ADVANCED SPRINKLER IRRIGATION SYSTEM USING SOLENOID VALVE BY MONITORING WIND SPEED VARIATION

MARY LINDA M
Professor, Dept of Electrical and Electronics Engineering
KIT-Kalaignarkarunanidhi Institute of Technology,
Coimbatore, India
mm.linda2002@gmail.com

AJITHKUMAR A
Assistant Professor, Dept of Agricultural Engineering
KIT-Kalaignarkarunanidhi Institute of Technology,
Coimbatore, India
2197ajithkumar@gmail.com

HARIHARAN S
Student, Dept of Electrical and Electronics Engineering
KIT-Kalaignarkarunanidhi Institute of Technology,
Coimbatore, India
kit.24.20bee014@gmail.com

HARIHARAN M
Student, Dept of Electrical and Electronics Engineering
KIT-Kalaignarkarunanidhi Institute of Technology,
Coimbatore, India
kit.24.20bee015@gmail.com

RAGHUNATH S V
Student, Dept of Electrical and Electronics Engineering
KIT-Kalaignarkarunanidhi Institute of Technology,
Coimbatore, India
kit.24.20bee034@gmail.com

Abstract— Agriculture is crucial to the cultivation of crops everywhere, but it's especially important in India. Because of variations in wind speed, the current system's water distribution to crops is uneven. The solenoid valve in the proposed work is controlled by an Arduino microcontroller. Anemometers in the suggested system measure wind velocity and send the measured signal to the Arduino controller. The Arduino controller regulates the solenoid valve, which aids in uniformly dispersing water onto crops via the sprinkler head, based on the speed of the wind. By using a bypass valve attached to a solenoid valve, water can be fed back into a reservoir or well if the rate of water flow is higher than what is needed for the sprinkler head. The sprinkler head's water supply can be adjusted with the aid of the solenoid valve. It disperses water to the crops uniformly and lowers water pressure. The project's goal is to create a sprinkler irrigation system that, in response to wind direction and velocity, automatically and uniformly distributes water to the crops without wasting any.

Keywords - Anemometer, Solenoid valve, Sprinkler, Irrigation, Arduino controller, Wind velocity.

1.0 Introduction

Sprinkler irrigation is a method of distributing irrigation water that simulates natural rainfall. Usually, water distribution involves pumping it through a system of pipes. It is then sprayed into the air with sprinklers, dispersing into minuscule water droplets that land on the ground. Agricultural sprinkler systems were developed in response to the desire of American homeowners for a lush, green lawn. Joseph Lessler [1], a resident of Buffalo, New York, invented the sprinkler in 1871. Lessler dubbed his invention a **"portable water fountain and sprinkler,"** claiming that it would eliminate the need for hand-watering a yard, hence cutting down on the amount of time spent on lawn care. Nechita Adrian Mihai [2] developed **"Solution For Water Management Using A Smart Irrigation System"** in 2019. The system operates using different parameters based on the requirements of a particular location (wet or dry soil). The system goes into "stand-by" mode when the humidity exceeds the threshold until the sensor sends fresh data to the microcontroller.

It consists of a system of lightweight plastic or aluminum pipes that are manually moved. The lateral sprinklers are spaced 9–24 meters apart and have a diameter of 5–12.5 cm. It's lighter to carry as a result. The lateral pipe is placed in the field and left there until the irrigation is completed. The lateral is moved to the next position and disconnected from the mainline after the pump is turned off. The irrigation is restarted upon reassembly and connection to the mainline. One to four lateral movements per day are possible. It is progressively moved across the field until it receives full irrigation. The design and installation of sprinkler irrigation systems are complex tasks best left to the expertise of trained professionals. The type of crop being irrigated, the soil's composition, the field's dimensions and shape, and the available water supply will all affect how the system is designed. The **"IoT Based Smart Sprinkling System"** was developed in 2018 by Rana Johar [3]. Its objective is to offer a watering system that is both economical and intelligent. The main objective is to integrate the real-time monitoring system, remote controlling, and cloud computing of the collected information.

Sprinkler water breaks up into droplets that are between 0.5 and 4.0 mm in size. The smaller drops fall closer to the sprinkler, while the larger drops fall closer to the edge of the wetted circle. When big drops could damage sensitive crops and soils, it is preferable to use smaller sprinklers. Drop size is also affected by pressure and nozzle size. The drops are usually much larger when the pressure is low because it is harder to break up the water jet. To protect crops and soil, use spray nozzles with small diameters that are operating at or above the standard recommended operating pressure.

