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Design of Automated Irrigation System using Internet of Things

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ABSTRACT- A vital role is played by agriculture in India's economy. India is majorly dependent on agriculture. Water scarcity is a major threat in recent years, so conserving water is necessity during agriculture. Among all kinds of irrigation systems, drip irrigation is considered as the most effective one. In drip irrigation technique, the supply of water is done by laying pipe lines across the agricultural fields and only the required amount of water is supplied, thus maintaining the moisture in the soil. Continuous monitoring is required in the irrigation system. It would be easy for a farmer if an automated system that controls the motor and enables live monitoring is designed. The frequently used parameters for sensing are temperature, moisture, image, humidity and pH for getting accurate result. So this paper focuses on survey of finding an automated irrigation system.

Keywords: Irrigation, Drip, Accurate, Moisture.

I. Introduction

Agriculture is the means of securing the necessities of life in India. The primary occupation of people is irrigation where water plays a vital role. The technique of irrigation should be chosen appropriately. But water scarcity is one of the major threats to agriculture in the recent times. In agricultural sector managing water resources plays a main role. Because of adopting the traditional practices this is not given much importance. In this situation, the method of irrigation plays an important role in the entire process. Thus water conservation is a mandatory process which can be achieved by choosing an appropriate method of irrigation.

Traditional methods where farmer fetches water from canals, rivers and lakes for irrigation are not much efficient. There are several irrigation techniques that had been in practice since long time. Drip irrigation is the most eminent one among all other techniques of irrigation. Water is supplied by laying pipes throughout the field in drip irrigation, thus only required amount of water is used as shown in figure 1. The problem is, this process is still a manual one where an individual has to monitor the conditions of the soil and control the water supply accordingly.

Each crop requires certain quantity of water. When the level of water quantity is exceeded, the water gets wasted. In order to use water judiciously during irrigation, volumetric Water content should be estimated. The farmer has to continuously monitor the field and manually control the motor. A smart irrigation system can be designed to make the system automatic.

Fig 1. Drip Irrigation, Courtesy- https://en.wikipedia.org/wiki/Drip_irrigation

II. SUPPORTED HARDWARE AND SOFTWARE TECHNOLOGIES :

A. *Arduino technology*:

Design of automated control and remote management of irrigation system by the use of low-cost device Arduino shown in figure 2 and operating system Android was described by Stefan Koprda et al. [17] (2015) . Also, Ahmed Imteaj et al.

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[1] (2016) have come up with a design for automatic water supplying system in farmland using raspberry pi 3, Arduino microcontrollers, WiFi module, GSM shield, relay boards and couple of sensors. The analog data received from the sensors are transmitted by Arduino as digital signal via Wifi Module to the Raspberry Pi 3. K. M. Ragibul Haque et al. [12] (2017) have come up with an approach to do away with such limitation is the utilization of natural resource for irrigation purpose, an intelligent auto irrigation system which is based on the concept of harnessing the power of sun. Setting would be programmed by a platform both hardware and software with Arduino Uno. The irrigation system in [17] consists of several modules which can be divided into three parts: control part, regulatory part and server part. The design brings comfort, automation and mostly energy savings for intelligent systems. Data monitoring of irrigation is important because it will be used in the decision-making process.

