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Precision Agriculture through Internet of Things

Aman Kumar[1], Anoop Chandra[2] and Assistant Professor Pradeep Kumar HS[3]
[1,2,3]*Information Science & Engineering, The National Institute of Engineering*

Abstract—Agriculture is the backbone of the Indian economy but recent trends shows a decline in its contribution towards the GDP. The main issue is that oral medium of communication has been used for the transfer of knowledge and over a period of time the quality of information has deprecated. The proposed solution involves digitizing agricultural metrics to build a crop recommendation system to assist the farmers in cultivating better crops. This system makes use of concepts of Internet of Things and Rule-based Classification algorithms to predict the suitable crops according to the climatic factors such as humidity, temperature, soil moisture and soil nutrient contents (nitrogen, phosphorus, potassium). A farming set up is installed in the farms which transfers the data collected by the sensors to the server using a micro-controller. At the sever side, the data is processed using classification algorithms. The recommended crop details will be provided to the farmers via SMS or IVR.

Keywords—farming; internet of things; sensors; wireless network; microcontroller; data mining.

I. INTRODUCTION

India is an agricultural country. About 50% of our total workforce depends on agriculture but agriculture only contributes to 13.7% of our GDP and the trend continues go downwards. Today in India, the effort to reward ratio in the field of agriculture is not as high as other sectors and because of this reason, people are not looking at agriculture as a profitable means of living.

One of the ways in which the profitability in agriculture sector can be boosted is by increasing the awareness among the farming community regarding the state of their farms, requirements of specific crops and their growing season. This is an issue that can be helped using technology such as Internet of Things and Clustering algorithms.

The Internet of Things is the network of physical objects or ”things” embedded with electronics, software, sensors and network connectivity, which enables these objects to collect and exchange data. The Internet of Things allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration between the physical world and computer-based systems, and resulting in improved efficiency, accuracy and economic benefit.

We can make use of the concepts and platform provided by Internet of things to gather data regarding temperature, humidity and moisture using sensors placed on the field, process the information using clustering algorithm and then provide the farmer with a avenue to environmental monitoring, precision agriculture and remote surveillance of their farms.

Using the assistance of Precision Agriculture using Internet of Things, farmers would have a better understanding of what crops to cultivate, amount of irrigation required for the crops and remote surveillance of the field.

"Slow agricultural growth is a concern for policymakers as some two-thirds of India’s people depend on rural employment for a living. Current agricultural practices are neither economically nor environmentally sustainable and India's yields for many agricultural commodities are low. Poorly maintained irrigation systems and almost universal lack of good extension services are among the factors responsible. Farmers' access to markets is hampered by poor roads, rudimentary market infrastructure, and excessive regulation."

— World Bank: "India Country Overview 2008"

1.1 Objective

The objective is to design a system to accumulate agricultural metrics for finding patterns in agriculture and to assist farmers by determining the best crop to grow in any particular season/area.

1.2 Traditional System

In the existing system, knowledge regarding agriculture is passed from generation to generation. Some of this knowledge has scientific backing and some of it has degraded in quality due to reasons like the unreliable nature of word of mouth as well change in climate patterns in recent times.

- The current system is hamstrung by issues such as
- Over or under usage of resources (Water).
- Lack of regular supply of electricity.
- Cultivation of unsuited crops.

1.3 Proposed System

The Proposed system tries to alleviate the issue of traditional by using following techniques

- Environmental monitoring: Field measurements of Soil quality, Weather data, Water quality.
- Precision agriculture: To analyze the collected data using statistical and predictive techniques.
- Remote surveillance: Land owners are provided with applications to monitor the usage of water, fertilizers etc.

II. WORKING.

The main aim of the project is to provide relevant crop details to the farmers and provide them remote surveillance to monitor the production. To achieve this, a sensor network consisting of NPK, soil moisture, temperature and humidity sensor is set up in the farm. The sensors will help to get the agricultural metrics and will help in the crop recommendation system. The amount of irrigation and fertilizers required for a crop is also an important factor for good yield .Agricultural metrics will also be used to determine the correct amount of irrigation and fertilizers required for a particular crop.

The data collected from the sensors is then formatted and sent to the server by the microcontroller. The frequency at which the data of a sensor is sent to the server is determined by the pattern of variation observed in that metric. The following table contains the frequency of data collected at the server.

Sensor	Frequency(per day)
Nitrate	2
Phosphorus	2
Potassium	2
Soil Moisture	24 (every hour)
Humidity	12
Temperature	24 (every hour)

Table 1 Frequency table for agricultural metric

The data collected by the sensors is then stored at the server and is processed using the Rule based classification algorithm. At the server the rule antecedent for the crops will be defined using the existing crop data. The rules will give the value of a given agricultural metric required for a particular crop.