With overspray, water waste can occur at a rate of 1.6 to 8 gallons per minute per zone. If your watering schedule is regular, that equates to 5,760 gallons of water wasted per zone per month. A single leak or broken head can result in the loss of nine to sixteen gallons of water per minute. A standard watering program with one broken head could result in 11,520 several gallons of water wasted each month. One of the main uses of water in the world is irrigation. Irrigation withdrawals in the United States in 2015 were estimated to be 118,000 million gallons per day (Mgal/d), or 132,000 thousand acre-feet annually. In 2015, there were roughly 63,500 thousand irrigated acres. About 34,700 thousand of the total acreage have sprinkler systems installed. High-pressure spray irrigation systems are still commonly used today, but they can be very ineffective. Up to thirty-five percent of the water is lost due to evaporation and wind. Irrigation systems with higher efficiency are being used more frequently.

2.0 Current Irrigation System

An important turning point was the 19th-century invention of mechanical sprinklers. A patent for a **"spray of water"** device, primarily for fire safety but potentially also for irrigation, was granted to John Henry Lane [4] in 1871. Technological developments in firefighting have facilitated the development of automatic sprinkler systems. A sprinkler system designed to prevent fires was patented in 1874 by Henry S. Parmelee, whose patent indirectly influenced agricultural irrigation practices. Inventors like Frank Zybach created traveling sprinklers in the later half of the 1800s. They replicated the patterns of rainfall by traveling across fields in a prearranged route. The foundation for modern sprinkler technology was established by the introduction of early stationary and rotating sprinkler head designs.

Fig.1: Electric powered sprinkler irrigation system

In the mid-1900s, technology advanced quickly; one example of this is the electric-powered irrigation systems depicted in Fig. 1. Automated timers and controls made it easier to deliver water precisely, which decreased water waste and raised output. Later in the nineteenth century, advances were made in materials, sprinkler head design, and water-saving technologies. Impact and rotary club sprinkler heads are becoming more and more common due to their increased coverage area and adaptability. Figure 2 illustrates how precision irrigation and computerized control systems entered a new era in the later half of the 20th century and beyond. Weather-based sensors and advanced computer programs enable the planning of irrigation operations based on current weather conditions and soil properties. Water conservation and sustainability are given top priority in modern sprinkler irrigation systems. Innovations like low-pressure systems, intelligent irrigation controllers, and pressure-regulated sprinkler heads boost efficiency even more.

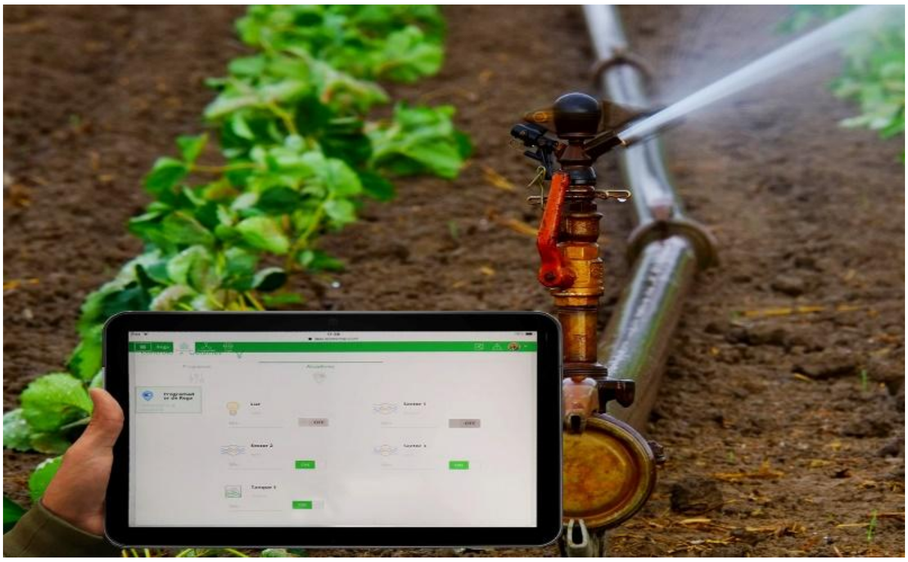


Fig.2: Computer controlled sprinkler irrigation system

2.1 The sprinkler system's drawbacks

- The distribution of water to the crops is uneven because of wind speed variation.
- The crops may stale because of more water go the crops and may dry because of less water go to the crops without limit.
- Wastage of water due to irregular wind speed variation.

