Intelligent Farm Irrigation System

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Abstract – The Intelligent Farm Irrigation System is aimed to benefit the millions of Indian farmers towards their farms timely watering requirement using scientific methods and the state of the art technologies with optimum usage of resources. The system consists of wireless ambient monitoring sensors like soil moisture, temperature etc. combined with low power wireless networks. The wireless sensor networks acquires the data on continuous basis (24x7 mode) from the sensors and analyse in conjunction with the Indian Metrological Department's weather predictions and makes intelligent decisions based on the available data and executes the watering activities. The information about the execution of activities will be sent to the user through email/SMS using internet. The entire sensor's data will be logged and stored in the cloud and this will be used as a base for fine tuning of the Intelligent Irrigation Systems for future to effectively meet the agricultural demands. Excess watering causes loss of minerals, and rotting up of the plants and wastage of resources. This system conserves the usage of man power, electricity and water resources optimally. The system allows the user to schedule the irrigation timings with a provision to override the timings from any computer with a web browser. No special software or clients are required, just a Web Browser on a computer or mobile phone.

Keywords: Internet of Things, Cloud, Sensors, agriculture.

I. INTRODUCTION

Agriculture plays a vital role in Indian economy, over 70% of the rural households depend on agriculture as their principal means of livelihood. As per estimates by the Central Statistics Office (CSO), the share of agriculture and allied sectors (including agriculture, livestock, forestry and fishery) was 15.35% of the Gross Value Added (GVA) during 2015–16. Irrigation helps to improve food security, agricultural productivity and improves rural employment without much depending on the monsoons.

The motivation for this paper came from the global climate shifts due to various reasons like global warming, excessive air pollutions etc. causes lack of seasonal rains and depletion of ground water table levels. Currently most of the Indian farmers cultivate their land depending on seasonal rains and water through bore wells. To combat these issues intelligent irrigation is thought by using scientific and technical methods and means to solve the current issues.

Even if the farm land has a water pump, manual intervention by farmers is required to turn the pump on/off based on the need. This process sometimes consumes more water or shortage of required water to the land may lead to damage to the crop. Water deficiency results in deterioration of plants growth before visible wilting occurs and also slow growth, light weight fruit yields. Also, the unplanned use of water inadvertently results in wastage of resources like power and water which leads to the increase of zones of low water table lands consequently they become dry/barron lands.

II. RELATED WORK

GSM Based irrigation System [5, 7, 9, 11, 12] works based on microcontroller rain gun irrigation system in which the irrigation will take place only when there will be intense requirement of water that save a large quantity of water. This application makes use of the GPRS feature of mobile phone as a solution for irrigation control system. The major limitation of this system is, it covers lower range of agriculture land and not economically affordable.

Yunseop (James) Kim et. all. Proposes Remote Sensing and Control of an Irrigation System Using a Distributed Wireless Sensor Network [16]. The setup of specialized framework depict in this paper is expansive based and is moderately one of the effective framework that has created windows application to screen the field. Field is outfitted with remote correspondence sensors that profits better encouraged sensor correspondence and spreads more extensive field zone. Point by point portrayal on location field sensors and Internet innovation is depicted quickly. The factual information gave is measured to be productive and utilized for exploration work.

Microcontroller Based Automatic Plant Irrigation System [14] is to provide automatic irrigation to the plants which helps in saving money and water. The entire system is controlled using 8051 micro controller which is programmed as giving the interrupt signal to the sprinkler. A wireless application of drip irrigation automation supported by soil moisture sensors [6] 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. But these system are not used different kinds of sensors (that is, temperature, humidity, and etc.) and internet to remote control of irrigation.

The developed system can also transfer fertilizer and the other agricultural chemicals (calcium, sodium, ammonium, zinc) to the field with adding new sensors and valves. Solar Powered Smart Irrigation System, Advance in Electronic and Electric Engineering [10]. It is cost effective and conserves electricity by reducing the usage of grid power and conserves water by reducing water losses. The main advantage of this system Discourage weeds, saves water and time, statistical data can be used to control diseases and fungal growth, simplest model. This system also suffers remote control operation through internet.

III. PROPOSED METHOD

In current fast growing technologies automation is to be introduced in place of regular repetitive tiring human efforts. Current life style demands everything to be smartly managed using gadgets like mobiles and ipads without much physical efforts.

