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AN INTELLIGENT WAY OF SMART IRRIGATION SYSTEM ON WEB USING INTERNET OF THINGS

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Abstract- An automated irrigation system was developed to optimize water use for agricultural crops. The system has a distributed wireless network of soil-moisture and temperature sensors placed in the root zone of the plants. In addition, a gateway unit handles sensor information, triggers actuators, and transmits data to a web application. An algorithm was developed with threshold values of temperature and soil moisture that was programmed into a microcontroller-based gateway to control water quantity. Problems about agriculture have been continuously delaying the growth of the country. The lone answer to this difficult is modern agriculture and technology for sustainable use of water by updating the present old-style methods of farming. Hereafter the planned method targets IoT enabled remotely real-time way of monitoring and controlling suitable irrigation systems. Raspberry pi mega founded automatic irrigation IoT system is suggested for upgrading and it will allow having a better water management and treatment on irrigation systems. Hence, exploitation of water resource again improves productivity of the crop. The proposed system is developed such that the data sent from the sensors and predict the amount of water needed.

I. INTRODUCTION

In India, where 60-70% economy depends on agriculture, there is a great need to modernize the conventional agricultural practices for the better productivity. Due to unplanned use of water the ground water level is decreasing day by day, lack of rains and scarcity of land water also results in decrement in volume of water on earth. Nowadays, water shortage is becoming one of the biggest problems in the world. We need water in each and every field. In our day to day life also water is essential. Agriculture is one of fields where water is required in tremendous quantity. Wastage of water is the major problem in agriculture. Every time excess of water is give to the fields. There are many techniques to save or to control wastage of water in agriculture. The objective of the system is to a) conserve energy & water resources b) handles the system manually and automatically c) detects the level of water.Due to the climatic changes and lack of precision, agriculture have resulted in poor yield as compared to population growth. Irrigation is mostly done using canal systems in which water is pumped into fields after regular interval of time without any feedback of water level in field. This type of irrigation affects crop health and produces a poor yield because some crops are too sensitive to water content in soil.

Agriculture is the major source of income for the largest population in India and is major contributor to Indian economy. However, technological involvement and its usability have to be grown still and cultivated for agro sector in India. Although few initiatives have also been taken by the Indian Government for providing online and mobile messaging services to farmers related to agricultural queries and agro vendor’s information to farmers. Based on the survey it is observed that agriculture contributes 27% to GDP, and Provides employment to 70% of Indian population [2].

Irrigation can be well-defined as the use of water to the soil for raising the moisture content which is important for plant root-growth and development to prevent stress that may cause reduce the quantity of crop as well as the merit of the crops. The country Ethiopia is found in East Africa and hence agriculture is the base for people’s basic achievement and the nation state is plentiful by water resource. Even if we have adequate amount of water still now rain-fed agriculture is more experienced than irrigation water use. Now 15 % of Farmers Starts Irrigation, we have seen that due to improper water utilization and due to erosion and cutting of canals, farmers suffer from irrigation problem and also when they go for the government offices then they have to wait for months for resolving the problem and hence it takes time, travel fatigue and also loss of money due improper convenience And still there are many problems of water management related to irrigation. The measured water parameter in this proposed system is pH level by means of an analogy pH sensor. The temperature is captured during pH measurement by using an analogy temperature sensor and Wireless Water Level Indicator Using Ultrasonic sensor [5]. Some of water quality parameters to be measured are pH Value of water and ambient temperature of water in addition Soil moisture measurement also influences the quality of agricultural production.

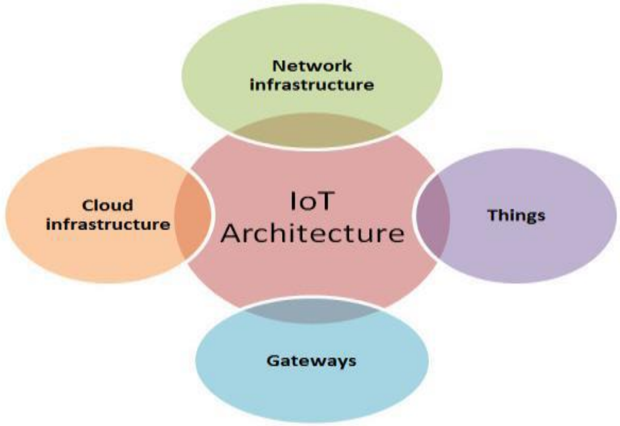

Fig 1 IoT (Internet of Things)

