A Review on Modern Irrigation Technologies for Water Management

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Abstract: A comprehensive survey is conducted to enable readers with an overall review of automatic irrigation system. The review study finds that the system makes use of recent technologies like GSM, Wireless sensor network, ARM, Arduino and IOT coupled with solar energy. Varity of sensors are used for monitoring the parameters like humidity, soil moisture, temperature, water level in the tank and many more. Websites and android applications are developed to enable remote monitoring and controlling of irrigation. The review concludes that these systems have more potential, and due to their cost-efficient designs, they can be used in various other ways. Incorporating such technologies into our country's agricultural domain helps to conserve our natural resources and boosts crop productions.

KEYWORDS: Efficient water management, Wireless Sensor Network, Android applications, remote monitoring and controlling.

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I. INTRODUCTION

The Indian economy is the largest developing economy in the present world. Agriculture sector plays the largest contribution in the Indian economy. To utilize the maximum man power and to obtain the maximum profit, we need to develop various advanced engineering techniques in agriculture field. Hence, we must follow efficient water management practice for irrigation system. Water quantity (moisture) in the soil should be maintained properly to obtain good harvest which is source of different types of nutrients.

In India, the agriculture sector is facing failures due to drought. Due to this reason the ground water level is decreasing drastically. Hence, there is a need to utilize every single drop of water wisely. This increased the need for development of advanced and efficient technologies to use the renewable sources in a best way possible.

The population of the country is increasing hence volume of the food required also increased. This definitely requires more water. On other side, the factors like reduction in amount of ground water, climate change, global warming and uncertainty in monsoon increases the importance of saving the water while increasing food production. In traditional irrigation system, farmer manually releases the water to crops either at regular interval. Such systems require labors and not always accurate. The solution to this is the adoption of efficient water management practices in irrigation system. Most important objective of this system is to develop the efficient water management practices that optimize the usage of water by keeping the crop health and yield intact through the implementation of automated irrigation system. Also to overcome problems like over irrigation, under irrigation, wastage of water and to reduce human intervention.

This article is arranged according to: Section II introduces essential technology solutions developed for automated irrigation system for efficient water management. Section III presents future scopes and conclusions derived from the literature survey or review.

II. LITERATURE REVIEW

In this paper [1], (Pavithra D. S, et. al, 2014) the systems are developed by using sensors like soil moisture, temperature, and humidity sensors. When the moisture content in the soil is reduced below the set threshold, the developed system turns ON the motor automatically. As the moisture content increases to the desired value the system turns OFF automatically. The moisture values obtained and the current status of the motor will be displayed to the farmer using application. Figure1 and Figure 2 give the hardware implementation and block diagram of the irrigation system. Agricultural, horticultural lands, parks, gardens, golf courses can be irrigated by this system. Automation is done by microcontroller it can process water pumping in an over-head tank and monitor the water level in a tank, turns the pump on and off accordingly and display the status on an LCD screen. GSM module is used for Remote Controlling of Gate Control, Temperature Control etc. GSM/GPRS modem with power supply circuit and communication interfaces (like RS-232, USB) for microcontroller. GSM informs the farmer about the field condition in the form of SMS. Figure 1 gives the prototype developed.

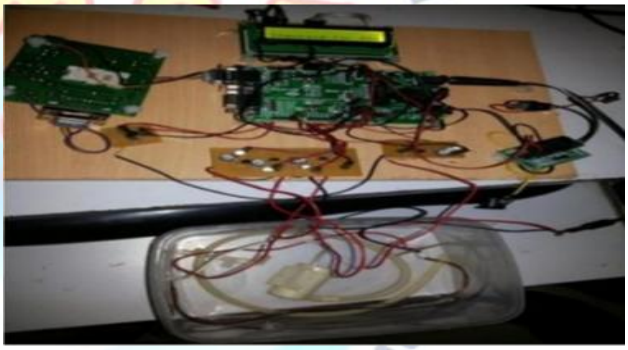

Figure 1GSM based automatic irrigation System[1]

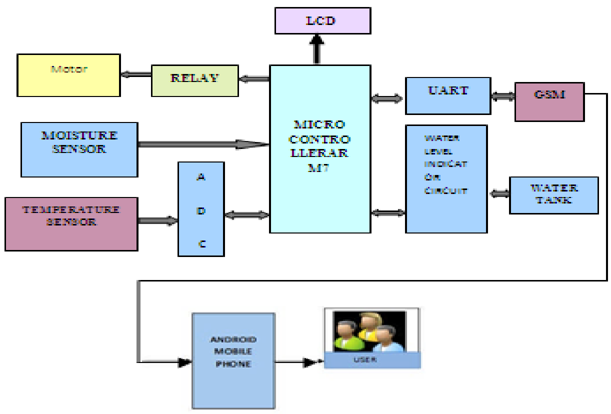

Figure 2 Block Diagram of the Irrigation control system by using an android mobile [1]

In this paper [3], (Sanjay Kumawat, et. Al., 2017) the three soil moisture sensors implemented in the system uses 3 ways to detect the soil moisture: (1) when the top sensor detects the moisture level greater than the set threshold, the motor continues to be in OFF state. (2) When the sensor at the top level is not at desired moisture level but the level 2 is at desired moisture value, the motor continues to be in OFF state. (3) When the moisture value of the both sensors at top are below the set threshold and the moisture value of sensor at level 3 is at some moisture, the motor turns ON for some period to irrigate the farm. These activities taking place on the field are transferred on to the cloud using IOT. It is accessible by the website developed. The data is constantly transferred on to the cloud. The data can be monitored on any android app using Bluetooth. The irrigation system can be controlled by the user through installed android app i.e., Semiautomatic System. This system also has pi camera to capture the soil images to determine the soil pH value to suggest as to which crop or plant can be grown in that field. Figure 3 and Figure 4 shows the system architecture and the model developed.

