# A Precise and Autonomous Irrigation System For Agriculture: IoT Based Self Propelled Center Pivot Irrigation System

Shilpa. A
*Computer Science and Engineering*
*Sri Krishna College of Engineering and Technology*
Coimbatore, India
17epcs014@skcet.ac.in

Muneeswaran. V
*Computer Science and Engineering*
*Sri Krishna College of Engineering and Technology*
Coimbatore, India
muneeswaranv@skcet.ac.in

Devi Kala Rathinam. D
*Computer Science and Engineering*
*Sri Krishna College of Engineering and Technology*
Coimbatore, India
17epcs004@skcet.ac.in

***Abstract*— Agriculture area performs a strategic function in system of financial development of a rustic. In India, the agriculture area acts as the backbone of a financial system. About 70% of general population of India is at once and circuitously rely on agriculture for their livelihood and other similar needs. Tremendously growing population of our country has positioned a tremendous strain on the farming quarter. Nowadays water shortage is a main difficulty for agriculture. Therefore efficient water control needs to be taken into consideration during irrigation, on that account availability of water to plants on the time of requirement is an indispensable aspect to get most manufacturing of plants to meet the food production target of the country. In this stage, the synthetic irrigation comes into the situation. At Present in India, Drip & Sprinkler irrigation are being practiced. This paper additionally discusses one such modern approach of irrigation known as Self Propelled Center Pivot Irrigation System. This pivot irrigation enables farmers to irrigate a land in a circular sample through the use of its specific method. And this technique commonly applies water quite uniformly, in order that equal quantity of water is shipped during the farmland.**

**Keywords—self-propelled, pivot, Drip irrigation, uniform distribution.**

## I. INTRODUCTION

The Center pivot irrigation system was found by a farmer Frank Zybach in the year 1940 in Colorado, Strasburg. After his invention this method has turned in to a water distribution technique to irrigate the field in an most efficient manner. This form of irrigation is also named as overhead sprinkler irrigation due to its structure as this system includes numerous pipe segments joined together by way of trusses to balance each other. The whole assembly is installed on tires due to which it rotates in circular manner round a primary point known as Pivot Point. The space between tires is called Span. The typical Assembly of center pivot irrigation system is shown in Fig. 2. The arm of the device is connected with range of pipes at fixed durations of horizontal distance between them are referred to as sprinklers. The common amount of water from sprinkler can be controlled by Control Unit. Various changes in the machine have accomplished time to time to gain ideal overall performance from the authentic idea of the gadget and to match various topographical and climatic situations of different locations of the area. The Centre Pivot irrigation comes beneath the class of Self Propelled irrigation system and in USA approximately 29% of the entire irrigation is done via such self-propelled system of irrigation. The aerial view indicates the sample of farm in Figure 1 Such a mechanized approach of irrigation leads to accelerated yields in much less use of water.

Fig. 1. Aerial View of landscapes with Center Pivots

Fig. 2. Assembly of Center Pivot irrigation system.

India has massive possibility to adopt this center pivot system even if it is more expensive than the conventional method of watering the crops like border strip or furrow method because of its long term returns to the farmers; the information of which can be given in in addition part of this paper.

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## II. ROLE OF IOT IN CENTER PIVOT IRRIGATION

In this work a thought is given towards the Self Propelled Center Pivot Irrigation System using IoT as first step towards future smart Irrigation. As this technology uses smart sensors like soil moisture, Temperature etc., to measures the values and send to the database for storage and analyze the data's obtained from the field and based on that result crops are irrigated. As this system is based on IoT, it is automated and can be accessed from anywhere in the world.

For irrigating land using center pivot irrigation, farmers/user needs to be connected to the internet. And need to be able to make quick, informed decisions from your field's data, so that you can spend more time on the things that matter most: your family, your friends, and other parts of your farming operation. And none of that is possible without the Internet of Things in our work. By connecting this device with IoT following uses will be obtained:

- Remote monitoring capability is available so that it reduces water resources and manpower, which in return saves money.
- Furthermore it helps to increase field productivity which is vital for production.
- The pivot monitor and controller enable users to remotely view and monitor their centre pivots for Irrigation IoT. Along with moisture probe readers and other sensors used in farming operations

## II. INTERNATIONAL RECORDS OF CENTER PIVOT IRRIGATION

T-L Irrigation Solutions commercially launched Centre Pivot system approximately 50 years in the past in USA. Fig 3 indicates primitive picture of the machine. This system is considered as "an historic landmark of agricultural engineering" in the year 1952 by the American Society of Agricultural & Biological Engineers. In 22 July 1952 a patent become issued to Frank Zybach named as a self-propelled sprinkler irrigation system.

