Irrigation Alert System for farmers based on External Intelligence and Field Sensors data

K.sumathi, Kundhavai, K. Selvarani, K.Nagarajan

Abstract— Agricultural sector is of greater importance in a country like India, the prime stakeholder of it being the farmer faces in numerous problems left unsolved. Among them are the issues related to "expert suggestion" for the farmer fraternity to overcome issues that prevail as a hindrance for their normal living. Among those issues the main aspect to be considered is the irrigation system. Since irrigation system plays the vital role this study focuses on the aspect of developing a framework that paves a way for external intelligence and field sensor data. This would in turn serve the purpose of providing support to the farmers on grounds of issues related to irrigation and enriching the farming. On one hand the researchers have contributed towards precision agriculture which is very cost effective, on the other hand in Indian perspective there are limited resources in hand which does evince of much of investment made in agriculture sector. Considering the avenues through which the farmers can avail through the governmental initiative, it will become a worthwhile effort to suggest with a platform for intelligence and field sensor data in irrigation system. This proposed platform will be enable to 1) Read data from field sensors and external Intelligence System which take farmers details such as crop type, soil type, sowing time etc., and irrigation partners data like crop type, no. of irrigation, duration details as input 2) Retrieve the weather forecast data based on the soil moisture content 3) Deliver the irrigation based alert to farmers through mobile device. The study enables the farmers to get external advisory services through which they can enhance rich harvest in the agricultural activities. The findings of the study would gauge the gap between the existing system and the proposed framework.

Index terms: Irrigation based Alert System, Analytics System for Irrigation, Decision Support System for Irrigation.

I. INTRODUCTION

India is basically an Agrarian country and the development of agricultural sector would ultimately contribute towards the economical growth of the Nation. Hence, this study contributes towards suggesting a suitable model to improve the irrigation system. It is imperative to improve irrigation system and help farmers and any initiative which is not technology based would fail. Therefore keeping in mind the technology, irrigation system in mind a proposed framework is formulated enabling the farmers to take suitable decision in farming. In this study the field is monitored continuously with the use of sensors and help the farmer fraternity. There are lot many technologies that prevail in current scenario to improvise the irrigation system, but intelligence irrigation system plays a pivotal role in today's agricultural world. The researchers of this paper have attempted to keep in mind the technology that would suit the farmers in helping them to have an intelligent irrigation system through a proposed framework. Technology plays a dominant role in agriculture development off late agricultural biotechnology; it is possible to grow crops in deserts. Using technology, plants have been monitored frequently and live on in drought condition and moreover different kinds of technologies are used in agriculture from sowing the seed to harvesting crop. Most of the farmers grow crop which needs a lot of water and they manage to grow crop using irrigation methods improved by advanced technology. In big farms, advanced water sprinklers are used to watering the plant so that the crops get enough water which is essential for their growth. Few farmers mix nutrients in this water to improve the growth of the crops and enrich their yielding These aspects are the basis of this study ensures of evolving intelligence irrigation system cater to the need of the farmers. In most of the cases, automated systems have been evolved in helping the farmers indicate the issues but a full-fledged system where the stakes concerned are beneficial is yet to be witnessed. There are varied research projects which have evolved intelligent irrigation system to control and monitor the water level and the time slots at which the watering should be done depending upon the saturated soil in order to enrich the crop yielding. There are also initiatives that are evolved by researchers in helping the farmers with micro controllers wherein through the interrupt signal motor, the temperature is monitored and signalling is indicated to the stakes as per the programmed inputs. Similarly, in a broader perspective – researchers have been working on initiatives that would benefit the end user especially the farmers with waste clean water conversion so that irrigation system is ensured uninterruptedly. A similar study to this research is that of an android based irrigation system where a sensor is enabled with the help of the algorithms developed keeping the readings of the water level, soil moisture, etc.

Revised Version Manuscript Received on 30 May, 2018.