In the current work a thought is given towards Intelligent Irrigation using Internet of Things (IoT) as a first step towards future smart irrigation. This technology uses smart and miniature sensors like moisture, temperature etc., to measure the ambient and report to the cloud for storage and analysis of the real ground data. The smart analyzers analyses the ground data and compares with the built in database in conjunction with the IMD weather forecasts and proposes the best actions to be taken towards irrigation.

This intelligent irrigation system uses the state of the art technology and optimizes the utilization of resources like usage of man power, electricity, water etc., and yields the best returns to the farmers. The system allows the user to schedule the pre-determined irrigation intervals and quantities based on type of crop and quality of soil with a provision to override the activities from any smart gadgets. Simple Web Browser on a computer or mobile phone is adequate without any dedicated software to exercise this smart irrigation. It also includes remote operation of water pump using a simple mobile app. The status of the activities are sent to the end user in real time through registered email or mobile.

The block diagram of the typical intelligent irrigation system is given in fig. 1 which explains in detail the interfaces between field sensors, field equipment, Power Supplies, Raspberry Pi and associated instrumentation along with cloud connectivity and the gadgets.

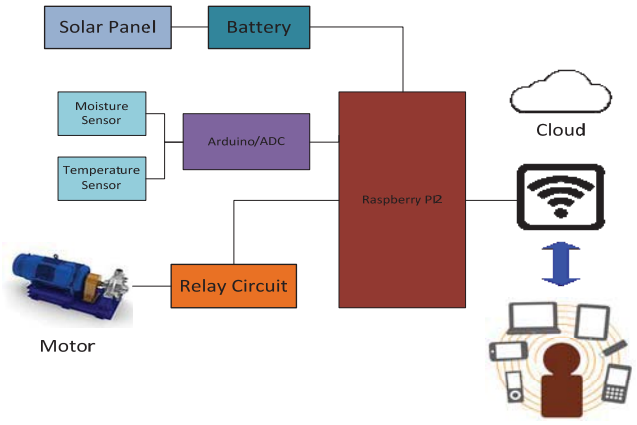

Figure 1: Intelligent Irrigation Block diagram.

A. *Objectives of the proposed system*

- Use of automation in place of valuable human resources using current state of the art technology.
- Elimination of erroneous human judgements by incorporating intelligent decision making system based on the strong historical and current weather shifts.
- Optimum utilization of natural resources and usage of real time remote sensing satellite data through government free resources.

- The app can be loaded and used in simple gadgets like mobiles and ipads without any special software or training.
- This smart irrigation system continuously surveillances the ground and weather conditions and yields the best profits to the farmers with minimum manpower and resources.
- It enhances the crop yield by timely meeting the demands of the crops.

B. Configuration of the pilot project

i. Internet of Things

The connection of physical objects or things with electronics, software programming, sensor circuits, and enabling the connectivity for exchanging data [2] between the sensors or devices or operating personnel is called as Internet of Things or shortly termed as IoT. The IoT allows objects to be sensed and controlled remotely across existing network infrastructure, [15] creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit.[1, 3, 4, 8, 13, 17]

An application is anything that has a connection to the internet and wants to interact with data from devices and/or control the behaviour of those devices in some manner and identifies themselves to the IoT Foundation with an API key & a unique application ID. Applications do not need to be registered before they can connect to the IoT Foundation.

Different makes and models of boards like Raspeberry Pi, Arduino Uno, Intel etc. are readily available in the market for supporting IoT projects along with various sensor kits to enhance their capabilities to fit into the real world usage.

ii. Raspberry PI

Raspberry Pi2 is selected for this project due to low cost, credit-card sized computer plugs into a monitor/TV and uses a standard keyboard and mouse as given in figure-1. It is a miniature device capable of executing required tasks and easy to use by all age groups. These devices are programmed using common languages like Python, Scrach, PHP etc. It's capable of doing everything like a desktop computer using minimum resources like browsing the internet, playing high-definition video, making spreadsheets, word-processing, playing games etc. In addition to this the device can be used for multipurpose tasks like security surveillance, video/audio recording, ambient weather measurements, by enhancing its capabilities through the integration of external sensors.

Figure 2: Raspberry Pi2 board.

iii. Soil Moisture Sensor

Soil moisture sensors measure the volumetric water content in soil. It is very important for agricultural applications to help farmers manage their irrigation systems more efficiently. Knowing the exact soil moisture conditions on their fields, farmers can monitor continuously and timely provide the watering to produce the best yields from their crops.

