



Explication of Conventional and Smart Irrigation Systems with Challenging Factors

Janani M and Jebakumar R*

Department of Computer Science and Engineering, SRM Institute of Science and Technology, India

***Corresponding author:** Jebakumar R, Department of Computer Science and Engineering, SRM Institute of Science and Technology, Kattankulathur Campus, Chennai-601302, India, Email: jebakumr@srmist.edu.in

Mini Review

Volume 7 Issue 2

Received Date: November 24, 2022

Published Date: December 08, 2022

[DOI: 10.23880/cclsj-16000176](https://doi.org/10.23880/cclsj-16000176)

Abstract

Throughout the world agriculture is the essential source of food. Therefore it is necessary to have a proper irrigation system for good productivity in agriculture. There are several factors that affect irrigation system such as irregularity in the distribution of rainfall, water scarcity, superfluous irrigation, scant irrigation, climate change, degradation of water quality etc. Each irrigation systems are combined with various technologies and proposed with various methods to enhance the irrigation management and reduce the water usage. Furthermore to raise the soil fertilization and diminish crop disease through the irrigation will help to magnify the productivity. The paper focused and analysed the existing and modern irrigation systems. This facilitates farmers to select suitable irrigation system according to their specifications.

Keywords: Sensor; IoT; Irrigation; Agriculture; Automation; Challenging Factors

Abbreviation: IOT: Internet of Things; WSN: Wireless Sensor Network; PMDI: Precision Mobile Drip Irrigation; PERC: Propane Education and Research Council; GUI: Graphical User Interface.

Introduction

In agriculture irrigation is the process in which water is supplied to soil or land. This helps to increase crop yields, maintain landscapes, revegetate distributed soils in dry areas and stabilize production. The water for this irrigation comes from diverse sources such as rainfall, ponds, wells, dams, rivers, reservoirs etc. The traditional irrigation methods used these resources and resulted in good cultivation. But it needs more number of manual interventions. Traditionally soil health was good and water problem did not exist. But in present situation global warming and population growth

leads into some problems such as water scarcity, unexpected climatic condition, low soil moisture content and absence of toxic substances in soil etc [1,2]. So there is a need to save water and use it properly and efficiently. Earlier decades modern irrigation systems have introduced to use water economically without wastage. But in modern irrigation initial cost is high. It requires proper deployment and maintenance. The hybrid modern irrigation also developed and applied in very large field in some countries which is complex in maintenance and requires high cost [3]. If the water scarcity continuous after some decade water availability will not be there for irrigation in agriculture.

To strengthen the irrigation system various methods of irrigation systems are combined with different technology. Those are Machine learning, IoT (internet of things), WSN (wireless sensor network), cloud computing, big data.

Machine learning technique can be used only with large number of data set to get result. Internet of things technology used for communication purpose between field and system. Wireless sensor network technology used to get real time data from field through sensors. Cloud computing technique used for store and access the data related to agriculture. The stored data can be processed through big data technique. Irrigation system using different method and technology were implemented using interfaces and performed regionally throughout the world. Because of the location and weather condition as well as the availability of nearby resources. It resulted in less manual intervention, decreased crop diseases, less water usage, less power consumption and increased cultivation [4]. The focus of the each developed irrigation system was to achieve efficient automatic irrigation in agriculture.

The major types of traditional and modern irrigation systems are discussed in section 2 and 3. The challenges behind the traditional and modern irrigation system listed in section 4. The introduction of different irrigation system is discussed in section 5.

Traditional Irrigation

Traditionally the arid or semi-arid area which has very low water content, the water is supplied manually to the fields or using different traditional method. Those are hand pumps, canals, tube wells, Check Basin, Furrow Irrigation, Strip Irrigation, and Basin Irrigation. That conventional method achieved good production in few decades ago but which needs human or animal intervention to function and had faced problems like high water use efficiency, superfluous irrigation, and scant irrigation [5]. Some traditional irrigation method discussed below.