Then in 1954, after two years modified version of the system is introduced in Nebraska and adopted it successfully by another American Robert Daughtery of Valley Manufacturing Inc. Up to 1960 Valley Manufacturing Inc advertised the system on big scale. In the year 1969 patent license got expired towards the updating in the system in several ways and later it was launched commercially by the big landlords of USA in order to serve their needs. By using traditional method of irrigation there were shortage of labors to supply the water to crops. For this reason this system's demand had increased suddenly after the year 1975. Another most important reason behind using this system for irrigation was due to uneven land topography. By the organization source of www.livinghistoryfarm.org it was the reported about 2, 58,000 systems which is of similar kind that were installed till 2002.

For irrigating rectangular fields this kind of system is used typically by other nation such as Australia, Brazil and New Zealand where they follow most advanced technology in farming especially to draw good attention towards the system.

Fig. 3. Primitive structure of Center Pivot system.

To accelerate the cultivation from their farms, the Indian farmers recommended the government using the annual report collected from the National Seed Corporation by the year 2014-15 to encourage the farmers to adopt this system particularly to the farmers who posses large amount of land. This irrigation system reaches the maximum numbers of farmers through their consistent demand from various manufactures of irrigation system to subsides the authorities and it has been proved that India is a leading manufacturer of the system from the recent survey in Pune (India) which can be used even during the time of power cuts/failure as it is solar powered.

## III. COMPARISION OF VARIOUS SYSTEM DESIGN

### *A. Circular system*

The most generally used design of the device includes an arm whose duration is set 1320 ft i.e. four hundred m and the arm is set 10 ft above the floor with the intention to additionally cover those crops whose top height is more including Wheat, Sugarcane etc. But plants which grow very close to each one are not appropriate for the system due to the fact they will oppose the motion of tyers in ahead, backward or circular manner.

In the primitive design of the device metal wheels have been used for motion but it found that the wheels get sunk in the muddy saturated soil which used to deliver a further pressure at the motor that's causing the motion of wheels. Therefore, within the modifier versions, low stress rubber tyers became famous which make easy for movement even on undulated area surface then systems were water powered in a while they became hydraulic but there days they may be pushed with the aid of electric powered vehicles or the usage of very increase technology which include sun power to decrease its running cost. For circular machine there may be a pivot factor round which the arm rotates in $360^0$ and water enters within the sporting point at this point. The entire weight of pipe material along with water is coped up by the vertical structure which is termed as tower and span

is defined as the distance between two towers. Then the wheels are used to move around the field and it is a part of the system. And truss system supports the whole assembly. The speed of rotation can be controlled through digital display unit and control panel which acts a heart of the assembly. Water quantity that to be discharged in the field can also be controlled through digital display unit.

The farmers can use this system in order to look after their other important task of the farm by making use of the advance package of the system and this circular system also provides the automatic on/off arrangement of the system for certain time period. More number of circular rotations is present at the inner circles as it contains smaller radius. And less number of rotations will be present at the outmost area of the farm in the similar time intervals. Therefore water sprinkle rate at outer portion is higher than that of portion in the inner layer. Typically low weight galvanized iron pipes are used for carrying water. These pipes are about 4 inch to 12 inch in diameter i.e. 100 mm to 300 mm. Due to more requirement of it increases water towards the outer side.

### *B. Rectangular System*

If the field is of irregular in shape most of times the circular systems are considered to be useless, so that the rectangular systems are used. Then the smaller systems are applied to the field, after that the field is partitioned in to rectangular shapes. Between two fixed ends, the movement of the assembly is forward and backward and it is considered as most important thing to note particularly for rectangular system. According to the Indian agricultural sector, in India most of the fields are of irregular in shape and it is less than 2 acres. Typically these characteristics are more suitable for Indian agriculture.

### *C. Lateral System*

The lateral system also comes up with the other version and that has a separate machine. Then the machine irrigates the field up to 95% by travelling along the sides of the field. This system is more efficient than the circular system in terms of irrigation under particular area. In order to supply water it requires the separate length of pipe to be attached to the system, so that this system is costlier than other systems. From the source water is supplied continuously through the attached length of pipe. For large farms it becomes uneconomical one especially for farms more than 100 acres.

### *D. Corner System*

The corners of the field are often left unirrigated on adopting the circular system and it is further irrigated through other methods of irrigation such as sprinkler irrigation system in order to cover the unirrigated area of the field. There is also other method called furrow method which can also be used to irrigate the field in useful manner and it is uneconomical for the farms. In most of the large fields this corner system is practiced to introduce the circular system separately at the small scale level and especially in the all circular corners of the land.

