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Fuzzy Based Irrigation Control using Wireless Sensor Network in Tomato Farming

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ABSTRACT

Fuzzy logic systems are used to check the degrees of truth in real life system. New advancement has been seen in the field of agriculture due to the advancement in wireless technology. The proposed system will describes about the uses of fuzzy logic systems with help of wireless sensor network in efficient farming of tomato crop which is an important crop and commonly suggested by many farmers. It leads more profit but, it has to be taken care properly. Because it gets affected to disease easily. The proposed system also explain the irrigation system as well as fertigation (fertilisers given through irrigation) and controlling the pesticides. Fertigation technique is established with wireless sensor network that will collect a data, monitoring to the crops to allow for higher yields and lower cost, with less impact to the environment. Each area receives only what is required for its particular space, and at the appropriate time and duration. Required information is collected which is scientifically accurate with the help of wireless sensors. And the fuzzy based irrigation controller will accept the data which is sent to by WSN from the farm. Based upon the condition the machine will sprinkle the fertilizer and drip the water. The main use of advanced technologies will leads to proper and efficient use of resources in tomato farming.

Keywords : WSN, Tomato Farming, Irrigation, Fuzzy Logic Systems

I. INTRODUCTION

Farmers now-a-days are trying to use modern ways for farming. By implementing more new effective technologies and automation in the farming will ultimately be efficient and time saver.One of the main reason of big loss in the field of agriculture is, crops are not properly taken care off. There is one term which is used often in recent days is “Precision agriculture” which means all the works related to agriculture should be done precisely. Everything which are lifeline to any farm like water, fertilizer etc., has to be given precisely and on time to time fashion.Now a days, farmers use many techniques for irrigation and disease control in crops manually. By doing manually, so the delays can occur and can affect the crop.For that reason, automation is required in irrigation and disease control system which is completely based on sensing device. Which reduce the man power and manual work take appropriate decision which makes more money. Tomato is a common crop which grows in Kharif season (July to October), Rabbi (October to March) and also in summer season. India is in 2nd place in world for cultivating tomatoes. It leads more profit but, it has to be taken care properly. Because it gets affected to disease easily.

The required wireless technology is widely used in many areas and are easily available in the markets in reasonable prices. It gives features like high speed data transfers, safe and reliable, flexibility, low cost etc. By using this technology will require less man power and has to be handled automatically. Fuzzy logic controller, it makes the decision whether to irrigate water through farm or not. The proposed system only specifies about the irrigation system of the farm. The crop needs many more resources than just water. The whole system was powered by photovoltaic cells and communication link for monitoring the states of the crops.A drip irrigation system was proposed for farming with the use of wireless sensors and fuzzy logic controller.The system will decides when and for how much time the values should be opened for dripping of water.The system will decides when and for how much time the values should be opened for dripping of water.It is helpful and efficiently use both water and fertilizers.

II. LITERATURE SURVEY

In the existing system work was done in the area of irrigation control systems using fuzzy logic controllers and wireless sensors. The existing system says about the various types oftechniques for irrigation to be done in the farm.Wireless sensors used in this particular technology are mainly used for collection of the information about the soil in the farm, collected information consists of the above all information is provided to the proposed system only specifies about the irrigation system of the farm.The system will decides when and for how much time the values should be opened for dripping of water.

- ✓ The soil depth from which a mature crop extracts most of the water needed for evapotranspiration.
- ✓ Available Water Storage Capacity (AWSC) is the range of available water that can be stored in soil and be available for growing crops.
- ✓ Plant water usage capabilities
- ✓ Soil moisture content, etc.

The water storage capacity can be measured by ES100 watermark sensor, which is a soil moisture and temperature sensor. It is possible to rate in which the soil gets It is possible to rate in which the soil gets dried.

S.NO	TITLE	AUTHOR	ABSTRACT	METHODOLOGY
1	Design and development of precision agriculture wireless sensor networks.	R.Nandurkar,V R. Thool	The system is particularly useful for agriculture applications in sparsely populated semi- arid areas since human involvement and intervention is not needed for irrigation purposes.	The main intension of the system is going on to increase the efficiency of the moisture sensors so as to minimize the effects of fertilizers on the value of soil moisture. system is very useful for small farmer as the initial cost is very low.