Dr.K.sumathi, Department of CS & IT, Kalasalingam Academy of Research and Education, Virudhunagar, Tamilnadu, India

Prof. Kundhavai, Department of Business Administration, Kalasalingam Academy of Research and Education, Virudhunagar, Tamilnadu, India

Dr.K.Selvarani, Department of Agricultural science, Kalasalingam Academy of Research and Education, Virudhunagar, Tamilnadu, India

K.Nagarajan, Senior Consultant, TCS, Chennai, Tamilnadu, India

An effective usage of intelligent irrigation system by the stakes in agriculture would ensure in using the natural resources appropriately as the study involves in alerting the stakes with necessary indications about the soil moisture, watering intervals, temperature requirement depending upon the sunlight or other climatic conditions, etc. Moreover, the

study having evolved the sensors would as an end result pave a way in not only protecting our natural resources but also avoids unnecessary wastages. For instance, when there is a need for watering the indicators would alarm the farmers for watering and in the absence of the system the watering would be continued and hence leading to wastage of water resources. Especially in this era of water scarcity and scarcity of other natural resources it becomes evident for all on earth to save natural resources and energy. Hence, in this study the initiatives evolved ultimately saves the time and efforts of farmers and ultimately results in best way to utilize the available resource and fulfil the farming member's expectations leading ultimately to the country's economic development.

II. TECHNOLOGY IN AGRICULTURE

There are lots of advantages available for farmers for them to use technology in agriculture. They may be as follows: 1) Technology reduces the time 2) Advanced machines help the farmers to produce high yield 3) Increase the price and demand of the products. 4) Helps in food transportation 5) Useful for sowing seeds 6) Helps in harvesting crop in large area 7) Effective use of natural resources etc.,

Coincidentally there are a lot of disadvantages that also exists while using technologies in agriculture. They are listed as follows: 1) using machines often may lead to environmental damage and unemployment of daily workers. 2) Though the efficiency is considered the side effects become the ill effect. 3) Lack of practical knowledge of farmers in handling the machines appropriately 4) Maintenance cost of machines are also high.5) Most of the farmers in rural area are illiterates and unable to use the advanced machines. In recent years there are technologies evolved using wireless design irrigation system in which Y Zhou et al (2009) had proposed. This framework on a longer run may be developed and the usage may be envisaged for the best use of farmers.

III. SENSORS IN AGRICULTURE

Off late sensors are used in agriculture and it helps the farmers to maximize their yield using minimal amount of resources such as water, fertilizer, and seeds. These field sensors can be used in conjunction with Global Positioning System (GPS) in order to have a consistent yield and turnover ratio. Once farmers are able to accurately map their crop fields, they will be in a position to monitor and apply fertilizer and weed treatments alone to areas on need basis. Sensors are also used to analyse the internal characteristics of soil which becomes an evident part of this study. With the help of sensors and the basis of internal characteristics soil, farmers are suggested of what kind of crop and pesticide can adjust the soil characteristics. Most of the foreign countries use number of sensing technologies to enable the precision agriculture, the sensors in the field provides data that helps farmers to monitor and optimize crops. In addition, many states in India have started using sensors in their fields to improve the agriculture activities.

Agriculture sensors are widely available in market in the present era and there are location sensors- to determine the latitude, longitude, and altitude to within feet, optical sensors to determine clay, organic matter, and moisture content of the soil, electrochemical Sensors provide information pH and soil nutrient levels, Mechanical Sensors measure mechanical resistance, Dielectric Soil Moisture Sensors assess moisture levels, Airflow Sensors measure soil air permeability and etc., the output of the Sensor may be applied for weed mapping, variable spraying , salinity mapping, yield monitoring, yield mapping and Guidance System. Nowadays lot of Smartphone tools are available for intelligent agriculture like camera, GPS, Microphone, Gyroscope, accelerometer etc.

IV. LITERARY REVIEWS

There seems to be a growing need for intelligence irrigation system not only how to use the invaluable resource water but the avenues in which the agricultural issues are resolved. Hence, this paper like other research papers that showcases on sensor based irrigation system, intelligence irrigation system,

The conference paper titled "Sensor based Irrigation System: A Review" by Priyamitra Munoth et al (2016) showcases the ways in which oil moisture sensors in irrigation is reviewed and solutions are proposed through the sensor system. In addition application efficiencies for irrigation systems are also suggested in their study which enables all the other researchers in this field to have an in-depth insight. Similarly, Kumar, Gaurav (2014) in his paper submitted in a conference proceeding has indicated of need to evolve fuzzy drip irrigation in the place of traditional drip irrigation system. This is one such initiative in irrigation system where the basis for technology. There were other studies based on IIS mainly the paper by Hussein M. Al-Ghobari& Fawzi S. Mohammad (2011) highlights of integration of smart controllers with intelligent irrigation and using microclimatic data to schedule irrigation water. The main objective of their work was to evaluate the use of intelligent system with sprinkle and drip irrigation systems and field crops with different scheduling techniques in arid region, such as Saudi Arabia. The farmers'challenges are highlighted elaborately in the research study by Matenge GR., (2017) keeping the cited work on automated drip irrigation system, proven water efficient means of optimizing agricultural production and fustigation process is discussed envisaging a clear understanding on the usage of intelligence irrigation system and other resources that help the agricultural stakeholders.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

An article in weblink titled “Smart Irrigation System Using IoT” also validates on the conditions of weather and how technology can help the farmers in improvising their productivity.

