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A Survey of the Automated Irrigation Systems and the Proposal to Make the Irrigation System Intelligent

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Abstract- Agriculture and farming are the key components and they contribute to the maximum in the income of any country. Farmers cannot depend on the rainfall for the crops cultivation. So, watering and monitoring of the crops becomes a critical issue. Less watering or more watering to the plants can be a serious issue and it may lead to the less yield of the crop. Also, farmers cannot be at the irrigation land all the time. So, we are proposing a design for automatic monitoring of the crops so that the system automatically understands the need of water to the plants and acts respectively. Also during heavy rains, we are proposing to drain out the excess water in the fields so that it will not affect the plants yield. We are also proposing to apply artificial intelligence to the irrigation system. By this the plants will be continuously monitored for any diseases affecting the crops and any changes in the quality of the crops which will be immediately notified to the farmer. Also planning to detect the budding weeds around the crops. In this paper the survey of different papers on automated irrigation system has been presented with their advantages, limitations and their future scope.

Keywords- Automated Irrigation, Arduino, Sensors, Artificial Intelligence, crop quality, Weeds

I. INTRODUCTION

It has been well said that India is an agricultural country. According to 2014 the land share for agriculture is 60.4% and growing at an alarming rate of 0.03%. A country where there is a huge share to agriculture should be well acquainted with irrigation. Irrigation plays an important role in India, not only to artificially supply water to our crops but also to make our crops healthier. Due to global warming there has been an unprecedented rise in temperature across the globe and as a result there are irregular and uncertain monsoons in the country. Technologies are growing and so do humans grow with them, and so do the automated irrigation in our country, which is a major step ahead to a modern India.

Irrigation helps to water the crops in the event of unexpected rains. There are variety of crops grown in India, of which some require water in excess while others in very less water. To meet these requirements irrigating the crops is vital. Jute and Paddy require excess amounts of water which cannot be fulfilled by rains and there is a need for watering them artificially. It also controls drought and other calamities faced by the country.

For a country like India where the population is solely dependent on crops for the food there is a necessity of further advancing our irrigation system so that our farmers do not toil all day.

Micro controllers like Arduino are being used to make the system to nearly complete automated. Arduino like any other device is an open source platform which is capable of interacting with the objects by sensing them in the real world. The advantage of this little small electronic device is that it is very easy to learn and implement. Arduino can receive inputs from many sensors and in turn can control the motors, solenoid valves and other LED lights. A Raspberry Pi can also be used which can perform even more complex tasks than Arduino. Machine Learning can also be added to the irrigation system which will make the system smarter. Use of machine learning will make the automated irrigation system to take the decisions based on the different parameters collected by the sensors deployed in the fields.

II. RELATED WORK

Many research papers have been published on this automated irrigation systems using Arduino, Raspberry PI and few sensors.

The summary of the research papers taken for the survey are as follows:

[1] Presents the use of grove moisture sensor, water flow sensor and Arduino. Communication is done using the Zig bee protocol. For the experiment master-slave combination is being used. The motor's function will be sent to the farmers mobile using GSM. The status of the motor can be checked anytime by the farmers. The gateway that is being used in the WSN (wireless sensor networks) is Zig bee or wifi of low power. Nodes of WSN acquire power with the help of battery

or any external electricity. Nodes contain the sensors and actuators for analyzing, monitoring and sensing the ambiance status. In the nodes a radio transceiver is present which may contain antenna externally or internally. The battery provides power to the nodes. WSN in this case follows the star or multi-hop wireless mesh network. The nodes of the WSN should be able to withstand harsh environmental conditions. The amount moisture content of the soil can be retrieved from the grove moisture sensor. Soil moisture is being measured by the dielectric constant. When the dielectric constant is high the moisture content of the soil is also high and vice-versa. Water flow will be allowed depending on the moisture content in the soil. The future work proposed in this system is to monitor a large-scale area.

In Paper [2] authors have used Arduino Leonardo and Zig Bee and the gateway used is Raspberry pi. Data delivery done using the TCP protocol, which controls the way information being sent by the sender and the way it is received by the receiver. The main aim of using this method is to avoid too long waiting time. Using Zig Bee protocol the performance of the TCP protocol is increased which involves AR Q protocol, link transmission layer and FEC. The data here is nothing but the data of the soil moisture sensor. The process of data acquisition is performed using the Arduino Leonardo and Zig bee which is later stored on the Raspberry Pi. The data includes date time, set point lower limit, set point upper limit, name of the sensor, value of the sensor, the actuator status which is stored in the form of the text file. The irrigation system architecture consists of Main and Field, where Main is in connection oriented mode and acts as a receiver. Field acts as a sender. The field controller includes gateway (sender), sensor node, sensor and actuator. Communication between the sensor and receiver is done using the reliable protocol TCP. This mechanism can calculate the throughput, packet loss ratio and packet delivery calculations. The future work proposed is an additional feature which includes error control. Design of error control is also proposed where data can include BCH code which consists of encoding and decoding. Generator polynomial is used, along with syndrome bit to detect for errors if any.