An alternative parameter to determine crop irrigation needs is estimating plant evapotranspiration (ET). ET is affected by weather parameters, including solar radiation, temperature, relative humidity, wind speed, and crop factors, such as stage of growth, variety and plant density, management elements, soil properties, pest, and disease control [8]. Systems based on ET have been developed that allow water savings of up to 42% on time-based irrigation schedule. In Florida, automated switching tensiometers have been used in combination with
ET calculated from historic weather data to control automatic irrigation schemes for papaya plants instead of using fixed scheduled ones. Soil water status and ET-based irrigation methods resulted in more sustainable practices compared with set schedule irrigation because of the lower water volumes applied [10].

II. LITERATURE SURVEY

Various researches have been carried out on how soil irrigation can be made more efficient .The researchers have used different ideas depending on the condition of the soil and quantity of water Different technologies used and the design of the system was discussed by the researchers. This paper aims at reducing the wastage of water and the labor that is used to carry out irrigation manually. The proposed system aims at detecting the moisture content of the soil using sensors that are placed directly into the soil. This sensors sense the water level of the soil and if the water level is not adequate then the user will be notified through a message that will be sent to the application which would be installed on the user's mobile phone. The Raspberry pi board, a microcontroller, controls the digital connection and interaction between objects in the proposed system, enabling the objects to sense and act [2]. Also, with its powerful on-board processing, various sensors and other application specific devices can be integrated to it. In the system, sensors detect the water and moisture level and send readings to a fixed access point, such as a personal computer, which in turn can access irrigation modules installed in the field or the physical module in the water tank, wirelessly over the internet. A wireless application of drip irrigation automation supported by soil moisture sensors Irrigation by help of freshwater resources in agricultural areas has a crucial importance. Traditional instrumentation based on discrete and wired solutions, presents many difficulties on measuring and control systems especially over the large geographical areas. If different kinds of sensors (i.e. humidity, and etc.) are involved in such irrigation in future works, it can be said that an internet based remote control of irrigation automation will be possible [3].

An automated irrigation system was developed to optimize water use for agricultural crops. The system has a distributed wireless network of soil-moisture placed in the root zone of the plants. In addition, a gateway unit handles sensor information, triggers actuators, and transmits data to an android application [4].

Primary investigation is carried out under the following stages, such as Understanding the existing approaches, Understanding the requirements, developing an abstract for the system. In this paper, soil moisture sensor, temperature and humidity sensors placed in root zone of plant and transmit data to android application. Threshold value of soil moisture sensor that was programmed into a microcontroller to control water quantity. Temperature, humidity and soil moisture values are displayed on the android application. This paper on "Automatic Irrigation System on Sensing Soil Moisture Content" is intended to create an automated irrigation mechanism which turns the pumping motor ON and OFF on detecting the dampness content of the earth. In this paper only soil moisture value is considered but proposed project provided extension to this existed project by adding temperature and humidity values. [2]

A. Different irrigation systems

The irrigation system is considered among the most important requirements of the agricultural sector. Irrigation is an artificial operation of water used on agricultural land. It permits bringing fresh water artificially to cultivated plants, with the aim of increasing and optimizing the production and development of crops. This technique is intended to cover the lack or insufficiency of water of natural origin (i.e., rain or groundwater), especially in arid areas or semi-arid areas. There are currently several irrigation systems, these systems can be

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classified according to three broad categories: (1) surface irrigation, (2) sprinkler irrigation, and (3) drip irrigation.

--Surface Irrigation: this is the most known and oldest irrigation technique. It includes all irrigation methods in which the distribution of water to the land is done entirely in the open air by simple gravity flow to the soil surface.

--Sprinkler irrigation: is a system that consists of imitating the phenomenon of rainfall. This method allows providing the necessary water to crops in the form of an artificial rainfall which spreads uniformly over the surface of the ground just at the needed moment, and that is analogous to natural rainfall.

--Drip irrigation: is a modern irrigation system with very low water consumption. This system is more suited to semi-arid and arid areas, achieving significant water savings in comparison with other irrigation methods. It consists of delivering water in drops on the ground surface under low pressure and with a low dose. This is achieved by bringing a low quantity of water under low pressure to the root zone of plants in a piping system. Then, this water is distributed to the field precisely at or near the root zone of plants in the form of drops using a set of drippers distributed all along rows of crop. With drip irrigation, the application of water is more frequent, more regular, more accurate, and more water-efficient. Therefore, if this technique is well managed, it is considered one of the most effective irrigation systems, since a set of benefits can be achieved such as water saving, minimizing runoff and evaporation, and reducing weeding.