2	Advances in greenhouse automation and controlled environment agriculture	Ramin Shamshiri, Fatemeh Kalantari, K. C. Ting, Kelly R. Thorp, Ibrahim A.	Smart greenhouse fuzzy logic based control system enhanced with wireless data monitoring.	Greenhouse cultivation has evolved from simple covered rows of open-fields crops to highly sophisticated controlled environment agriculture (CEA) facilities that projected the image of plant factories for urban agriculture. The advances and improvements in CEA have promoted the scientific solutions for the efficient production of plants in populated cities and multi-story Buildings
3	A fuzzy logic based irrigation system enhanced with wireless data logging applied to the state of Qatar	Farid Touati Mohammed Al-Hitmi Kamel Benhmed Rohan Tabish	The system specifies about the fuzzy logic controller acquires data From these sensors and then applies well-devised fuzzy rules to produce appropriate time and duration for irrigation.	The system consists of a feedback fuzzy logic controller that logs key field parameters through specific sensors and a Zigbee- GPRS remote monitoring and database platform. The system is easy to deploy in existing drip irrigation systems without any physical modification.
4	Automated early plant disease detection and grading system	Rizk, Hashem	As the agriculture industry grows, many attempts have been made to ensure high quality of produce.	Hence, many techniques and technologies have been developed to help solving or reducing the impact of plant diseases. Imagining analysis tools, and gas sensors are becoming more frequently integrated into smart systems for plant disease detection.
5	Combining Multi-Agent Systems and Wireless Sensor Networks for Monitoring Crop Irrigation	Gabriel Villarrubia Juan F.De Paz,Daniel H.De La lglesia and Javier Bajo	The system will describes about tool that allows us to monitor the condition of crops on a TV screen using a low cost device.	This work presented the development of an intelligent system based on WSN that monitors and automates crop irrigation in an easy and economical way.
6	A Survey on usage of Soft Computing Techniques in Crop Production	Silky Narwal Vijay Nehra	This survey table is very useful to understand problems and corresponding problem solving technique.	Soft computing techniques shows great ability in solving problems like crop selection, crop planning, irrigation planning, water resources management, vegetable production, water resource management etc has been discussed in the present paper.

7	Fuzzy logic based irrigation control system using wireless sensor network for precision agriculture	Prakashgoud Patil, Umakant Kulkarni, B.L. Desai ,V.I. Benagi and V.B. Naragund	The irrigation controller regulates the desired moisture level in agricultural soil by making the irrigation pump on,off basedon sensor readings.	This work has been carried out using MATLAB simulation tool. The developed software for the proposed work was tested under different input condition and provided good results in terms of accuracy and has a wide scope of being established in near future.
3	A fuzzy logic based irrigation system enhanced with wireless data logging applied to the state of Qatar	Farid Touati Mohammed Al-Hitmi Kamel Benhmed Rohan Tabish	The system specifies about the fuzzy logic controller acquires data From these sensors and then applies well-devised fuzzy rules to produce appropriate time and duration for irrigation.	The system consists of a feedback fuzzy logic controller that logs key field parameters through specific sensors and a Zigbee- GPRS remote monitoring and database platform. The system is easy to deploy in existing drip irrigation systems without any physical modification.

III. Creating Ideal Conditions

Available Water Storage Capacity (AWSC) guide

Table 1: Soil texture with Available Water Storage Capacity

Soil Texture	AWSC[Inch of water per foot of soil]	Linguistic variable
Sand	0 to 1	Sandy
Loamy sand	1 to 1.2	Sandy
Sandy loam	1.3 to 1.5	Sandy
Fine sandy loam	1.6 to 1.7	Loamy
Loam	1.8 to 2.1	Loamy
Slit loam	2.2 to 2.5	Loamy
Clay loam	2.4	Clay
Clay	2.4	Clay
Organic soil	3	Clay

Loam: Is considered ideal for gardening and agricultural uses because it retains nutrients well and retains water while still allowing excess water to drain away A soil dominated by one or two of the three particle size groups can behave like loam if it has a strong granular structure, promoted by a high content of organic matter.

Sandy loam: Is a type of soil used for gardening. This soil type is normally made up of sand along with varying amounts of silt and clay.

Split loam: Loam is soil composed mostly of sand (particle size > 63 μm), silt (particle size > 2 μm), and a smaller amount of clay (particle size < 2 μm).In the USDA textural classification triangle, the only soil that is not predominantly sand, silt, or clay is called "loam".