There are other article reviews on weblinks envisaging the importance of intelligence irrigation system and need for the framework that helps the farmers take effective decision, inline with that the article titled “irrigation systems” highlights of the application oriented part in agricultural sector – where The LoRa® RF platform is a 2-way wireless

solution that offers long-range communication with extremely low power requirements are suggested as effective tool to address various power and environmental issues of farmers.

In the work of Gauri and Patel., (2016) the focus on the smart irrigation system is given with the platform supported with transmitter, microcontroller usage, Data transmission, Zigbee module, etc.

There are other reviews on weblinks that highlights of smart irrigation system and the application of IoT helping the conditions improve in agricultural sector. One notable article is that titled "Smart Irrigation in IoT: 12 Important Things To Know" by Mornica Daga (2018) where the need for smart irrigation, the IoT usage, the use of internet and the cost advantage aspect , types of sensors have been the base which is included in this study for proposing the framework.

The advantages of smart irrigation system is elaborately showcased in Mitshell’s landscape weblink (2014) highlighting namely Smart irrigation systems and its optimization of water levels based on things such as soil moisture and weather predictions. The use of wireless moisture sensors that communicate with the smart irrigation controls and help informing the system whether the landscape is in need of water or not. Additionally, the smart irrigation controlled receives local weather data that can help in determining when a landscape should be watered. If you have ever returned home during a storm only to see your sprinklers spraying water you know how beneficial this is.

V. PROPOSED FRAMEWORK

The framework of guided analytics for irrigation system is proposed in this paper and this system offers Automatic Irrigation Alert to farmers based on crop type, sowing time, soil internal parameters that are retrieved from field sensors and weather prediction system. The framework ensures in enriching the farming efficiency and attempts to eradicate few disadvantageous effects existing in farming activities.

The source of data is mainly from farmers and irrigation partners and weather prediction reports only as the focus is on irrigation based alert to farmers. Those data pertaining to farmers include sowing time, crop type, crop details, farm area, expected harvesting time,etc. The irrigation partner’s data includes crop type, soil parameters and irrigation period (time) and duration. The field sensor data contributes towards soil characteristics.

The input which has to be fed in would be farmer’s data and irrigation data respectively. After which the output is drawn. The output of intelligent system is monitored continuously and based on the output of External Intelligence System (EIS), field sensors and weather prediction data is taken and necessary alerts regarding irrigation are sent to the appropriate farmers to save the natural resource. Figure 1 shows the overall framework of Intelligent Irrigation System.

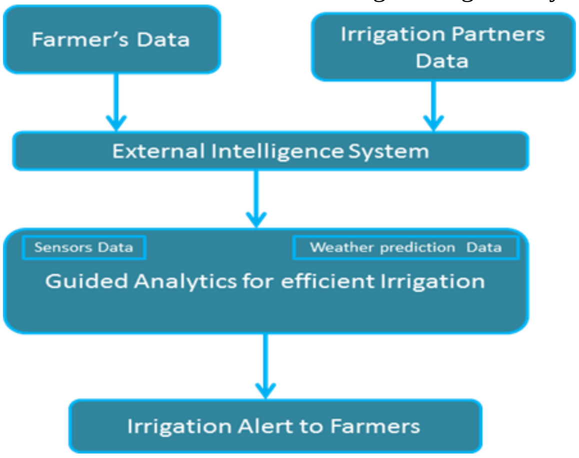

Figure 1: Framework for Intelligent Irrigation System

Intelligent System identifies three aspects as inputs which are type of crop; sowing time of crop and characteristics of soil and suggests whether the values of moisture sensors have to be checked or not. If the output of EIS indicates “yes”, then the average of last 8 hours data of moisture sensors mounted on the fields are taken. Incase the average moisture value is greater than threshold value, an alert will be sent to the farmer as “wait and go for irrigation” and the moisture sensor value will be monitored after 24 hours and the same process is repeated. If the moisture value is less than threshold value, the weather prediction for the next 24 hours will be checked. If prediction system says “no rain”, alert will be sent to the farmer like “go for irrigation”. If the weather prediction says “yes rain”, then “wait and go for irrigation” alert will be sent to farmers and after 24 hours, sensor values will be taken and the same process is repeated.