B. Wireless Sensor Networks

With the evolution in technologies and diminution in size, the WSNs have attracted worldwide attention in recent decades, especially by the proliferation in MEMS (i.e., Micro-Electro-Mechanical Systems) technology that has eased the development of intelligent sensors. These sensors are inexpensive and autonomous, have a miniature size with computing and processing resources, and can be deployed in dense and random manner in the controlled environment. WSN is a particular type of Ad-Hoc network and consists of multiple detection elements called sensor nodes. These nodes communicate between them via radio links for the sharing of information and the co-operative treatment. The sensor network achieves three fundamental functions: sensing, communication, and computation.

In this network, the sensors are dispersed over the field and collect the information to build a global view of the region controlled. The data collected by these sensors are routed directly or via other sensors of close in close to a "collection point ", called base station for subsequent treatment. The base station also acts as gateway node whenever there is a requirement to communicate and connect with the external network [23] shown in Fig. 1.

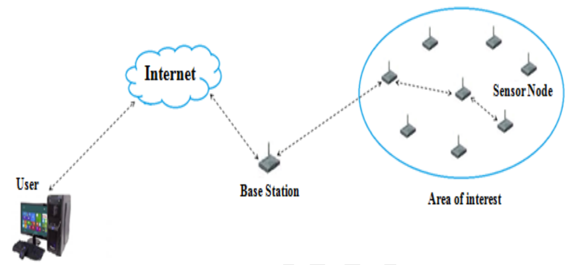

Fig.2: Wireless Sensor Network (WSN)

Initially, the wireless sensor network was developed for military reasons (e.g., battlefield monitoring). But the evolution of technologies and the pliability of WSNs have enabled searchers to consider this network as a prospective application in various other areas. Therefore, the WSNs can be very useful in a set of applications when it comes to collect and to treat information from the environment. There are numerous applications of WSNs include areas such as military, agriculture, environment, industrial, automobiles, and medical device.

The sensors are the basic units of WSNs. They are devices equipped with features of advanced sensation. The sensor nodes appear as autonomous systems miniaturized with a set of units. Having organized in form of network; the sensors in a WSN, despite the limitation of their computing resources, storage and energy, have the mission to collect data and transfer them to a base station. A sensor composes of four basic units, as shown in Fig.3.

--Sensing Unit: it is the main component of a sensor. It is composed of two subunits: a sensor which obtains measurements from the monitored environment, and Analog/Digital Converter (ADC) that converts measured information and transmits it to processing unit.

--Processing Unit: it includes a processor (computing unit) which allows doing simple calculations for collaboration with other sensors, and a memory (storage unit) integrating a specific operating system.

--Transmission Unit (Transceiver unit): is responsible for all transmissions and receptions of through a radio communication medium. It can be optical type (e.g., Smart Dust), or radiofrequency type (e.g., MICA2).

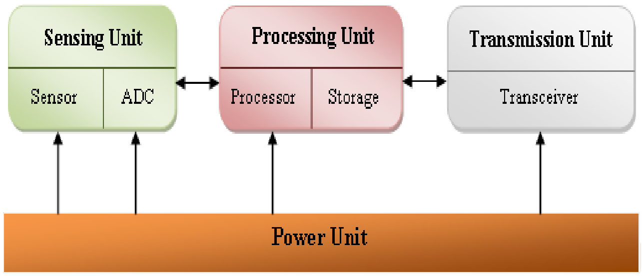

Fig.3: Sensor node architecture

III. PROPOSED SYSTEM

From the data treated above, we conclude that the common irrigation technique around the world is characterized by a remarkable increase in the demand for agricultural productivity, very low water availability and poor performance. These problems can be corrected appropriately through effective management of irrigation water, an adequate choice of the irrigation system, and use of an automatic control for this system. The integration of wireless sensor network technology with irrigation systems will be beneficial to solve the issues mentioned above in order to save water and increase the performance and efficiency of irrigation. Therefore, we want to develop a smart irrigation system based on the use of WSN that operates automatically by detecting temperature and moisture of soil and other environmental parameters and by activating/deactivating the mechanism of irrigation without the intervention of the farmer. To apply our proposed system, we select several tools and methods:

