International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-4, November 2019

Low Cost Design of Automated Drip Irrigation System with GSM

Ashwin Venkatesh.V, Aruna Devi.B

Abstract*: This paper is about an automatic irrigation control system which is cost effective and can be used for irrigation by a farmer. Today's industrial automation and controlling of machine is high in cost and not suitable for a farming field. So, here we design a smart drip irrigation technology with effective control system in low cost. The voltage monitoring unit informs the farmer about the power supply conditions on the field. The aim of this study, is to control the motor automatically, and decide the direction of the water flow through valves, based on the inputs from the farmer and also with the collective inputs from the sensors, which finally notify instantly about the happenings and conditions of the field. It operates under low hardware cost by distributing irrigation to crops by elevation change and gravity. The soil moisture and amount of flow of water in each sector are major consideration to design a fail-safe system for a variety of crops planted at a time.

***Keywords:-* Drip Irrigation, Smart Agriculture, Safe Smart Farming, Motor Control.,**

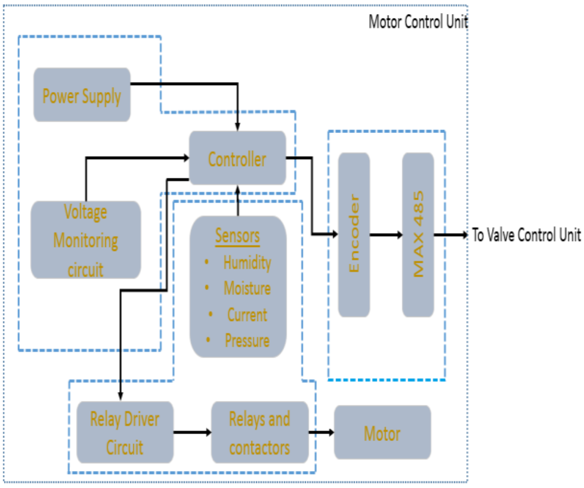
.

I. INTRODUCTION

The increasing demand of the food resources requires rapid growth in food production technology. In a country like India, where the economy is based on agriculture and farming, and the climatic conditions are also isotropic, still we are not able to make an efficient use of agricultural resources. The continuous extraction of water from earth is reducing the water level due to which lot of land is coming slowly in the zones of un-irrigated land. Generally farmers visit their agriculture fields periodically to check soil moisture level and based on requirement, water is pumped by the motors to irrigate respective fields.

This irrigation method takes lot of effort particularly when a farmer need to irrigate fields with multiple crops distributed in different geographical areas. Automation in irrigation system makes farmer work much easier. Sensor based automated irrigation system provides solution to farmers where presence of farmer in field is not compulsory.

In this paper we propose a prototype of an automatic control system for accessing irrigation motor and electromagnetic valves for controlling the direction of water supply for drip irrigation.



II. II CONVENTIONAL METHOD

S.R Barkunan [1] implemented a system for automatic drip irrigation with temperature and humidity and moisture sensors for paddy cultivation. Control with inputs depends from sensors only. The prevailing climatic conditions of the field are observed and processed for decision control.

Neha K. Nawandar [2] proposed a system which controls the water supply for irrigation based on the data fed to a server. The data essentially is on the water need of the soil and crops. The farmer has to select the type of crop and soil for the system to irrigate accordingly.

Zang S. [3] proposed a system with an irrigation controller and a system server connected through a mobile network to implement an automatic irrigation system. The irrigation server uses weather data and makes decisions on irrigation using water balance method combined with the growth period of the crop.

SabrineKhriji [4] designed an irrigation solution based on a WSN (Fig 2.1) with the appropriate componentsand technology that satisfy manydesign constraints in engineering such as economic or energy. Sensor networks play important role in this approach.

Manuscript published on November 30, 2019.
* Correspondence Author
Ashwin Venkatesh V*, Research scholar, Dr. N.G.P. Institute of Technology, Coimbatore ,Tamilnadu, India.
Dr. ARUNA DEVI B , Assistant Professor, Dr. N.G.P. Institute of Technology,coimbatore, Tamilnadu, India.