[3] Has proposed about the automation reduced considerable amount of time of the farmers. Sensors were integrated with wireless network device and the data was received by the AT MEGA-328 micro controller which is located on top the Arduino Uno. Raspberry Pi was used to send messages through the Internet. Due to the automation used, the water is less wasted. The setup consists of sensor node and the control node. Soil moisture sensor is deployed in different directions of the field, the sensed data through the wireless network device is sent to the micro controller. After receiving the value, the controller node checks the value with the soil moisture value. If the controller finds that the soil moisture is inadequate it turns on the motor to carry out irrigation in the respective areas. The soil moisture sensor consists of the comparator whose job is to convert the analog data into the discrete data. Raspberry Pi is used to process the data and the SMS is sent to the farmer's mobile number when he is away from his field. Automatic sending of the messages can be achieved by using the python programming language. Automatic irrigation system is achieved which optimizes the water resources and helps the farmers when he is away from his field. It also saves the energy because the whole system is automated. This technique can very well be employed in different irrigation systems such as channel, sprinkler and drip. Since less number of sensor nodes are employed the cost is less and since the power consumption is less it is likely that this system will last for a longer time. The disadvantage of this system is though the technique can be adopted by various irrigation techniques, the output will be on the lower basis, as a system is required so that it can take into account the various conditions required by these different types of irrigating.

[4] Has proposed a system that can be employed both in home as well as in the fields. Also, the system uses ultrasound sensors and solenoid valves. Python programming is used for the automation. The working of the system is via the email to notify the farmer to switch ON the system for a certain amount of time, usually the email account used is the Mail. Raspberry pi is used as a gateway between the Arduino board and the emails sent. Raspberry pi is in turn connected to the Arduino micro controller using the Zig bee protocol. Arduino then sends the signals to turn on the relay, which is connected to the 240V power supply. Arduino is also connected to the ultrasound distance sensor, which indicates the water level in the tank. The two latter devices are connected to the water storage tank, which is controlled by solenoid valves. The main reason for water storage tank is for testing. The water storage tank is then connected to the water pipes to provide it to plants such that there is no wastage of the water. This technique is cost effective as no maintenance is required. The limitation is that if one particular part or a device fails which remains uninformed and has to be tested out manually. Emails are also a limitation. Uses Arduino Uno and raspberry pi.

In Paper [5] authors have proposed to use a low-cost micro controller Arduino and android as the operating system. This irrigation system consists of three parts- control part, regulatory part, server part. This setup requires the use of Internet all the time, in case of the connection failure this setup works on the saved settings. Monitoring activity related to the data transmission. Data monitoring can be used in the process of making decisions. This is one possible way of automatic irrigation, which can be used for decision making regarding how to control the settings of the irrigation network, and as to how to control the floodgates, and also the water flow control in such a way to avoid wastage and can be used later. The front-end in essence, control part is android of version 4.0.3 and above. The regulatory part is the hardware Arduino Yun which is the core and controls the switching of the solenoid valves. The concept design follows, Arduino which measures the humidity and sends it to the database. The android commands are saved on the PHP script. Server is

PHP and MySQL. The advantage of this setup is that it allows automatic control of the solenoid valves. However, the user can control the whole system by using his mobile phone. However, this mechanism can work only on operating system android 4 and above. Use of artificial Intelligence can be taken into account.

In [6] The soil moisture sensor provides the signal which is proportional to the moisture level in the soil which is then compared with the threshold value that is obtained by sampling the various soil as well as the specific type of the crops, the result then obtained is being fed into the Arduino micro controller which is connected to the smart phone, using which the information regarding the moisture content can be fetched and which also acts like a remote control which include turning ON/OFF the motor(switching). Switching is the technique that is used, the soil is tested at various moisture levels. Discussed on the Chennai floods which was resulted because of poor planning of urban areas as well as there was encroachment on land. This remote-controlled management can be used during the natural calamities like floods and extreme rainfall. The irrigation pumps along with the valve system can be used to control the water flow as well as the direction of flow. However, the quantity of the water flow can be controlled with the switching of the pump motors, the direction of the water flow can also be regulated which enables the draining and letting the water out of the farm fields. In the end, by updating the above system we can deploy in the real-time agriculture applications.

In [7] the system uses low cost home-made moisture sensor which is quite accurate. This home-made sensor uses a block of thermo-col along with two long copper wires which are inserted at a fixed distance which acts like a sensor. The wires are supported with the sticks in order to avoid bending of the wires when inserted into the soil. Also, multiple sensors are being used to increase the range of the sensing device. The two wires placed in the soil form variable resistance which is then connected to the voltage divider. Arduino then receives the voltage proportional to the resistance. This system uses two methods which are discussed as follows. In the first method the sample of soil the moisture is tested by changing the amount of water content and the values are recorded. Three zones of conductivity are defined which are indicated by the three LED'S. If the red LED glows, then it indicates that the soil is dry also referred as the dry zone. If the green LED glows on the PCB, it indicates that the moisture content is up to the level and does not require any more water. The third zone is the one in which the soil has more water content than the normal. The second method deals with the same sample of soil taken in a bottle of certain height and the moisture at different levels of the soil is being tested, three sensors are being inserted at three different depths. The output of the three sensors is given as an analog input A0, A1, A2 to the Arduino board. The LED's can be used as an indicator of the warning if the water level is too low or too high. The pros are-low cost, efficient. The calculation of the moisture at different levels helps to understand that when and how much water is required for the root of the crop. Cons include-the thermo col which is being used is of very light weight and may have the tendency to be carried away by wind, as a result the whole setup may have to be done repeatedly. Also, as we all know that polystyrene is non-biodegradable and has dangerous effects on the environment.