Fig 2. Arduino

B. Soil moisture sensor:

A system was designed in order to control an irrigation system by Nattapol Kaewmard et al. [10] in the year 2014, they developed the communication methodology of the wireless sensor network for collected environment data and sending control command to turn on/off irrigation system. This paper presents the process of how microcontroller (MCU) gather the environment information included humidity and temperature sensor, soil moisture and groundwater level. The data transmission for collecting the data and the controlling commands of smart phone can be controlled watering system. Bennis et al. [4] in the year 2015 had proposed a model for drip irrigation system using the WSANs. This model includes the soil moisture, temperature and pressure sensors to monitor the irrigation operations. When the pipes burst or emitters block, this case is taken into account where system malfunction occurs. It uses an adequate priority based routing protocol to achieve high quality of service. The information transmitted by the WSAN is differentiated by two main traffic levels. K.S. Vijula Grace et al [20] in the year 2015 had described an automated system to make effective utilization of water resources for agriculture and crop growth monitoring using GSM. The effective utilization of drip irrigation process is improved by using the signals obtained from soil moisture sensor. Nelson Sales et al. [11] in the year 2015 had proposed a system that aims to address a variety of distinct scenarios, such as agriculture, greenhouses, golf courses and landscapes. The algorithm uses them for taking decisions concerning the need for irrigation. The end of irrigation is triggered whenever network soil moisture sensors assume a soil moisture value higher than the defined field capacity point. Riadh Zaier et al. [14] had proposed an automated system that is wireless and avoids decisions about volumes and timing of irrigation. It introduces smart irrigation via the use of moisture and conductivity sensors to ensure that farmers use only the required volumes of irrigation water and meet the crop water requirement under the quota limits. A. Sathya et al. [16] (2016) have proposed a system that automatically irrigates the field through the entrance valve when the water level is lower than the threshold level and also according to the moisture of the soil. Paper [1] makes decisions depending upon the moisture level of farmland and daylight intensity, the system can detect the appropriate time of water supply in the trees and can also keep track of the water level to prevent water from being accumulated around the roots of the saplings. This system can be applied in farmland as well as small pot plants. The soil moisture shown in figure 3 is a key variable that can be used to determine the quantity of water needed. Besides, the availability of the amount of daylight is also very crucial for a tree. Wrong timing of watering can cause more harm rather than benefit. Daniel A. Winkler et al. [5] (2016) had proposed to overcome the physical limitations of the traditional irrigation system. The local soil moisture, communicate wirelessly which is developed by a sprinkler node to sense. It actuates its own sprinkler based on a centrally-computed schedule. The moisture from runoff, absorption and diffusion is computed using the model developed. Kavianand G et al. [7] (2016) have kept forward a system that makes use of ARM 9 processor to control as well as monitor the irrigation system. The abnormal conditions like less moisture content, even concentration of CO_2 and temperature is informed to the user through GSM module via sms. The user is informed about any abnormal conditions like less moisture content and temperature rise, even

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concentration of CO2 via SMS through the GSM module by the system. Rajalakshmi.P et al. [13] (2016) had proposed a model to increase the crop yield by reducing wastage and using fertilizers effectively. The crop-field is monitored using sensors (soil moisture, temperature, humidity, Light) and the system is automated. Víctor H. Andaluz et al. [19] (2016) have come up with the control drip that is applied to hydroponic farming in which is developed an interface between human and machine in a free software allowing continuous monitoring of moisture, pH, temperature and electrical conductivity of soil through the sensors housed in the crop root zone also, the controller performs the conditioning sensors, actuator control resource to irrigate water, and nutrient solution, and monitoring via web. In paper [12] in order to drive the pump into action, two conditions need to be fulfilled one darkness, detected by a photo resistor and the second one is the dryness of soil, to be determined by a moisture sensor, and this setting would be programmed by a platform both hardware and software with Arduino Uno. Ateeq Ur Rehman et la [3] in the year 2017 had proposed a model for automatic irrigation system that makes use of solar panels hence this liberates power supply due to load shedding. The moisture sensor along with temperature and humidity sensors were used to control the system by sending a signal to the motor. The papers [10],[21],[6],[7] use smart phones for collecting data, controlling data and receiving the status of the irrigation system. The system malfunction occurs when the pipes burst or the emitters block in paper [4]. It also differentiates two main traffic levels for the information transmitted by the WSAN, and uses an adequate priority-based routing protocol in order to achieve high Quality of service. Accurate results are shown when simulations are conducted over the NS-2 simulator in terms of delay and Packet Delivery Ratio (PDR), mainly for the priority traffic. The soil moisture, temperature and pressure sensors are used to monitor the irrigation operations. The microcontroller coordinates the output signals of the sensors. It is transmitted to the user using GSM Modem. The workload of the cultivator is reduced by this mechanism. Appropriate soil condition is also maintained. The involvement of the cultivator is eliminated by this system. The rainwater is generally stored in a tank and used for irrigation. TCP/IP protocol is used to access the farm. Wireless transmission is used to send data to web server database. The wireless sensor nodes continuously senses the crop field and send it to the coordinator node where decision making is done to automate irrigation based on the field conditions. Data are encoded in JSON format in server database. If the moisture and temperature of the field falls below the brink, the irrigation is automated. In addition to irrigation, the greenhouse light intensity control can also be automated. Roux J. et al. [15] (2016) had proposed a model that addresses the challenge of Irrigation Ingénierie Système. This is done by cylindrical sensor buried under the ground. The content in different depths can be measured. The water absorbed by the plants is also estimated. The data are transmitted from the plant irrigation to soil properties via an ISM 869 MHz radio frequency link.