Check Basin Method

Based on the capacity of water the entire field is divided into multiple basins. Which are joined through a tiny furrow type for water flow? This method is very useful in soils that have less infiltration. . It does not need any technical knowledge. In basin method, rain water stays in basins, so there is less chance for soil erosion. Economic investment is less. It irrigates wide area. Crops get efficient water [6]. The water absorption in drains causes of water wastage.

Furrow Irrigation Method

Furrows are formed in between crops. The water provided in field by gravity to reach crops and moisturises soil till the end of the field. The quantity of water supplied maximum depends on the intake of water by plants and soil infiltration rate. The furrow irrigation mainly has five

types which used based on the different situation. Those are contour furrow, sloppy furrow, corrugated furrow, serial furrow, and levelled furrow. If the furrow filled once then need not to do irrigation second time. At a time irrigation is possible for large area [6]. Crops gets efficient amount of water by this method. But it is not suitable for all kind of crops.

Basin Irrigation Method

Basin irrigation is one of the surface irrigation methods. It maximum used in orchard field. The farmed basins are joined with each other via drains. It requires levelled field for less economical investment [6]. Once the irrigation starts it reaches each tree subsequently and automatically but this method is not suitable for all crops.

Strip Irrigation Method

Strip irrigation is a hybrid method.it is a combination of basin and furrow irrigation. The field is divided into multiple number of strips in various size based on the slope. The field levelled perpendicularly to make the water flow in centre of the border strip irrigation. If the strips are wider which causes water wastage? In field the source of water is supplied from the high place to achieve water flow throughout the field. It is a low cost irrigation method for wide area and it needs less manual intervention.

Modern Irrigation

To overcome the conventional irrigation problem modern irrigation system has introduced .it has different types. Those are drip irrigation, sprinkler irrigation, pot irrigation. But to adopt this irrigation farmer needs to spend money to buy hardware equipment and setting up the process of this irrigation requires provider [6]. Maintaining the irrigation set up is complex which has to be serviced by providers in limited time period or it has to be exchanged by new setup due to some factors.

Drip Irrigation

Drip irrigation method was developed in Israel then it is started to use in most of the water scarcity areas which is mostly used for irrigate field like vegetables and fruits. It is also known as trickle irrigation. This method can also be used for soil management. Required amount of water is supplied in the form of drops via nozzles, it uses tubes to irrigate particular area around the plant or root zone of the plant and reduces weed's growth and improves water efficiency. Compared to flooding method the water may be saved up to 70%. In addition pesticides and fertilizers can also mix with water and passed through tubes.

The two types of drip irrigation system are Surface and sub-surface. In Surface drip irrigation mechanical harvesting is not easier and it is short-life span system. The sub-surface irrigation is more efficient compared to surface irrigation because of less evaporation rate and less water usage. It is effective system that transports the water directly to the root zone and it is especially suitable for arid and windy area. It is long-life span system and mechanical harvesting is easier. But maintaining the mechanical components such as pumps, filters, valves and repairing the buried pipes is complex. The rodent management is another difficult task to protect the system [7]. The Sub surface system is cost effective that requires expert design and maintenance and it is suitable for medium and large-scale production.

Drip irrigation provides both significantly higher yields using less quantity of water, the same time less environmental impacts in different categories. But it has high power consumption and financial costs associated with its establishment are higher. It is not suitable for all the crops and plants may not get efficient nutrients. It requires technical knowledge.

Sprinkler Irrigation

Sprinkler irrigation method can be installed in three ways such as permanent, semi-permanent; temporary in which water is supplied to the field through pipes on the top sprinkler is attached with that to spray water. To maintain humidity this method adopted in regions like high temperature, water scarcity, uneven ground level and sandy soil. The efficiency of this irrigation may increase from 60 to 90%.

In permanent installation pipes can be installed in surface or underground but it cannot be shift from installed place. In case of surface installation there is a chance of breakage. In semi-permanent installation, main pipelines are secured in sub surface and other pipelines are fixed in surface. Through that in entire field the water supplied by moving the place of other pipelines. In temporary installation, according to the requirement it is possible to change the position of pipelines which is installed temporarily. Drawback of this system is expensive, crops can be damaged by frequent changes of pipelines and clogging issue in flow path of pipes will affect the sprinkler head pores. It also has different types like drip irrigation such as Rotary Heads, Spray Heads, Bubblers [7,8].