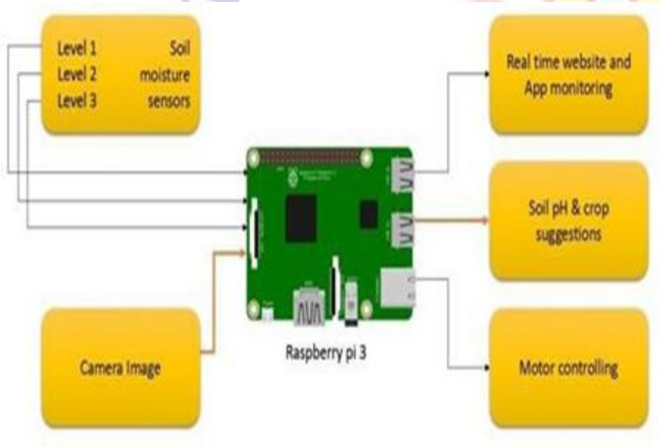

Figure 3 System Architecture [3]

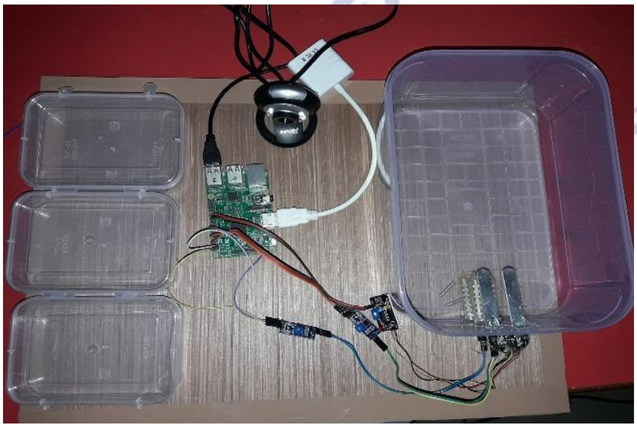

Figure 4 Working Model [3]

In this paper [4], (Bharath M N, et. Al., 2018) the authors have developed intelligent drip irrigation system which is used for proper maintenance of irrigation system. This system concentrates on monitoring the crops automatically, to reduce the man power. Microcontroller and sensors are used to measure the soil moisture value and turns ON and OFF the relay. The relay is employed to control the flow of water by solenoid according to the moisture value desired by the user. The system objective is to reduce the wastage of water. The system is also enabling low maintenance, cost effectiveness, time reducing, eco-friendly and efficient irrigation service. The entire system is solar powered and hence energy efficient.

In this paper [5], (R.A. Rahim, et. al., 2016) automatic solar watering system is developed. The prototype used PIC micro controller shown in Figure 6 and solar tracking system which obtained feedback from the LDR sensors as shown in Figure 5. The system aimed at reducing water wastage and human intervention. The soil moisture sensor was used to sense the various conditions of moisture like soil dryness, humid condition and also water overflow conditions. ISIS & ARES tool in the Proteus Software Simulation was done to design the system. A charge controller was designed to obtain maximum charging of 12V of lead acid battery. The authors are providing information regarding future scope of the project like using switching power supply with multiple batteries, Real Time Clock (RTC) DS1307 IC integrated with PIC18F4550 to provide real-time facility to the system. To reduce the power usage the controller may be set to low power consumption mode until the sensor reads below a certain threshold value.

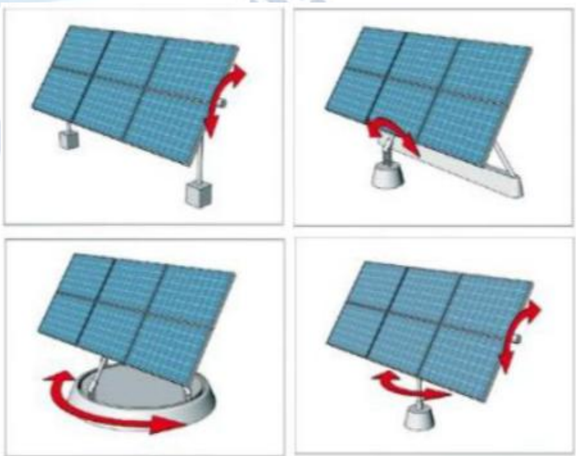

Figure 5 HSAT, VSAT, PSAT and Dual-axis [5].

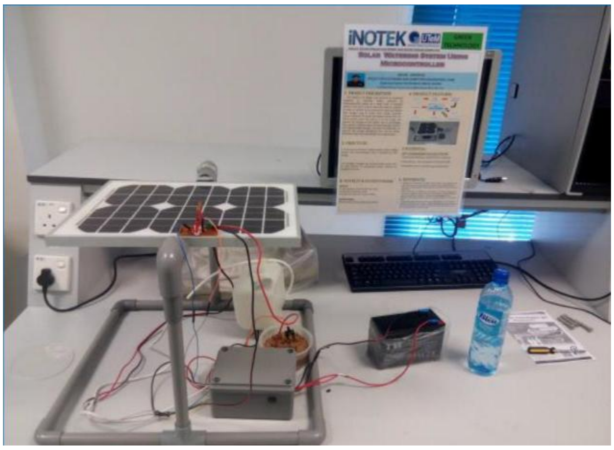

Figure 6 Full prototype testing [5].

