Internet of Things based Embedded System for Smart Irrigation

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ABSTRACT: India is a world second populated country, each year the population of people is increasing and the requirement of water and food also increasing; hence the management of water and food resources is more important for this increased population. As per the survey 89% of ground water is used for Agriculture in which more than 60% water is used for Paddy and Sugarcane irrigation, where as only 6% & 5% water is used for Domestic and Industrial purpose respectively. Internet of Things (IoT) plays a very important role in the agriculture industry. The smart agriculture system reduces the wastage of excess water and effective usage of fertilizer and thereby increases the crops yields. In this paper, the system is developed to monitor crops fields with taking in the consideration of environmental and soil parameters which are mostly used to automate the irrigation system. Based on the soil moisture and light intensity the threshold values we operated the motor and light automatically. The developed the hardware system and get the data from sensors and all these sensors are connected to the controller board which prints the data on LCD. The controller is serially connected with the Wi-Fi module then the data is stored on open-source IoT platform and then data is also show on mobile application. This system is more useful in areas where water and electricity are main issues; also we can reduce the time, money, manpower and workload of the farmer.

Keywords: IoT, Sensors, Arduino ATmega2560, Wi-Fi module ESP8266, ThingSpeak, Android app.

I. INTRODUCTION

The agriculture system plays a major role in the life of an economy. It is the backbone of the economic system. Agriculture system not only gives the food but also provide large job opportunities. 60-70% of the Indian population depend on agriculture system, and day-by-day the percentage of doing agriculture people is decreased and the yield of the crop also reduced, So we need to increase the crop yield with efficient seeds and field's knowledge and proper water usage. Nowadays the rain falling is not proper so in the agriculture system, the selecting crops for the former are very difficult for the particular season hence the irrigation is a very important factor (Meha Jain, 2013). So in agriculture system the facing of irrigation problems is a big challenge. For this purpose, we are developing the sprinkler irrigation system and drip irrigation system by using the technology of smart embedded IOT based system. By Soil Moisture Sensor (SMS) based irrigation controllers (Michael D. Dukes, 2018) is make the system smart, by this we can achieve more crops per drop of water.

In the agriculture system, we look at four main qualities.

- Soil quality
- Seeds quality
- Environmental condition
- Irrigation system

Before going to planting first we must check the quality of soil like pH value, NPK (Nitrogen, Phosphorus & Potassium) values and electric conductivity of the soil (Vinay Kumar, 2014). So we must check the soil conditions, then after we can select the crop which is suitable for this type of soil we must provide some awareness about the selection of crops to the formers. After the selection of crops, we must select good quality of the seeds (Y. Sako, 2007).

There are different types of an irrigation system that has been doing by our older. From the last few years, the time they have followed two types of irrigation systems (Karan K., 2015).

These irrigation systems are more water consuming, the surface irrigation system and sub-surface irrigation system (N.B. Jadhav, 2016). In the irrigation system the water resource like tank or reservoirs placed at the height. These are flows to the channels. Surface irrigation is applied in the smooth surface areas. The old method of irrigation is lifted irrigation method, in this method the water is lifted give to the crops with the help of pumps. The main water source in India are well, tanks, canals, rivers using pumps, from the last few years the groundwater also pumped to the fields.

Our goal is to help the farmers for reducing the water wastage and getting more crop yields, we must improve the automated irrigation system. These irrigation systems should be simple and low cost. These are the sprinkler and drip irrigation system; we can operate this system by the smart embedded system based on the IoT (Mehamed A., 2015). The sprinkler irrigation system is like a natural rainfall. This method is useful for the paddy, groundnuts, non-plain surface area, etc. Another method is drip irrigation system which provides the water directly to the root of the plant. This system is useful for the row type of plants like Mango, Orange, Lemon gardens and cotton crop, etc. Using these systems we can reduce the flooding. The soil quality is very important for selecting the crop. Also, we can see the environmental impact on the agriculture system, like measuring the temperature, humidity, light intensity, and the rainfall, and wind speed. Based on the soil moisture level we can operate the pump is ON/OFF automatically etc. The LDR sensor senses the light intensity (Shreesh Mishra, 2016).