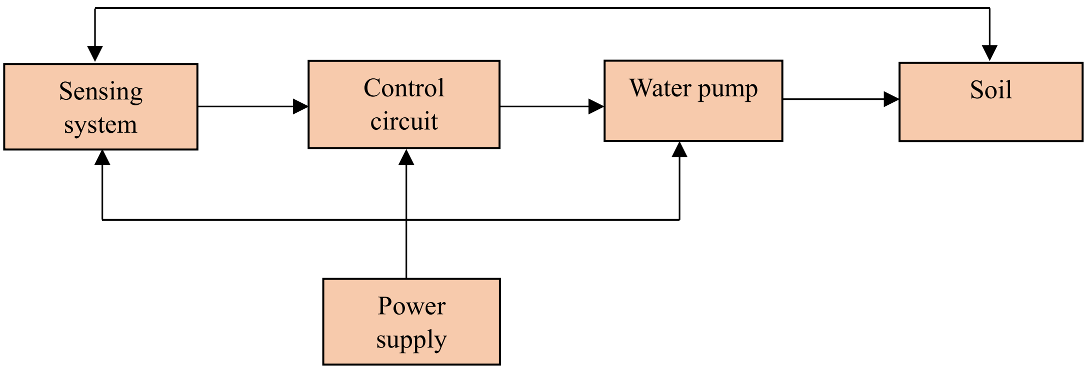


Fig.3: Block diagram of sprinkler system

3.0 Enhanced Sprinkler System

The recommended system makes use of an automated sprinkler irrigation system that measures wind speed using anemometer and disperses water among the crops uniformly. The Arduino controller uses the anemometer to measure the speed and direction of the wind to control the solenoid valve. When wind speed varies, the water is sprayed unevenly on the crops instead of reaching our target. Either in front of or behind our target, it mists water. By measuring the wind speed with an anemometer, we can modify the solenoid valve. By adjusting the valve with an Arduino controller, we can distribute the water to our target. If the wind direction changes, the water distribution to our target is also not aligned. By modifying the sprinkler head position, we can resolve this problem and guarantee that crops receive water uniformly. The suggested system has the capacity to save more water than the previous, installed system.

3.1 Automatic Sprinkler Irrigation System

Anemometer measure the wind velocity and wind direction and feed that measured signal to the Arduino controller. Arduino controller controls the solenoid valve based on the wind velocity and wind direction. The controlled pressurized water from solenoid valve is come out from sprinkler head. Depend on the sprinkler head the pressure of water is varied. The excess of water from the solenoid valve is again fed back to the well or reservoir. It helps to save large amount of water which exceeds from the sprinkler irrigation system. It can be reused again in the same sprinkler system. If wind direction changes, the sprinkler head tilted automatically based on the wind direction and distribute the water to the crops evenly.

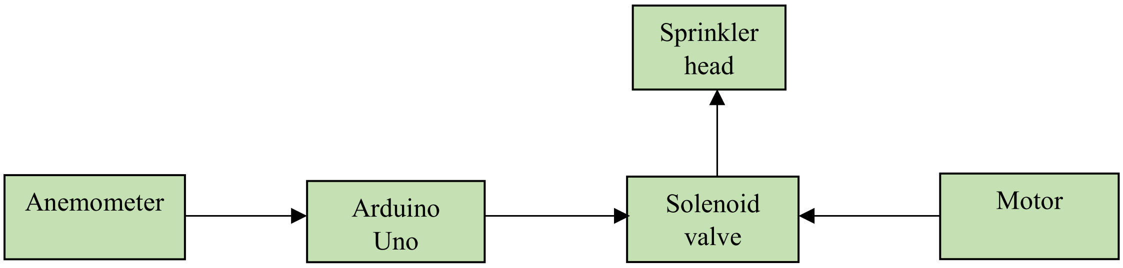


Fig.4: Block diagram of automatic sprinkler irrigation system

4.0 Results and Discussion

The clever device that measures wind speed, the anemometer, is the star of the show. The anemometer's revolving cups measure wind speed and translate it into electrical signals, much like a pinwheel dancing in the breeze. The simulation program then receives these signals, providing real-time wind data. It's time to bring the virtual world into reality after PROTEUS has perfected the irrigation plan. This is where the hardware prototype enters the picture. You can design and test a sprinkler system that incorporates the optimized settings in real life by using the insights obtained from the simulation.

