EMBEDDED REAL TIME SYSTEM FOR FARMING IN SEMI ARID ZONES OF RAJASTHAN

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ABSTRACT

The Great Indian Desert ‘Thar’ is expanded in Rajasthan state. On the basis of climate conditions, this desert has been divided in two zones. The arid zone covers three districts and nine other districts are in semi arid zone. In these twelve district areas availability of water is extremely low and the seasonal variations in temperature and humidity is very high. During hot summer the maximum temperature touches 50 degree Celsius and winter freezes the mercury around zero in these districts. Rain water harvesting is being promoted by the government agencies in these zones. Drip drop irrigation systems have been provided at subsidized cost to progressive farmers for maximum utilization of the preserved water resource and to increase the productivity, and in addition the area of cultivation. Researchers have developed special species of vegetables, fruits and grains for water scarcity areas. The presented in-field sensor-based irrigation system is highly beneficial to achieve efficient water management.

In this course of study an embedded system based sensing and controlling prototype is developed for automotive cultivation in the semi arid areas. Each sensor station measures soil moisture, soil temperature, and air temperature. A weather station records precipitation, wind speed with direction, and solar radiation. Sensors and data logger are self-powered by a solar panel. The water level in reservoir and pressure in drip channels are continuously measured by water level and pressure sensors. These data are transmitted to the controlling electronics. This host computer receive the real-time field data without interference and control the irrigation system functioning. Details of the design and system control has been discussed and reported in this paper. Soil properties monitoring and fertilization along with plant disease control using embedded system has been suggested for future study.

Keywords: Irrigation system, embedded system, soil moisture.

INTRODUCTION

Economically condition of India mainly depends on agriculture or farming system. But in whole India resources are not same for farming. In Indian states climate regions differ and resources like water, soil have a variety. The farming conditions in all four corners of the country are specifically different. Kashmir and Uttarakhand are hill states; Tamil Nadu and Kerla in southern India are expanded on sea shores. Meghalaya is most rainy region but Rajasthan is lowest rainy region. Rajasthan is biggest state in India. Total area of Rajasthan is 342234 square kilometre. The Great Indian Desert “Thar” covers about 75,000 square kilometre area. In Rajasthan three districts Jaisalmer, Jodhpur and Barmer are in arid zone and nine districts Sriganganagar, Hanumangarh, Bikaner, Nagour, Churu, Sikar, Jhunjhunu,
Jalor and Pali are in semi arid zone. Sriganganagar and Hanumangarh are canal area but tail points of canals remain dry. The farmer of the desert area faces extreme and harsh conditions where water the primary need for cultivation is not available in form of surface and ground water. The rain based farming is full of uncertainty and very low yields of the crops are causing migration of people from this area. It is concluded and reported in this course of study that advanced technology based cultivation is a solution to this natural challenge in the desert area. Sensor based monitoring [1,5] and controlled irrigation is a method to obtain high yield in harsh climate conditions. In other words the adoption of embedded real time based irrigation system is the key solution to the problem of irrigation-water scarcity affecting economy of Rajasthan.

The semi arid zone of the Thar desert covers nine districts where the soil is fertile and human resource involved in cultivation are intended towards innovations in the sector. In these areas availability of water is low and the seasonal variations in temperature and humidity is very high. Rain water harvesting is being promoted by the government agencies [2,3] in these zones. Drip drop irrigation systems have been provided at subsidized cost to progressive farmers for maximum utilization of the preserved water resource and to increase the productivity, and in addition the area of cultivation. Agriculture scientists have developed special species of vegetables, fruits and grains for these areas. These species require minimum water after longer time period. During hot summer the maximum temperature has been recorded 51[6] degree Celsius and winter freezes the mercury around zero in these districts. The temperature fall is recorded in summer nights with moist air. These variations in enclosure parameters demand continuous monitoring for obtaining high yield and profit. Irrigation through an automated sensor control is helpful in continuous monitoring and programmed control on requirements of nutrients and moisture in bed soil. An in-field sensor-based irrigation system is of benefit to producers in efficient water management.

An embedded system based sensing and controlling prototype developed for automotive cultivation in the semi arid areas of nine districts situated on western side of Aravali hills in Rajasthan is studied and reported in this course of research work. The field conditions are real-time monitored site-specifically by in-field sensor stations distributed across the field. Each sensor station measures soil moisture, soil temperature, and air temperature. A weather station records precipitation, wind speed with direction, and solar radiation. Sensors and data logger are self-powered by a solar panel. The water level in reservoir and pressure in drip channels are continuously measured by water level and pressure sensors. These data are transmitted to the controlling electronics. This host computer receive the real-time field data without interference and control the irrigation system functioning. Details of the design and system control has been discussed and reported in this paper. Soil properties monitoring and fertilization along with plant disease control using embedded system has been suggested for future study.

