Prediction of Crop and Intrusions Using WSN

S. Sangeetha, M.K. Dharani, B. Gayathri Devi, R. Dhivya and P. Sathya

Abstract Nowadays, the major problem in the agriculture sector is stumpy crop production due to less number of workers in the farm and animal intrusion. The main objective is to improve the sustainable agriculture by enhancing the technology using wireless sensor technology. It uses Micro Electro Magnetic System which is used to measure temperature, humidity and moisture. The characteristic data obtained from the Wireless Sensor Network will be compared with the pre-defined data set in the Knowledge Base where historical data's are stored. The corresponding decisions from the Knowledge Base are sent to the respective land owner's mobile through SMS using radio frequency which has less power consumption. The sensors are co-ordinated using the GPS and are connected to the base station in an ad hoc network using WLAN. Another common issue is animal intrusion, especially in the places like Mettupalayam, Coimbatore, and Pollachi where elephants are destroying the crops. To protect the crops and common people, Seismic sensors are used to detect the footfalls of elephants in hilly areas. This sensor uses geophone to record the footfalls of elephants and immediately alert message is sent to the people.

Keywords WSN-Wireless sensor network · MEMS-Micro electro magnetic system · SMS-Short message service · WLAN-Wireless local area network · GPS-Global positioning system

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1 Introduction

Recently the modern agriculture uses advanced technology such as Wireless Sensor network to enhance the crop cultivation [1]. The crop prediction and animal prediction increases the efficiency of crop production. The ontology based crop prediction understands and analyzes the knowledge of agriculture. It establishes a semantic network to predict the crop to be grown [2].

The crop monitoring system makes farmers to be more profitable and sustainable, since it provides better water management [3, 4]. If rainfall comes, land owners no need to irrigate the land because humidity gets changed. So, water can be saved which in turn consumes power. Also if the temperature or humidity or pH goes beyond the threshold level, then it generates alert to the corresponding land owners. An early warning system is used to minimize the elephant intrusion. To protect the crops and common people around, Seismic sensors are used to detect the footfalls of elephants in hilly areas [5, 6]. This sensor uses geophone to record the footfalls of elephants and immediately alert message is sent to the people and to the forest authorities as a advanced information to take necessary actions [7].

2 Ontology Based Crop Cultivation

The Ontology classifies the crop cultivation based on knowledge base. It consists of 3 attributes such as Soil, Climate, and life span. Climate is classified into temperature and humidity. Humidity sensors are used to measure the amount of water vapour in air. Temperature sensors are used to sense the temperature level of air from radiation and moisture. pH sensors measures the pH value and is used to analyze the acid level of the soil, by which the fertilizer usage can be reduced. Based on this pH value of the soil, the crop to be grown can be identified. The attribute and its related variables of crop using Agriculture ontology are represented [8, 9] in Tables 1 and 2. Based on this Classification using knowledgebase, the type of crop yielding best can be identified.

Table 1 Soil related variables

Attribute	Types	Crops to be grown
Soil	Alluvial soil	Rice, wheat, sugarcane, cotton, jute
	Black soil	Rice, wheat, sugarcane, cotton, groundnut, millet
	Red soil	
	Laterite soil	Tropical crops, cashew, rubber, coconut, tea, coffee
	Mountain soil	Tea, coffee, spices, tropical fruits
	Dessert soil	Barley, millet

Table 2 Climate related variables

Attribute	Types	Relative temperature	Relative humidity	Crops to be grown
Climate	Summer	Very hot (32–40 °C)	Very high to moderate	Millets, paddy, maize, groundnut, red chillies, cotton, sugarcane, turmeric,
	Autumn	Warm days (<30 °C) cool nights (21–29 °C)	Low	Maize, oats
	Spring	Warm days (<30 °C) cool nights (25–29 °C)	Low to moderate	Wheat, barley, mustard, peas
	Winter	Cold (10–15 °C)	High	Oats