Selecting PROTEUS as the simulation program was a brilliant move. PROTEUS offers more features and functionalities than other irrigation simulation programs. Envision possessing an abundance of tools in your toolbox, each one precisely crafted to optimize the functionality of your sprinkler system. That is the PROTEUS power at your command.

4.1 Proteus

For electronic design automated processes, a proprietary software tool package known as Proteus Design package is primarily used. It is a Windows application for creating schematics and designing circuitry on printed circuit boards (PCBs). Lab Center Electronics Ltd. created the Proteus Design Suite software tool set, which is shown in Fig. 5. It is primarily used for developing schematics, replicating electronics and embedded circuits, and constructing PCB layouts. It is used by both professional engineers and learners to model and diagrammatically depict different electronic circuits. Depending on the size of the designs being made and the specifications for microcontroller simulation, it is available in several forms. Basic mixed-mode SPICE simulation capabilities and an auto router are included with every PCB Design product.

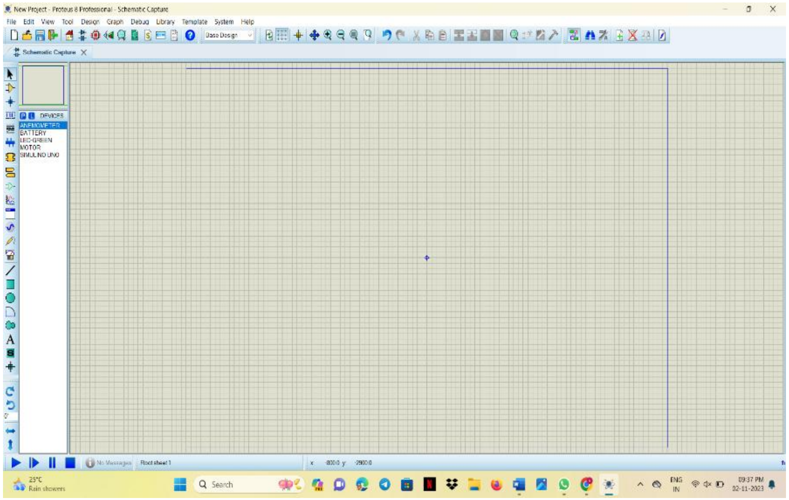


Fig.5: Simulation Page

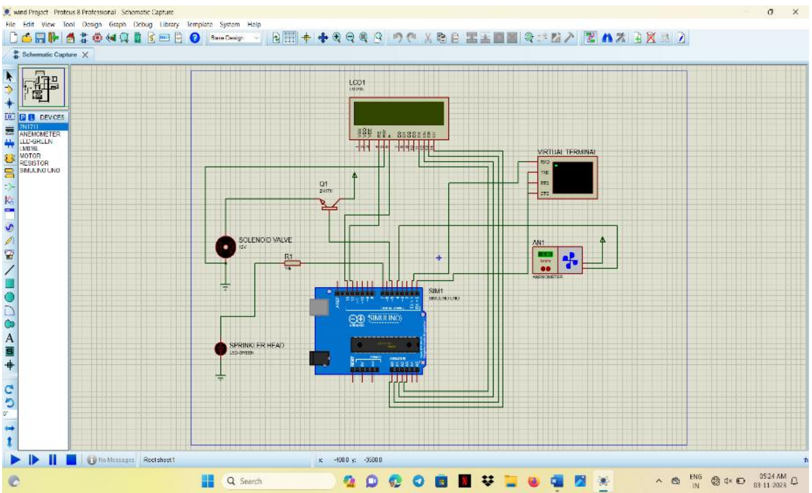
Proteus is an extremely flexible circuit design tool that functions best under perfect circumstances. Stated differently, the absence of pull-up resistors will prevent garbage values from being produced by Proteus simulation. With Proteus ARES, it is also utilized for PCB design. Schematic capture and PCB layout modules are combined by Proteus PCB Software to create an easy-to-use, robust, and reasonably priced toolkit for professional PCB design. In Proteus Virtual System Modelling (VSM), advanced rapid microcontroller simulation is combined with mixed-mode SPICE simulation. It allows for the rapid software prototyping of both firmware and hardware designs.