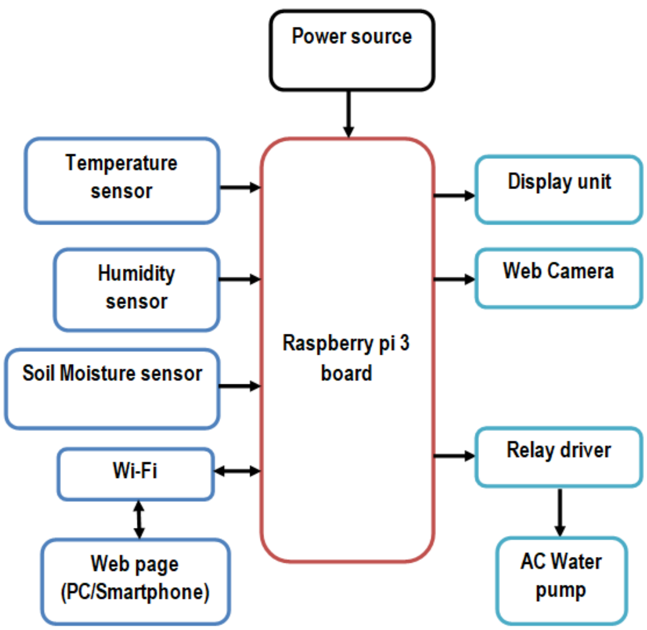

Fig.4: Proposed Block diagram

--The most important parameters for irrigation systems are temperature and moisture of soil. From these key parameters, we choose to use the humidity and temperature sensors like EC-5 Soil Moisture Sensor and DS18B20 temperature sensor - waterproof.

The objective of our proposed smart irrigation system is to utilize different new technologies: the wireless sensor network and ZigBee wireless communication to design a remote irrigation control system for farmers. To realize this, we propose a prototype that permits to monitor and measure soil moisture and temperature and air humidity and temperature using several special sensors. Then we analyze and check the measured data with predefined threshold values of measured parameters (predefined threshold values can be modified according to the type of crop). Based on the result of this analysis and verification, the irrigation system is activated / deactivated. A set of steps describing the flow of operation of our intelligent irrigation system using the WSN and ZigBee, these steps are shown in Fig. 3.

Our proposed irrigation system is based on the integration of a drip irrigation system with the wireless sensor network and other technologies such as ZigBee to achieve a smart and automatic control for irrigation. In Fig. 4, we describe and show the prototype of our proposed system. In our proposed prototype, we divide the agricultural land to be irrigated into multiple small areas in order to prolong the lifetime of the WSN, and thus the system. In each area, we deploy a set of temperature and humidity sensors to monitor and measure the moisture and temperature of the soil and the humidity and temperature of the air. The soil parameters are measured using EC-5 Soil Moisture Sensor and DS18B20 temperature sensor – waterproof; these sensors were placed near the root part of plants. The data measured by the sensors are transferred to a coordinator node (collection point), called a base station. The coordinator node receives and processes the data and stores the processed data in a database. These sensors are connected to each other and to a coordinator node via ZigBee wireless communication technology. After that, an analysis of the recorded data is performed by checking them with a developed base of threshold values for each measured parameter. From the result of this verification, the irrigation system is turned ON or OFF (Activated / Deactivated). In case of dry area, it will activate drip irrigation if the values reached less than threshold values.

To describe the working of our proposed system, show the different desired features of this system and depict the different interactions found. We present a use case diagram where we

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illustrate the different actors of the system as well as their different interactions.

Irrigation can be automated by using sensors, microcontroller, Bluetooth, android application as shown in Fig.3. The low cost soil moisture sensor and temperature and humidity sensor are used. They continuously monitor the field. The sensors are connected to Raspberry pi board. The sensor data obtained are transmitted through wireless transmission and are reached to the user so that he can control irrigation. The mobile application can be designed in such a way to analyze the data received and to check with the threshold values of moisture, humidity and temperature. The decision can be made either by the application automatically without user interruption or manually through application with user interruption. If soil moisture is less than the threshold value the motor is switched ON and if the soil moisture exceeds the threshold value the motor is switched OFF.

