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Smart Irrigation System

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***Abstract*— Water requirement for agriculture is large. Due to inadequate rainfall, water requirement is not been able to meet. Under conventional irrigation system, irrigated land is either under irrigated or over irrigated resulting in adverse effects on crop growth and wastage of water. There is a need of an automated system. The proposed Irrigation System in this paper aims at fulfilling water requirements of the crops, by monitoring the soil moisture and other environmental parameters. The system which is based on Internet of Things, logs the sensor data to the cloud and the farmer can monitor and control all the water pumps remotely over internet using Android application. It consists of wireless sensor node with Arduino publishing sensor data to cloud using Wi-Fi module and controlling the pump using relay. The paper presents an automated irrigation system providing precision agriculture and thus preventing water wastage.**

Keywords*— *Android Application, Arduino, Internet of Things, Wi-Fi module, Relay.

I. INTRODUCTION

In the present era, the greatest problem faced by world is scarcity of water. Agriculture is an occupation demanding plenty of water. Irrigation refers to the supplying water to cultivation land as supplementation of rain fall. There are various types of irrigation system that have been adopted. The efficiency of the irrigation system in conserving water is not appreciable. Moreover, the water requirement by the crop depends on type of soil, crop and environmental parameters like temperature and humidity. Conventional Irrigation system either result in over irrigated or under irrigated land. As growth and development of plants is prevented due to scarcity of water, similarly excessive water has adverse effect on growth of plants. Under Conventional Irrigation system, many parts of irrigated field are over or under irrigated due variability in the water holding capacity of land, water infiltration and water runoff. Over irrigated area, suffers from poor plant health due to increase in salinity. Excessive water replaces air in pores of the soil. Hence roots of the plants do not get sufficient air. It may lead to leaching. While under irrigated area suffers water stress. Hence efficient water management plays key role in agriculture.

In conventional Irrigation system, requires human effort and is time consuming. Today Internet of Things is able to provide smart solution to irrigation system. The Internet of Things (IoT) refers to the ever-growing network of physical objects that feature an IP address for internet connectivity, and the communication that occurs between these objects and other Internet-enabled devices and systems.

Wireless Sensor Networks (WSN) have been the subject of research in various domains over the past few years and deployed in numerous application areas. WSN is seen as one of the most promising contemporary technologies for bridging the real and virtual world thus, enabling them to interact. A WSN is composed of a number of sensor nodes, which are usually deployed in a region to observe particular phenomena in a geospatial domain. Sensor nodes are small stand-alone embedded devices that are designed to perform specified simple computation and to send and receive data. They have attached to them a number of sensors, gathering data from the local environment that is being monitored. WSNs have been employed in both military and civilian applications such as target tracking, habitant monitoring, environmental contaminant detection and precision agriculture [1].

The proposed irrigation system is efficient in managing water based upon soil moisture, environmental temperature and humidity. This automated system minimizes farmer's intervention in farming, increases crop production, saves time, helps remote monitoring and controlling and easy to install.

II. PROPOSED SYSTEM

The proposed system consists of two modules: transmitter and coordinator. Transmitter module as shown in the Fig. 1 consists of soil moisture senor and temperature-humidity sensor interfaced with the microcontroller. Microcontroller is connected to the internet via Esp8266 acting as Wi-Fi module [2]. A channel is created in ThingSpeak, which is open source IoT (Internet of Things) application. ThingSpeak provides an API (Application Programming Interface) key which is used to send the sensor data to the cloud and store it in the created channel and specified fields created [3]. The microcontroller collects the sensor values and sends them to the ThingSpeak cloud through internet using the HTTP protocol [4].

Coordinator module in Fig. 2 receives the command from the Android App through internet. It consists of microcontroller interfaced with relay to control the motor and is connected to internet by Wi-Fi module.

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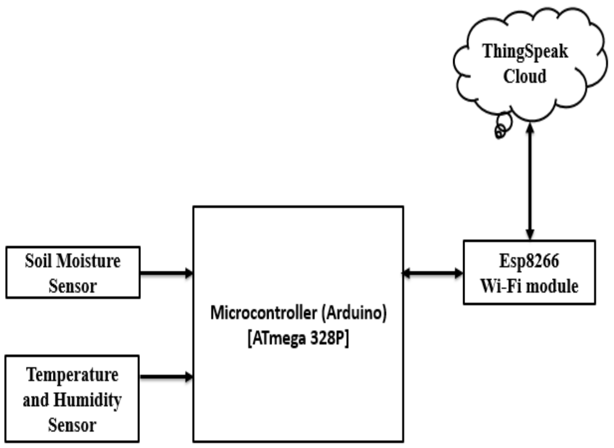

Fig. 1. Transmitter Module.