4.1.1 System Requirements

- Proteus software (Proteus 8.13)
- Windows 7/8/10 as the operating system
- 3GB of RAM
- The Online/Offline Installation Wizard

4.2 Simulation Results

In our project, measure the wind speed depicted in Fig. 6 to simulate the sprinkler irrigation system. The anemometer is operating normally at the beginning. The virtual terminal panel display (Fig. 8) indicates that the solenoid valve is open. The LCD shows that the wind speed is normal. The solenoid valve will activate if the anemometer is powered on. As seen in Fig. 9, the virtual terminal panel display reads "Solenoid valve is close." LCD displays changes in wind speed. The sprinkler head's water spray will be indicated by the glowing



LED.

Fig.6: Proteus Simulation

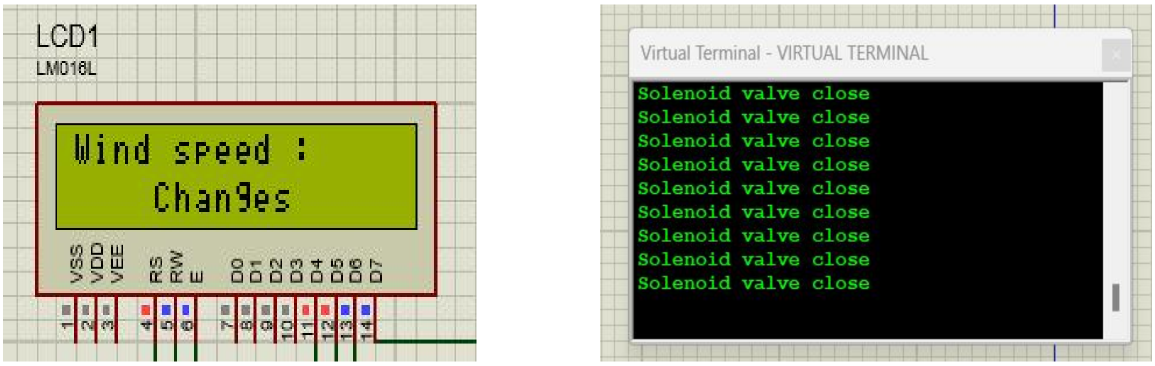


Fig.7: Changing wind speed

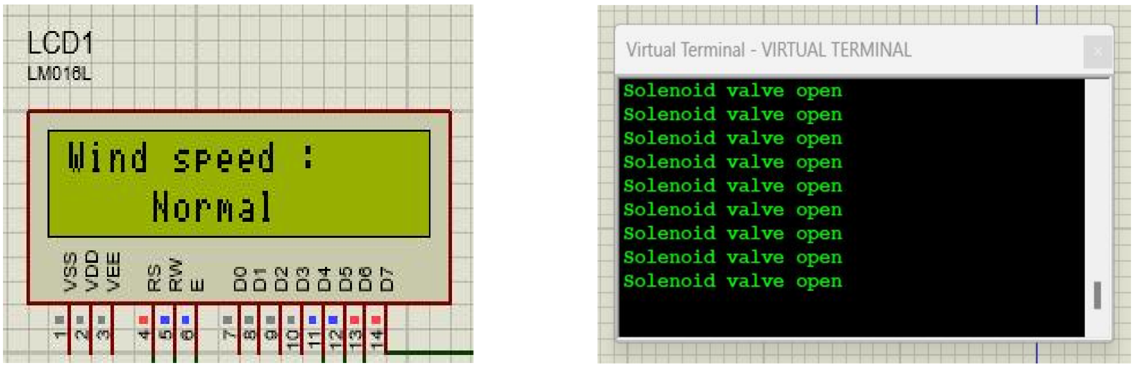


Fig. 8: Wind speed normal

4.2.1 Simulation Output

The valve stays open, allowing the water to flow freely as long as the wind whispers its secrets at a speed of 10 km/h. However, if the wind's amusing murmurs intensify into a loud shriek that surpasses 10 km/h, the valve opens. It clicks shut decisively, stopping the flow and shielding the fragile leaves from water jets driven by the wind. On the other hand, the valve opens again if the wind's breath wavers, dying into a quiet stillness. Water droplets hang heavy without the playful jostle of the wind, potentially suffocating the grass.