Available water storage capacity: Is the maximum amount of plant available water a soil can provide. It is an indicator of a soil's ability to retain water and make it sufficiently available

Organic Soil: And Amendments. Organic soils contain organic matter that is rich in many nutrients and minerals. The scientific definition of organic soil is "Of, relating to, or derived from living matter." Organic soil consists of decaying plant material, microorganisms, worms, and many other things.

Clay loam: is a soil mixture that contains more clay than other types of rock or minerals. A loam is a soil mixtures that is named for the type of soil that is present in the greatest amount. The particles of clay are very small, which is one of its most important characteristics.

Clay: Is a finely-grained natural rock or soil material that combines one or more clay minerals with traces of metal oxides and organic matter.for plant use. Available water capacity is the water held in soil between its field capacity and permanent wilting point. capacity (θfc) and permanent wilting point (θpwp): $\theta a \equiv \theta fc - \theta pwp$.

Temperature

Ideal temperature is 18 c to 30 c for tomato crop to grow, and it can be measured by a sensor which is used for analysing

Table 2 : Temperature classification

Sensor reading	Level	Linguistic variable	Range
Temperature obtained by a sensor	10	Very cold	[0 5 10 15]
	20	Cold	[10 15 20 25]
	30	Normal	[20 25 30 35]
	40	Hot	[30 35 40 45]
	45	Very Hot	[40 45 50 50]

Smoke detection

As tomato crop is susceptible to the smoke generated through any source, which badly affects the growth of the crop. To detect smoke there is a need of smoke detectors.

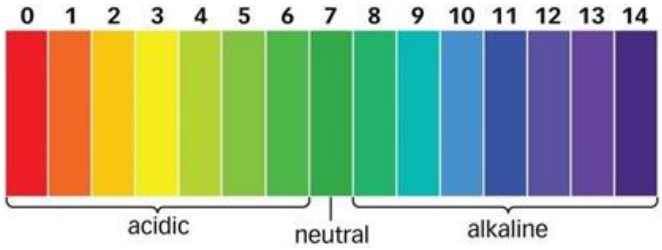

Fig 1: pH Scale [7]

pH of soil

pH 6.0 to 6.8 of the soil is the best for the tomato to grow. It requires slightly acidic to grow. The pH of the soil can be tested by many applications available in the marke.

IV. BUILDING A SYSTEM

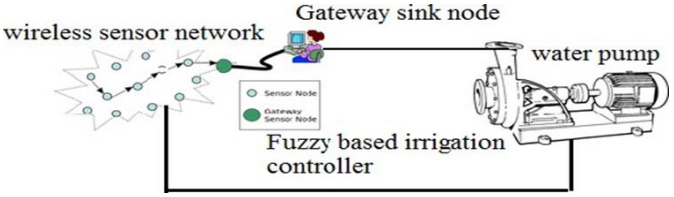

Fig 2: Structure of system

V. ARCHITECTURE OF SYSTEM

From the image of the architecture of the system

- ✓ Farm- Wireless sensors for all the parameters are distributed evenly for getting all the relevant data to send to the fuzzy controller.
- ✓ Gateway sink node - The data sensed by the wireless sensors will be sent to the gateway, which will a router like a device. The gateway node is directly connected to the fuzzy controller.
- ✓ Fuzzy based irrigation controller- It will accept the data which is sent to by all the sensors from the farm. It will analyse it and according to rules

specified in the system and will send the signal to respective machine (pump, sprinkler etc.).

- ✓ Machine (water pump) - It will act according to the signals received from the fuzzy logic controller. The pump pipelines are distributed in the farms.

VI. SENSORS IN THE SYSTEM

MESMIC eKo Pro – A wireless agriculture and sensing system used for crop monitoring.
ES100 WATERMARK SENSOR – A soil moisture and soil temperature sensor.
ES1201 – A temperature/humidity sensor that measures the relative humidity and air temperature

VII. ACTION TAKEN IF THE CONDITION ARE NOT IDEAL

The system starts right after checking for the ideal conditions of soil. If the conditions are not proper then the following measures are taken the controller.