## IV. OBECTIVES OF THE SYSTEM

The primary objective of this Center-pivot irrigation system is to save water and energy by making efficient use of available resource. And it provides the control amount of water supply limitedly in short interval of time. Also it enables the operators by obtaining better available irrigation scheduling procedure. Conventional high pressure Center-pivot irrigation system requires a huge volume of energy needed for development of the necessary pressure for the powerful operation. If the pressure requirement is able to be lowered, then the energy savings can be achieved between 20% and 40%. Application of runoff water can be increased on gradually decreasing the pressure of center pivot system. The individual sprinklers water distribution radius is reduced automatically on lowering the pressure of water. Hence by reducing the area on which the water is applied.

Due to this reason the system results in rise of water application rate, also the runoff potential increases the water application. And the irrigation application efficiently reduces the performance of it, while part of the energy gained through savings are nullified by pressure reduction.

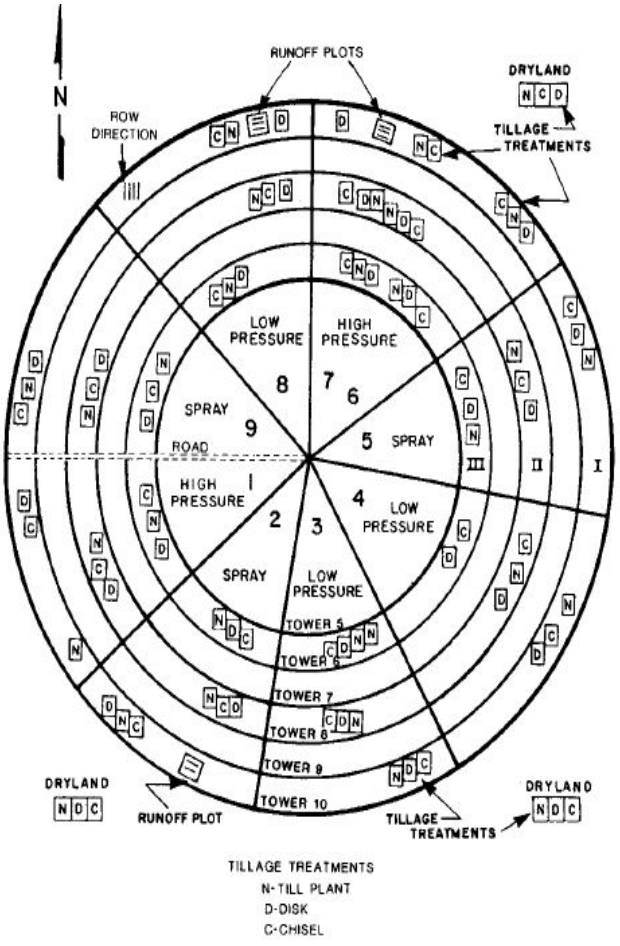


Fig. 4. Layout of Center Pivot Irrigation System in Experimental form

The runoff irrigation water inhibits the soil infiltration loss on depending upon the topography and type of the soil as explained in Fig. 5. Then the rate of application in irrigation water gets exceeded based on the infiltration rate of soil. An outer end of conventional system becomes little high while compared to other systems. And it is often

unpredictable one as its infiltration rate exceeds over the application rate.

Under the reduced pressure systems this problem may become more difficult to solve. In order to control the runoff water tillage system must be developed over the irrigated agriculture from the center pivots in a reduced pressure for allowing their use up on larger variety of topography and types of soil. By incorporating the limited number of tillage system represented in Fig. 4, residue on plants helps in maintaining the surface of soil by ensuring the maximum protection from the erosion of soil. And through this system surface water storage is increased. It also provides the solution for reducing the runoff problem.

In the Nebraska University research program has been started comprehensively for the purpose of evaluating the low pressure pivot system and to examine the result of interactive, reduced tillage system. The solutions for problems of reduced pressure tillage system are been found using detailed field experimentation on combination with the mathematical modelling. And hence the guidelines are been developed further to implement the system in some other locations. The experimental center-pivot system is described using the system performance.