This sensor has two copper leads act as the sensor probes. They are immersed into the specimen soil whose moisture content is under test. The conductivity of soil depends upon the amount of moisture present in it. It increases with increase in the water content of the soil that forms a conductive path between two sensor probes leading to a close current flowing path [2, 4, 13].

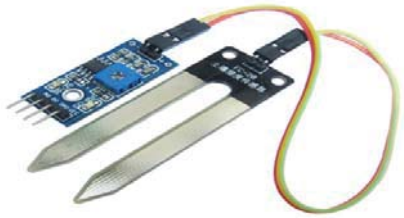

Figure 3: Moisture Sensor.

iv. Temperature Sensor

For temperature measurement, LM35DZ sensor has been used. The soil temperature is one of the important environmental factor with a change of climate, topography, vegetation, soil type, planting form and other factors. The soil temperature is closely related with some processes such as crop planting time, Growth, wintering safety etc. The change of soil temperature directly impact on soil nutrient absorption and soil moisture holding capacity, various physical processes of soil. The soil water and heat migration phenomenon is a topic of research. Therefore, the observation of real time soil temperature and understanding of its interdependency on agricultural production and scientific research [1, 2, 15, 17] is very important.

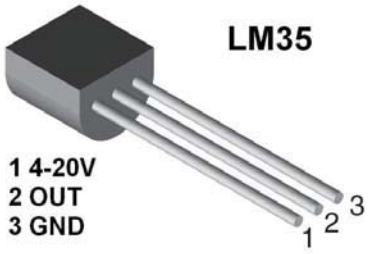

Figure 4: LM35 Temperature Sensor.

C. Working principle

Initially setup Rasbian OS in the SD card as mentioned in Raspberry PI official web site and place the SD card into the Raspberry Pi's SD card Slot. Connect keyboard, mouse and monitor with respective ports. The LAN cable/WIFI adapter is connected to LAN cable slot/USB slot given in Raspberry Pi. Finally power supply is given to the Raspberry Pi with micro USB cable.

The sensors are installed in the farms at required locations to have homogeneous field data and all these sensors are powered with 5v power supply through cable network and interfaced with the Arduino board to the respective analog pins. Now the Arduino board is connected to Raspberry Pi2 using USB cable and read moisture & temperature sensors data from soil and processed through Raspberry Pi2 processor using algorithm-1. At regular intervals field data will be captured and uploaded to cloud for storage. Based on the field sensor's measurements data Raspberry Pi2 processor processes and executes the required commands for the irrigation system in auto mode/discrete mode if required.

Algorithm-1:

The following algorithm gives the step by step process for intelligent irrigation

1. Read the moisture and temperature values in regular intervals from Arduino and the data is uploaded into the cloud for further analysis.
2. Analysis of data based on the set of guide lines like comparison of temperature and moisture level with reference values along with the Indian Metrological Department (IMD) weather predictions and finalizing the actions. The actions may include powering ON/OFF pump to meet the requirement and the action will be reported to the user through email/SMS to the registered email account/mobile.
3. Scheduled watering can also planned depending on the crop requirements with manual overriding provision.
4. Apart from this, the motor can be remotely operated (ON/OFF) from the former's mobile in case of any necessity.

IV. RESULTS AND DISCUSSIONS

Being it is a simple project we tested this project simultaneously on four potted plants. We periodically measured the moisture from these four potted plants and averaged the moisture and stored in the relyr cloud.

The maximum and minimum moisture levels are the relayr cloud are shown fig 5(a) and fig 1(b) respectively. When the moisture level falls/raises specified level the motor is ON/OFF and the same will be sent as mail as shown in fig. 6(a)/fig. 6(b). The remote status of the motor is shown in fig 7(a) and 7(b). Here we use the moisture maximum and minimum reference levels are 500 and 200 respectively. Depending on the crops the reference level may vary. From the obtained results the proposed method almost we same 40% of the water for irrigating the plants. And also it is cost effective and uses latest technology to full fill the needs of Indian farmer.