In these papers [6], (Priyadharsnee, et. al., 2017), [7], (M. A. Murtaza, et. al., 2017), [8], (BimalMahato, et.al., 2018) the authors have designed automatic irrigation system which measures the water content of soil using soil moisture sensor to control the water content present in the farm land. The system has a water level sensor to indicate the water content in the tank. Moistness and temperature sensors LM35 are used for making this system more reliable and features of GSM are included for operation of system at remote location. These GSMs placed, send the data about the motor state and field condition to the registered number. The controlling is done by microcontroller. The GSM is used to report the details about the on-going irrigation. The moisture and temperature of plants are accurately controlled. The valves may be easily automated by employing Arduino and solenoids. Figure 7 and 9 shows the Block diagram representation of the system and Figure 8 the result of the moisture sensor communicated and Figure 10 represents the prototype developed.

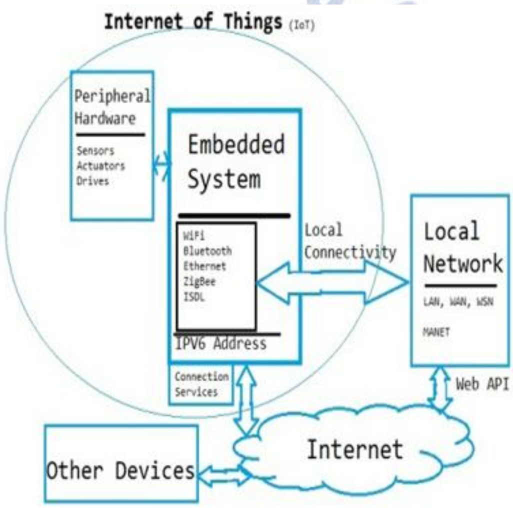

Figure 7 Block diagram [6]

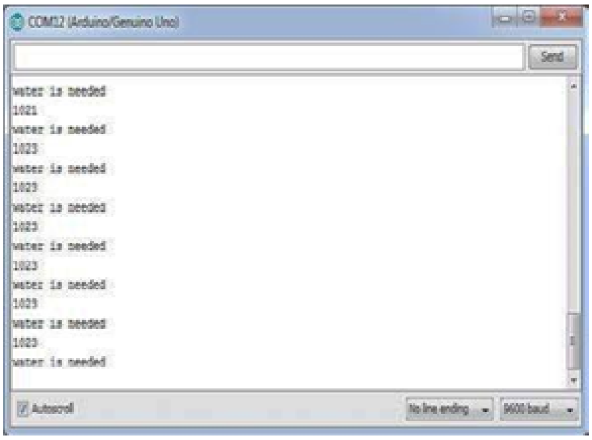

Figure 8 Moisture Sensor output [6]

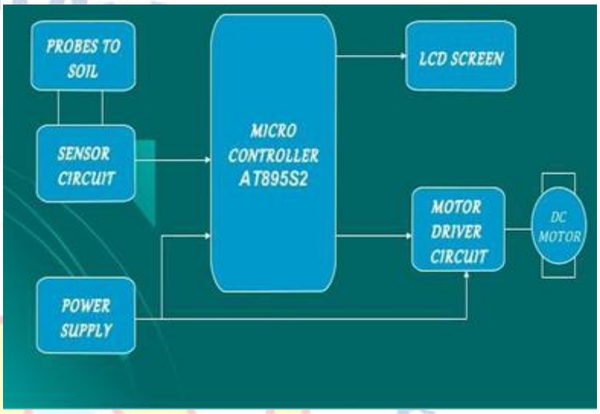

Figure 9 Block diagram of the system [8]

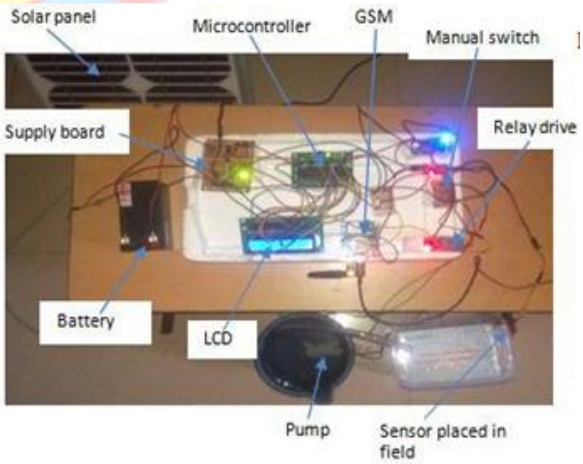

Figure 10 Prototype Model [8]

In this paper [9], (Gauri Tope, et., al., 2016)SMS are sent via wireless technology to send detected temperature, soil moisture and water level. Humidity sensor HS1100 is used to sense the humidity in the air. Microcontroller communicates the measured values to wireless communication zigbee module and further GSM module sends message to the farmer. The former receives information with respect to temperature, soil moisture and humidity as SMS through Wireless network.

In this paper [10], (J. JegatheshAmal Raj, et. al., 2019) the authors have presented a Comparative study of various Smart Agricultural Systems. The paper describes literature review of smart irrigation system using IoT. The comparison is with respect various parameters like Existing System, Technologies used, Advantages, Cloud Implementation, and Data Acquisition. It mentions that for automated irrigation system the environmental parameters shown in Figure 11 will have to be measured and by deployment of various technologies mentioned for better control of the agriculture production.