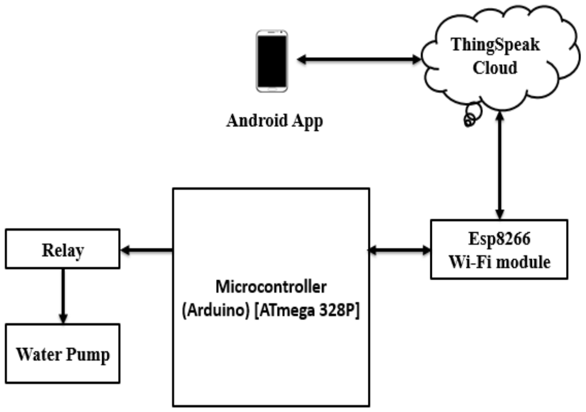

Fig. 2. Coordinator Module

III. HARDWARE REQUIRED

A. Arduino Uno

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. Arduino Uno shown in the Fig. 3 can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. An Arduino board consists of an Atmel 8-bit AVR microcontroller with complementary components to facilitate programming and incorporation into other circuits. An Arduino microcontroller is also preprogrammed with a boot loader that simplifies uploading of programs to the on-chip ash memory, compared with other devices that typically need an external programmer.

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with AC-to-DC adapter or battery to get started.

Fig. 3. Arduino Uno

B. YL-69 Soil Moisture Sensor

YL-69 Moisture Sensor or the hygrometer shown in Fig. 4 is usually used to detect the humidity of the soil. So, it is perfect to build an automatic watering system or to monitor the soil moisture of your plants. The sensor is set up by two pieces: the electronic board, and the probe with two pads, that detects the water content. The sensor has a built-in potentiometer for sensitivity adjustment of the digital output, a power LED and a digital output LED. The voltage of the sensor varies with the moisture, when the soil is dry voltage is high and when soil is wet voltage is low.

C. DHT11 Temperature Humidity Sensor

DHT11 Temperature and Humidity Sensor in the Fig. 5 features a calibrated digital signal output with the temperature and humidity sensor complex. Its technology ensures the high reliability and excellent stability.

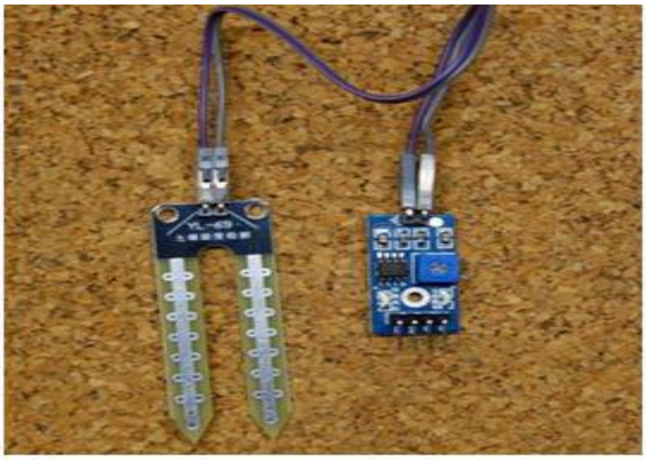

Fig. 4. YL-69 Soil Moisture Sensor

This sensor includes a resistive element and a sense of wet NTC temperature measuring devices. It has excellent quality, fast response, anti-interference ability and high cost performance advantages. For measuring humidity, the humidity sensing component is used which has two electrodes with moisture holding substrate between them. So as the humidity changes, the conductivity of the substrate changes or the resistance between these electrodes changes. This change in resistance is measured and processed by the

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Integrated Chip which makes it ready to be read by a microcontroller. For measuring temperature these sensors use a NTC temperature sensor or a thermistor. A thermistor is actually a variable resistor that changes its resistance with change of the temperature. These sensors are made by sintering of semi conductive materials such as ceramics or polymers in order to provide larger changes in the resistance with just small changes in temperature. The term "NTC" means "Negative Temperature Coefficient", which means that the resistance decreases with increase of the temperature.

Fig. 5. DHT11 Temperature Humidity Sensor

D. Esp8266 Wi-Fi Module

ESP8266 in the Fig. 6 offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor. When ESP8266 hosts the application, and when it is the only application processor in the device, it is able to boot up directly from an external flash. It has integrated cache to improve the performance of the system in such applications, and to minimize the memory requirements. Alternately, serving as a Wi-Fi adapter, wireless internet access can be added to any microcontroller-based design with simple connectivity through UART interface or the CPU AHB bridge interface. ESP8266 on-board processing and storage capabilities allow it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. With its high degree of on-chip integration, power management converters, it requires minimal external circuitry, and the entire solution, including front-end module, is designed to occupy minimal PCB area. Some of the important features are

- 802.11 b/g/n protocol
- Wi-Fi Direct (P2P), soft-AP
- Integrated TCP/IP protocol stack

Fig. 6. Esp8266 WiFi Module ESP-01

IV. WORKING

The soil moisture content and environmental factors like temperature and humidity are read by the microcontroller of the transmitter module. These values are sent to the cloud through internet for every 30 seconds [5]. The logged data is represented in the Thingspeak cloud in the form of graphs. When the sensors values go beyond the threshold, an alert message is sent to the farmer. Android Application enables farmer to turn on the water motor by controlling the relay connected to coordinator module through internet. When the desired environmental parameters are met an alert is sent again to the farmer to turn off the motor.