5.1 Implementation

Required data can be collected from farmers, field sensors and other weather prediction system. The data being collected from farmers through appropriate APIs or by asking set of standard questions. The weather information can be collected through relevant APIs and based on the moisture level; data can be collected from field sensors by using NodeMcu and stored in cloud for analysis. The NodeMcu is an open-source firmware and development kit that helps to Prototype the application. The important features of NodeMcu is Open-source, Interactive, Programmable, Low cost, Smart, WI-FI enabled. Figure 2 shows NodeMcu kit.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

Figure 2: NodeMcu kit

The NodeMcu has the following specification 1) Voltage: 3.3V. 2) Wi-Fi Direct (P2P), soft-AP. 3) Current consumption: 10uA~170mA. 4) Flash memory attachable: 16MB max (512K normal). 5) ntegrated TCP/IP protocol stack. 6) Processor: Tensilica L106 32-bit. 7) Processor speed: 80~160MHz. 8) RAM: 32K + 80K. 9) GPIOs: 17 (multiplexed with other functions). NodeMcu pinmode is displayed in figure 3

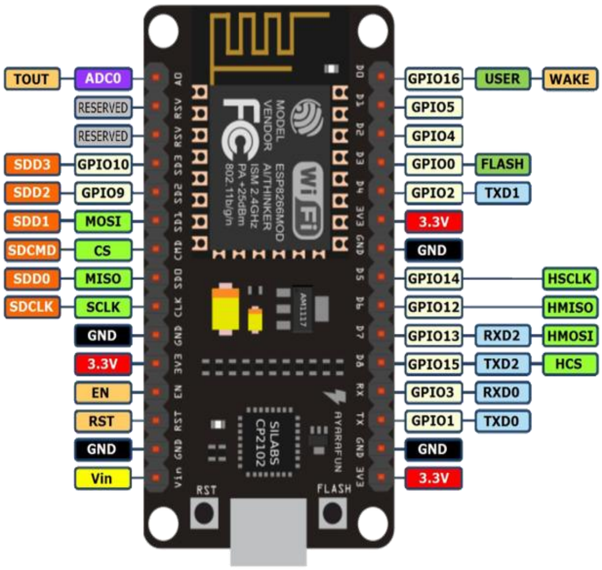

Figure 3 : NodeMcu Pinmodes

Pin Description

NodeMca includes 30 pins. The controller takes 13 GPIO pins. In these Pins, we have 1 ADC converter with a single channel, 3 UART TX and 2 UART RX, 1 EN(Enable) and 1 RST(Reset) for the purpose of LCD functions, One IIC Bus, SPI and 2 pins are Reserved Pins.

Specification

1. ADC0 - 10 bit resolution, 2. GPIO - 50 microsecond resolution, 3. UART default Baudrate -115200, 4. UART frequency - 80MHz to 160 MHz 5.controller -ESP 8266 6. Operating voltage +5v to +9v

The algorithm to implement the effective irrigation system is as follows:

Automatic Alert to Farmers regarding Irrigation

This system includes 2 modules such as EIS module and DA Module each will have specific objective function from observing data from relevant data set still delivering the irrigation based alert to farmers to improve the agriculture activities.

EIS module takes data from farmer and Irrigation partners and decides whether field sensor values to be checked or not.

If the output of EIS is "yes", DA Module reads the moisture sensor values and checks whether it is greater than given threshold value. It also checks the weather prediction value and delivers the irrigation based alert to farmers.

5.2 Algorithm for External Intelligent System

EIS Module ()

Input: Farmers data and Irrigation partner's data

Output: alert to Data Analytics (DA) Module like "yes" or "no"

1. Read farmers Data such as crop type, soil type and sowing time of the crop from farmer dataset
2. For each farmer data
3. Extract Irrigation partner's data that matches the crop type and soil type of the farmer
4. If the irrigation time reaches for the crop then
   a. Send the response "yes" to Analytics Module
5. Else
   a. Send the response "No" to Analytics Module

Algorithm - Data Analytics Module

DA Module ()

This algorithm is applicable on the grounds of output being "yes" of EIS.