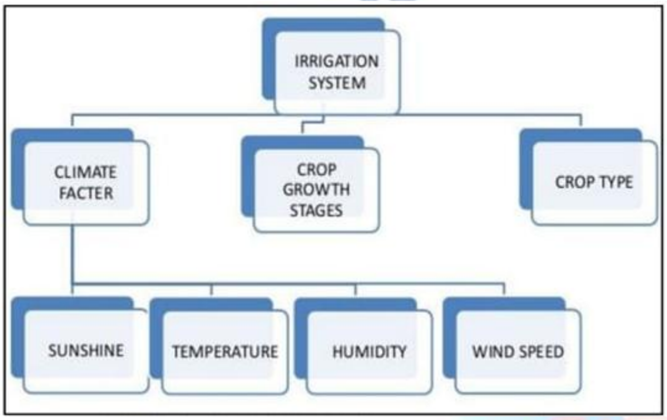

Figure 11 Factors influencing irrigation system [10]

The paper [11], (AmarendraGoapa, et., al., 2018) designed an IoT based smart irrigation architecture which makes use of a hybrid machine learning based approach to show the soil moisture. The soil moisture value is obtained using Field sensor data and weather forecasting data. Machine Learning based support k-means model and vector regression clustering algorithm are used to tell the soil moisture. The algorithm and device generated data is saved in MySQL Database at the server. The evaporation of soil moisture is considered based on air temperature, air relative humidity, soil temperature, and radiation. These parameters helps in finding the pattern of soil moisture variation based on the collected information of soil moisture. An IoT based architecture given in Figure 12 is designed to collect, these field parameters along with the weather forecast data to maintain the irrigation efficiently. An algorithm is developed to use this combination of supervised and unsupervised machine learning techniques. Support Vector Regression (SVR) and K-means clustering is used for estimation of change in soil moisture due to weather conditions. The authors mention that it gives good accuracy and less Mean Squared Error (MSE) in the prediction of the soil moisture.

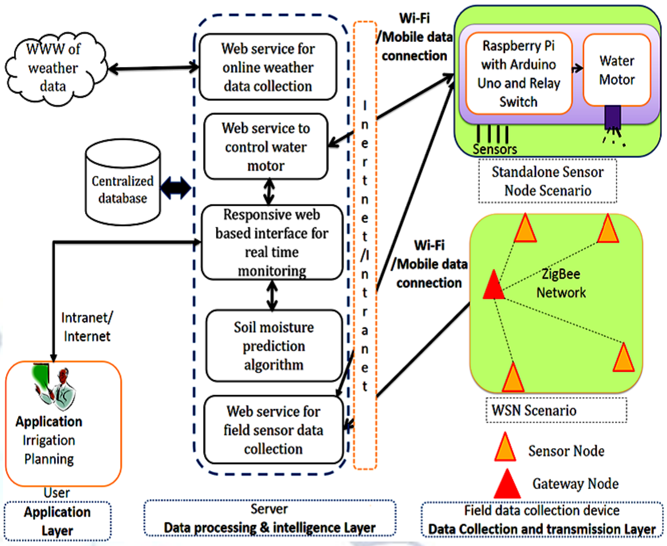

Fig. 12 Architecture of IoT based irrigation management system [11]

In the paper[12], (P. Sindhuja, et.al., 2016) the authors use soil moisture sensor, temperature sensor, Aurdino controller, Relay, Solenoid valve, Liquid Crystal Display, GSM, Solar panel, Ni-Cd battery to develop the GSM based automatic irrigation system. The measured parameters are displayed on LCD and the information about water pumped to field will be sent to the farmer via GSM. The system is powered by solar panel.

The paper [13], (SharadShinde, et. al., 2017) proposes a solution for efficient water management which uses Wireless Sensor Networks, control section and user interface shown in Figure 13. The system uses moisture, temperature and humidity sensors, shown in Figure 14. The threshold value is set and the soil moisture value level is measured and compared with threshold as upper and lower values.WSU has microcontroller, sensors, signal conditioning, RF transceiver and power supply as shown in Figure 14 Several WSUs are deployed in the field depending upon the area to be covered. The control section consists of Wireless Interface Unit-WIU, it has microcontroller, RF transceiver, Wi-Fi module and actuator (water valve) as shown in Figure 15 It communicates with both WIU and Web module.

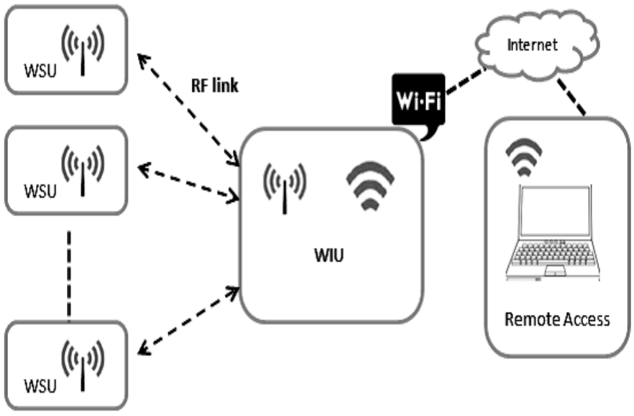

Figure 13 General Block Diagram [13]

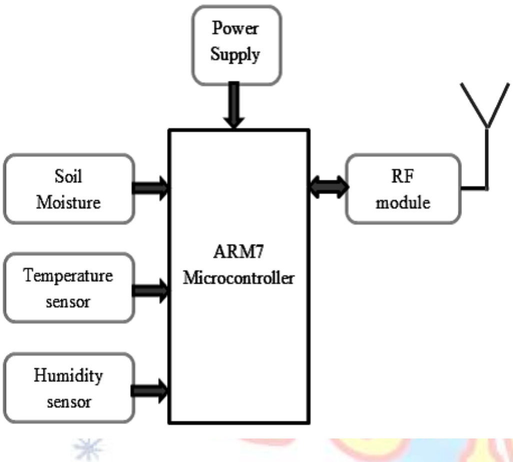

Figure 14 Block Diagram-WSU [13]

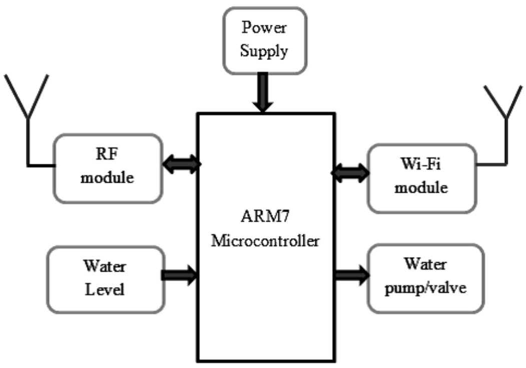

Figure 15 Block diagram-WIU [13].

