Intelligent Agriculture mechanism using Internet of Things

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***Abstract*— Agriculture is one of the major backbones of India. Agriculture sector is one of the largest employment providers. Though there is a large area under cultivation, we don't get maximum yield. Reasons for this can be, insufficient rainfall, deficiency of parameters (needed by a plant to grow healthy), farmers may not know the timely requirements of the crop. If technology is embedded with agriculture farmers can sense the timely requirements of crops. In this paper we are trying to integrate Internet Of Things in Agriculture.**

Keywords— Agriculture; Internet of Things; Sensor; WSN, Data mining;

I. Introduction

Agriculture is the largest livelihood provider in India. . It has about 195m ha under cultivation of which some 63 percent are rain fed (roughly 125m ha) while 37 percent are irrigated (70m ha). With the second largest arable area in the world, India is the largest producer of rice, wheat, cotton, sugarcane, farmed fish and tea.

Despite the overwhelming size of the agricultural sector, yields per hectare of crops in India are generally low compared to international standards. There can be various reasons for this such as, insufficient rainfall, deficiency of parameters (needed by a plant to grow healthy), farmers may not know the timely requirements of the crop. As a result farmer may not provide those requirements to the crop.

We can implement technology into agriculture and help farmer understand the requirements of the crop and take action accordingly.

When Wireless sensor network is implemented into the land, we establish a network of sensor nodes that are connected to each other. When the sensor nodes are deployed in the land, they will sense data at regular interval of time, perform the computations that are to be done and inform the farmer about the result of the computation. Internet of things is most promising and suitable technology for this.

There exists few technologies to make aggriculture smarter. Few are based on RFID[3], few are based on adapting sensor to regulate water supply to agricultural land [4][5].

In this paper we are using Intenet of things to make agriculture smarter. When IOT is implemented into the land, we establish a network of sensor nodes that are connected to each other. When the sensor nodes are deployed in the land, they will sense data at regular interval of time, perform the computations that are to be done and inform the farmer about the result of the computation. Internet of things is most promising and suitable technology for this.

Through IOT and WSN agriculture can be connected to the Internet, which creates a network of agronomists, farmers and crops. As a result agronomists will have better understanding of crop growth models and farming practices will be improved.

In this paper we are considering Sugarcane crop as an example and implemented internet of things into agricultural land where Sugarcane crop is grown.

II. Related Work

A. Sugar Cane Crop

India is the second largest producer of sugar cane. According to [8], the crop of Sugarcane takes around 12 to 18 months to grow. Generally January to march is the period of sowing and December to March is the period of harvesting.

According to an estimate published in [2], as of 2011-2012, in India a total of 5.6 million ha land was under sugarcane cultivation. Sugarcane is extensively grown in the states of Karnataka, Maharashtra, Tamil Nadu, Andhra Pradesh, Gujarat and Kerala.

For the Sugarcane crop, the various soil parameters and environmental parameters has to be considered to ensure maximum and healthy yield. Various parameters and optimal range is shown in table 1 and table 2[1][2].

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Table 1: Soil Parameters and their ranges

Parameter	Optimum range	Critical Value
Ph	6-8	-----
Nitrogen	2.00-2.60 %	1.8 %
Calcium	0.22 – 0.45 %	0.20 %
Phosphorus	0.22 -0.30 %	0.19%

Table 2: Environmental Parameters and their ranges

Parameter	Optimum range	
Temperature	30°C(Initially)	32°C- 38°C(Stem Cutting)
Rainfall	70-150cm	-------
Humidity	45-65%(Ripening period)	80-85%(Cane elongation)

When the parameters mentioned in table 1 and table 2 are not met, we may not get the required yield capacity, along with it the obtained crop may be infected by the diseases like Ca deficiency, P deficiency, N deficiency [1].

B. Existing Approaches

The decision of when to irrigate, when to feed fertilizers and other required parameters is usually based on past experiences, weather-based information or soil based measurements. Past experiences may not be accurate. Therefore, soil-based mesurements may be the preferred technique. There exists several method for gathering these information from land.

According to [5], Human-based computation can be used to gather requirements of crops. This approach involves prediction based on the past history through computations. But this method is not simple and not easily acceptable by farmers.