3 Knowledge Representation for Crop Prediction

Ontology knowledge based crop prediction system is used to estimate the cultivation of crop based on weather and soil conditions. Figure 1 shows functional flow of crop prediction. The function takes soil, Climate, pH of the soil as input variables. Fuzzy rules are constructed to predict the climate based on temperature and

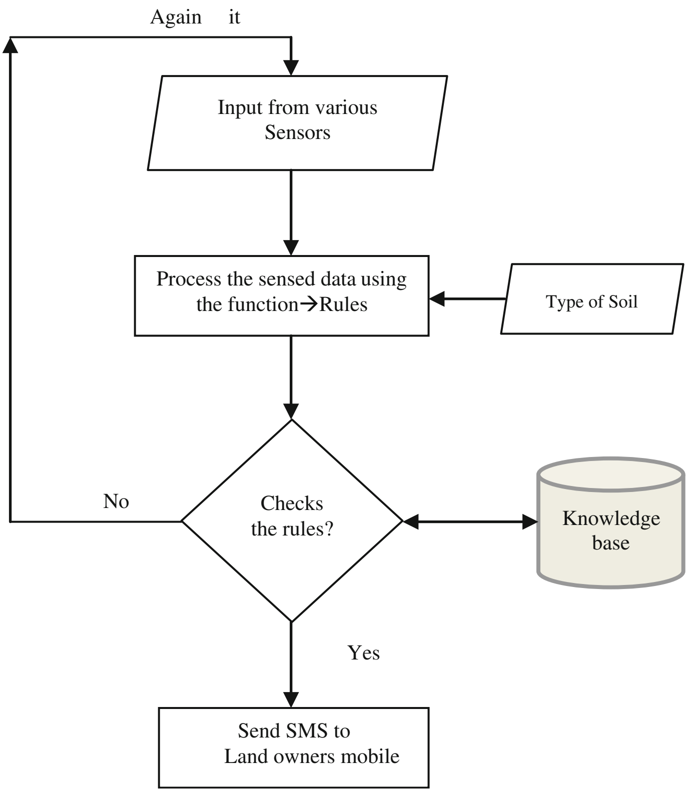

Fig. 1 Functional flow of crop prediction

Table 3 Climate related variables

h	t		
	High	Moderate	Low
High	Summer	Spring	Rainy
Moderate	Summer	Spring	Winter
Low	Autumn	Autumn	Autumn

humidity, since it keeps on changing over time [10, 11]. Fuzzy Associate Memory (FAM) is used to map fuzzy rules in the form of a matrix which is shown in Table 3. These rules take two variables (temperature and humidity) as input and map them into a two dimensional matrix. The rules in the FAM follow a simple if-then-else format. Samples rules for predicting the climate is shown in Table 4. Fuzzy Associative Memory reduces the rate of false negatives.

3.1 Attribute Representation

$$\mathrm{Si} = \{\mathrm{A},\ \mathrm{B},\ \mathrm{C},\ \mathrm{D},\ \mathrm{E},\ \mathrm{F}\}$$
$$\mathrm{X} = \{\mathrm{Ai},\ \mathrm{Bi},\ \mathrm{Ci},\ \mathrm{Di},\ \mathrm{Ei},\ \mathrm{Fi}\}$$
$$f(\chi) = f(S_i, pH, Z)$$

where

x crop to be grown and $x \subseteq X$.

Si set of Soils

A, B, C, D, E, F—Alluvial Soil, Black Soil, Red Soil, Dessert Soil, Laterite Soil, Mountain Soil respectively. Ai, Bi, Ci, Di, Ei, Fi—set of crop to grown in respective soils.

X Set of crops

pH pH value of soil

z Climate predicted based on temperature and humidity

The function $f(\chi)$ predicts the crop to be grown. It takes type of soil, Climate, pH of the soil as input variables. It calculates the plant to be grown on each input variable then it predicts the crop to be grown by intersecting the matched inputs with the knowledge base. The sample rule for predicting the crop is shown below.