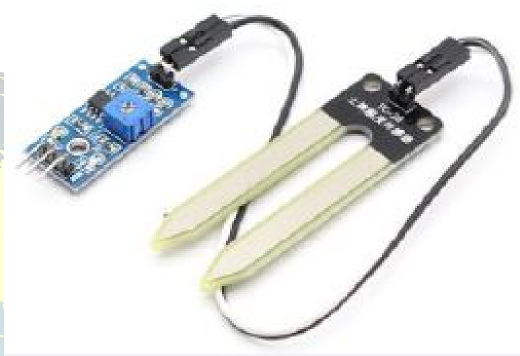

Fig 3. Moisture Sensor

MOISTURE SENSOR > HUMIDITY > TEMPERATURE > PRESSURE

Fig 4- Efficiency of sensors

C. Motor Automation:

A possible way of automatic irrigation described in paper [17], such as how to control setting of irrigation network, how to open or close the floodgates, and how much flow of water to be used so that it can conserve water usage later. The irrigation system allows the user to control the irrigation in the household. The system is controlled fully by online interface and requires active connection to the Internet. The irrigation system irrigates also in absence and turns off when the plants do not need any water. The design brings comfort, automation and mostly energy savings for intelligent systems. Data monitoring of irrigation is important because it will be used in the decision-making process. The motor automatically stops in [3] after the soil reaches maximum upper threshold value decided by the user. Every time the motor starts or stops automatically ,the user will get the status of the operation using GSM feature. Zhonghu Yuan et al. [21] (2015) have

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put forward a design idea about remote monitoring device of three-phase irrigation motor based on GSM signal. The overall hardware structure of vehicle navigation terminal is introduced. The design of several important modules was seriously analyzed, such as the power module, the TC35i module circuit, TC783A module circuit and so on.

D. GSM:

Information is sent to the cultivator through SMS where GSM facility in [20] serves as an important part for controlling the drip irrigation. Then the entire agriculture irrigation system is controlled by the user through SMS. The design of mobile phone software in [21] and the terminal software was simply introduced. After debugging and running, the mobile phone software can send SMS command to control the remote terminal switch of motor and real-time display the state of motor returning from remote terminal. The mobile phone software of the control terminal is based on the multisystem to develop, more wide scope of application and simple operation. The entrance valve in [16] closes after the water level reaches the threshold level and also the GSM modem sends SMS about the time taken to fill the farm with water to the farmer. It uses the water level sensors and moisture sensors to measure the water level and the moisture level in the fields for controlling the valves which directs the water flow in the fields. The objective of paper [7] is to design a fully automated drip irrigation system using GSM and ARM processor. In this system GSM modules is interfaced with the main controller chip. GSM is used for remotely monitoring and controlling the devices via a mobile phone by sending and receiving SMS via GSM network. Trifun Savić et al. [18] (2016) was proposed which allows flexible control of the three electromagnetic valves for releasing water to agricultural field. Closing of the valves can be scheduled based on duration of irrigation or amount of water that is released. This system is implemented with Libelium Waspmote using an open source platform, supported by GPRS module. The control of the system can be performed manually, on the main control unit, or remotely, by commands sent over the SMS service. SMS report is sent to the user about current configuration and amount of released and also to remote server for further analysis. A flexible control of irrigation and optimal water consumption is provided. The system in [1] is able to notify the administrator if water shortage arises in the main water supply and an administrator can also communicate with the system by sending SMS (Short message service) of a particular keyword. This system can be applied in farmland as well as small pot plants. Lala Bhaskar et al. [8] in the year 2015 had proposed a design that is helpful for the farmers who are facing power failure issues to maintain a uniform water supply due to power failure or inadequate and non-uniform water supply. The automatic irrigation system also keeps the farmer updated with all the background activities through a SIM900 Module that sends messages on the registered number. This device can be a turning point for our society. The device is easily affordable by the farmers of the country. This proposed design is helpful for reducing the human labour. This is a low budget system with an essential social application. Some sensors such as temperature sensor and humidity detector are used to control the watering system. The system also has the capability to indicate the water level. The system sends all the activity information to the registered mobile number through GSM technique. It sends information regarding temperature, humidity, farm field water level and also the main tank water level.

E. Xbee and Zigbee technologies:

A single collecting node for data collection is connected to the host computer in [14] for each farm. The slave nodes are connected to Xbee. The solenoid valve and the two sensors are included in the master node. The slave nodes along with the master nodes control the irrigation of the field. A lithium battery with photovoltaic charging panels is used to give power to the Xbee network and the solenoid valves. The communication in [11] between the wireless nodes has to be performed by a low range communication protocol, such as ZigBee and 802.15.4. Depending on the deployment scenario, the data transmission between the sink node and the cloud platform can be performed through a variety of technologies (wired or wireless). ZigBee is used in [16] to transmit the measured values to the PIC microcontroller, which compares the measured values against the stored threshold values to control the valve operations. When the water gets filled and directed to next farm the microcontroller signals the GSM modem to send SMS to the farmer about the time took to fill first farm.