For this project we referred some papers. The crop field monitoring and irrigation system (P. Rajalakshmi, 2016) the sensors are used for the monitor the crops by three sensors like humidity and moisture and temperature and transformed the data using NRF24L01 wireless module. An automated irrigation system (Joaquín Gutiérrez, 2014) automated the irrigation by using solar power and turn ON/OFF the motor based on the water level in the tank, the disadvantage of this paper is the motor operates manually; the electrical supply for the entire system is from solar energy. The proposed automated irrigation system (Jia Uddin, 2012) the motor is ON/OFF based on the water level; the farmer will take the decisions accordingly by getting the message to the mobile. The proposed a system is for An Automated Irrigation System Using Sensors (R. Suresh, 2014) GSM, Bluetooth and Cloud Technology based on the Arduino Uno microcontroller system sensing the moisture and temperature and light. By using the wireless sensor (Stefanos A. Nikolidakis, 2015) the field can be protected by the animals by using the digital image capturing the moving particles and send the message to the farmer and automate the motor based on the soil moisture level. The water controlled (A. Kumar, 2014) based on the soil moisture level by using the XBEE wireless communication module for more numbers of load which is better than Bluetooth and WiFi. A survey on IoT cloud platforms (Parth Ray, 2017).

The novelty of this paper, we are sensing the environmental, water and soil parameter. Based on the field condition we can control and operate the actuator by using the embedded IoT based system. In this we are using Arduino (ATMEGA2560) collect the sensors data and using the Wi-Fi module (ESP8266) which stored the sensors data in the ThingSpeak and display all sensor data on the LCD using the keypad control. The motor is ON/OFF based on the moisture sensor. The indoor plants need the light when light is not falling on the plant so for this purpose operating the light automatically based on the LDR sensor value. We can control the sprinkler or drip irrigation automatically by using the solenoid valve. We will develop the android app in the MIT app inventor. By using this app get the real-time monitoring sensor data on mobile.

II. PROPOSED SYSTEM & COMPONENTS REQUIRED

The system consists of nine types of sensors namely, temperature sensor, humidity sensor, pH sensor, LDR sensor, soil moisture sensor, rain sensor, water level sensor, wind speed sensor, water flow measure sensor and has the two actuators namely solenoid value and DC 12V pump, as shown in the fig. 2.1

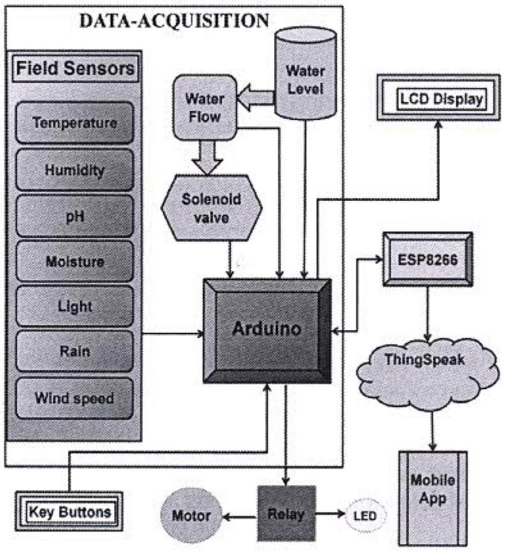

Fig 2.1 Block Diagram of Proposed System

In order to the development of smart agriculture system, we must use the following hardware components.

a) Temperature and Humidity Sensor

The DHT22 sensor measured the temperature and humidity (Deeksha Srivastava, 2018). The thermistor is a variable resistor change with a change in temperature and the measuring range from -40 to 80°C. Measure the humidity based on the resistance changing with respect to the change in moisture content in the air, measuring the range of humidity from 0 to 99.9% relative humidity. This sensor having the four pins, the supply voltage is DC between the 3V to 5.5V.

b) Soil pH Sensor

The pH value is very important for selecting the crop. The pH value is deciding the acidic or basic nature of the soil. Mainly the pH value changes with respect to the change in the concentration of [H] + ions present in the soil solution (Kristoffer O. Flores, 2016). This sensor has two electrodes one is reference electrode and another one is glass electrode which is sensitive to the hydrogen ion and we can connect this sensor with the Arduino with the help of the circuit board.