The sensors are connected to the Raspberry pi board. These hardware communicate through wireless Bluetooth transmission so that user can access the data through his mobile that has an android application which can get the sensor data from the Raspberry pi via Bluetooth. As far as cost of device is considered Bluetooth technology is usedwhich can be replaced by wi-fi. motor is switched OFF.

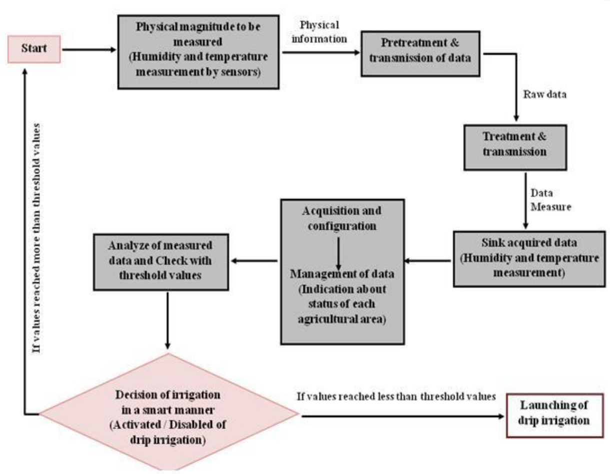

Fig. 5. Steps of operating flow for our proposed irrigation system

The proposed system has been designed to overcome the unnecessary water flow into the farm or crop lands and prevent impurity that infliction to plants or crops without any impact increases the productivity by monitoring and controlling when irrigation start and stop the time remotely any ware in real time to give up immediate actions.

The irrigation system is automated once the control received from the mobile application. Through Bluetooth the decision is sent to the Raspberry pi and accordingly the motor switches are operated. The ultrasonic sensor is used to monitor water level in reservoir. The ultrasonic sensor work based on the piezoelectric method. It has trigger pin and echo pin. The trigger pin act as transmitter and the echo pin is a reflector. The trigger pin sends ultrasonic waves once it started functioning. The ultrasonic waves once it started functioning. The ultrasonic waves hit the water and reflected towards the echo pin. The duration to receive the echo is calculated and that indicates the water level.

Farmers start to utilize various monitoring and controlled system in order to increase the yield with help of automation of an agricultural parameters like temperature, humidity and soil moisture are monitored and control the system which can help the farmers to improve the yield.

This proposed work includes an embedded system for automatic control of irrigation. This project has wireless sensor network for real-time sensing of an irrigation system. This system provides uniform and required level of water for the agricultural farm and it avoids water wastage. When the moisture level in the soil reaches below threshold value then system automatically switch ON the motor. When the water level reaches normal level the motor automatically switch OFF. The sensed parameters and current status of the motor will be displayed on user's android application.

Before the motor is switched on, the water level is checked to ensure that require amount of water is available for irrigation. If required amount of water is not present, the motor will not be switched on or only less amount water is supplied. The notification is sent to the farmer's mobile for further decision to be made. The farmer can also be able to switch on and off the motor from the mobile application.

This system is a combination of hardware and software components. The hardware part consists of different sensors like soil moisture sensor, photocell sensor, etc whereas the software part consists of an android based application connected to the Raspberry pi board and other hardware components using Internet of Things (IoT). The android based application consists of signals and a database in which readings are displayed from sensors and are inserted using the hardware. The improvement in irrigation system using wireless network is a solution to achieve water conservation as well as improvement in irrigation process. This research tries to automate the process of irrigation on the farmland by monitoring the soil water level of the soil relative to the plant being cultivated and the adaptively sprinkling water to simulate the effect of rainfall.

The project is designed to develop an automatic irrigation system which switches the pump motor ON/OFF on sensing the moisture content of the soil. In the field of agriculture, use of proper method of irrigation is important. The advantage of using this method is to reduce human intervention and still ensure proper irrigation.

IV. IMPLEMENTATION

The proposed agricultural system is designed to solve to find an optimal solution to the water crisis. The design implements IoT technology using an android device, a main controlling unit (MCU), sensors to measure various parameters and a water pump, which will be used to supply water to the farm.