Paper [14] (V. Ramachandran, et. al., 2018) demonstrated the reduction of water usage for farming land by developing an automated irrigation system that combined the Internet of Things (IoT), cloud computing and optimization tools refer Figure 15. Thingspeak cloud service is used for monitoring and data-storage. The Wi-Fi modem and GSM cellular networks transmits the data to cloud. Traditional method of irrigation is compared with Automated Irrigation, Drip Irrigation, and Sprinkler Irrigation using the solenoid valve, sprinkler, and Drip, these components with specification is shown in Figure 17. The experimental work carried out by the authors demonstrated that the automated irrigation system reduced water usage in agriculture.

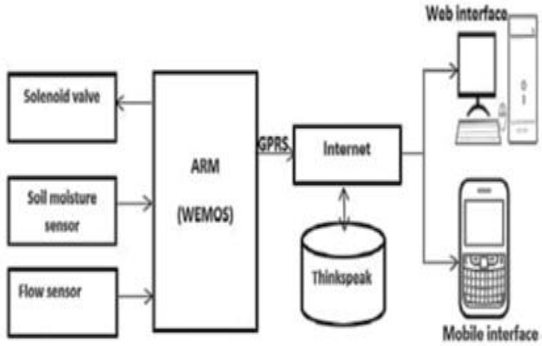

Figure 16 Smart irrigation system IoTArchitecture [14]

Device	Specifications
WEMOS D1 Controller	ESP-8266EX
Soil Moisture Sensor	YL69
Solenoid Valve	1/2 Inch, 12V
Gardening sprinkler	4-hole female
Drip irrigation hose	4 mm, 2 meter (length)
Water Flow Sensor	YF-201
Humidity & Temperature sensor	DHT 11
pH sensor	pH meter probe (0-10)

Figure 17 Components used [14]

In paper [15] (Tran AnhKhoa, et all, 2019) the authors explain IoT and design a water management system which uses inexpensive and highly efficient sensor nodes topology. The system uses sensors like temperature, humidity, water level, soil moisture, and rain sensors. In this paper, the combination of a LoRa module, WiFi ESP8266 module, and ATmega2560 is gateway communication. This communication module is based on LoRa LPWAN technology and HC12 Transmission/Receiver module. RFID functions as the central feature for operating the pump directly at Node 1.When node 1 receives the data from sensor. LCD in Node 1 is used to display the information of Node 1. AC–DC converter with 7 V is used to power all the components. The block diagram of the Node 1 shown in Figure 18(a) along with other components used. Figure 18(b) gives the smart watering system architecture. The designed sensor network is tested in the research lab, and real fields. The user can control automatically or manually using the mobile Application. In this smart watering system the real-time data input is received from sensors that are embedded in a farm tunnel and other locations. This smart watering system, schedules a date and time that assures watering when the water level falls below the threshold in the tunnel farm. The user is notified by the system and can switch on the water pump (manual or automatic) in time to water the plants. ATmega328 uses five different sensors for the Node 2: temperature, temperature–humidity, soil moisture, rain, and water level. Node 2 is designed for orchardswith conditional topographic groves suitable for pumps directly at Node 2 without separating the sensor like Node 1. LoRa module, RFID, and LCD are also used.

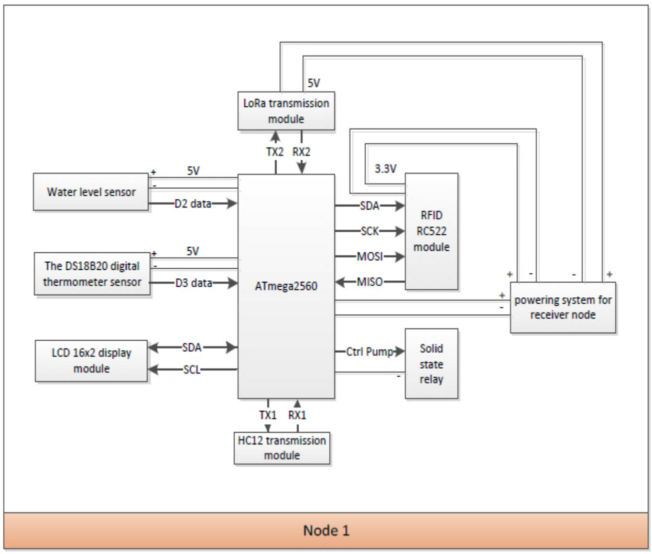

Figure 18(a) Block diagram of Node 1 of Smart watering system [15]

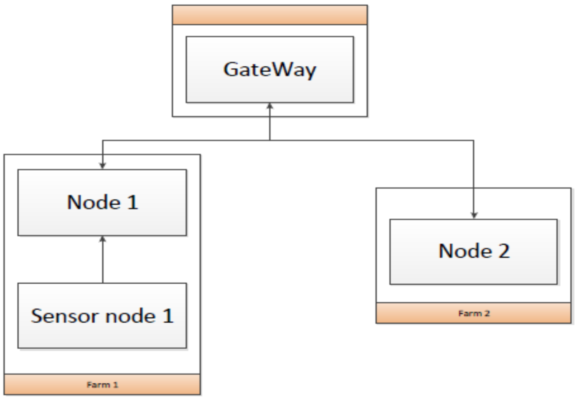

Figure 18(b)IoT framework block diagram[15]