When the valve detects an imminent threat, it closes to preserve the valuable resource for when the wind starts dancing again. This expanded edition tells a story about how sprinklers work by delving deeper into the complex interplay between wind, water, and technology. It highlights the function of the valve as a protector of the water in harmony with the wind and uses personification and metaphors to make the situation come to life.

Because of this advantage, we can able to save large amount of water from the irrigation system. This system can be used in variety of applications like home garden, industrial applications and suppress growth in grain fields etc.

Table.1 Simulation output

INPUT/ Wind speed	OUTPUT/ Solenoid valve position
10 km/hr (Normal speed)	Solenoid Valve Open
>10 km/hr	Solenoid Valve Partially Close
>14 km/hr	Solenoid Valve Partially Close
>20 km/hr	Solenoid Valve Partially Close

5.0 Conclusion

Imagine an automated sprinkler system that is more than simply a sprinkler; it is a water whisperer, a careful steward of each and every one of life's precious drops. This creative sprinkler optimizes water use and safeguards your crops by measuring the whisper of the breeze using an anemometer. The anemometer senses the direction and speed of the wind, acting as a vigilant watchman. The silent conductor of the system, a smart solenoid valve, is empowered by this information. The valve modifies water flow in response to wind speed, avoiding unnecessary overspray. Additionally, the valve ensures that water is used efficiently by conserving it when the winds whispers stillness.

There are hints of even more promise in the future. Imagine an artificial intelligence-infused version of this system - a meteorological maestro that can forecast rainfall and modify water schedules on its own. A data-driven dance takes place on your field, with abundant harvests pinning water efficiency in a graceful manner. This sprinkler system is essentially a conversation starter rather than just a tool. It's a conversation between technology and the natural world, an attentive waltz of plentiful harvests and water conservation. It is a glimmer of hope for a day when each drop finds its ideal mate, nourishing life and guaranteeing a sustainable future.

References

[1] Zakaria Issaka, Hong Li, Yue Jiang, Pan Tang, Chao Chen, "Overview of emerging technologies in sprinkler irrigation to optimize crop production", Vol. 12 No.3 2013.

[2] Chandan kumar sahu, *Pramitee Behera*, "A Low Cost Smart Irrigation Control System", *IEEE Sponsored 2nd International Conference On Electronics And Communication System*, IEEE 2015.

[3] Anitha K, "AUTOMATIC IRRIGATION SYSTEM" *2nd International Conference on Innovative trend in Science, Engineering and Management*, ISBN: 978-93-86171-10-8, 2016.

[4] Vijayalekshmy S, Karthika Bose, Devika CM, "Automatic Plant Irrigation System using Arduino", *Proceedings of 2017 IEEE International Conference on Circuits and Systems (ICCS2017)*, IEEE 2017.

[5] Varsha P M, Varsha A, Shubhu H V, Parneeth Charanthimath,"Smartphone based Automatic Irrigation System", *International Journal of Engineering Research & Technology*, Vol. VI Issue 15,2018.

[6] Rana Johar, Ahmed Bensenouci, Mohamed-Amine Bensenouci, "IoT Based Smart Sprinkling System", IEEE 2018.

[7] Arijit Ghosh, Sraddha Chakraborty, Avrajit Ghosh, Prajjwal Mondal, Asmita Mondal, Madhumita Guha, "A Smart Irrigation System", *Proceedings of 2018 IEEE Applied Signal Processing Conference (ASPCON)*, IEEE 2018.

[8] Arif Nursyahid, Tholud Aprilian, Thomas Agung Setyawan, Helmy, Ari Sriyanto Nugroho, Deddy Susilo "Automatic Sprinkler System for Water Efficiency Based on LoRa Network", IEEE 2019.

[9] Nechita Adrian Mihai, Ocoleanu Constantin Florin, "Solution For Water Management Using A Smart Irrigation System", IEEE 2019.