The collected data from the meteorological database contains the various climatic parameters like evaporation rate and/or the precipitation on the following day. So, alterations in water requirements have to be done in such a way that it neutralizes the water loss due to evaporation and/or increase in water due to precipitation. For example, the former optimum value of water requirement was 20 units and say if evaporation causes loss of 5 units of water, then 25 units of water are supposed to be released. Or say if precipitation would cause 10 units of increase in water then 15 units of water is supposed to be released. After all the comparison and decision-making mechanisms finish execution, we get a final optimum value of water requirement for respective field sections. This data is stored in the output database and is transmitted to Raspberry pi through the master router.

Raspberry pi commands the digital pump about the total water requirement in the field. Once, the digital pump starts to release the water then at every half of a second, the on-field sensor transmits the updated value of water in each field section. This updated value is then subtracted from the total water requirement value to decide whether to continue releasing the water or to turn off the current valve. Once all the valves are turned off, then the digital pump is turned off as well.

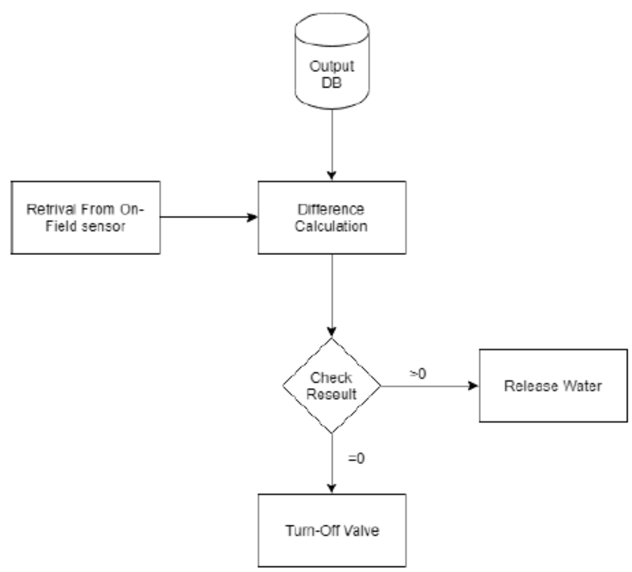

Fig.6: Difference Calculation Process for Water Requirement

V. OUTCOMES FROM PROPOSED SYSTEM

Different crops require different amounts of water at different ages. The data are given in the paper [7] was used in order to obtain the following table: -

Table 2. Water Requirement in mm

Crop	Initial Stage	Intermediate Stage	Final Stage
Rice	146.60	286.80	192.90
Maize	42.75	225.90	360.30
Wheat	24.10	27.80	127.20

This table represents the water requirements of crops at various stages in their life cycles. The water requirements of these crops were analyzed with meteorological and other datasets to obtain the final optimum values of water requirement.

These values are displayed along with the weather conditions through an application interface provided to the user (farmer) so that the user can track the developments throughout the field.

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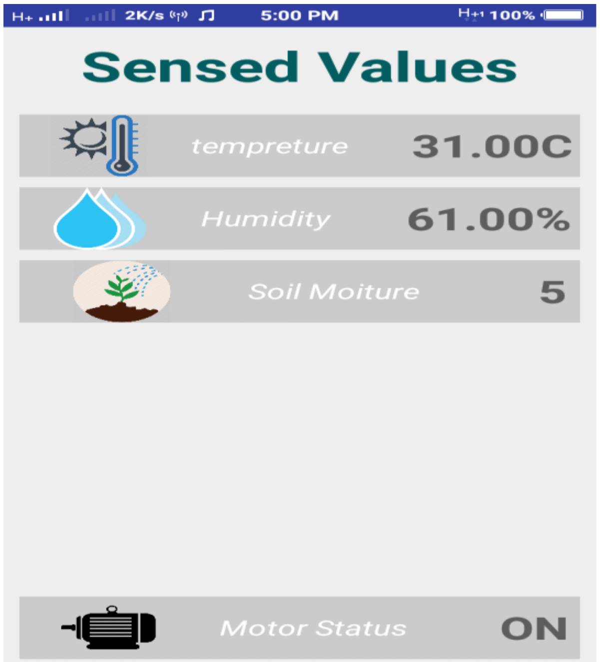
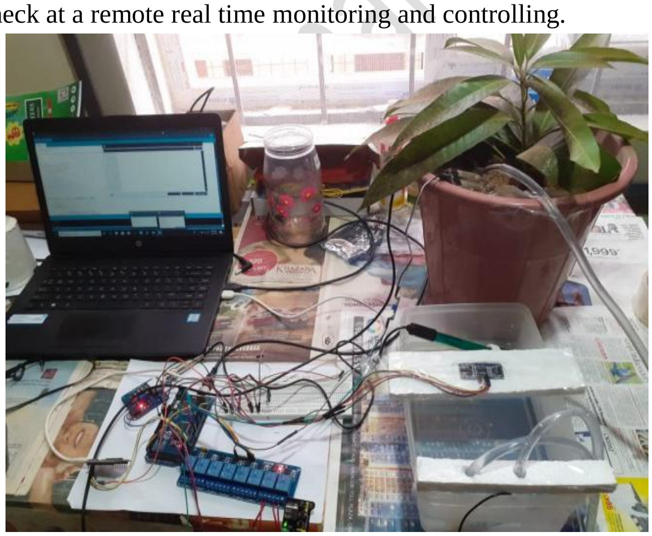