The papers [16], (Shweta S. Patil, et all, 2014) contain ARM core processors, GSM modem and zig bee module as the main components. The main objective the system is to develop modernization in agricultural environment to overcome the traditional farming practices. Humidity, temperature, and soil moisture sensors are installed in field to monitor and control those parameters. Also, water level of the tank and 3-ϕ supply in the field is monitored. The monitored information is transferred to the processor later it is sent to zig bee module and then to the framer's mobile using GSM SIM900 module. The LCD display in the field enables the farmer to view the ongoing process and field parameter. Figure 19(a) and Figure 19(b) shows transmitter and receiver of the system that is placed in the agricultural field, which will sense the respective parameters and displays on the LCD and process them and send SMS through GSM to the user mobile.

Figure 19(a) Transmitter [16]

Figure 19(b) Receiver [16]

In paper [17], (N.D. Pergad, et all, 2015) developed a water management system for agriculture using ARM processor and GSM for communication. The block diagram of the system proposed is shown in Figure 21(a) and Figure 21(b) is transmitter developed to transmit the data collected by the sensors. In this system the receiver is the mobile of the user. The results sent by the ARM processor will displayed on the screen.

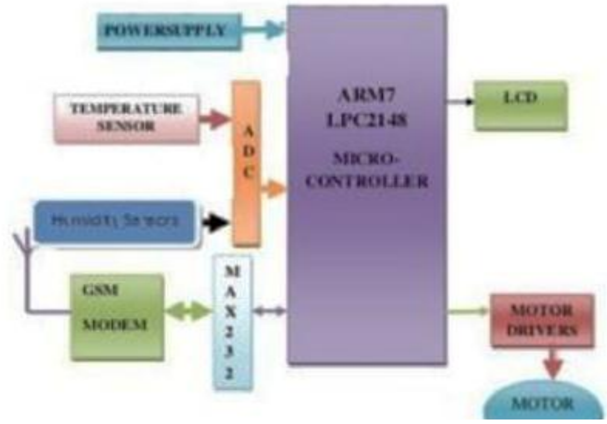

Figure 20(a) Block diagram of proposed system [17]

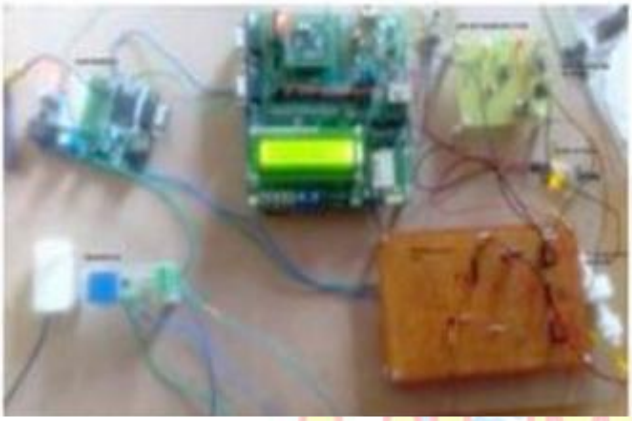

Figure 20(b) Transmitter section [17]

In this paper [18], (Shyam R. Dutonde. 2018)the author discuss about modern agriculture by applying technology and collecting information to control the system. Also, the potential success achieved and support provided to private and public sources is described. Modern agriculture in United States depends on highly sophisticated systems that move, store and processes producers output throughout an extensive value chain that extends to food products and final consumers. It mentions that modern agriculture has become much more productive. There are many more challenges coming upon. Hence, the future development needs to increase. The author also suggests improving the public understanding about the important investments.

Paper [19], (OmidAbrishambaf, et all, 2019) proposes an autonomous Central Pivot irrigation system with sprinkler to improve irrigation efficiency. Soil moisture, wind, local temperature, precipitation forecast and soil evapotranspiration calculation is used to schedule the watering for lower cost periods. The system is powered by both solar and utility grid. It aims at optimization of the irrigation cost. Sensors such as temperature, humidity, solar irradiation, and soil moisture sensor enable scheduling process in the system. Evapotranspiration of each zone and the precipitation forecast of the different zones are considered by the system to calculate the time needed for the level of soil moisture to go below a desired threshold for the plantations. Fig 21(a) shows the Central Pivot irrigation system implemented and Figure 21(b) the zones of the field for CP irrigation system.

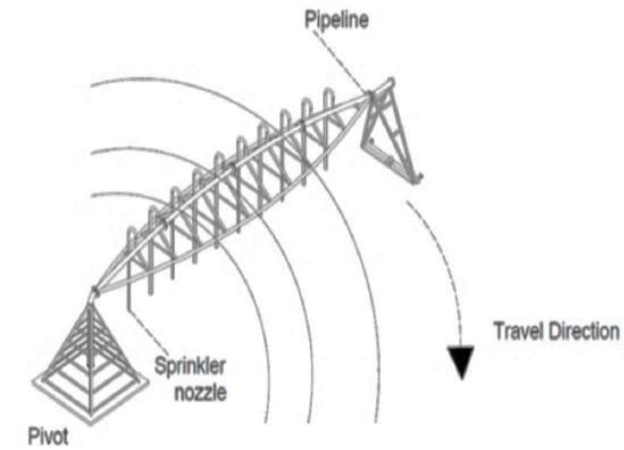

Figure 21(a) Central Pivot irrigation system [19].