c) LDR Sensor

The light-dependent resistance (LDR) sensor is used to detect the light intensity. It has two terminal's component its assists basic resistance and having the module and this module consists of four terminals. The LDR sensor made with photoconductivity materials, this material conductivity is reduced when the light is observed by this material. The light incident on the LDR is changed the resistance is inversely proportional that means the illumination of light is more, the resistance is less.

d) Soil Moisture Sensor

The soil moisture sensor is used to find the water quantity presents in the soil. The input voltage is 5V and the output current maximum is 20mA we can interface to the analog pin with the Arduino. It is working on the principle of change in resistance. If the water quantity is more in the soil its act as more conductivity that means the resistance is less the output current is more.

e)Water Level Sensor

The measurement of the water level is very important, using the ultrasonic sensor we find water level in the tank based on the water level we automate the motor. If the water level is low then motor is ON and it will fill the tank, else the motor is OFF. The ultrasonic sensor is located at the top of the tank. It has an ultrasonic wave transmitter and receiver, the transmitter sends the sound wave in the form of bursts in downwards directions, the waves hit the surface of the water sound echoes gets reflected and received by the sound receiver, Time taken by sound waves to return back is directly proportional to the distance between the sensor and water. Time duration is measured by the sensors which turn used to calculate the level of the liquid in the tank. This ultrasonic sensor measures the maximum 8-meter water level in the tank.

f) Rain sensor

The rain sensor is just used for the rain is falling or not. It's working based on the raindrops, if the raindropsfall on the rain sensor it shows the output is high else the output is low. We can also measure the analog read. By using the analog reading of this sensor, we can convert analog read into the 0 to 100 percent using the Arduino code.

g) Wind Speed Sensor

The analog wind speed sensor is measured the wind speed. This sensor is a common weather station instrument. This sensor is made and designed to sit outside and measures the wind speed. It has three wires colored as black and blue and brown. The black wire relates to Arduino GND pin, and the brown colored wire connected with the supply of 7-24VDC pin of the Arduino, and the blue colored wire known as the output of the sensor data relates to Arduino analog pin. This gives the output voltage is 0-2V. It measures the maximum wind speed is 32.4m/s.

h) Arduino ATmega2560

The Arduino ATmega2560 is an AVR microcontroller board. This board having the 54-digital input/output pins, 16 analog input pins, and the 4 pins UART (hardware serial ports), and 16 MHz crystal oscillators. In the digital pin14 pins can be used as PWM pins. It has one USB port and it has reset button and TX/RX and LED, and it contains everything needed to support the microcontroller.

I) Arduino Interface board

Interface module designed to provide an interface for the various types of communications like I2C& UART. It also contains RTC on hardware for real-time tracking. Provide an interface for LCD and keypad.

j) ESP8266 Wi-Fi module

The node MCU, we are using the only four pins those are the GND, 3.3.V, TX and RX pins. For serial communication between the Arduino and ESP8266, we must connect the Arduino TX pin with the esp8266 RX pins and the Arduino RX pin with TX pin of the esp8266. When we are uploading the data into the node MCU we must disconnect the TX and RX pin from the Arduino, then only we can upload the data into the ESP8266 from the Arduino IDE otherwise it shows the errors.

k) Solenoid valve

For the flow control, we are using the solenoid valve. The working principle is when we apply the current to the winding it generates the magnetic field. Because of this magnetic field, the mechanical spring is attracted than the plunger is open then the water flows from inlet pipe to outlet vice versa we can close the plunger by open the supply switch.

l) Relay Module

We are using the 5V relay module is used. Which is having four relay module. It has five pins; these are coil1, coil2, com, normally closed, normally open. The relay having two coil pins we can give 5V to the coil1 and the ground give to the coil2. When we give supply to the relay the com pin3 connected to the normally open pin from the normally closed pin4 vice versa. By using this relay, we can actuate the pump and solenoid valve and the light.

m) Water flow sensor

The plastic helical flow sensor measures the amount of water flowing through a pipe and with what amount of water is flowing. This sensor working on the principle of Faraday's Law of Electromagnetic Induction, for more rapid the water flow to the rotor, therotor is rotating and cuts the magnetic flux according to faraday law the voltage is generated. This voltage we can convert into pulses and this plus converted into lit/min.

