Soil Moisture Monitoring and Irrigation Automation

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***Abstract*—**As India is an agriculture-oriented country and the rate at which water resources are depleting is a dangerous threat. Hence, there is a need of smart and efficient way of irrigation. The proposed paper aims at determining the most efficient soil moisture monitoring method in an intelligent remotely monitored system. The project also demonstrates the economic viability of an integrated system of production were water requirement, nutrients and pH are kept optimum automatically. The system is designed to overcome the challenges of water wastage, nutrition deficit, pH imbalance and leaching of nutrients. In the proposed automation system, water availability for crops is monitored through sensors and as per the need, watering is done through the controlled irrigation.This is a Mobile Integrated and smart irrigation system using IOT based application-controlled monitoring system. The main objective of this project is to control the water supply and monitor the plants through a smartphone from anywhere in the world.This proposed smart farming technology is environment friendly, efficient, cost effective and gives the farmer the power to control and monitor production in real time.

Keywords*—Soil moisture sensor, pH sensor, npk Sensor, Arduino Mega, IOT, GSM, Automated irrigation system.*

I. INTRODUCTION

As agriculture is the main source of food for any country, it is important to have a proper irrigation system. Indian economy is mainly based on agriculture, more than 70% of Indian population depends on agriculture for their sustenance. Water is one of the most vital resources for all living creatures, since each living creature uses water as per its desire, it is highly necessary to use it as minimal and effective as possible.Agriculture uses 85% of available freshwater resources worldwide for irrigation purpose. In upcoming years, this demand is likely to increase because of population growth and increased food demand. To meet this demand, we must adopt new techniques which will conserve the need of water for irrigation purpose. Hence For better irrigation system, it is crucial to measure the soil moisture for agriculture application, so that it help's farmers to manage their farm land more effectively.Monitoring the vital parameters of a farm namely soil moisture, pH value, nutrient contents and control measure through internet of things technology.The sensor data collected are stored and managed at the cloud as well as shared betweenperson to person, machine to machine, or person to machine. With IOT this information gathered from the sensor can be exchanged to the farmers through smartphones and controlled using an android application. In the present scenario were farmers are still using traditional manual methods of irrigation, there is an increased demand for connectivity with farm lands wherever we are on the planet. Here comes the role connecting every device to the internet so that it is accessible via internet access. This is where internet of things comes into picture. Hence,the main objective of this paper is to control the water supply and monitor the plants through a smartphone from anywhere in the world.

II. SYSTEM DESIGN

The proposed automation irrigation system consists of Arduino Mega 2560, Soil Moisture Sensor, pH Sensor, NPK Sensor (Nitrogen, Phosphorous, Potassium), Water Level Sensor, GSM, Wi-Fi Module, Relays, Water Motor and an Android Application. Wi-Fi module is used for communication between the IoT device and android application.

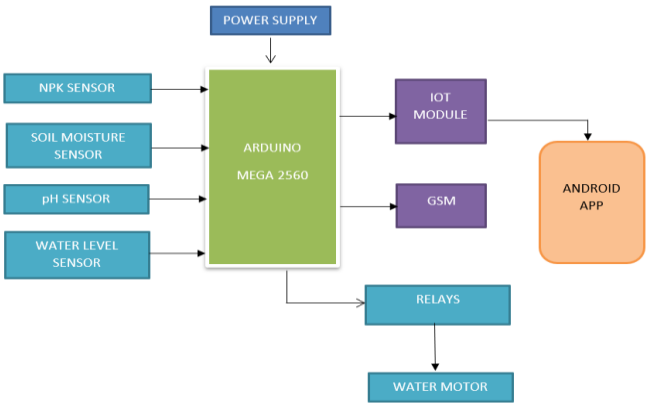

Fig. 1.1 Proposed System Design

In the proposed work, plants or crops are considered along with their water requirement at different stages. The crops or plants are irrigated with respect to the water requirements at different stages of their growth.

Fig 1.1 shows the design of the proposed model. The mobile application is connected to IoT device through the Wi-Fi module. The on/off of the motor is done by the smart phone application and the motor is controlled by the "relay" that is used in the proposed system.

In order to build the proposed framework for automated irrigation system, we have used the following hardware and software components.

A. Arduino Mega 2560

Arduino Mega 2560 is the open source platform which consists of both physical programmable circuit board and a piece of software or IDE that runs on your computer. It comes with more memory space and input output pins. It comes with a USB Cable Port that is used to connect and transfer code from computer to board.