There are few methods based on wireless sensor networks (WSN) but the sensor nodes in the Wireless Sensor Networks have limited energy, limited bandwidth, small communication range, limited memory, and limited processing speed.

According to [8], Pervasive agriculture is a farming management concept based on observing, measuring and responding to inter and intra-field variability in crops.

III. Proposed System

In this paper, we are proposing a intelligent technology based on IOT for agriculture with the following objectives:

- To design and simulate a Smart Agriculture system which can sense the various parameters in soil and environment required for better growth of plants.
- To apply better data mining technique on the sensed information in order to detect the timely requirements for better growth of crops.
- To predict the diseases that can affect the crops based on the sensed information and prevent the diseases before it occurs.

The working of proposed technique is shown in fig 1. Fig 2 shows the proposed architecture.

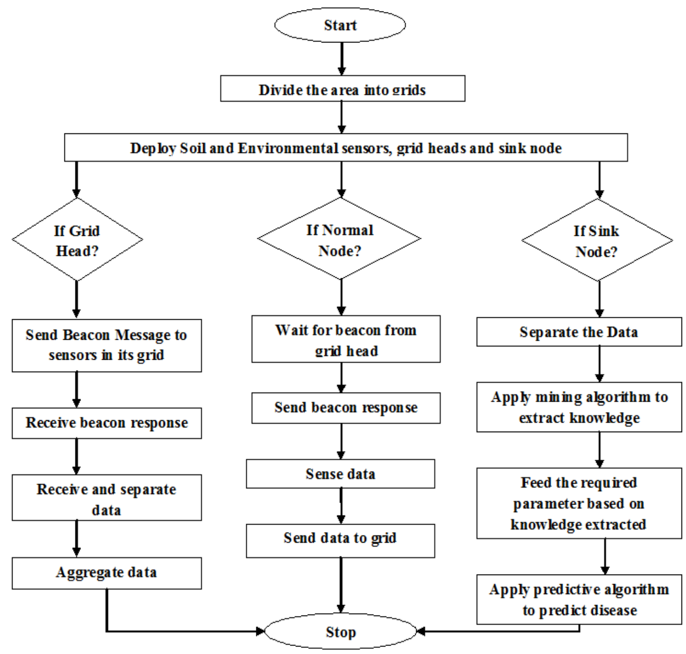

Fig 1: Working of proposed approach

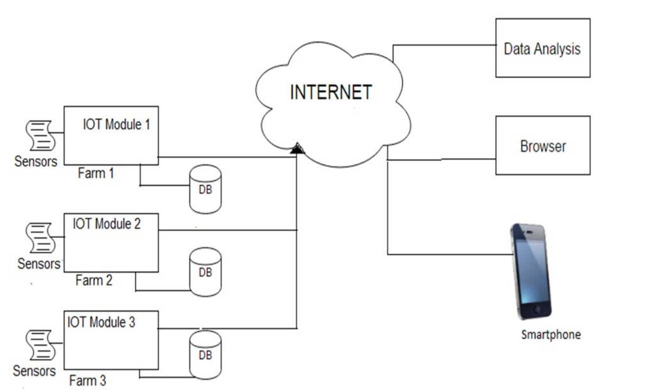

Fig 2: Proposed Architecture

A. At the Sensor node level

- Node Deployment.

The farm is divided into equal sized grids. In each grid soil sensor node and environmental sensor node is deployed at the suitable location. The soil sensor nodes are placed partially inside the soil and environmental sensor nodes are deployed on the surface. In each grid one grid head is deployed to gather the data from soil and environmental sensor nodes.

- Sensing of Environmental and Soil parameters.

Once the nodes have been deployed and network has been established, the environmental sensors senses environmental parameters which are temperature, humidity etc., whereas the soil sensor senses soil parameters which are ph level, calcium content etc.

- Transmitting collected data to sink node.

All the sensed values are transmitted to the sink node for further computation.

B. At the Sink node:

- Gathering and storing the data

Sink node gathers the data from each node and stores these data in a cloud through internet.

- Applying mining techniques.