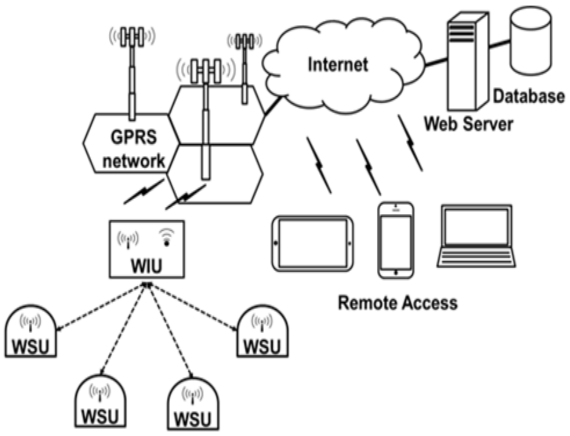


Fig 2.1: Wireless Network of sensors and devices.

H.Navarro-Hellín [5] developed an automatic decision support system to manage irrigation in agriculture. The use of real time data information from soil based parameters in a closed loop control scheme allows adapting the decision support to local perturbations.

Chandankumarsahu [6] implemented a prototype for automatically controlling an irrigation system with sensor nodes deployed in fields for sensing soil moisture. The system remains in ON condition when the field is dry and in OFF condition when the field is wet.

Genghuang Yang [7] presented a paper which brings forward about a wireless network built with a GSM module, a mobile phone and a PC to be a control system. Orders can be sent from thePC or from phone to the controller.

S.A.M. Matiur Rahman [8] developed a minimum cost system to sense the tank water overflow without the use of float sensor. The floatless sensor based system is a level monitoring system to sense and avoid overflow wastages of water.

OlutobiAdeyemi [9] suggested a predictive irrigation scheduling system enabled by a model that uses feedback from soil and climatic sensors to predict the water crop demand. This paper has presented a dynamic neural network approach for modelling the time series of soil moisture content.

ShahinAwezPathan [10] proposed a data acquisition system built with MATLAB and a controller to program an integrated efficient decision taking system. Using MATLAB Programming it displays threshold value and previous data in an excel sheet.

G. Sushanth [11] presented an idea on an agriculture system based on IoT, along with a sensing system that senses an invasion of animals, and notification to the farmer about the invasion.

Daniel K.Fisher [12] developed a prototype of a system and constructed it for automating the measurement process and recording of soil, and atmosphere temperature, and soil moisture level in the cropped fields. The microcontroller based control system consists of inexpensive electronic components and solid-state sensors.

Mehmet FatihIsik [13] developed and implemented an automatic irrigation system using the sensor network technology. The amount of water present in the soil was measured with sensors that were placed on marked points of the area that is to be irrigated. The data from these collective sensors was transferred to the IOS/Android server via the programmable logic controller (PLC).

V. Divya [14] proposed an automatic irrigation system that controls based on voice commands from the farmer. A separate software module for speech to text conversion is interfaced to the farmer's mobile. The control unit is based on PIC controller and solid state relays that are connected to various valves.

BezaNegashGetu [15] designed a water level sensor device that is able to detect and control the level of water present in a certain water tank or a similar storage system. The system senses the amount of water available in the tank by using the level detector part and then adjusts the state of the water pump in accordance to the water level.

M. O. Sharma [16] proposed an android based agricultural decision support system, an automatic irrigation controller which adjusts the quantity of water that is used based on sensor data. Monitoring and control of water in irrigation and level detector with liquid fertilizer is being proposed.

Rahul Dagar [17] proposed a model which is a simplified architecture of IoT based sensors that collect every information and send it over the network to the server (Fig 2.2), from there, the server can take actions and improve crop yielding and provide better production.

Y.Kim [18] presented the design of decision support system of software and its integration with an in-field wireless sensor network (WSN) to implement a site-specific sprinkler in irrigation control viawireless communication. Wireless in-field sensing and Control (WISC)software was designed.