The metrics for a paddy crop are

Metric	Value
Nitrate	217 kg/ha
Phosphorus	68 kg/ha
Potassium	256 kg/ha
Soil Moisture	70% - 80%
Humidity	60%-80%
Temperature	30^oC-32^oC

Table: 2 Metrics for paddy crop

So based on the data collected from the farm, it will be compared against the rules of different crops.

If the data collected is near to any crops rule, that particular crop will be recommended to the farmer via message or IVR.

The data collected by the sensors will also be used for remote surveillance. As we are collecting the metrics we can calculate the following things:

- Amount of water required for irrigation of a particular crop.
- Amount of nutrients required to grow in a particular land.
- Duration at which a particular area will get electricity.
- Control overflow.

Thus the system will help to monitor and increase the yield of crops for the farmers.

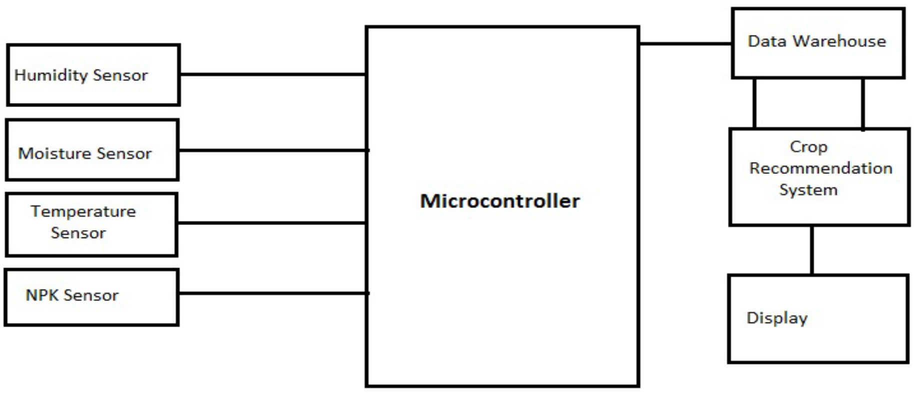

Figure 1: Block diagram of the system

The system consist of the following components:

1. Sensors to detect parameters of soil like soil moisture, temperature, humidity, nitrogen, potassium and phosphorus
2. Arduino Uno R3 microcontroller

3. GSM module
4. Server

2.2 Sensors Used:

Sensors are the device which converts physical parameter into the electrical signal. The system consists of 6 different sensors to collect data of the different parameter of the soil and atmosphere like temperature, soil moisture, humidity, nitrate, potassium and phosphorus content of the soil. The sensors used in the system are explained below.

a. **Temperature Sensor**
   NTC thermistor is used as a temperature sensor. NTC stands for Negative Temperature Coefficient. The sensor provides an analog output that can be converted into the ambient temperature in any unit require.
b. **Soil Moisture Sensor**
   Soil moisture sensors measure the volumetric water content in soil.
c. **Humidity Sensor**
   To measure humidity, amount of water molecules dissolved in the air of environment, a smart humidity sensor is used.
d. **NPK(Nitrate, Potassium and phosphors) Sensor**
   Nitrate, Potassium and phosphors are the important macronutrients in the soil. With the help of this sensor will be able to get the nutrient level of a particular soil.

A wireless sensor network will be connect using Zigbee then the data will be sent to the microcontroller for later processing. Following is the architecture diagram of the proposed system.