[10] Nirali Hemant Patel, Chintan Rajnikant Prajapati, "Agricultural Sprinkler for Irrigation System", *International Journal of Engineering Research & Technology (IJERT)*, ISSN: 2278-0181, Vol. 9 Issue 05, May-2020, 2020.

[11] N. Kaewmard, and S. Saiyod, "Sensor data collection and irrigation control on vegetable crop using smart phone and wireless sensor networks for smart farm," *Proc. 2014 IEEE Conference on Wireless Sensor (ICWiSE)*, Malaysia, pp. 106 – 112, 2014.

[12] G. Rajagopal, V. Lodd, A. Vignesh, R. Rajesh, and V. Vijayaraghavan, "Lowcost cloud based intelligent farm automation system using Bluetooth low energy," *Proc.2014 IEEE Region 10 Humanitarian Technology Conference (R10-HTC)*, India, pp. 127 – 132, 2014.

[13] B. Balaji Bhanu, M. Ali Hussain, and P. Ande, "Monitoring of soil parameters for effective irrigation using Wireless Sensor Networks," *Proc.2014 Sixth International Conference on Advanced Computing (ICoAC)*, India, pp. 211 – 215, 2014.

[14] F. Caetano, F. Pitarmaa,and P. Reisb,"Intelligent management of urban garden irrigation," *Proc. 2014 9th Iberian Conference on Information Systems and Technologies (CISTI)*, Spain, pp. 1 – 6, 2014.

[15] G. Yang, Y. Liu, L. Zhao, S. Cui, Q. Meng, and H. Chen, "Automatic Irrigation System based on Wireless Network," *Proc. 2010 8th IEEE International Conference on Control and Automation (ICCA)*, China, pp. 2120 - 2125, 2010.

[16] A. Tyagi, N. Gupta, J.P. Navani, M.R. Tiwari and M.A. Gupta, M.A., "Smart Irrigation System", *International Journal for Innovative Research in Science & Technology*, vol. 3, 2017, pp. 9-12.

[17] R. Subalakshmi, A.A. Amal and S. Arthireena, "GSM Based Automated Irrigation Using Sensors", *International Journal of Trend in Research and Development*, 2017, pp 4-6.

[18] V.L. Akubattin, A.P. Bansode, T. Ambre, A. Kachroo and P. SaiPrasad, P., "Smart Irrigation System" *International Journal of Scientific Research in Science and Technology*, vol. 2, 2016, pp. 343-345.

[19] P.Rajalakshmi, S.Devi Mahalashmi (2016) "IOT based crop-field monitoring and irrigation automation", *10th International Conference on Intelligent Systems and Control (ISCO)*, IEEE Press., 2016, pp. 1 – 6.

[20] R. K. Kodali, A. Sahu, "An IoT based soil moisture monitoring on Losant platform ", *2nd International Conference on Contemporary Computing and Informatics (IC3I),* IEEE Press. 2016, pp.: 764 – 768.

[21] V. Vijayhari Ram, Vishal, S. Dhanalakshmi, A. Sahu, P.Meenakshividya, "Regulation of water in agriculture field using Internet of Things" *IEEE Technological Innovation in ICT for Agriculture and Rural Development (TIAR)*, 2015, PP.122 – 115.

[22] D. K. Sreekantha; A. M. Kavya, "Agricultural crop monitoring using IOT – a study" *11th International Conference on Intelligent Systems and Control (ISCO)*, 2017, PP.134 – 139.

[23] G. Ali, A. Shaikh, A. Rehman, and Z. Shaikh, "A framework for development of cost-effective irrigation control system based on Wireless Sensor and Actuator Network (WSAN) for efficient water management," *Proc. 2010 2nd International Conference on Mechanical and Electronics Engineering*, pp. V2-378 - V2-381, 2010.

[24] N. Vijay, "Application of Sensor Networks in agriculture," *Proc. IET Third International Conference on Sustainable Energy and Intelligent System (SESICON 2012)*, India, pp. 1- 6, 2012.

ISSN: 2366-1313

[25] A. Imteaj, T. Rahman, M. K. Hossain, S., 'IoT based percipient autonomous irrigation system using raspberry Pi',*19th International Implementation of IOT In Smart Irrigation System Using Arduino Processor Conference on Computer and Information Technology (ICCIT),* IEEE press., 2016, pp. 563 – 568.