The data mining technique is applied on the received data. We apply association mining technique. Association rule mining algorithm is used for knowledge extraction from the sensed information. Based on this information we can detect whether the available parameters are sufficient or insufficient for the proper growth of plants. We can also detect weather plant is growing properly or not, whether the environmental conditions are suitable for crop etc. Based on Mining information proper fertilizers can be provided to the crops.

- Predictive classification algorithm.

Predictive Classification algorithm can be applied on the sensed information to predict the diseases that can occur. Based on predictive analysis we can take suitable measures for preventing the diseases.

- Future course of action.

After applying the data mining algorithms and retrieving useful information, we will have obtained the results. Based on this result, proper alert message is transmitted to farmers. This helps to take suitable action in order to ensure maximum and healthy crop yield.

IV. SIMULATION AND EXPERIMENTAL RESULTS

The proposed work is simulated using MATLAB. Table 3 describes the simulation parameters. Farmland of area 50 x 50 unit is divided into equal sized cluster of size 10 x 10 unit. In each grid 1 soil sensor and 1 environmental sensor node is deployed.

Figure 3 shows the test bed used. This represents the agricultural land. Here the red node indicates the grid head. Figure 4 shows the routing of information to sink node using inter grid routing. Figure 5 shows the data gathered at the sink node and Figure 6 shows the processed information representing whether the particular paramer is high, low or normal.

Table 3: Simulation Parameter

Parameter	Parameter value
Area of interest	50 x 50
Grid size	10 x 10
No. of Environmental sensors in each grid	1
No. of soil sensors in each grid	1
Data packet payload	512 Bytes
Energy level of each node	4 KJ
Transmission range	20m
Data rate	4kbps

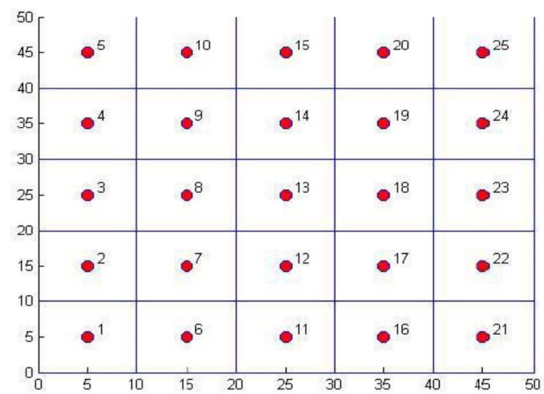

Fig 3: Test Bed

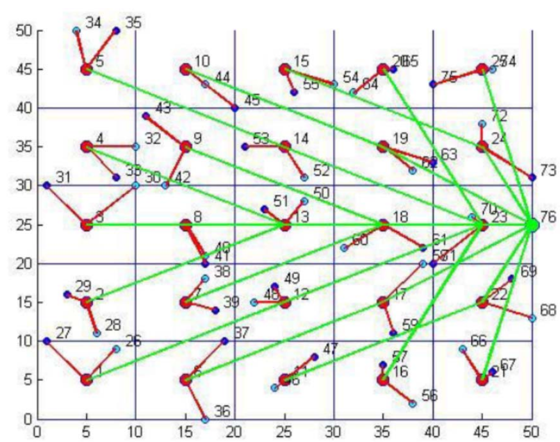

Fig 4: Inter grid routing

Figure 7 shows the processed data in the graphical representation. Processed information will be transmitted to farmers through SMS in a simple format. Based on that farmer can take suitable action.

Epoch	AirTemp	Humidity	Phosphorous	Nitrogen	SoilTemp	Moisture	PH	Calcium
1	34	94.000000	0.194354	2.199783	55.000000	88.000000	7.000000	0.473194
2	18	70.000000	0.269569	2.216799	80.000000	78.000000	6.000000	0.329495
3	30	89.000000	0.338585	2.772741	51.000000	48.000000	8.000000	0.228146
4	24	58.000000	0.215521	2.705154	81.000000	68.000000	9.000000	0.231203
5	26	68.000000	0.274914	2.542545	65.000000	66.000000	5.000000	0.207330
6	21	95.000000	0.196845	1.844166	73.000000	87.000000	6.000000	0.253695
7	36	64.000000	0.294448	2.464280	47.000000	64.000000	6.000000	0.415001
8	37	61.000000	0.262054	2.176011	71.000000	56.000000	5.000000	0.330898
9	34	73.000000	0.245050	2.589644	62.000000	72.000000	8.000000	0.461443
10	17	95.000000	0.249314	1.836382	85.000000	49.000000	5.000000	0.381788
11	38	77.000000	0.185146	2.496314	71.000000	43.000000	9.000000	0.299061
12	25	97.000000	0.223423	2.333163	98.000000	56.000000	6.000000	0.478302