- ✓ pH –Specifically soil pH is very important because it has such a strong influence on how well your crops will grow. The pH sensor senses the pH of the soil, if the pH is more acidic than required level then it can be raised by adding base into that which can be through the automated irrigation system by using mixture of water and lime stones.
- ✓ Measuring plant leaf sap pH
- ✓ Measuring foliar and hydroponic fertilizers
- ✓ Measuring pH of rain and irrigation water

Water the sensor gets the information about pH being too acidic then it tries to control that, at the same time it will set the controller for giving water regularly in the farm after particular amount of time period. If the pH is more alkaline then, it can be made acidic by using compost manure and can control the soil pH.

Soil temperature – In affects plant growth directly, that is all crops practically slow down their growth below the soil temperature of about 90C and above the soil temperature of above 50 0C.If the soil temperature is more than required then the sensor sends signals to the controller and then the timer is set into the controller for watering the soil regularly until the temperature is maintained. If the soil temperature is lower than nitrogen should be provided to the crop.

- ✓ Formaldehyde – If all the conditions are proper sensed by the sensors then a signals is send to the controller for sprinkling formaldehyde into the farm field. This will be automated when all other factors are appropriate.
- ✓ Water logging – The wetness sensors will sense the soil and if it is wet for more amount of time then the water irrigation should be stopped.

After Planting

- ✓ NPK – Nitrogen, phosphorous and potassium are useful for increasing the durability, attractiveness and shine of the tomato fruit.

If all the conditions are proper then Nitrogen. Phosphorous and Potassium should be circulated at proper time period throughout the tomato farming. All the conditions should be checked daily.

NPK requirements –

- o 120 kg/hector
- o 60 kg/hector
- o 120 kg/hector

It can be mixed with water and then can be circulated in the farm through the distribution system.

- ✓ Water irrigation – If all the conditions are proper then the water should be irrigated to farm after each 10th day. If the water is logged in the farm then the irrigation should be stopped. If the temperature drops to the ideal conditions then the irrigation should be stopped till the ideal conditions are maintained.
- ✓ Zinc and Boron – These two elements are essential for making fruit attractive
- ✓ Theses elements are given as a mixture with water. At the time of 2nd or 3rd irrigation, these should be circulated in farm.
- ✓ Damping off – Tomato crop gets affected by the disease called as 'Damping off' This happens because of humid temperature and wet and cold soil. To control this sensors keep watch the conditions of soil and climate for particular amount of time.

VIII. ALGORITHM FOR SYSTEM TO MAINTAIN PROPER CONDITION

t>=19 && t<=21 the >3
Conditions are good.
Else
Send Information to farmer with a message
When a t humidity>requirement then >1
Irrigate H2O2 solution by water. Humidity Count++;
If humidity> 2 then >2
Inform farmer through message. Sprinkle planofix on the crops.

Increase the dailyCount by 1

If (dailyCount/15) =0 then >1
Sprinkle CH2O on the farm (on every 15th day)
Check for (dayCount%10=0) till 120 days (Each 10th day till 120 days)
With proper amount the water should be irrigated
Check for minuteCount till 60 minutes
If dayCount=3 then >2
A mixture of zinc and boron should be given by the water.
If dayCount%2 equals to 0 then >3
Sprinkle Dimethoate in the farm.
Increase minutesCount by 1; Until minuteCount less than equals to 60;
dayCount++;
Until dayCount less than equals to 120;

IX. CONCLUSION

Crop irrigation and fustigation are the most important factors in the farming. It is very necessary to find out the proper requirements for the crop and take measures according to that. In the case of tomato crop, it is quite hard to maintain because it gets affected to disease easily. As it is very susceptible for the environmental factors. So, if proper care is not taken for the crop then the profit making crop can turn into a disaster.

The problems which farmers face regularly are, water shortage and adequate amount of fertilizers. If the proper scientific measures are taken and analysed, on the basis of temperature, soil humidity, soil moisture, environmental conditions, a way higher field can be achieved.

In the points which are discussed above, there are still some limitations regarding the solid materials which are required to be discussed with the farmers because at present there is no mechanism present for it. The materials which are liquid and the materials which are soluble in water can be flown very easily in the farm and certainly there are some factors in which a machine actually can't do anything but just inform farmers. Thus, the proposed work concludes that by using the proposed ideas following advantages can be

achieved - Increasing Irrigation Efficiency, reducing the labour cost, saving water and electricity.

X. REFERENCES

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