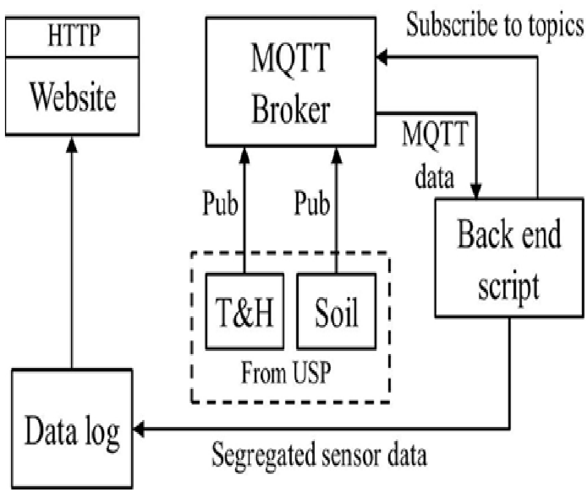


Fig 2.2: Server Communication in IoT

DrashtiDivani [19] implemented an automatic plant watering system. System is designed in such a way that it reports its current level, and as well as remind the user to add water to theover head tank. All this notifications are made through mobile application.

BishnuDeo Kumar [20] designed a system that provides us with the values of the atmospheric temperature along with the humidity to keep check on the proper and efficient faultless functioning of the system. NeametAkeelFawzi [21] designed a middleware software program using Python which uploads the data from the Base station to the cloud server.

Retrieval Number: D8357118419/2019©BEIESP
DOI:10.35940/ijrte.D8357.118419
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

A website was also created and implemented based on Google's cloud infrastructure, where it displays all information to farmers in the farm.

SoumilHeble [22] proposed a low-power, low-cost IoT network for smart agriculture. In the proposed network, the IITH mote is used as a sink and the sensor node is used to provide low-power communication link. The proposed architecture is evaluated only based on power consumption and cost.

Dr. Freddie R. Lamm [23] proposed a technique of using crop canopy temperature readings to minimize or manage plant water usage stress have the potential of providing an automated irrigation scheduling plan without resorting to the traditional soil water measurement based or weather based water budget scheduling.

AjinkyaKaner [24] suggested a system where the working of water level controller is based upon the fact that water conducts electricity as it contains minerals. Thus the water in the tank can act as a close to a circuit. These signals are used for automatic switch OFF the power supply of the motor pump so as to avoid the unnecessary overflow wastage of water.

ChetanDwarkani M [25] established a method for smart farming by combining a smart sensing system and smart irrigating system through the wireless communication and network technology. Based on the required physical and chemical parameters of the soil measured, the required quantity of manure and water is splashed on the crops using a smart irrigator.

YuthikaShekhar [26] developed an Intelligent IoT based Automatic Irrigation control system where the sensor data of soil moisture and atmospheric temperature is captured. Machine learning algorithm is deployed for analyzing the sensor data for prediction of irrigating the soil with water. This system designed here provides a unique, wireless and an easy solution.

A Sumalatha [27] proposes an automatic smart irrigation which uses solar power for irrigation control. The proposed solar powered water motor with pump operates automatically based on the parameters like Soil moisture and Air Temperature. Hence this ensures an efficient irrigation as it uses solar green energy as backup whenever a power failure occurs.

Sony CahyaPratama [28] demonstrates that the Gain Scheduling in PID with a Back Calculating Integrator and Anti windup helps to enhance the response level of the automatic water level control system's performance.

Ibrahim Mat [29] built a system for cropsmonitoring in the agricultural field with the help of moisture sensors and automating the irrigation. The famers can also monitor the field remotely with the help of an internet based control and GUI system.

Nilesh R. Patel [30] developed a monitoring system that mainly focuses on predicting the starting of germination of a particular disease. Sensor module is used to detect in different environment conditions across the farm field and the sensed data is displayed.

Joaquín Gutiérrez [31] developed an automated irrigation control system with distributed wireless network of sensors and a gateway of server with GPRS. The system is energy efficient and low cost, useful in water limited and geographically isolated fields.

Dr. P. Banumathi [32] presents an automatic irrigation system to provide water to the farm lands based on water level conditions using an android application, WSN and GPRS modules. An algorithm is being developed such that sensor values are continuously fed to the ARDUINO microcontroller.

GaddipathiBharathi [33] discussed a PLC controlled Water Distribution System. The conventional method used before in older times, results into problems like empty running, overflow, leakage. The automation of the process thus helped to overcome this problems based on level, pressure, flow parameters and it minimizes human efforts for the same.