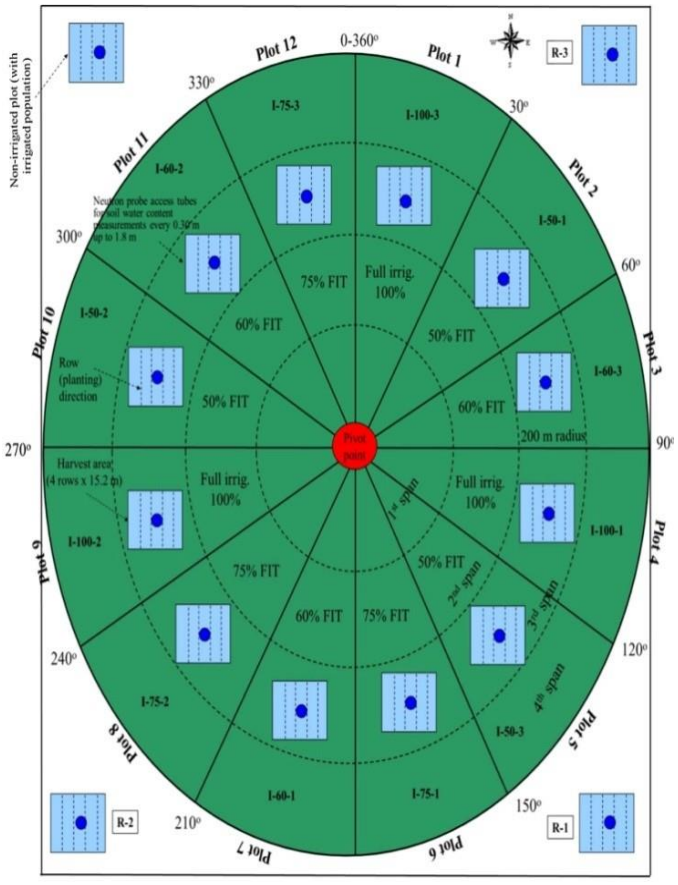


Fig. 5. Evaluation of Long-Term result of Variation in Pivot Irrigation System in Interannual Evapotranspiration of Maize Irrigation

## V. ADVANTAGES & DISADVANTAGES

### A. Advantages

- For irrigating large fields it is the most economical and efficient method. It considerably saves water as it requires only about 60% of water than the traditional irrigation method.
- For each plant Herbicides, pesticides and soluble nutrient can be directly fed in to it.
- Chance of getting affected by diseases is been greatly reduced as water washes the leaves of the plants.
- In order to prevent disease and theft, the towers of the system can also be equipped with CCTV cameras to inspect the diseases on crop plants and for theft supervision for large fields.
- The system is suitable even for undulating field, as the rubber tyres with moderate shock absorbing arrangement is made.
- As the water flowing over the ground is not due to gravity effect, So that soil needs not be in level.
- This system do not need almost no labours for operating as the Indian farmers suffers a lot due to shortage of labour power often so this system is to be proven best one for irrigating the field.
- The farmers needs not be present in farm during the time of application of water as the system is fully automatic.
- Farmers can watch the live footage of water application during irrigation through the farmers own smart phones and computers.

### B. Disadvantages

- Proper service and maintenance must be given to the system at right time, if not the system may lead to failure or breakdown.
- Blockage of sprinkler nozzles may happen due to disseverment of heavy constituent of salt and this may lead to frequent replacement of sprinkler nozzles.
- It involves large no of initial cost.
- In Indian preview, threats from thieves are the major part of total failure of the system.
- In a muddy wet soil the wheel does not get stuck but in clayey soil there is chance of getting stuck, so care must be taken for the clayey soil.

- As this system requires a large amount of capital investment to be invested so it is considered as difficult one to adopt this type of system and accordingly today each and every Indian farmers are even hesitate to use methods like Drip and Sprinkler method.

## VI. Experimental Result And Analysis

During irrigation process pivot in self propelled system rotates continuously in order to supply the water needed for irrigation. Then the supplied water passes through the point of the pivot pipe with the help of the system. In this system each and every tower aligns accordingly in between small intermediate steps without any mess. The center quadrant pivot pipe is a fixed one and from that all process gets started. It acts as an important component of this center pivot irrigation system as only through this pivot pipe water and electricity are supplied. And it is the most essential part of irrigation without that irrigation is impossible. Then the anchor point which is also an essential thing for maintaining field location in proper manner.

Center pivot irrigation can be almost followed in all types of land. By using this system uneven topographic field can also be irrigated. Even there are no crop limitations by using this system as it irrigates almost all variety of crops like sugarcane, carrots, asparagus, cucumbers, melons, onions, pumpkins, sweet corns, strawberries, Tomatoes, peppers, potatoes.

At an average rate a self propelled center pivot system can cover up to 160 acres of the field. Through this survey it indicates that center pivot system can irrigate 126 acres land along the line from the 160 acres field, about 78% of area is covered through normal circular irrigation without placing an end gun with system. After placing an end gun the system covers some more additional areas in the field by means of reducing the unirrigated area.