III. SYSTEM IMPLEMENTATION & RESULT

We have developed proper hardware interface board to connect with Key, LCD module (20*4), Arduino and Node MCU module. We collect the data from the sensors and send into the ThingSpeak using the Wi-Fi module with proper SSID and password. We displayed all the data on LCD with the help of the keypad. We developed the Android App using the MIT App Inventor and we see the data on the mobile App. The system development as shown in fig. 3.1

The developed hardware system displayed the real time data on LCD; if we press key-1 displayed the temperature and humidity, and pH value and light intensity of field. If press key-2 displayed the water level and water flow. If we press the key-3 displayed the soil moisture value and motor condition on LCD and if we press the key-4 displayed the rain sensor and wind speed sensors values. Based on the soil moisture sensor threshold value we automate the solenoid valve & pump and based on the LDR sensor value we automate the light.

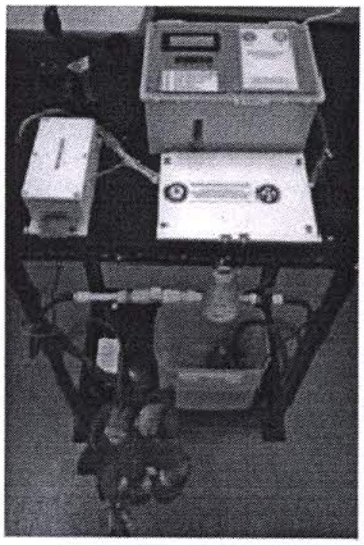
Fig. 3.1 Hardware implementation

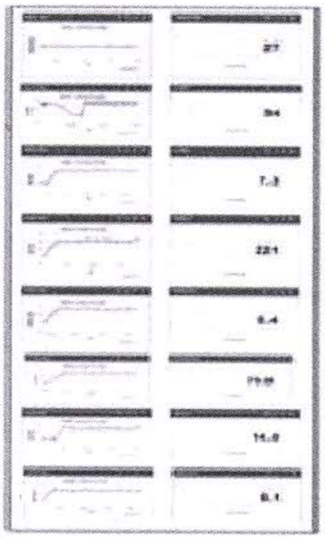
Fig. 3.2 ThingSpeak data

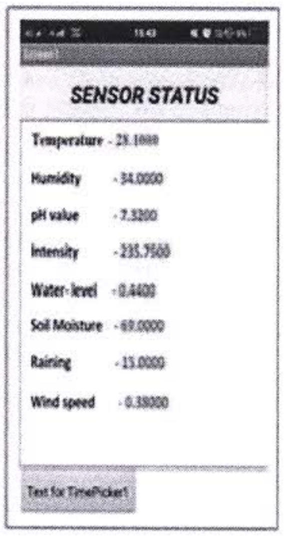

Fig. 3.3 Mobile App Data

We serially communicate with ThingSpeak and Arduino using the Wi-Fi module, we sent the data into the cloud storage using the ThingSpeak, by this we see and store the data of field. The eight fields are namely from field 1 to field 8, temperature, humidity, pH value, light intensity, water level, soil moisture, rainfall, wind speed respectively as shown in fig. 3.2. We developed the android App using the MIT App inventor. we initialize the global variable, get the data from the ThingSpeak using the read API key, call the Arduino in every one minute we got the all sensors data in the graphical form between the sensor data vs. date & this value shown in the numerical display as shown on ThingSpeak and the mobile App as shown in fig 3.3.

IV. CONCLUSION AND FUTURE SCOPE

The IoT based embedded automated irrigation system implemented for reducing the water wastage and getting more crop yields. We got real-time monitoring data came from the field, using sensors. The sensing element deployed on the field of sensing the environmental & water condition and soil parameters. We accessed the same data on the cloud and mobile successfully. Based on the total amount of water flowed we can know the next time how much water is needed for the same crop. By using the Smart Irrigation Controller, we improved the irrigation system where face the water shortage.

In Future, the smart embedded IoT based system for smart Irrigation system can be extended not just for irrigating the field with water but also for deciding on spraying appropriate chemicals for proper growth of the crop. The extension of this project extended for running the motor we can use renewable energy sources such as Solar, Wind, Bio-Gas, etc.

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