DikshaS.Dasare [34] proposed an irrigation system automated with the use of low cost sensors and GSM technology and the simple electronic circuitry makes this project a low cost product, which can be bought even by a poor farmer.

Gagandeep [35] developed an automatic wireless sensor network based Irrigation Water Regulation system. The system estimates the water required for the crops on the basis of soil moisture data measured by several sensor nodes deployed in the farm field.

Table 1 : Comparison of different control methods in irrigation.

Author	Implementation details	Components	Controller	Decision influencing paramteter	Analysis	Ref
S. R. Barkunan (2019)	Automatic drip irrigation with temperature and humidity and moisture sensors for paddy cultivation.	GSM, Android App, Motor Driver, Sensors	ARM LPC 2148	Humidity, Temperature, Light.	Rainfall is sensed through moisture and temperature of atmosphere.	[1]
Genghuang Yang (2010)	wireless network with a GSM module, a cell phone and a PC control system	RTC, EEPROM, Radio Emitter, GSM.	MSP430	Soil Moisture, Farmer's Input	Orders can be sent from the PC control system	[7]
Chandankumarsahu (2015)	The system is ON when the field is dry and OFF when the field is wet.	Moisture sensor, E.M Valve	Arduino, Rasperry Pi	Moisture level	Irrigation system with sensor nodes deployed in fields	[6]

S.A.M. Matiur Rahman (2014)	Floatless sensor for water level detection	Solenoid valve	-	Water level	development process of an automatic control system for tap water	[8]
ShahinAwezPathan (2016)	MATLAB Programming to display threshold value and previous data	MATLAB, WSN, GPRS, ZIGBEE.	PIC16F877A	LDR, Moisture	a smart system that uses a soil moisture sensors	[10]
G. Sushanth (2018)	smart agriculture using automation and Monitoring	ESP 8266,GSM, MAX232.	ARDUINO	Temperature, Humidity, Sunshine.	Easy hardware installing	[11]
V. Divya (2013)	Voice commands based control	STT, RF Transceiver.	PIC	Voice command	Interactive user interface	[14]
BezaNegashGetu (2016)	Floatless sensor for water level detection	Encoder, 7 segment, Transistors.	-	Water level	senses the amount of water available	[15]
M. O. Sharma (2017)	Protects motor from dry loads	GSM, ZigBee	PIC18F	Sensor inputs	reduce water overflow and power	[16]
Rahul Dagar (2018)	Crop monitor for nutrients and water	pH sensor, moisture sensor	Arduino	Sensor inputs	Maintain best conditions for plant to grow	[17]
DrashtiDivani (2016)	automatically triggers water pump on till sensor meets threshold.	Water pump, Moisture sensor	Arduino	Moisture data	overall activity is reported to the user using mobile application.	[19]
BishnuDeo Kumar (2017)	All time tracking of field requirements	DHT11	ATMEGA 328	Temperature, Moisture	Interfacing of run time switches with microcontroller	[20]
AjinkyaKaner (2017)	transistor as a platform connected to relay along with local materials for low cost.	Transistors, LED's, Relay	-	Water level	can be used for various liquids & oil level in industries	[24]
ChetanDwarkani (2015)	The problem of manual labor was solved by crane system	GSM, Spectroscopy, PLC, database	ATMEGA 328	Presaved data, Moisture level	provides precise results and the Smart irrigator system manages to spray the necessary nutrients	[25]
YuthikaShekhar (2017)	prediction with date and time in the cloud server for farmer's to access	Ethernet, Water pump.	Raspberry Pi	Climate conditions, Soil moisture	Machine learning algorithm been employed for predicting the soil condition	[26]
Sony CahyaPratama (2016)	implementation of conventional PID and Gain Scheduling PID	Gain Scheduling controller	PID	Water level	Efficient logic controls	[28]
Nilesh R. Patel (2013)	wireless module for the data transfer, communication purpose.	DTMF, Moisture sensor	PIC	Moisture level	water is provided directly to the roots of the crop.	[30]
Dr. P. Banumathi (2017)	sends message to the user whenever sensors exceed there threshold	GSM, RTC.	Arduino	Sensor input	Immediate response to farmer	[32]
DikshaS.Dasare (2017)	Wireless technology to connect with controller	GSM, Logic shifter, Relay	8051	User command	use of low cost sensors and SMS technology and the simple circuitry	[34]
Gagandeep (2017)	suitable both the adverse conditions of exuberance and scarcity of water	DTMF decoder, Moisture sensor	8051	Dtmf command	Overcomes the scarcity and also the excess flow of water	[35]

Table 2 : Comparison of technology implementations in irrigation.