Fig. 1.2 Arduino Mega 2560

B. Soil Moisture Sensor

The soil moisture sensor has two probes which is inserted into the soil. The probes are used to pass current through the soil.

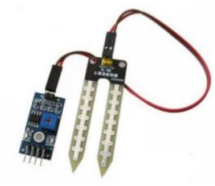

Fig. 1.3 Soil Moisture Sensor

The moisture soil has less resistance and hence passes more current through the soil. Whereas, the dry soil has high resistance and passes less current through the soil. The resistance value helps in detecting the soil moisture level. Fig . 1.3 shows Soil Moisture Sensor.

C. pH Sensor

pH sensor is used to measure the acidity and alkalinity in the soil. pH value varies from 0 to 14.The soil is said to be acidic if its value is between 0 to 7 and is said to be basic if the value is between 7 to 14 and neutral if it is 7. Whereas, for most of the crops, the ideal pH value remains between 5.5 and 7.

Fig. 1.4 pH Sensor

A pH sensor measures the voltage (electrical potential) produced by the solution whose acidity we're interested in, compares it with the voltage of a known solution, and uses the difference in voltage.

D. Water level sensor

Detects and Indicates the level of water in the tank and also in the other containers.

Fig 1.5 water level depth sensor

E. NPK Sensor

This sensor detects the nutrient content in the soil namely Nitrogen, Potassium and Phosphorous.

F. Wi-Fi Module

The ESP8266 is a low-cost Wi-Fi module which adds functionality to the existing Arduino mega via UART serial connection. This module is reprogrammed in such a way that the data from the sensors are transmitted to the cloud storage and android application.

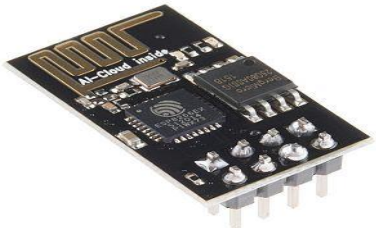

Fig. 1.6 ESP8266 Wi-Fi Module

G. Arduino IDE

The Arduino software is an open source software that can be downloaded from the Arduino website. This is used to write codes and upload it onto the board. All sensors and actuators are controlled by varying the code.

H. Relay and Pump

The relay is used to turn on/off the pump according to the moisture level of the soil depending upon the notification in the android application. It's controlled by interfacing it to the microcontroller. The pump is triggered on/off by relay.

I. GSM Module

The GSM Module used works with SIM900 quad-band solution which is embedded in the customer's application. It consumes low-power and hence is widely used. It's is interfaced to Arduino mega and transmits the sensed data via text message and any malfunction observed will also be sent.

III. METHODOLOGY

The proposed automated irrigation and monitoring system consists of four sensors namely, soil moisture sensor, pH sensor, npk sensor and water level sensor. The soil moisture sensor is used to sense the moisture level of the field and it varies according to the environmental changes in the field. The pH sensor is used to identify the pH value of soil, whether it is acidic or base in nature. The npk sensor is used to monitor the level of Nitrogen, phosphorus and potassium in soil and eliminates need for carrying the soil to the lab. The water level sensor is used to examine the amount of water in tank. The data from sensor is taken as input by the Arduino microcontroller and microcontroller is programmed using embedded C in Arduino IDE. Using ESP8266 Wi-Fi module the data from microcontroller is transmitted to the cloud server and notification will be sent to android application. In case of offline mode, GSM module is interfaced with the Arduino to establish cellular communication between the system and the authorized user. Threshold values are set for each sensor in the field. If the sensed data is less than the pre-defined threshold value a notification is sent to the authorized user both in Android application and via text message. Based on the notification, appropriate actions are taken by the authorized user such as controlling the flow of water and monitoring the nutrients and pH of the field.