Fig 5: Data Collected

Epoch	Node	AirTemp	Humidity	Phosphorous	Nitrogen	SoilTemp	Moisture	PH	Calcium
1	1	LOW	HIGH	NORMAL	NORMAL	LOW	NORMAL	LOW	NORMAL
1	2	NORMAL	HIGH	NORMAL	LOW	NORMAL	HIGH	LOW	NORMAL
1	3	NORMAL	HIGH	LOW	NORMAL	LOW	HIGH	LOW	NORMAL
1	4	HIGH	HIGH	LOW	NORMAL	NORMAL	NORMAL	NORMAL	HIGH
1	5	NORMAL	NORMAL	LOW	LOW	HIGH	NORMAL	NORMAL	NORMAL
1	6	HIGH	NORMAL	NORMAL	NORMAL	NORMAL	LOW	LOW	NORMAL
1	7	NORMAL	NORMAL	NORMAL	LOW	HIGH	HIGH	NORMAL	NORMAL
1	8	NORMAL	HIGH	NORMAL	LOW	NORMAL	NORMAL	LOW	NORMAL
1	9	LOW	LOW	HIGH	HIGH	NORMAL	LOW	LOW	NORMAL
1	10	HIGH	LOW	LOW	LOW	NORMAL	NORMAL	HIGH	NORMAL
1	11	NORMAL	NORMAL	NORMAL	LOW	NORMAL	NORMAL	LOW	NORMAL
1	12	HIGH	LOW	HIGH	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
1	13	NORMAL	NORMAL	HIGH	NORMAL	NORMAL	NORMAL	HIGH	NORMAL
1	14	NORMAL	HIGH	HIGH	NORMAL	NORMAL	NORMAL	LOW	NORMAL
1	15	NORMAL	NORMAL	HIGH	LOW	NORMAL	LOW	LOW	NORMAL
1	16	NORMAL	HIGH	NORMAL	LOW	HIGH	HIGH	NORMAL	NORMAL
1	17	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	LOW	NORMAL
1	18	NORMAL	NORMAL	NORMAL	NORMAL	LOW	NORMAL	HIGH	LOW
1	19	HIGH	HIGH	NORMAL	NORMAL	NORMAL	NORMAL	HIGH	NORMAL
1	20	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	LOW	HIGH
1	21	LOW	HIGH	HIGH	NORMAL	LOW	NORMAL	LOW	NORMAL
1	22	LOW	HIGH	LOW	NORMAL	NORMAL	NORMAL	HIGH	HIGH
1	23	HIGH	NORMAL	NORMAL	LOW	LOW	NORMAL	NORMAL	NORMAL

Fig 6: Processed data

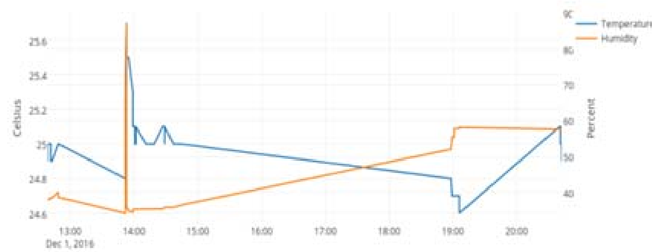

Fig 7: Temperature and humidity at various time slot in a day

V. Conclusion

By using Internet of things, Sensors and Data mining in Agriculture, we can help farmers to understand the timely requirements of the crop. With this, better yield can be generated. The usability of the proposed work is shown through the simulation. The action of deploying sensors in the agriculture land to sense the data and mining the data to identify the parameters required for better growth of crop is clearly shown through simulation. Prediction of specific diseases with respect to Sugarcane crop can be considered for future enhancement.

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