Author	Implementation details	Technology used	Analysis	Efficiency parameter	Ref
Neha K. Nawandar (2019)	Controls the water supply for irrigation based on the data fed to a server	IoT, MQTT Protocols, Weather changes through server.	The data essentially is on the water need of the soil and crops.	Water saving of 67% over traditional methods.	[2]
Zhang S. (2018)	server connected through a mobile network for an auto irrigation system.	IoT, Server, Wireless valve controller,	Use of water balance method	Wireless communication upto 700-800 meters	[3]
SabrineKhriji (2014)	An irrigation solution based on a WSN	Wireless node, Motes network architechture	Sensor networks play important role	Data accuracy +/- 2%	[4]
H.Navarro-Hellín (2016)	use of real time information from soil parameters in a closed loop	Server, Data analytics.	automatic decision support system to manage irrigation in agriculture	Prediction error of 200 min/week	[5]
OlutobiAdeyemi(2018)	one-day-ahead prediction of the volumetric soil moisture content based on past soil moisture	IoT, Presaved Server Data, Weather updates	Advance Correct data prediction	Water saving between 20 to 46%	[9]
DanielK.Fisher (2010)	Soilmoisture sensorswere calibrated and providedmeasurements	Data analytics, IoT	Completely data dependent	cost for circuit & sensors 84US$.	[12]
Mehmet FatihIsık (2017)	Complete monitor of crops, various phases of plant growth	Water req analysis, Crop need analysis	a precision irrigation system, which takes advantage of the various phases of plant growth.	60% decrease in the labor force	[13]
Y.Kim (2009)	GPS based site-specific irrigation	GPS tracking, Wireless sensor nodes.	Enabledreal-timeremoteaccess to thefield conditions	-	[18]
NeametAkeelFawzi (2017)	using Python language which uploads data from the Base station to the cloud server.	IoT, Wireless network	Visual GUI makes easy interface	-	[21]
Dr. Freddie R. Lamm (2008)	scheduled on the basis of data collected from a NOAA weather station.	Temperature-Time Threshold method	Water use efficiency tended to be slightly greater with the TTT treatments	65% more efficient than traditional methods	[23]
Joaquín Gutiérrez (2013)	Solar powered wireless network of sensors	Wireless sensor Unit, GPRS, Remote Unit	solar powered irrigation is significantly important for organic crops	Avg power consumption was 4 Ah per day.	[31]
GaddipathiBharathi (2017)	Interactive GUI for interface	PLC, Ladder logic Fuzzy logic	PLC controlled Water Distribution System.	-	[33]

III.RESULTS AND ANALYSIS

The different strategies and results are compared by tabulating with the implementation details are discussed .The survey shown in the Table 1 and Table 2 enables in figuring out the automatic irrigation system that is designed to reduce the physical intervention of the farmer in the field.

Efficient Technologies like Water balance method can be used to increase the efficiency in water saving. The below formula (1) illustrates the volume of water required for particular irrigation field.

Irrigation volume = field capacity - effective rainfall – ground water recharge + crop transpiration. (1)

IV.DISCUSSION AND CONCLUSION

The design should include prevention and control of the Motor pump from Dry load, over load and other power supply failures. And also an automatic decision taking system of the direction control of water through electromagnetic valves. The decisions can be dependent on the sensor's collective inputs and also inputs from the farmers. The farmer's input is also quite important, because he will be well aware of the field conditions. The system also includes an immediate notification module so that the farmer is always well informed about the conditions of the field.