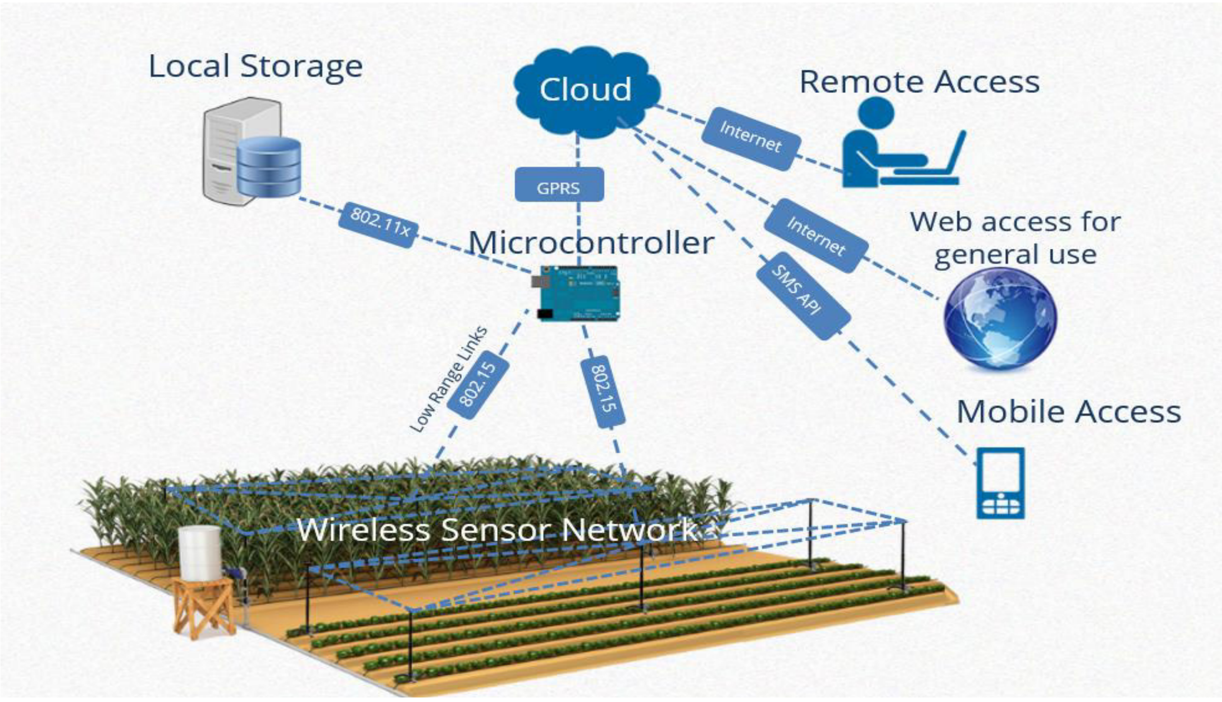

Figure 2: Architecture diagram

As shown in the Figure 3 the data collected by the sensors is send to the cloud for the processing of the data. After that depending on the type of request the data will be provided to the end user.

The following activity diagram shows the flow of the data in the system.

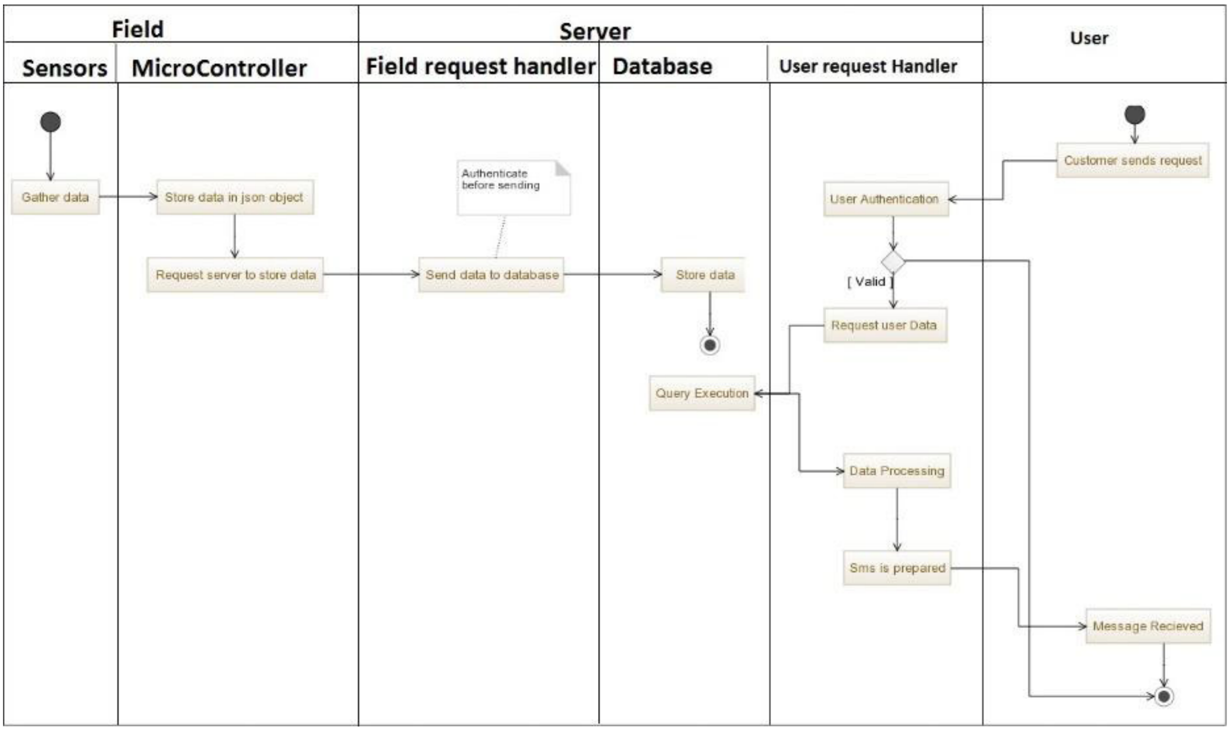

Figure 3: Activity diagram of data flow

III. RESULT

The prototype of the following system has been made using soil moisture, humidity and temperature sensor and the collected data is as follow.

