof. Ashfaque shaikh *et al.* aims on **Smart Irrigation System using IoT** [19] which is a cluster of moisture, pH and photocell sensors with a microcontroller to check the soil content and surrounding conditions. According to the parameters obtained by the moisture and pH sensor, the microcontroller initiates the sprinkler algorithms, while a photocell algorithm is activated if the microcontroller detects low light presence through the data by the photocell sensor. The users can be communicated by using the GPRS technology.

The paper **Design &implementation of Automatic Irrigation System using Wireless Sensor Network & Zigbee Module** [20] commenced by Nilesh Kuchekar *et al.* discuss about monitoring of the agricultural land through sensors such as temperature, moisture and humidity. The Wireless Sensor Unit (WSU) and Wireless Information Unit (WIU) are setup with different hardware components and communication technology such as Zigbee and GSM respectively.

S.No	Title	Board	Sensor	Technology
1	IoT based Smart Irrigation [3]	Arduino uno Atmega 328	1.DHT11, 2. pH electrodes.	1. GSM, 2. GPRS.
2	Arduino based Smart Irrigation [4]	Ardunio Atmega 328	1.PIR Sensor, 2. DHT11 Sensor.	1. GSM, 2. GPRS.
3	Automation Irrigation System using IoT [5]	Arduino uno 1.0	1.Temperature Sensor, 2.Moist Sensor, 3. pH Sensor.	1. GPRS, 2. Real Time Clock (RTC).
4	Sensor based Automatic Irrigation System with IoT [6]	Microcontroller LP C2125	1.Moist Sensor, 2. Temperature sensor.	1. GSM, 2. GPRS.
5	IoT based Smart Agriculture [7]	AVR Microcontroller Atmega 16/32	1.Soil Moisture, 2.Temperature, 3.Humidity, 4. Light.	1. GPS, 2. Raspberry pi.
6	An IoT based Smart Irrigation System [8]	Arduino	1. Soil Moisture, 2. Electrical Conductivity of the soil, 3. Temperature LM35.	1. GSM.
7	Smart Irrigation: IoT based Irrigation Monitoring System [9]	Microcontroller	1. DHT11, 2. pH Sensor, 3. Pollutant Sensor (MQ135, MQ131, MQ2, MQ9), 4. Moisture Sensor, 5. Ultrasonic Sensor, 6. Water level indicators.	Wireless Communication Modules: 1. Wi-Fi Module, 2. GSM.
8	Automated irrigation System using Embedded System and GSM Technology [10]	PIC Microcontroller	1.Soil Moisture Sensor, 2. Temperature Sensor, 3. Humidity Sensor, 4. Light Dependent Resistor (LDR).	1. GSM
9	Intelligent IoT based Automated irrigation System [11]	Arudino	1. Temperature Sensor, 2. Soil Moisture Sensor.	1. RaspberryPi3, 2. KNN- Machine Learning Algorithm.
10	Implementation of IoT in Smart Irrigation System using Ardunio processor [12]	Arudino At Mega 328	1. Humidity sensor Sy-HS-2, 2. Temperature Sensor, 3. Ultrasonic Sensor, 4. Soil Moisture Sensor, 5. Light Dependent Resistor (LDR).	1. Wi-Fi, 2. IoT Server Technoartista.
11	Design and Implementation of Automatic Irrigation System using ARM7 [13]	LPC 2148 Microcontroller	1. Soil Moisture Sensor, 2. Temperature Sensor, 3. Humidity Sensor.	1. Zigbee, 2. GSM.

12	Water Saving – Irrigation Automatic Agricultural Controller [14]	PIC Microcontroller	1. Soil Moisture Sensor, 2. Temperature Sensor, 3. Atmospheric Temp. Humidity Sensor, 4. Wind Speed and Direction Sensor, 5. Radiation and Sunshine Sensor, 6. Rainfall Sensor.	1. GSM, 2. RTC.
13	Automatic Soil Moisture Sensing Water Irrigation System using Arduino processor [15]	Arduino Uno Microcontroller At mega 328	1. Soil Moisture Sensor	1. RTC
14	IoT based Smart Irrigation System [16]	Arduino Uno Microcontroller At mega 328p	1. Moisture Sensor YL-69	1. GSM, 2.GPRS, 3. THINGSPEAK Channel.
15	A Smart Irrigation and Monitoring System [17]	WeMos Board	1. Soil Moisture Sensor Yl-100, 2. DHT22 Sensor.	1. Microsoft Azure Machine Learning.
16	GSM based Automatic Irrigation Control System for Efficient Use of Resources and Crop Planning by using an Android Mobile [18]	Microcontroller ARM7	1. Moisture Sensor, 2. Temperature Sensor.	1. Universal Asynchronous Receiver/ transmitter (UART), 2. GSM.
17	Smart Irrigation System using IoT [19]	Ardunio Microcontroller	1. Moisture Sensor, 2. pH Sensor, 3. Photocell Sensor.	1. Sprinkler Algorithm, 2. Photocell Algorithm, 3. GPRS, 4. Mesh technology.
18	Design & Implementation of Automatic Irrigation System using Wireless Sensor Network & Zigbee Module [20]	1. PIC 16F877 Microcontroller, 2. ARM7 LPC2138 Microcontroller.	1. Temperature Sensor LM35, 2. Humidity Sensor SY-HS-220, 3. Soil Moisture Sensor.	1. Zigbee, 2. GSM