OBJECTIVES

1. To develop an embedded real time system for the farmers of semi arid areas where water is available in less.
To develop an automated water management system in a farm to increase the yield and hence the profit margin for the marginal farmers.

3. To reduce the dependency on man power in agriculture sector and develop a tool for progressive farming in hard areas.

4. Monitoring of pest addition to soil and check on excess addition of toxicants in environment is an eco-friendly objective of this study.

PROBLEMS OF FARMERS IN SEMI ARID ZONE OF RAJASTHAN

1. Lack of surface water – in semi arid zone of Rajasthan there is no year flowing river, only seasonal rivers like Luni, Katli, Sukadi, Ghaggar and Balotara are flowing during rain season. Churu and Bikaner are two districts where no river flows, even seasonal. There are lack of water reservoirs for irrigation in this semi arid area.

2. Low ground water level – Ground water is only source for irrigation in these districts covered in semi arid zone. Excess exploitation of the resource has caused drastic fall in ground water level and government has declared most of these districts tehsil area as dark zones and drilling new wells are banned.

3. Low rainfall – Rainwater based farming is the major pattern in Rajasthan. In semi arid zone the average rainfall is 53.7 Cms. The rain fall averages of different zones of Rajasthan state are given in table 1.

4. High temperature - The temperature during summer days in the months of May and June is recorded highest in Rajasthan all over the India. Churu in Rajasthan recorded the highest temperature in India of 46.5°C and placed at third hottest worldwide below Nawabshah in Pakistan at 49.3°C and Kisumu in Kenya at 48.4°C in April 2017. In 2016, Phalodi of Rajasthan had set a new record for India with a temperature of 51°C on May 19, 2016. The semi arid zone climate features statistics of the state are summarized in table 1 [4].

Table 1 Rajasthan state climate zones average temperature and rainfall

<table>
<thead>
<tr>
<th>Climate zone of Rajasthan</th>
<th>Average temperature (°Celsius)</th>
<th>Average rainfall (Cms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arid</td>
<td>5.3</td>
<td>45</td>
</tr>
<tr>
<td>Semi Arid</td>
<td>8.3</td>
<td>42</td>
</tr>
<tr>
<td>Humid</td>
<td>7.8</td>
<td>40.5</td>
</tr>
<tr>
<td>Sub Humid</td>
<td>10.6</td>
<td>41</td>
</tr>
</tbody>
</table>

In Rajasthan seasonal variation in temperature is very much. The average maximum summer temperature has been recorded about 43c to 48c and min. winter temperature falls between 2 –13 degree Celsius. For last few years min. temperature has been recorded about 0 degree. This variation is not suitable for farming and farmers are not gaining profit margins and the huge losses are forcing farmers towards a social problem of suicide.

In Rajasthan drought is a recurring factor and it affect the farmer badly. In 2002, Rajasthan’s semi-arid zone effect by drought badly, and large population migrated to big cities for searching livelihood.

PROMOTION SCHEMES BY GOVERNMENT OF RAJASTHAN

1. Rainwater harvesting is being promoted by the government agencies in these zones.

2. Drip drop irrigation systems have been provided at subsidized cost to progressive farmers for maximum utilization of the preserved water resource and to increase the productivity, and to expand the area of cultivation.

3. Agriculture scientists have developed special spices of vegetables, fruits, and grains for these areas. These spices require minimum water after longer period.
4. Government distributes free seed kits in these zones.

5. Government has issued “kissan credit card” for providing loans to farmers for implementation of schemes. Whenever it droughts government waive off loan interests.

6. Kissan sewa kendras are providing expert advice to the farmers to obtain high yield and margins.

**EMBEDDED REAL TIME SYSTEM**

An in-field sensor based irrigation system is of benefit to producers in efficient water management by continuous monitoring and control on machinery like as water pump, water level controller. The programmable system controls water supply to plants, paste supply, temperature, humidity, moisture detection and soil pH detection by sensor technology. Remarkable results have been observed under this automation in progressive farming in open farms and in green houses. Increase in productivity with limited water and resource has been reported. Efficiency of sensors based system is recorded 3-4 times greater than working manually. Problems of desert zones farmers have been reduced by this system. The electric bills are reduced to half after adoption of drip drop systems and time saving in nutrition phases has established this system over the manual system. Embedded real time system controls many parameters and devices at a time. The programming can be varied according to the crop and season. Following are some of the advantages of the embedded real time system in farming:

1. Automatic and programmed control of water pumps.
2. Automatic water supply to plants.
3. Paste supply according to the soil moisture.
4. Detect the humidity at particular point around the roots of plant.
5. All operations and results are displayed on main monitor and reduce man power costs, which helps the farmer to obtain high yield and profit by investing less.