Pot Irrigation

Pot irrigation method was introduced in Iran and North Africa. This irrigation mostly adopted in less rainfall area and saline soil region. A cylindrical shape of pots are buried in the sub surface up to the neck and loaded with water. The

purposes of the Pores made in pots are for seepage in soil. Some attributes affecting the spreading of humidity around the pot such as size of pot, type of soil, seepage of water from pore and distance in-between the pots. Advantage of this method is less evaporation rate, absorption of the moisture limited around the pot [7].

Hybrid Irrigation

Hybrid irrigation was implemented and used in western countries. For example to reduce the water cost and boost yields precision mobile drip irrigation (PMDI) was developed by Bob Gruner. PMDI system is the combination of drip and sprinkler irrigation. Which consist of drip tubes? The tubes are dragged through the field, emitters provides an even water pattern throughout the field. In this the water distributed in field and absorbs into the soil which avoids the problem of runoff and evaporation. This system reduced the irrigation expense and increased the yields. To prevent clogging issue the system needs filtration and chemical treatment [9]. The system ties up with hoses in winter season to avoid the damage from rodents and livestock.

Propane Powered Irrigation

Instead of diesel powered engine propane powered engine developed to irrigate crops by PERC (Propane Education and Research Council) in America. It showed 28 percentage higher performances [10]. The propane powered farm equipment's are low cost, more reliable compared to diesel engine.

Challenging Factors in Irrigation System

There are some challenging factors that minimize the performance of smart irrigation system. Some factors are discussed below.

Power Consumption

Power consumption is the one of the main factor in irrigation technology. There is an inherent link between climatic condition and the load of electricity used for irrigation. If the drought rate is high then crop and soil needs more water. So providing water frequently and long-duration of time is essential in arid area. In night time irrigation it uses less water due to less evaporation rate and seepage. The water pressure differs according to the irrigation types for e.g. hydraulic gun sprinklers needs high pressure and micro or surface irrigation needs low pressure. The selection of high pressure irrigation and frequency of irrigation and depth of irrigation uses more power [11]. The same time over irrigation leads to crop getting destroyed and water wastage along with electricity wastage too.

In modern irrigation technology various hardware devices were integrated and used for automatic irrigation such as wireless sensors (low power consumption sensor), microcontroller, laptop, mobile phone, interfaces, batteries, motor, and pumps. These devices require electricity to do irrigation. Based on sensor measurement if the thresholds limit goes below the irrigation process get started through micro controller. Then after reaching threshold limit automatically the process get stopped. To reduce the power consumption these integrated devices subsequently and automatically will go to sleep mode after completing its own process in that way it programmed in microcontroller [11].

Cost

Traditionally irrigation management cost is very less but current irrigation management it requires more cost for multiple purpose. Those are hardware deployment and maintenance, usage of electricity and internet connection between server and user. Buying Fertiliser and pesticides also increases the cost of irrigation system. Then rodent, wildlife can cause damage in irrigation tubes. To prevent the damage strip tillage method used along with burying in surface irrigation [9]. The integration of solar energy system with new modern irrigation technology helps to reduce the electricity cost of irrigation system.

Water Consumption

Superfluous irrigation and scant irrigation are the two main issues in irrigation management. Excess irrigation leads to crop diseases, poor quality in production and land degradation. Under irrigation leads to salinization, dehydration of plant, and yield reduction. Wireless sensors are used to sense some parameters like soil moisture, soil temperature, and weather condition etc. Based on prefixed value the sensor's sensed values are compared automatically. According to that efficient amount of water is irrigated in field [5,12]. Thus constant monitoring through sensor assists to provide efficient water and reduce the water wastage.