Fig. 7. Working Prototype

V. RESULTS

The prototype of the Smart Irrigation System is shown in the Fig. 7. The system is experimented for potato plant to check the reliability of the system. The potato plant's water requirements is 500-700mm a day. So the analytics on the cloud are set to soil moisture of 300-600 range [6]. It is found that system works properly and water is pumped into the field as and when required. If the soil is dry, alert message is sent to the farmer. The farmer turns on the motor using the Android App as shown in the Fig 8. When the desired soil moisture is

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met, the system asks the farmer to turn off the motor through App. The Fig. 9, 10 and 11 show the graphical representation of soil moisture, humidity and temperature respectively.

Fig. 8. Android Application

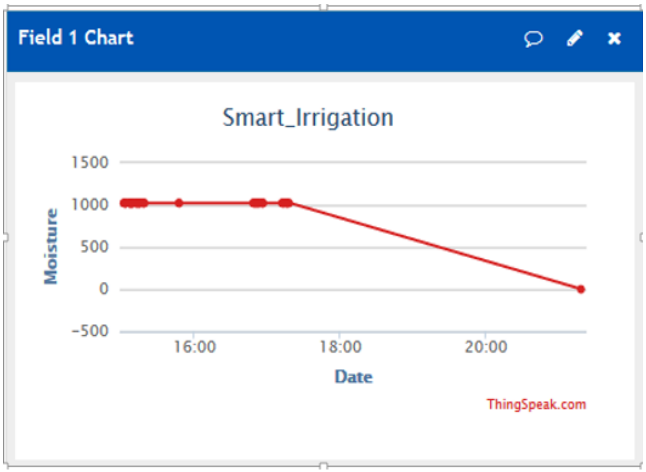

Fig. 8. Graphical representation of Soil Moisture in ThingSpeak

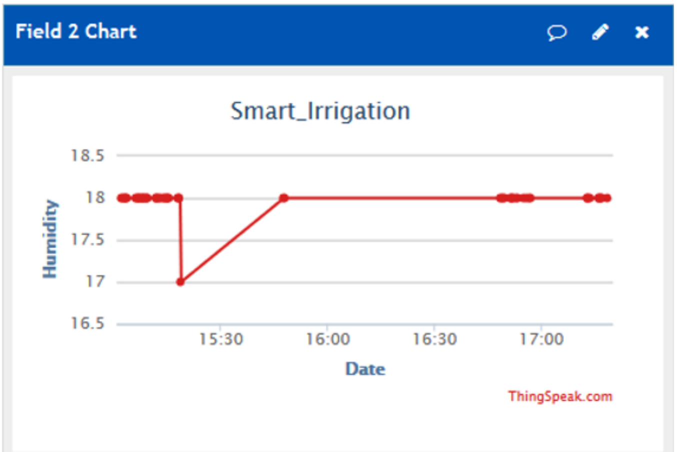

Fig. 8. Graphical representation of Humidity in ThingSpeak.

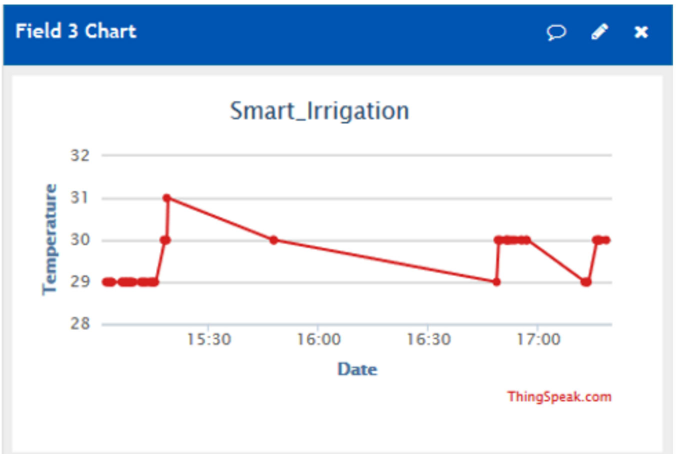

Fig. 8. Graphical representation of Temperature in ThingSpeak

VI. CONCLUSION

The proposed system provides the efficient and reliable method of irrigation. Due to regular updates of the soil conditions and environmental factors, it becomes easy to analyze the data and get knowledge about what amount of water is required at what interval of time in a day. Moreover in dry areas where there is inadequate rainfall, the system can efficiently manage water and ensure better yield of crops by precisely watering. The system reduces human intervention. It enables the farmer to know about the crops and surrounding environment and control the water pump and monitor the field by accessing the data from anywhere.

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