Fig.7: Sensed values displayed on user android application

The proposed system hardware and the real time results of four sensors are also revealed in the figure below. The information get from sensors are kept in the cloud and can be observed by agriculturalist through his mobile/ PC. The system exact values which really occur from the system are perceived remotely by agriculturalist; without his interference at his farm fields the irrigation ran automatically. The Raspberry pi administered and linked information found from four different sensors checks at every time to the threshold values. Here calibration of the sensors system is so important. The system displays pH value, water level and temperature condition of soil moisture, based on the four sensors conditions. The status of the system can able to check at a remote real time monitoring and controlling.



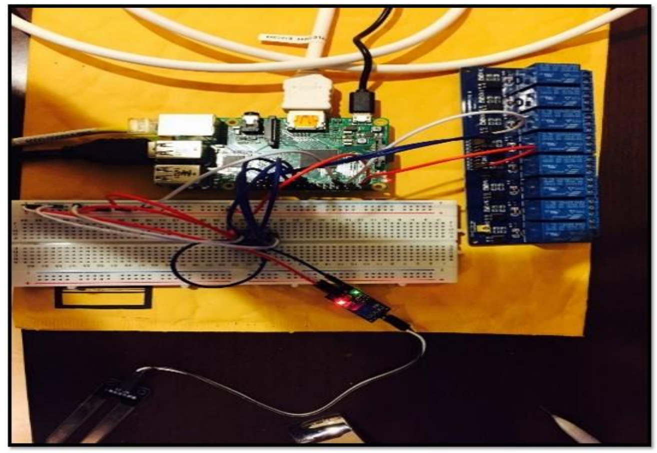


Fig.8. System hardware

Lastly the communication was created successfully all data sent to the Raspberry pi from the connected sensors would also be available on nodeMCU. Since nodeMCU has a built-in Wi-Fi and it possible to send data to the cloud, the data incoming from the Raspberry pi would be directly pushed to the cloud.

In this project, the data would be sent to thing speak. Which is a cloud-based, open source an IoT API that enables us to store, retrieve, aggregate, analyze and visualize streams of live data According to this the data will be store and retrieve from things by using of HTTP protocol inter changing information in real time through the internet.

VI. FUTURE ENHANCEMENTS

For future developments, it can be enhanced by developing this system for large acres of land. Also, the system can be integrated to check the quality of the soil and the growth of crop in each soil. The sensors and microcontroller are successfully interfaced and wireless communication is achieved between various nodes. Also, the system can be further improved by adding machine learning algorithms, which are able to learn and understand the requirements of the crop, this would help the field be an automatic system. The observations and results tell us that this solution can be implemented for reduction of water loss and reduce the man power required for a field.

VII. CONCLUSION

The automated irrigation system implemented was found to be feasible and cost effective for optimizing water resources for agricultural production. This irrigation system allows cultivation in places with water scarcity thereby improving sustainability. The automated irrigation system developed proves that the use of water can be diminished for a given amount of fresh biomass production. The use of solar power in this irrigation system is pertinent and significantly important for organic crops and other agricultural products that are geographically isolated, where the investment in electric power supply would be expensive. The irrigation system can be adjusted to a variety of specific crop needs and requires minimum maintenance. The modular configuration of the automated irrigation system allows it to be scaled up for larger greenhouses or open fields. In addition, other applications such as temperature monitoring in compost production can be easily implemented. The Internet controlled duplex communication system provides a powerful decision making device concept for adaptation to several cultivation scenarios. Furthermore, the Internet link allows the supervision through mobile telecommunication devices, such as a smart phone.

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