Table 1

3. Proposed System

This paper deals with the real-time supervision and management of irrigation to the farms through the IoT concept. The persuading features such as air temperature and soil moisture level has been identified to determine the intervals and the amount of water to be irrigated to the farms. These facts are measure with their related sensors such as Temperature and Soil Moisture level sensors. These sensed values are communicated to the Microcontroller and are also displayed on the LCD panel. According to the fraction received the IoT system research to make appropriate decision whether to pump water through the motor system. This information can also be communicated to the user via the wireless network, Wi-Fi. Thus, the user can supervise the cultivation in spite the time and the location. The following Fig 1. describe system block diagram-

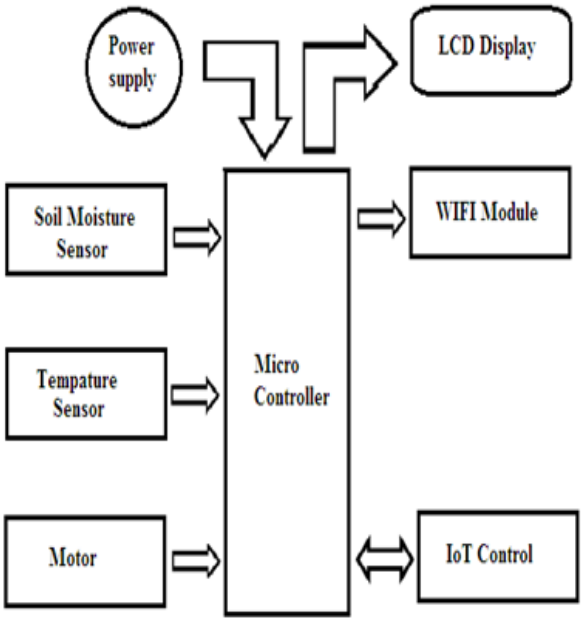

Fig 1. Block Diagram

4. Contributed Components

4.1. PIC16F877A microcontroller

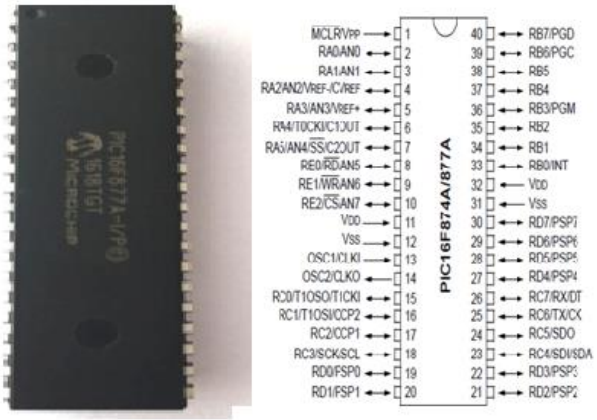

Fig 2. PIC16F877 Microchip and its Configration

Microcontroller used in this paper PIC16F877A from Microchip family, being cost-effective and user-friendly has a rewritable flash memory with 14 bit core and 40 pin Dip working at the speed of 20 MHz . The multi-tasking microcontroller makes it possible to use various peripherals which being suitable for the paper.

4.2. Soil Moisture Sensor

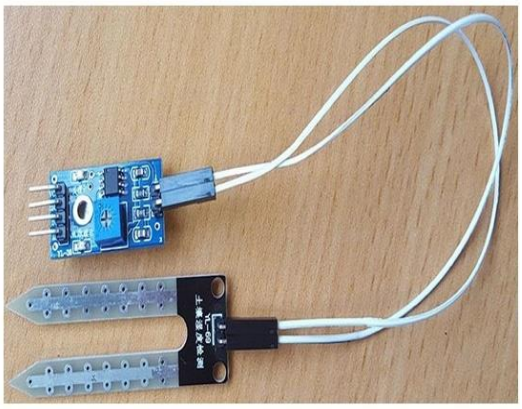

Fig 3. Soil Moisture Sensor

To determine the available percentage of water (moist) content through the electrical resistance property of the soil, the Soil Moisture Sensors are used. These sensors are mostly used in pairs, calibrated to senses the moisture level in the soil. The values are transfer to the microcontroller which helps to consider the time and quantity of water for the irrigation.

4.3. Temperature Sensor

Climatic factor such as air temperature affects the cultivation of the crops. The increase in air temperature increases the rate of Evapotranspiration (Evaporation + Transpiration). In this paper, LM35 which is directly proportional to the centigrade/ Celsius has been used. With the rise in the temperature around, the output voltage of the sensor increases linearly and the value of the voltage is communicated to the microcontroller which multiplied by the conversion factor in order to provide the actual temperature value.

4.4. LCD

Fig 4. LCD Display Panel

A Liquid Crystal Display (LCD) is a flat panel of electronic visual display using the light-modulating properties. A 16 x 2 LCD used in this paper displays the factor in 5 x 7 pixel matrix. The physical changes around the field as sensed by the respective moisture and the temperature sensors connected to the microcontroller are displayed with this panel.

4.5. Relay Switch

Fig 5. Relay Switch

Whenever it is obligatory to control several circuits by one signal or by a low power signal, the electrically operated switch called the Relay are used. A relay which can handle the high power required to directly control an electric motor or other loads is called as contactor. To perform logical operations these were used in early computers and telephone exchanges.

4.6. WIFI

Fig 6. WIFI ESP8266

ESP8266 is a complete and self-contained Wi-Fi network solution with built-in cache memory which boosts better system performance by reducing external memory requirements. Wireless network accessing can be made possible with the Wi-Fi adopter.

V. Conclusion

Surplus or deficit amount of water to the cultivation may result in unnecessary nutrition leaching, soil compaction, erosion, or drought respectively. Hence, regular monitoring and irrigating which can lead to effective cultivation has been integrated with the IoT technology. This optimal solution enhances the user to analyze the condition around the field via the sensor system and can control the irrigation beyond the time and the place.

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