If Si = A AND Z = Summer AND pH > 7.0 then Ai ∩ Zi ∩ pHi

Table 4 Sample rules for predicting the climate

Rule 1	If (t==Low) AND (h==*Moderate*) THEN (Season==Winter);
Rule 2	If (t==Moderate) AND (h==*Moderate*) THEN (Season==Spring);
Rule 3	If (t==Moderate) AND (h==*Low*) THEN (Season==Winter);

4 Crop Monitoring System

Due to scarcity of workers, automatic monitoring system has been established to measure temperature, humidity, pH at different time and from different locations by deploying various sensors [12, 13] which is shown in Fig. 2. The measured value will be converted to Digital signal using Analog to Digital Converter (ADC). Micro Electro Magnetic System which acts as a processing Unit transmits the data to Wireless Sensor Network. The sensors are co-ordinated using the GPS and they are connected to the base station in an ad hoc network using WLAN [14]. These values are compared with the pre-defined data set in the Knowledge Base where historical data's are stored in ontology knowledgebase. The corresponding decisions from the Knowledge Base are sent to the respective land owner's mobile through SMS. If rainfall comes, land owners no need to irrigate the land because humidity gets changed. So, water can be saved which in turn consumes power. Also if the temperature or humidity or pH goes beyond the threshold level, then it generates alert to the corresponding land owners.

5 Elephant Intrusion Prediction

Elephants are destroying the crops in the places like Mettupalayam, Coimbatore, and Pollachi. The elephant intrusions are predicted in order to resist the crop cultivated [15]. Seismic sensors are deployed around the hills which are used to detect the elephant and to protect the crops and people. It uses geophone to record

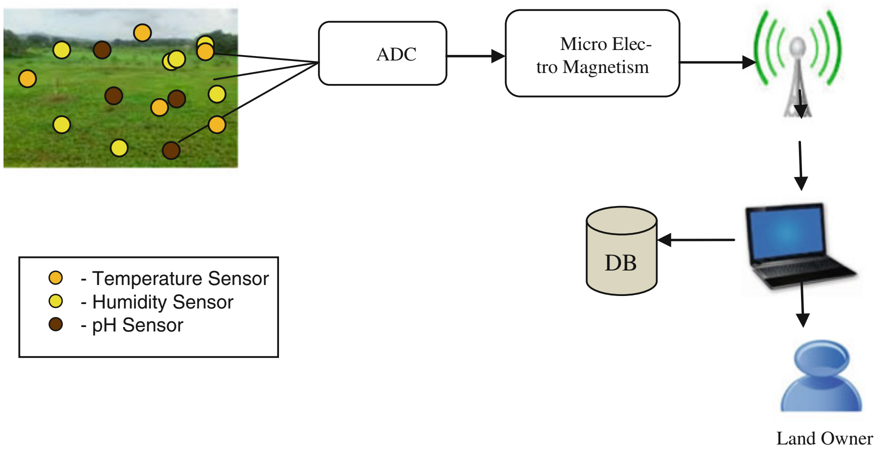

Fig. 2 Crop monitoring system

the footfalls of elephants. The exact measurement of each sensor identifies the exact place of elephant intrusion. After detecting, the alert message is sent to the land owners through RF and to the forest department immediately to protect the people.

6 Conclusion

This paper uses WSN technology for Crop cultivation, it provides low cost, consume less power. The ontology based crop cultivation predicts the crop to be cultivated with high yield. Fuzzy Associative Memory is used to predict the climate condition which is mainly to reduce the rate of false negatives. Automatic crop monitoring system has been established to avoid paucity of workers. Seismic sensors are used to detect the footfalls of elephants in hilly areas. This sensor uses geophone to record the footfalls of elephants and immediately alert message is sent to the people. The crop prediction and elephant intrusion prediction makes the farmer to have high yield.

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