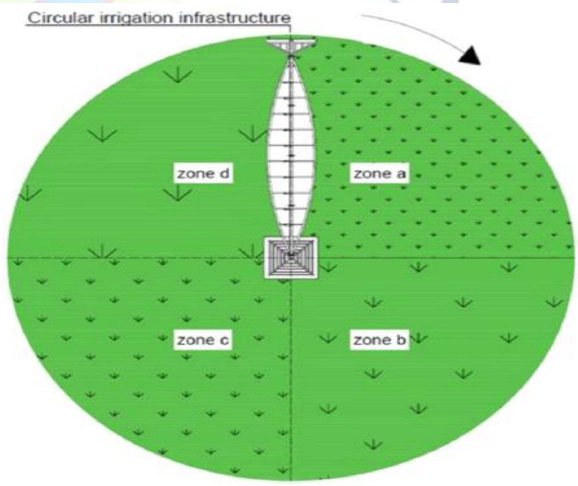

Figure 21(b)Multiple zones CP irrigation system [19].

An automatic irrigation system in the paper [20], (Joaquín Gutiérrez, et. all, 2014) is developed to enable efficient usage of water for irrigation purpose. The system is energized by photovoltaic panels and duplex communication link based on a cellular-Internet interface which allows the information obtained and irrigation status to be programmed through a web page.

Soil moisture and temperature sensors will be placed near the roots of the plants that are wireless network distributed all-over the field. Figure 22 shows the configuration of the proposed automated irrigation system. The system also possesses triggers, actuators, gateway unit handles sensor information. These data are transmitted to a web application. Algorithm is developed to control temperature and soil moisture value using set threshold value that is programmed by microcontroller-based gateway to control the water flow. The system is also tested and proves to save water up to 90% of regular irrigation techniques. The system is energy saving and cost efficient it can be used in geographically isolated areas which faces water scarcity. The authors conclude that the system can be made suitable for all types of crops. The proposed irrigation system is also eco-friendly as it is solar powered. Figure 23(a) gives the details of the WIU developed by the authors and Figure 23(b) details the WSU developed by the authors for automatic irrigation system.

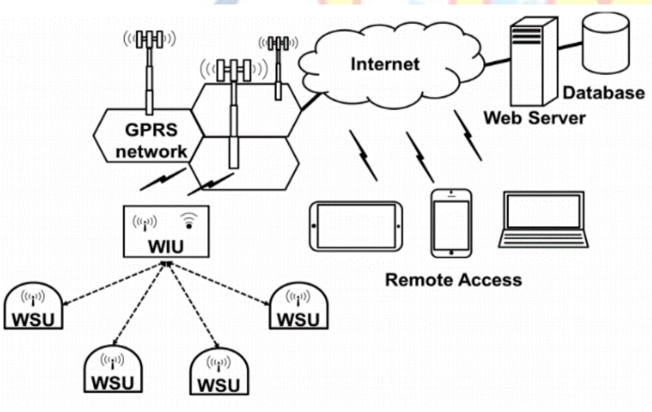

Figure 22 Automated irrigation system Configuration. Microcontroller, ZigBee, and GPRS technologies based WSUs and a WIU [20].

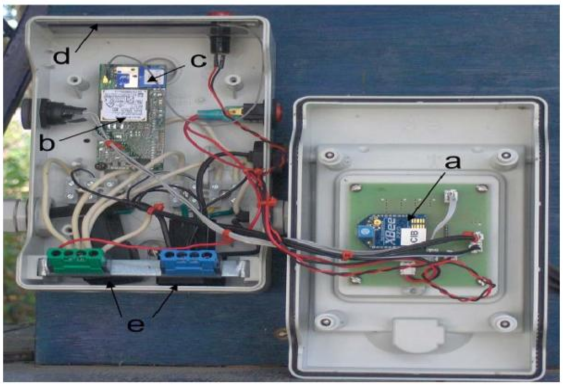

Figure 23(a) Inside view of the WIU. [20]

(a) ZigBee Radio modem
(b)GPRS module
(c)SIM card
(d)GPRS PCB antenna
(e)Pumps relays

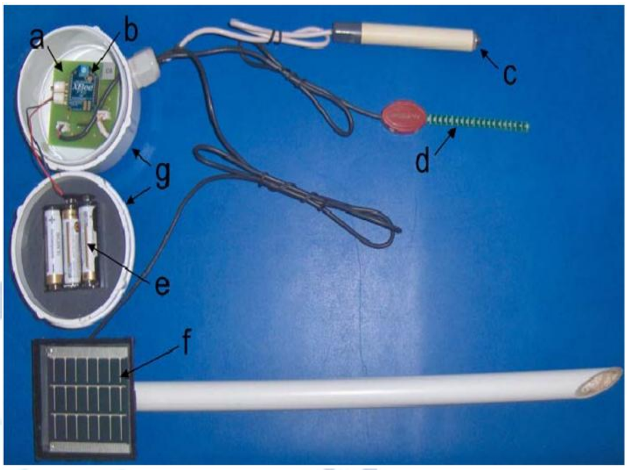

Figure 23(b) WSU [20].

(a) Electronic component PCB
(b) ZigBee Radio modem
(c) Temperature sensor.
(d) Moisture sensor
(e) Rechargeable batteries
(g) Polyvinyl chloride container
(f) Photovoltaic cell

III. FUTURE SCOPE AND CONCLUSION

This review paper explored that the scarcity of water and the importance of agriculture for the existence of human life on earth, conservation of water resources used for agriculture is becoming a huge challenge. To tackle this challenge the automated irrigation system based on different types of modern technologies have been designed and developed. The wireless data communication among WSN, GSM, IOT and user application requires less maintenance. Application are developed which allows the user to monitor and control of the irrigation without any advanced technical knowledge. These developed systems are cost efficient and also enable optimum usage of water. The system can also be made suitable for different types of crops which require specific amount of water for a better quality of yield. These technologies can be used for farm lands at remote place where human monitoring is difficult or presence is not feasible. This system can also be extended to greenhouse monitoring.