V.FUTURE SCOPE

Major challenges on low pressure drip irrigation system is with pressurecompensating emitters and the flow rate . Design considerations in main line sizing , critical path selection , manifold inlet pressure, filtration and vaccum vents would optimize the proposed novel methodology. Also study on potential for foliar diseases in drip micro irrigation is to be undergone.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCE

1. S.R. Barkunan, V. Bhanumathi, J. Sethuram , (2018), " Smart sensor for automatic drip irrigation system for paddy cultivation" , Elsevier journal of Computers and Electrical Engineering, Vol 73, pp. 180-193.
2. NehaK.Nawandar ,Vishal R. Satpute , (2019), "IoT based low cost and intelligentmodule for smart irrigation system", Computers and Electronics in Agriculture , Vol. 162, pp. 979–990.
3. Zhang S, Wang M, (2018), " Construction of intelligent water saving irrigation control system based on water balance", IFAC International Federation of Automatic Control,Vol.55 .No.17,pp. 466-471.
4. SabrineKhriji , DhouhaElHoussaini,MohamedWassimJmal, Christian Viehweger, (2014), "Precision irrigationbasedonwireless sensornetwork", Special Issue on EnvironmentalMeasurement and Instrumentation, Published in IETScience,Measurement and Technology, Vol 8, iss 3,pp. 98-106.
5. H.Navarro-Hellín ,J.Martínez-del-Rincon , R.Domingo-Miguel , F. Soto-Valles , R. Torres-Sánchez, (2016), "A decision support system formanaging irrigation in agriculture", Elsevier Journal ofComputers and Electronics in Agriculture, Vol. 124, pp. 121-131.
6. Chandankumarsahu, (2015), "A Low Cost Smart Irrigation Control System", IEEE sponsored 2nd international conference onelectronics and communication system. Pp. 1146 – 1152.
7. Genghuang Yang, Yuliang Liu, Li Zhao, Shigang Cui, QingguoMeng and Hongda Chen, (2010), "Automatic Irrigation System Based on Wireless Network", 8th IEEE International Conference on Control and Automation, pp. 2120-2125.
8. S.A.M. MatiurRahmani, Md. Abdullah Al Mamun , Nizam Uddin Ahamed, (2014), "Design of Automatic Controlling System for Tap-Water Using Floatless Level Sensor", IEEE International Symposium on Robotics and Manufacturing Automation, pp. 18-21.
9. OlutobiAdeyemi , Ivan Grove , Sven Peets, YuvrajDomun, (2018), "Dynamic Neural Network Modelling of Soil Moisture Content for Predictive Irrigation Scheduling", MDPI journals on Sensors, Vol. 18,Iss. 3408, pp. 1-22.
10. ShahinAwezPathan , Mr. S.G. Hate, (2016), "Irrigation system using a sensors and MATLAB Programming.", International Journal of Advanced Research (2016), Volume 4, Issue 5, pp. 320-324.
11. G. Sushanth and S. Sujatha, (2015), "IOT Based Smart Agriculture System " ,IEEE International Conference on Control and Automation, pp. 1-4.
12. DanielK.Fisher ,HirutKebede, (2010), "A low-costmicrocontroller-based system tomonitor crop temperatureandwater status", Elsevier Journal ofComputers and Electronics in Agriculture, Vol. 74,pp. 168-173.
13. [13] Mehmet FatihIsık, Yusuf Sönmez, (2017), "Precision Irrigation System (PIS) Using Sensor Network Technology Integrated with IOS/Android Application", MDPI journal on Applied sciences,Vol. 7,Iss. 891, pp. 1-14.
14. [14] V. Divya ,Umamakeshwari, (2013), "An intelligent irrigation system with voice commands and remote monitoring field", ANSI journal of Artificial intelligence, Vol. 6,pp. 101-106.
15. [15] BezaNegashGetu, Hussain A. Attia, (2016), "Automatic Water Level Sensor and Controller System", IEEE International Conference on Control and Automation, pp. 1-4.
16. [16] M. O. Sharma, P. M. Sonwane, (2017), "Remote Monitoring and Control for Liquid Fertilizer and Water Irrigation", International Conference on Computation of Power, Energy, Information and Communication (ICCPEIC), pp. 516 - 521.