Days	TEMPERATURE		HUMIDITY		Soil Moisture
	Min	Avg	Min(%)	Avg(%)	Avg(%)
21/02/2016	19°C	35 °C	29%	44%	64
22/02/2016	21°C	36 °C	22%	37.70%	62
23/02/2016	19°C	34 °C	22%	45.50%	63
24/02/2016	20°C	33 ° C	34%	47%	65
25/02/2016	22°C	34 ° C	38%	57.80%	64
26/02/2016	20C	31 °C	37%	64%	62
27/02/2016	19°C	32 °C	29%	53.80%	61

Table 3: Data collected by the sensors

The data collected from the sensors are processed and average value of the metric is stored on daily basis. Following is the graphical representation of the average value of the metrics:

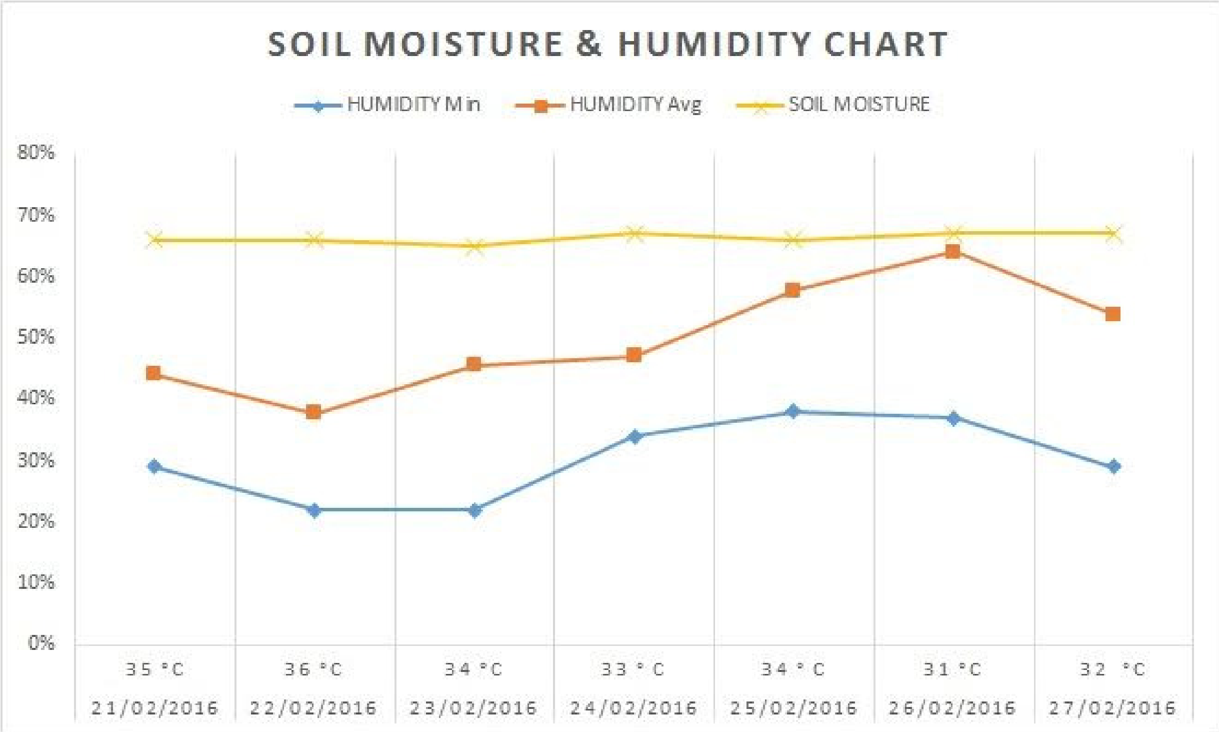

Figure 4: Graphical representation of the collected data.

When the user request a query for crop recommendation, based on his location the metrics are checked and the crop which has a match with the metrics is recommended to the farmer.

IV. CONCLUSION

The main objective of the project is to build a crop recommendation system using Internet of things and provide remote surveillance of the land to the farmers. One of the biggest reason for people to drift away from agriculture is that people are not finding profit from farming. This system will guide the farmers to use the right amount of irrigation and fertilizers for a particular crops, thus will increase the production for the farmers. As said India has the second largest area of fertile land, So the aim is to get the full yield from the land and make agriculture once again the backbone of Indian economy.

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