REFERENCES

1. Pavithra D. S, M. S .Srinath, "GSM based Automatic Irrigation Control System for Efficient Use of Resources and Crop Planning by Using an Android Mobile", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), e-ISSN: 2278-1684, Volume 11, Issue 4 Ver. I, 2014, p. 49-55.
2. B. Sandhya, V. Ramesh, "Automated Irrigation System Using A Wireless Sensor Network For Social Modernization Of Indian Agriculture System", International Research Journal of Engineering and Technology (IRJET), Feb 2018, volume 5, Issue 2, p. 1105-1108.
3. Sanjay Kumawat, ApurvaNagare, MayurBhamare, AshwiniKapadnis, "Sensor Based Automatic Irrigation System and Soil pH Detection using Image Processing", International Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 04 | Apr -2017, p.3673-3675.
4. Bharath M N and R. Varunbaba, "Solar Powered Automatic Drip Irrigation System with Alternate Water Storage", International Journal of Engineering Research & Technology (IRJERT), volume:06, issue:13, 2018, p.1-4.
5. R.A. Rahim, S. Amardas, "Development Of Automated Solar Watering System", International Journal of Engineering and Science (IJES), volume:5, issue 12, 2016, p.55-62.
6. Priyadharsnee. K, S. Rathi, "An Iot Based Smart Irrigation System", International Journal of Scientific & Engineering Research, Volume 8, Issue 5, May-2017, p. 44-51.
7. Mr. M. A. Murtaza, Mr. Mragank Sharma, RohitYadav, RajvardhanChaudhary, Kriti, "Solar Powered Automatic Irrigation System", IJESC, Volume 7, Issue No.4, April-2017, p.10719-10722.
8. BimalMahato, Anish Kumar Yadav, SudilThapa, "Solar Based Automatic Irrigation Using Soil Moisture Sensor", International Research Journal of Engineering and Technology (IRJET), Volume 05, Issue 05 ,May-2018, p. 1781-1784.
9. Gauri Tope, A.S. Patel, "Smart Irrigation System", International Journal of Current Engineering and Scientific Research (IJCESR), VOLUME-3, ISSUE-3, 2016, p. 23-26.
10. Dr. J. JegatheshAmal Raj, S. Banumathi, J. Jereena John, "A Study On Smart Irrigation Systems For Agriculture Using IoT", International Journal of Scientific and Technology Research, Volume 8, Issue 12, December 2019, p. 1935-1938.
11. AmarendraGoapa,b, Deepak Sharma, A.K. Shuklab, "Rama KrishnaaAnIoT based Smart Irrigation Management System using Machine Learning and Open Source Technologies", Computers and Electronics in Agriculture 155 (2018), Science Direct, 2018, p. 41–49.
12. P. Sindhuja, M. Prathusha, M.C. Kalaiselvi, S. JaaSudhaa, R. Velthai, "Solar Driven Arduino Based Automatic Irrigation Using GSM", International Journal of Advanced Research in Biology Engineering Science and Technology (IJARBEST), Volume 2, Issue 10, March 2016, p.175-183.
13. SharadShinde, VipulGohil, "Automated Irrigation System using WSN and Wi-Fi Module", Int. Journal of Engineering Research and Application, Vol. 7, Issue 4, (Part -6) April 2017, p.58-63.
14. V. Ramachandran, R. Ramalakshmi, and SeshadhriSrinivasan, "An Automated Irrigation System for Smart Agriculture Using the Internet of Things", 2018 15th International Conference on Control, Automation, Robotics and Vision (ICARCV) Singapore, November 18-21, 2018.
15. Tran AnhKhoa, Mai Minh Man Tan-Y Nguyen, VanDung Nguyen and Nguyen Hoang, "Smart Agriculture Using IoT Multi-Sensors: A Novel Watering Management System", Journal of Sensor and Actuator Networks, MDPI, 2019, 8, 45; doi:10.3390/jsan8030045, p. 1-22.
16. Shweta S. Patil, Ashwini V. Malviya, "Agricultural Field Monitoring System Using ARM", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 3, Issue 4, April 2014, p. 8781-8788.
17. N.D. Pergad, Y.P. Patil Assistant Professor, "GSM based Water Management in Irrigation System Using ARM7", International Journal of Science and Research (IJSR). Volume 4 Issue 12, December 2015.
18. Dr. Shyam R. Dutonde Department of Sociology, "Modern Agriculture: Concept and it's Benefits", International Journal Of Current Engineering And Scientific Research (IJCESR), VOLUME-5, ISSUE-1, 2018.
19. OmidAbrishambaf, Pedro Faria, Luis Gomes, Zita Vale, "Agricultural Irrigation Scheduling for a Crop Management System Considering Water and Energy use Optimization", 6th International Conference on Energy and Environment Research: "Energy and Environment: Challenges Towards Circular Economy", ICEER 2019, 22–25 July 2019, p.133-139.
20. Joaquín Gutiérrez, Juan Francisco Villa-Medina, Alejandra Nieto-Garibay, and Miguel ÁngelPorta-Gándara, "Automated Irrigation System Using a Wireless Sensor Network and GPRS Module". IEEE Transactions on Instrumentation and Measurement, Vol. 63, no. 1, January 2014, p. 166-175.