17. Rahul Dagar, SubhranilSom, Sunil Kumar Khatri, (2018), "Smart Farming – IoT in Agriculture", International Conference on Inventive Research in Computing Applications, pp. 1052-1056.
18. Y.Kim,R.G.Evans, (2009), "Softwaredesign forwireless sensor-based site-specific irrigation", Elsevier Journal ofComputers and Electronics in Agriculture,Vol. 66, pp. 159-165.
19. DrashtiDivani, PallaviPatil, (2016), "Automated Plant Watering System", International Conference on Computation of Power, Energy Information and Communication, pp. 180-182.
20. BishnuDeo Kumar, Prachi Srivastava, (2017), "MICROCONTROLLER BASED AUTOMATIC PLANT IRRIGATION SYSTEM", International Research Journal of Engineering and Technology, Vol 4, Iss 5, pp. 1436-1439.
21. NeametAkeelFawzi, Ali SadeqAbdulhadi Jalal, (2017), "Design and Implementation of Smart Irrigation System Using Wireless Sensor Network Based on Internet of Things", International Journal of Scientific & Engineering Research, Volume 8, Issue 4, pp. 109-113.
22. Dr. Freddie R. Lamm,Dr. Robert M. Aiken, (2008), "Comparison of Temperature-Time Threshold-and ET-based Irrigation Scheduling for Corn Production", ASABE Annual International Meeting,Paper Number: 084202, pp. 1-12.
23. AjinkyaKaner,MilindRane, (2017), "Automatic Water Level Indicator & Controller", InternationalJournalofAdvancedResearchinElectronicsandCommunicationEngineering (IJARECE) Vol6,Iss11, pp. 1287-1290.
24. ChetanDwarkani,M Ganesh Ram , R Jagannathan, (2015), "Smart Farming System Using Sensors for Agricultural Task Automation", IEEE International Conference on Technological Innovations in ICT for Agriculture and Rural Development (TIAR 2015), pp. 49-53.
25. YuthikaShekhar, EktaDagur, Sourabh Mishra, (2017), "Intelligent IoT Based Automated Irrigation System", International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 18 (2017) pp. 7306-7320.
26. A Sumalatha , G Eswar Kumar, (2017), "Energy Efficient Solar Powered Automatic Irrigation System", International Journal of Engineering and Management Research, Volume-7, Issue-3,Page Number: 650-653.
27. Sony CahyaPratama, Erwin Susanto, (2016), "Design and Implementation of Water Level Control Using Gain Scheduling PID Back Calculation Integrator Anti Windup", International Conference on Control, Electronics, Renewable Energy and Communications (ICCEREC), pp. 101-104.
28. Ibrahim Mat, Mohamed RawideanMohdKassim, (2018), "Smart Agriculture Using Internet of Things", IEEE Conference on Open Systems, pp. 54-59.
29. Nilesh R. Patel ,Swarup S. Mathurkar, (2013), "MICROCONTROLLER BASED DRIP IRRIGATION SYSTEM USING SMART SENSOR", Annual IEEE India Conference (INDICON), pp.1-5.
30. Joaquín Gutiérrez, Juan Francisco Villa-Medina, (2013), "Automated Irrigation System Using a Wireless Sensor Network and GPRS", IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT, pp. 1-12.
31. Dr. P. Banumathi, D. Saravanan, M. Sathiyapriya, (2017), "An Android Based Automatic Irrigation System Using Bayesian Network with SMS and Voice Alert", International Journal of Scientific Research in Computer Science, Engineering and Information Technology, Volume 2, Issue 2, pp. 573-578.
32. GaddipathiBharathi, ChippadaGnanaPrasunamba, (2017), "Automatic Irrigation System for Smart City Using PLC AND SCADA", International Journal of Scientific Research in Computer Science, Engineering and Information Technology, Volume 2, Issue 4, pp. 309-314.
33. DikshaS.Dasare , PunamS.Kale , PriyankaR.Kale, (2017), "Automatic Irrigation Control System", International Journal For Technological Research In Engineering, Vol. 4, No.8, pp.1250-1252.
34. Gagandeep , Dinesh Arora, (2017), "Design and Implementation of an Automatic Irrigation Feedback Control system based on Monitoring of Soil Moisture", Proc. IEEE International Conference on Inventive Computing and Informatics (ICICI), pp. 540-544.