Health

Farmers or field workers were used to fed pesticides and fertilizer to field. The direct contacts of fetching those substances are harmful for their skin. In modern irrigation substance are mixed with water and passed through tubes or sprayed through drones to enhance the irrigation. It protects the field worker and farmer from skin diseases. Excess amount of feeding fluid through irrigation will affect the Food consumer health. To product consumers health sensors are used to measure the pH value and according to that

appropriate amount of fluid are applied. Farmers updating the cultivation process information step by step in database through network [13]. This helps consumer to know about the source/treatment of their food.

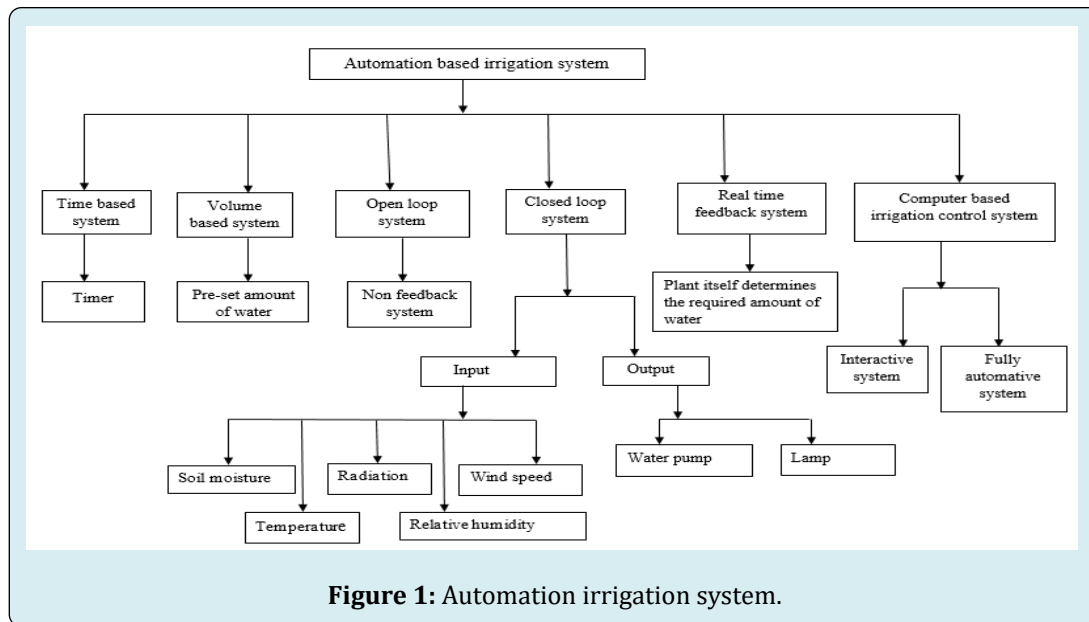
Internet and Security

Presence of human availability is important in traditional or manual irrigation. Which consumes more time? In modern irrigation technology Graphical user interface (GUI) is software developed for irrigation. GUI used for two way communication in between farmer and field through internet. It helps to set the irrigation scheduling. Real time monitoring takes input from the user and accordingly performs desired action. It can be accessed by owner alone for security purpose. Otherwise without the knowledge of field owner the attacker will misuse the irrigation system. The Stored information can be viewed by anyone for informatics purpose. GUI helps owner to access irrigation system from anywhere at any time [14]. This remote monitoring reduces the need of presence of availability. The network failure may occur due to variety of reasons including communication issues, battery failures and loose cabling. Various schedule audit tools are used to understand the reason for failure.

Automation Based Irrigation System

Automated irrigation is possible with the combination of hardware and software devices and integration of multiple technologies as mentioned in introduction. The different irrigation system based on automation [15-18] mentioned in Fig. 1. It has six different types of system. Those are time based system, volume based system, open loop system, and closed loop system [19], real time feedback system and computer based irrigation control system. Timer or clock controller is an integral component of time based system. it is important tool to distribute efficient amount of water at the right time. The process of irrigation started and stopped by timer. The level of water pre fixed in volume controller that is volume based system. The operator decides how much quantity of water to be distributed and the timing of the irrigation process in open loop system. The control strategy is developed by operator in closed loop system (Figure 1).