F. Humidity sensor, image capturing, expert system and fuzzy logic:

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M.Amir Abas et al. [2] (2016) proposed a system in which the control is used to manage the irrigations hours. Its main aim is to reduce cost and increase plant growth performance. This distinctive management involves with loop signals through weather sensors that monitors the changes of atmospheric
phenomenon. Three sensors specifically temperature, humidn ess and pyranometer area unit wont to givesignals that area unit called multiplying issue for the management algorithmic rule to perform autonomous adjustment for following irrigation time. The algorithmic rule involves with a continuing K that is applied as time setting for daily irrigation. The time setting autonomously modified related to the changes of weather like dry climax, descending and weather.
The management algorithmic rule has been tested and therefore the result shows the management of soil wetness through weather feedback part is economically improved and would be potential to extend yearly crop yield. In the year 2015 Joaquin Gutierrez et al. [6] had designed an automated irrigation sensor to use in agricultural crops. The sensor uses digital images of soil nearby root zone of the crop and estimates optically the water content. An android app was developed to operate directly the connectivity components. There is a built in camera in the smart phone that takes a picture of the soil though anti–reflective glass window. An RGB to gray process is used to estimate the ratio between the wet and dry area of the image. The ratio is transmitted to an irrigation water pump using Wi-Fi. Maryam Hazman [9] in 2015 had put forward a system whose main task is to utilize irrigation expertise for a crop and calculates the detailed irrigation operations. The irrigation operation determines the exact water requirements and time for the crop according to different environmental parameters and the cultivated crop parameters. Separating these parameters from the expert system knowledge base is required to generalize the presented irrigation system to be applied for any crop. Therefore, the proposed system takes these parameters as input data. Since these parameters are not usually known by the ordinary user, then the proposed model uses predefined services for collecting the needed parameters based on the plantation date, location, and crop type. A case study is applied to demonstrate how the proposed system can be applied for generating Fababean irrigation schedule. The result shows the applicability of the proposed system to be used in generating the irrigation schedule for any crop. It's aim is to support farmers for optimizing their crop water usage using the expert system technology. Zohaib Mushtaq et al. [22] (2016) have put forward to design and simulate a fuzzy controller using MATLAB for automatic land irrigation. This controller is mathematically designed and simulated in MATLAB. It consist of inputs/outputs values with membership functions. Input involve agricultural land water level categorization and time. Output of designed controller consist of tube well operation and power source. Software and calculated evaluation have been done on input controlling outputs. We calculated outputs to get minimum percentage error difference between calculated and simulated results. We got 1.9% error in Tube well operation and 1.15% error in power source.

REFERENCE MODEL	SENSORS			MICRO CONTROLLER		COMMUNICATION MODULE		
	MOISTURE	TEMPERATURE	HUMIDITY	ARDUINO	AT89S52	GSM	XBEE	ZIGBEE
[1]	✔			✔		✔		
[2]		✔	✔					
[8]		✔	✔		✔	✔		
[11]	✔					✔		✔
[12]	✔			✔		✔		
[14]	✔						✔	
[16]	✔					✔		✔
[17]		✔		✔				
[20]	✔				✔	✔		

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S.no	Paper title with author name	Advantages	Limitations
1	Automated plant Watering system, Drashti Divani et al, 2016 International Conference on Computation of Power, Energy Information and Communication (ICCPEIC)	Reminds user about the water level. Uses ATmega328 microcontroller	ATmega328 needs an Arduino board to operate which is highly delicate and using it in agricultural fields may cause it to malfunction.
2	Wireless sensor based control system in agriculture field, K. S. Vijula Grace et al, Communication Technologies (GCCT), 2015 Global Conference	Uses GSM technology. Reduces water consumption.	Using GSM may cause electronic interference.
3	Sensor data collection and irrigation control on vegetable crop using smart phone and wireless sensor networks for smart farm, Nattapol Kaewmard et al, Wireless Sensors 2014 IEEEConference	Uses wireless sensor network. Automatic system that reduces water usage.	Data collected are not close to accurate.
4	IoT Based Crop-Field Monitoring And Irrigation Automation Rajalakshmi.P et al, IEEE 2016	Low cost for implementation.	Used only to monitor the conditions.

III. Conclusion

In this work we have provided various ways of controlling the irrigation system by measuring the soil parameters using sensors. The status of the system can be notified to the user in multiple ways but the most frequent way is by sending SMS. This can be further improved by implementing an user friendly application.

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