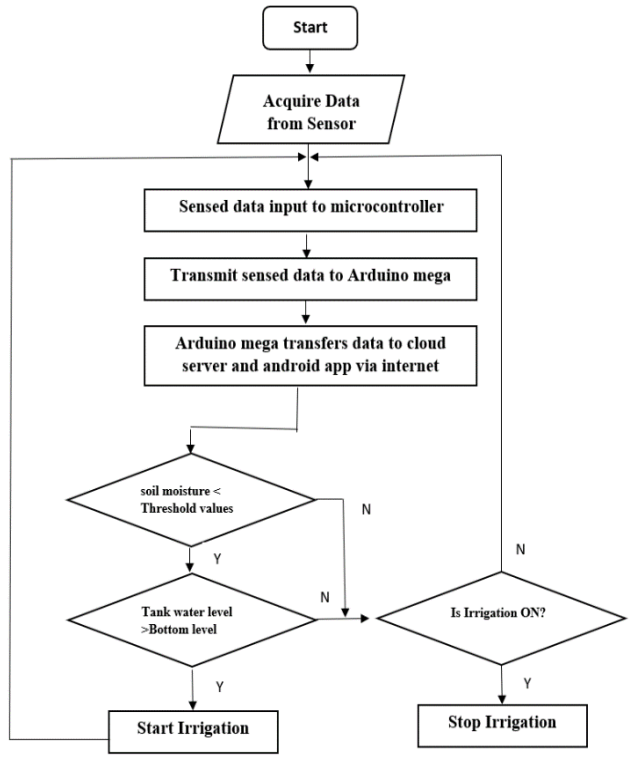

Fig. 1.7 Flow chart for proposed irrigation automation.

IV. IMPLEMENTATION

In this section we will discuss about different modules that make the project whole.

A. Integration of soil moisture, pH, npk and water level sensor with the Arduino Mega:

The microcontroller collects the sensor value through input ports. The soil moisture sensor records the moisture level of the soil, if the moisture is less than threshold value and water level is greater than threshold value in the tank then motor is turned on. If moisture level is greater than threshold value or water level is less than threshold value in the tank then motor is turned off. The pH sensor records the pH value of the soil,pre-defined standard threshold is set to decide whether the soil is acidic, basic or neutral in nature. The npk sensor records the Nitrogen, Phosphorus and potassium value in the soil. Ideal values are taken, difference is obtained between ideal value and measured value, by using the guidelines shown below and notification is sent to the android application to use appropriate fertilizer to increase the level of nutrients which leads to higher crop yield.

TABLE I. GUIDELINES TO CALCULATE THE FERTILIZER RECOMMENDATION FOR NITROGEN.

Nitrogen		
	Recommendation	
	For low fertile Soil, increase Nitrogen by	For high fertile Soil, decrease Nitrogen by
$N_d \leq \pm 50$	No change	
51 to 100 kg	+12.5 kg	-12.5 kg
100 to 175 kg	+25 kg	-25 kg
175 to 250 kg	+37.5 kg	-37.5 kg
251 to 325 kg	+50 kg	-50 kg

TABLE II. GUIDELINES TO CALCULATE THE FERTILIZER RECOMMENDATION FOR PHOSPHORUS.

Phosphorous		
	Recommendation	
	For low fertile Soil, increase Phosphorous by	For high fertile Soil, decrease Phosphorous by
$P_d \leq \pm 25$	No change	
26 to 75 kg	+12.5 kg	-12.5 kg
76-125 kg	+25 kg	-25 kg

TABLE III. GUIDELINES TO CALCULATE THE FERTILIZER RECOMMENDATION FOR POTASSIUM.

Potassium		
	Recommendation	
	For low fertile Soil, increase Potassium by	For high fertile Soil, decrease Potassium by
$P_d \leq \pm 25$	No change	
26-50 kg	+12.5 kg	-12.5 kg
51-100 kg	+25 kg	-25 kg
101-175kg	+37.5 kg	-37.5 kg

B. Controlling motor by Android application:

The moisture, pH and nutrient value is displayed, for every Pre-defined interval of time. An android application is used to turn on and off the motor.

C. Send sensor data to cloud:

The sensor detects and measures the changes in parameters such as soil moisture, pH and nutrient content in the soil. By use of Wi-Fi module the sensed data is sent to the cloud for future prediction

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V. CONCLUSION

In this work, we successfully develop a system that can help in an automated irrigation system by analyzing the moisture level of the ground. The smart irrigation system proves to be a useful system as it automates and regulates the watering without any manual intervention. The primary applications for this project are for farmers and gardeners who do not have enough time to water crops/plants. The famers are facing major problems in watering their agriculture fields. It is because they have no proper idea about when the current available so that they can pump water.

The moisture sensors and temperature sensor measure the moisture level (water content) and temperature of the plants. If the moisture level is found to be below the desired level, the moisture sensor sends the signal to the raspberry pi and sends an alert message which alerts the Water Pump to turn ON and supply the water to respective plant. Also, without visiting will get the status of the motor and temperature on mobile.

The system features a custom sensor design for power efficiency, cost effectiveness, cheap components, as well as scalability end ease of use. In future there are some tasks that
should be done and would develop the system to a more mature state. The system may be further extended for outdoor utilization.

VI. ACKNOWLEDGMENT

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