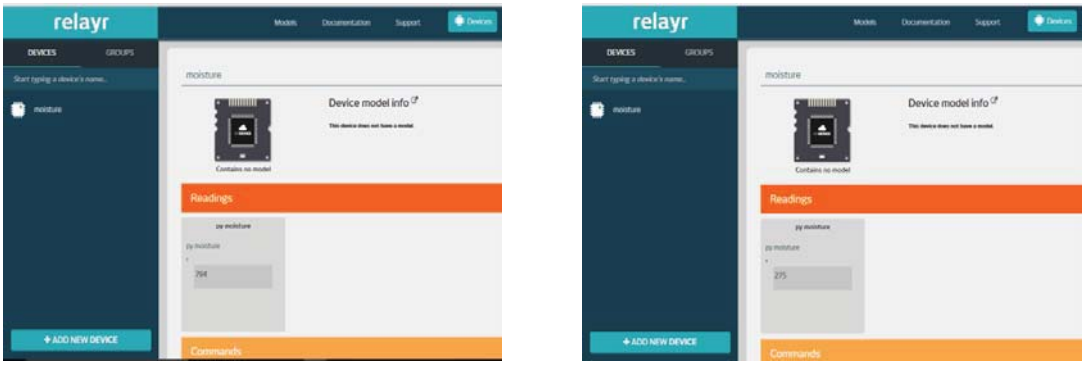

Figure 5: (a) Maximum moisture value (b) Minimum moisture value

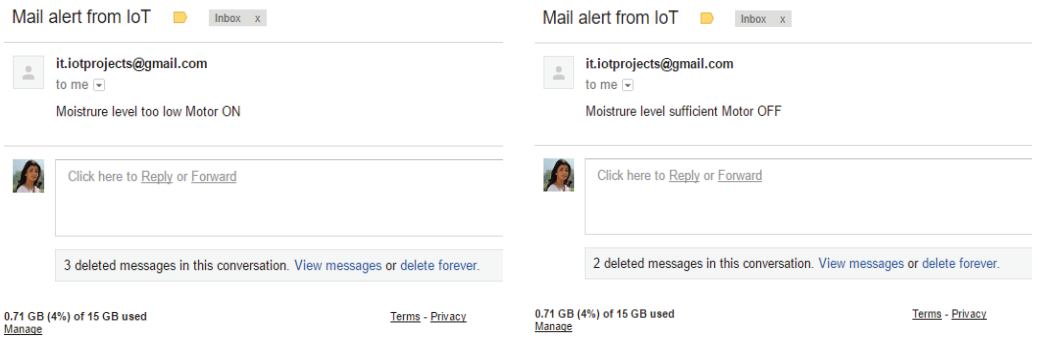

Figure 6: (a) Mail alert when motor is ON (b) Mai alert when motor is OFF

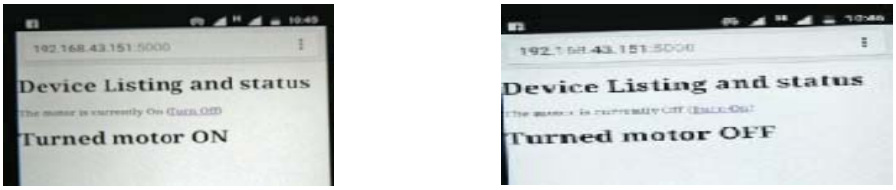

Figure 7: (a) ON state of the motor in mobile (b) OFF state of the motor in mobile

V. LIMITATIONS

Currently it is studied based on single plant watering with single moisture and temperature sensors. However, in real life farms are having multiple plants distributed over a wide area in such cases proper location of multiple sensors to be studied for acquiring required data homogeneously throughout the farm area. Sensors failure modes are to be incorporated in the software to eliminate erroneous operation of the irrigation system. Intelligence to be built-up in systems to diagnose and analyse sudden variation of field parameters.

VI. CONCLUSION

The current work aims to develop a smart state of the art intelligent irrigation system using scientific approach with IoT technology and associated sensor kits. This system monitors the dynamically changing ground parameters on continuous (24x7) basis and enables the decision making using IMD data and historical database. The pilot project realized with demo kit was tested thoroughly by simulating various field ground conditions along with failure modes and response of the algorithms are validated with reference to its designated objectives and found the results are satisfactory. This work helps to Indian farmers to utilize current cutting edge

technologies in their regular irrigation activities to overcome the unforeseen hurdles and optimum utilization of the available resources and avail the best yields from the crops.

VII. FUTURE SCOPE

Further this project work can be extended towards development of new sensors to measure the soil conditions and ambient weather conditions for effective field measurements and also an intelligent data base can be generated for various crops, soil conditions along with frequency and quantity of water requirements in consultation with the field experts for the effective utilization of this system. With passage of time the data acquired through the field acts as a treasure and enables the fine tuning of the decision making module.

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