Based on the strategy system will take decisions to provide water. Different sensors are used to measure environmental characteristics and send the real time data in real time feedback system. In computer based system it consists of the combination of software and hardware. It will act as a supervisor to manage and maintain the irrigation system.



Conclusion

According to this study by applying different technology such as wireless sensor network, internet of things, machine learning, and cloud computing and big data in smart irrigation system helps to use water in efficient manner. It increased the water saving level and reduced the water wastage. The survey analysed existing and modern irrigation systems and discovered the familiar method used for water savings, less power consumption, time management, low cost production, and less manual intervention. This survey may helpful for provide prior knowledge about entire irrigation system. This facilitates farmers to select suitable irrigation system according to their specifications.

References

- Gutiérrez J, Villa Medina JF, Nieto Garibay A, Porta Gándara MA (2014) Automated Irrigation System Using a Wireless Sensor Network and GPRS Module. *IEEE Transactions on Instrumentation and Measurement* 63(1).
- Issaka Z, Li H, Yue J, Tang P, Darko RO (2018) Water-smart sprinkler irrigation, prerequisite to climate change adaptation: a review. *Journal of Water and Climate Change* 9(2): 383-398.
- Tharran Gaines (2017) Cut Water Costs and Boost Yields with Drag Hose System. *Irrigation*.
- Raheman A, Rao MK, Vamsi Reddy B, Ravi Kumar T (2018) IoT based self-tracking solar powered smart irrigation system. *International Journal of Engineering & Technology* 7(7): 390-393.
- Gupta A, Krishna V, Gupta S, Aggarwal J (2016) Android based Solar Powered Automatic Irrigation System. *Indian Journal of Science and Technology* 9(47): 1-5.
- Traditional and Modern Irrigation Methods.
- (2015) Modern Irrigation Techniques. Technology.
- (2019) Different Kinds of Sprinkler Irrigation Systems. *Water Conservation for Lawn and Landscape*.
- Sorensen RB, Nuti RC, Lamb MC (2007) Rodent Management for Surface Drip Irrigation Tubing in Corn, Cotton, and Peanut. *Peanut Science* (2007) 34(1): 32-37.
- David Bennett (2014) Propane or diesel engines?. *Farm industry news*.
- Latham T, White CJ, Remenyi TA (2018) The relationship between irrigation-induced electrical loads and antecedent weather conditions in Tasmania, Australia. *Irrigation Science* 36: 167-178.
- Montesano FF, van Iersel MW, Boari F, Cantore V, D Amato G, et al. (2018) Sensor-based irrigation management of soilless basil using a new smart irrigation system: Effects of set-point on plant physiological responses and crop performance. *Agricultural Water Management* 203: 20-29.
- Scott CA, Drechsel P, Sally LR, Bahri A, Mara D, et al. (2010) Wastewater Irrigation and Health: Challenges and Outlook for Mitigating Risks in Low-Income Countries. *Research in Agriculture & Applied Economics* pp: 381-384 .

14. Fan Tong Ke (2013) Smart Agriculture Based on Cloud Computing and IOT. Journal of Convergence Information Technology (JCIT) 8(2): 1-7.
15. Stauffer B, Spuhler D (2018) Automatic irrigation. Sustainable Water Supply.
16. Lee Jaenam (2022) Evaluation of Automatic Irrigation System for Rice Cultivation and Sustainable Agriculture Water Management. Sustainability 14(17): 11044.
17. Janani M, Jebakumar R (2019) A study on smart irrigation using machine learning. Cell Cellular Life Sci J 4(1): 1-8.
18. Shivam R, Deepti Singh. (2022) Comparative Analysis of Smart Irrigation System Using IOT. Proceedings of the 2022 Fourteenth International Conference on Contemporary Computing pp: 653-659.
19. Sandeep KS, Jahnavi MS, Swapna K, Keerthi D, Tejaswini A (2022) Automated Irrigation Management System using IoT. 6th International Conference on Intelligent Computing and Control Systems (ICICCS 2022) IEEE.