Next, the irrigation uniformity which is the most important one to be noted from this system that is to measure the amount of water distribution throughout the field. It is tested by placing the containers along the line in the field by measure the level of water stored in each container uniformity of irrigation is determined. Each user and designer expects 100% uniformity to be provided by the system but in reality achieving nearly 90% is greatest thing.

Most commonly devices with low pressure and sprays with energy saving capability are used. In order to avoid drift of wind in a reduced manner hanging pipes are used as it sprays the water closer to the plants for better yield of crops. This center pivot system lasts for about 20 plus years of life span without any damage or rust. Life span of system can be reduced due to salt build up which accumulates salt at dividing line between the irrigation areas that result in reducing life span of the center pivot system.

Fig. 6. Outcome Model of Center Pivot Irrigation System

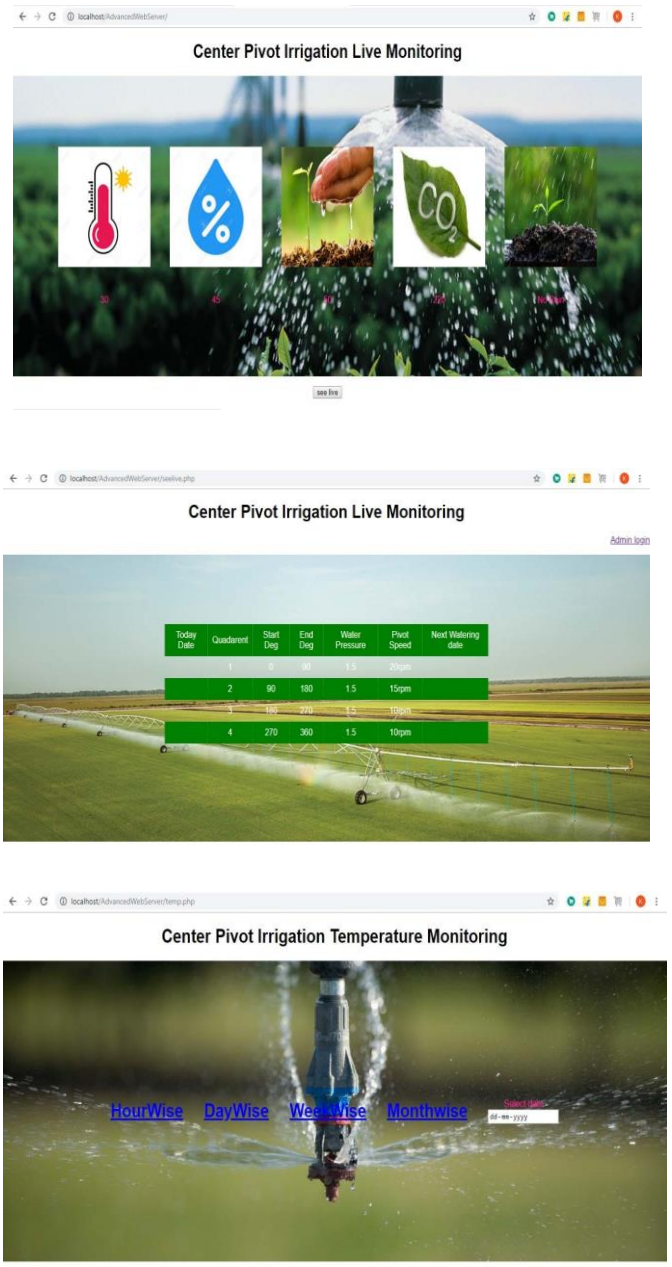


Fig. 7. Web page Design for Live Monitoring of Irrigation process

## CONCLUSION

In this paper modern method of irrigation called center pivot irrigation method are briefly discussed. Also its history, objective and system design are studied in detail. There is a vast opportunities available in India to practice modern method of irrigation, according to Indian perspective there is more advantage on compared with other system, as this pivot type of system operates automatically according to the available power. Due to this reason Indian farmers can relieve from greater burden in search of labor power. And larger area on field are saved by this center pivot and it considerably avoids the land from digging the trenches and getting wasted, While installation charges are been the other greater issue discussed so far. Therefore various researchers on combined with government agencies are in search of innovative solutions. The system need to be cost efficient one and should be able to install it easily; to make it possible different research institute in India need to be collaborated and put their full effort towards it. Also the central government must support Indian farmers by giving subsidy and encourage them to follow this method and save water and energy which would also help in yielding better productivity thereby satisfying nation's food demand. This system helps in reviving the Indian farmer's economical background.

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