Input: Output of External Intelligent System (EIS) whose output based on soil internal characteristics and type of crop and sowing time of crop.

Output: alert to farmers like "go for irrigation" OR "wait and go for irrigation"

1. If output of External Intelligent System is "Yes" go to step 2
2. Read past 8 hours data of moisture sensor mounted on the field and calculate the average value of moisture sensors
3. If average data of moisture sensor > threshold-value then send alert to farmer "wait and go for Irrigation" and wait for 24 hours and go to step 2
4. Otherwise check weather prediction for preceding 24 hours if weather prediction says "Yes" then send alert to farmer "wait and go for Irrigation" and wait for 24 hours and go to step 2
5. If weather prediction says "No Rain", send alert to farmer "go for irrigation" and update date and time of irrigation in farmers dataset.

The dataflow diagram of Intelligent Irrigation System is given below in Figure 4.

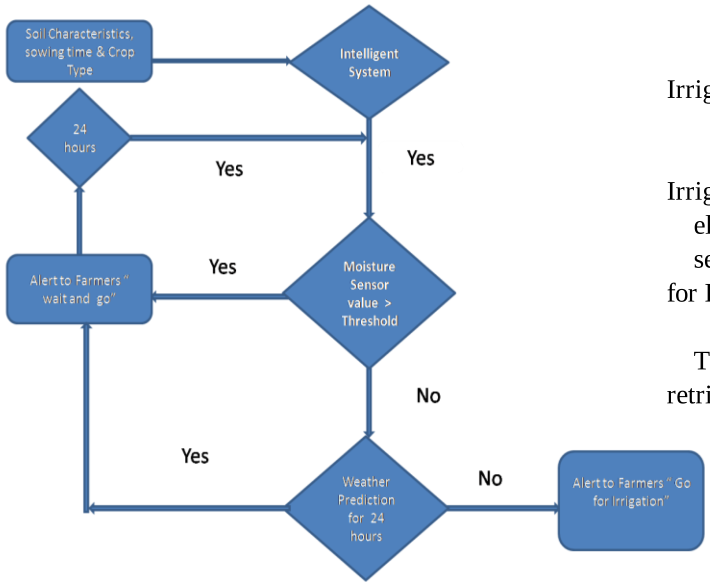

Figure 4: dataflow diagram of Intelligent Irrigation System

Sample code for reading data from moisture sensors

```
int wet= 16; // at Digital pin D0
int dry= 2;  // at Digital pin D4
void setup() {
  Serial.begin(9600);
  pinMode(wet, OUTPUT);
  pinMode(dry, OUTPUT);
  delay(1000);
}
void loop() {

  Serial.print("SOIL MOISTURE LEVEL : ");
  value= analogRead(sense_Pin);
  value= value/10;
  Serial.println(value);
     if(value<80)
     {
        digitalWrite(wet, HIGH);
     }
    else
    {
       digitalWrite(dry,HIGH);
    }
    delay(1000);
   digitalWrite(wet,LOW);
    digitalWrite(dry, LOW);
}
```

Sending alert to farmers

```
const int avg_moisture = 800;  // moisture threshold given by irrigation partners
pinMode(moisture_sensorPin,INPUT);
int sm = A0;
soilValue = analogRead(sm);//Get analog values of Soil Moisture Sensor
 if (smValue < avg_moisture)
   //chk weather_prediction
     weather_prediction = get_WPD();   // get_WPD()-collects weather prediction data for  next 24 hours();
      if weather_prediction=" yes" then
      sendAlertToFarmer("Soil Moisture - HIGH ,No Irrigation");
      else
      sendAlertToFarmer("Soil Moisture - LOW, Go for Irrigation");
  else
  sendAlertToFarmer("Soil Moisture - HIGH ,"Wait and go for Irrigation");
```

The sample output of soil Moisture values which is retrieved from field sensors are given below in figure 5.