**WORKING OF EMBEDDED REAL TIME SYSTEM**

As shown arrangement, we use two water pumps (water pump1 and water pump2) level detector, water tank, microcontroller, and an irrigation sensor. All the devices are connected with each other and complete a circuit. Water pump1 is used for fill the water tank it’s operation depends on level detector’s output and the water pump is used for supply tank water to crops, water is fed till the irrigation sensor dug near the roots detects and display crop specific output of required moisture through microcontroller. This automation reduces man power and prevents the wastage of water. As the required moisture data for a specific crop are already fed in the system.

In this system at first step level detector detect the water level of tank and send a signal to microcontroller. The signals possibilities are of two types, one the water tank is full and another some part empty or total empty. In first case microcontroller sends signal to pump no.
For OFF and second case microcontroller send signal to pump no.1 for ON. When water tank is full then level detector detect level of water and again send a signal to microcontroller for OFF water pump1 and microcontroller control or OFF the Water pump 1. Water pump no.2 ON-OFF states depend on irrigation sensor irrespective to the states of pump no.1. When moisture in bed decreases the microcontroller starts pump no.2. The working table of the system is summarised in Table 2.

**Table 2** Embedded real time system working for controlled supply of water and pests to crops

<table>
<thead>
<tr>
<th>Level detector signal</th>
<th>Water pump no.1</th>
<th>Irrigation sensor signal</th>
<th>Water pump no.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empty tank</td>
<td>ON</td>
<td>Level maintained</td>
<td>OFF</td>
</tr>
<tr>
<td>Partially empty tank</td>
<td>ON</td>
<td>Level low</td>
<td>ON</td>
</tr>
<tr>
<td>Tank full</td>
<td>OFF</td>
<td></td>
<td>ON</td>
</tr>
</tbody>
</table>

Parametric sensing and functioning of the embedded real time system is reported in Table 3.

**Table 3** Farm parameters and functioning of embedded real time system

<table>
<thead>
<tr>
<th>Temperature of enclosure (Open farm/ Green house)</th>
<th>Humidity of enclosure (Open farm/ Green house)</th>
<th>Water/nutrients level in field beds soil</th>
<th>Supply pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 10</td>
<td>High</td>
<td>High</td>
<td>OFF</td>
</tr>
<tr>
<td>10 to 20</td>
<td>High</td>
<td>Low</td>
<td>ON</td>
</tr>
<tr>
<td>20 to 30</td>
<td>Low</td>
<td>Low</td>
<td>ON</td>
</tr>
<tr>
<td>30 to 40</td>
<td>Low</td>
<td>Low</td>
<td>ON</td>
</tr>
</tbody>
</table>

**CONCLUSION**

In nine semi-arid districts of Rajasthan availability of water is extremely low and embedded real time systems are very useful in achieving excellent water management. In this area under study seasonal variations in temperature and humidity is very high and this system maintains the enclosure constant and high yield has been achieved by the progressive farmers. This technique has been proved fruitful in Israel, a country with similar climate conditions. Rain water harvesting is being promoted by the
government agencies in these zones. Drip drop irrigation systems have been provided to farmers through NGOs and government departments. By installing embedded real time system automatic water and nutrients supply to crops or plants is achieved. The progressive farmers of Rajasthan have proved that they are highly intended to preserve water and are dedicated to achieve high yield and profit. This system eliminates the probability of both the excess irrigation and the insufficient irrigation to a crop. Water in desert zone is available very low and proper and controlled at right time is the only way to preserve this resource. The system is upgradable to smart phones where user receives the real-time field data without interference and controls the irrigation system functioning from a distant place. The design and system control is field specific and beneficial for marginal farmers as well as in large fields. Fertilization along with plant disease control using embedded real time system has been suggested for future study and shall contribute in soil pollution control in terms of checking the unwanted and excess addition of pesticides in the soil.

REFERENCES

6. The Telegraph India, 22 April, 2017.