In [8] authors have given the details of automated irrigation systems using the ESP8266 Wi-Fi module. Smart irrigation system should be implemented in India as it is the second largest exporter of rice. Rice on the other hand requires abundant amounts of water and in this country where there is scarcity of water, there must be a system to regulate the supply of water flowing into the fields. This system consists of diverse sensors-moisture sensor, temperature sensor and the water flow sensor. The main function of the temperature sensor is that it records the temperature of the crops, because they are temperature sensitive and if the temperature of the crops exceeds a certain limit the farmer can switch on the sprinkler to cool it down. This system can be accessible throughout the year and 24*7 of availability rests on a greater advantage. The water flow sensor has a pinwheel sensor which can measure the amount of water that has been moved through it. It also has a small magnet attached that can record the number of times the pinwheel has rotated. The pulses are recorded which can indicate the amount of water that is flowing through it. Soil moisture sensor uses the dielectric permittivity. Here the dielectric permittivity is nothing but the function of water content in the soil. The sensor creates the voltage proportional to the water content of the soil and the moisture is being measured. All the control takes place by using the website. The main advantage of using this system is that it can be implemented in the farms and agricultural lands like those of the rice crops in India with a very low cost. Whereas the drawback includes the usage of website, which can be hacked by anybody and the system malfunctions. Also, all the farmers will not be familiar with the usage of the web site and also, they cannot afford it.

In [9] it tells how we can effectively utilize the water resources in the irrigation process using the Wireless Sensor Networks (WSN) by supplying water to the roots of the plants, which can be done using the drip irrigation system and it uses low water pressure. The future work that can be done is to supply water based on the soil moisture as well as based on specific crops and changes to temperature.

III. RESULTS AND DISCUSSION

There are very few papers [9] who have proposed automatic watering of the plants without human intervention using the concept of Artificial Intelligence. So, we are proposing automatic irrigation system by applying the concepts of supervised machine learning so that the entire irrigation system will become self-learning and act upon it randomly. We are also planning to monitor the crop yield so that the farmer will get immediate notifications if the health of the

plants is not good or the grains are not of required quality. We have decided to use like leaf wetness sensor, temperature sensor, relative humidity sensor and moisture sensor near the plants. Using the values from these sensors and applying machine learning on these values we can get the health status of the plants and the crops. Depending on this information necessary pesticides can be sprayed on the plants to stop spreading the disease. We can also get the information about the unwanted plants growing near the crops so that the next action can be taken. In the majority of the papers, the entire automated irrigation system is controlled by the Android Application. We feel that this will become a limitation as we cannot expect all the farmers to use the android smart phones. Also, that the knowledge level of the farmers to control the entire system may not be adequate.

Considering the advantages and disadvantages of each survey paper an automated irrigation system using Arduino Uno, Moisture Sensor, Temperature Sensor, Rain Sensor, Solenoid valves and Motor to water the plants has been designed. The moisture content in the soil will be read by the moisture sensor deployed in the soil and will be sent to the Arduino micro controller. Depending on the moisture content Arduino will control the motor which will water the plants till the moisture content reaches the required threshold.

We have also used the ESP 8266 Wi-Fi module to send the readings of the different sensors read by the Arduino micro controller to the android application used by the farmer anywhere in the world so that the he can water the plants remotely. Android Application is used by the farmers to control the entire system.

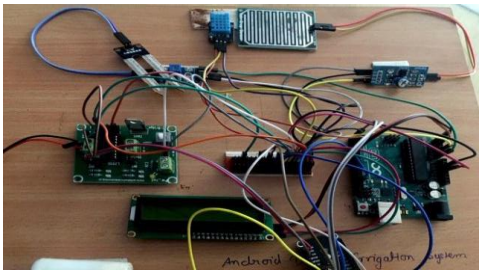

Fig 1: Automatic Irrigation System using Arduino

IV. CONCLUSION AND FUTURE SCOPE

As irrigation is an important component for any country's development an effort is made to make the irrigation system more efficient and intelligent. A survey of nine different research papers on irrigation system using Arduino and other micro controllers has been presented here. The advantages and disadvantages of each system has also been discussed. The system developed by the authors for watering the plants is controlled by the android app which can be a disadvantage sometimes as the main aim of the authors is to avoid the human intervention totally. The authors are interested to make the watering system automated without the need of explicitly switching on the motor. The future work is to get the information about the health condition of the crop grains and the plants using the different sensors. Using these values machine learning modules will make the predictions about the affected diseases of the crops or the plants. Also, the information about unwanted plants and weeds growing near the crops can be collected and appropriate decisions can be made.

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