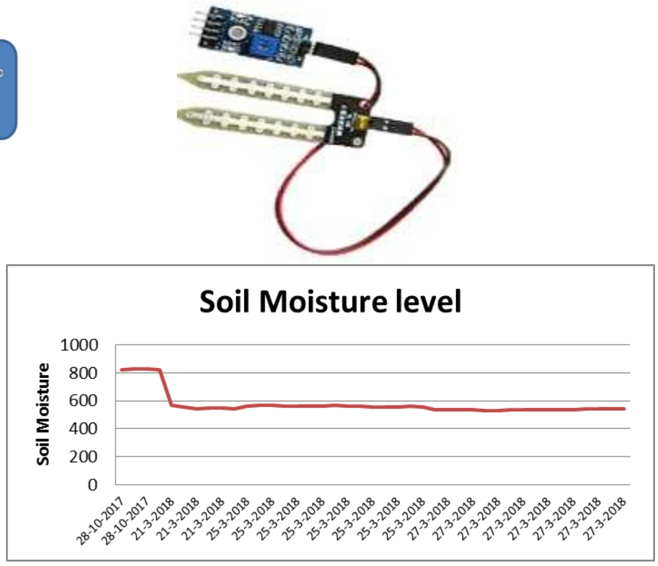

Figure 5: Soil Moisture Sensor and moisture levels in different period

VI. RESULTS AND DISCUSSION

The proposed guided analytics system keeps the output as the basis of data submitted by farmers, the values of field sensors and weather prediction data. External Intelligent System takes farmers data such as sowing time, crop type, location details, crop details, expected harvesting time, etc., Irrigation partners data which includes crop type, soil parameters and irrigation period(time) and duration. The output of External Intelligent system is monitored continuously, based on the output of EIS, field sensors and weather prediction data is taken and necessary alerts regarding irrigation sent to the appropriate farmers to save the natural resource.

VII. CONCLUSION

In a nutshell in this paper our main focus is on how to enhance the yielding for the formers by availing Analytics system which automates the irrigation alerts to farmers. Hence, this system can help the farmers with necessary irrigation based on advisory services on continuous basis.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

This analytics system accept farmer's information such as farm area and location, soil type, sowing time, sowing seed details, etc., details through the farmers Application Programming Interface (API). Once they have submitted the data, guided analytics system will offer irrigation based alerts to farmers whenever necessary. The focus is streamlined towards irrigation system alone for advising the farmers to yield the crops, whereas there are other issues that need to be identified apart from this aspect. Hence, those researchers on futuristic perspective who intend to work on irrigation system alone will be the beneficiaries. Other beneficiaries who might be evolved are not included as a part of this study and it becomes a limitation. Though this limitation exists, the focus on irrigation contributes a lot for an effective system and farmers who are benefitted with the alert system needs to be taken as a worthwhile aspect at the current scenario.

REFERENCE

1. Munoth., Priyamitra, Goyal., Rohit and Tiwari., Kuldeep (2016), "Sensor based Irrigation System : A Review", Conference: Conference: NCACE-2016, At Jaipur, Volume: 4
2. Kumar, Gaurav (2014), "Research paper on water irrigation by using wireless sensor network", International journal of scientific research engineering and Technology (IJSRT), ISSN:2278-0882 , IEERET, conference proceeding, 3-4 November,2014
3. Prajkta Bodkhe & M. T. Kolte., (2016), "Intelligent irrigation system for farms", International Journal of Advanced research in Electrical Electronics and Instrumentation Engineering, Vol(5): 6
4. Al-Ghobari ., Hussein M. & Mohammad., Fawzi S.. (2011), "Intelligent irrigation performance: evaluation and quantifying its ability for conserving water in arid region", Appl Water Sci Vol(1) Pp.73–83
5. Gauri Tope, Patel.A.S (2016), " Smart Irrigation system",Itnernational Journal of Current Engineering and Scientific Research(IJCESR), ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, Vol;3 (3)
6. Matenge GR., (2017) " Soil Moisture Based Irrigation Test in a Remotely Monitored Automated System", Irrigat Drainage Sys Eng 2017, Vol 6(3): 192
7. Yiming Zhou, Xianglong Yang, Liren Wang, Yibin Ying (2009), "A Wireless Design of Low-Cost Irrigation System Using ZigBee Technology",
8. https://www.sprinklerwarehouse.com/seather-sensor-types-s/8310.htm
9. http://horttech.ashspublications.org/content/23/6/735.full
10. https://www.researchgate.net/publication/313804002_Smart_farming_IoT_based_smart_sensors_agriculture_stick_for_live_temperature_and_moisture_monitoring_using_Arduino_cloud_computing_solar_technology
11. http://www.tjprc.org/publishpapers/2-50-1371394630-3.%20Intelligent%20Irrigation%20-%20full.pdf
12. http://www.intelligentirrigationllc.com/

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication