Cost Effective Precision Agriculture Using Mobile Wireless Sensor Rover

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ABSTRACT

Today Agriculture needs a revolution for growing, sustaining and expanding to meet the requirements of rising population on the planet. By giving this research paper we would like to take initiative to make agriculture more robust and sustainable where limited amount of natural resources are available. Here we have implemented the concept of wireless sensor networks for achieving precision in agriculture. We have designed a Rover which is loaded with sensor. Rover can move around the farm taking the required data and sending them to base station.

Keywords: - *Precision agriculture, wireless sensor networks, Wireless Nodes, Wireless Rover Car Wireless communication , Base Station, Autonomous Robot Car, Temperature, Soil Moisture, measurement*

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1. INTRODUCTION

The concept of precision agriculture has been around for some time now. It can be defined as a comprehensive system designed to optimize agricultural production by carefully tailoring soil and crop management to correspond to the unique condition found in each field while maintaining environmental quality, economy and yields.
Literature available and research by people has grown very much during last decade in this area. This type of agriculture practice is being implemented in Europe under a project called 'LOFAR'.

1.1 LOFAR - THE AGRO PROJECT

In Europe, the LOFAR Agro project is a study of precision agriculture that focuses on tailored management of a crop. This involves monitoring soil, crop and climate conditions in a field, generalizing the result and providing a decision support system (DSS) for treatments or taking differential action such as real time variation of fertilizer or pesticide application. The DSS gathers information from a weather station and the wireless network.

2. PRECISION AGRICULTURE AND CURRENT SOLUTIONS

• Agriculture is by far the human activity that uses the most of freshwater resources (65-70%). Worldwide only 17% of the croplands are irrigated, but they account for 40 % of the global harvest. More than ever, water management has become vital for agriculture. Considerable volumes of water are wasted due to inadequate irrigation management, which can also lead to water-logging or to soil salinization (10 to 15 % of irrigated lands worldwide). Furthermore, due to overuse, irrigation is frequently responsible for the depletion of the groundwater table and loss of aquifer storage capacity. Hence there is need to go for precision agriculture like activities to optimize the us e of resources.

•There is an interest in monitoring the probability of occurrence of pests or diseases based on the evolution of climatic parameters (temperature, humidity, soil moisture). In this way, farmers can schedule more efficiently the application of pesticides and fungicides and limit the associated monetary and environmental costs.

•Intensive use of nitrogenous fertilizers can result into soil acidification. We need to know the right amount of fertilizer required for a soil type to optimize the quality.

2.1 CURRENT SOLUTION

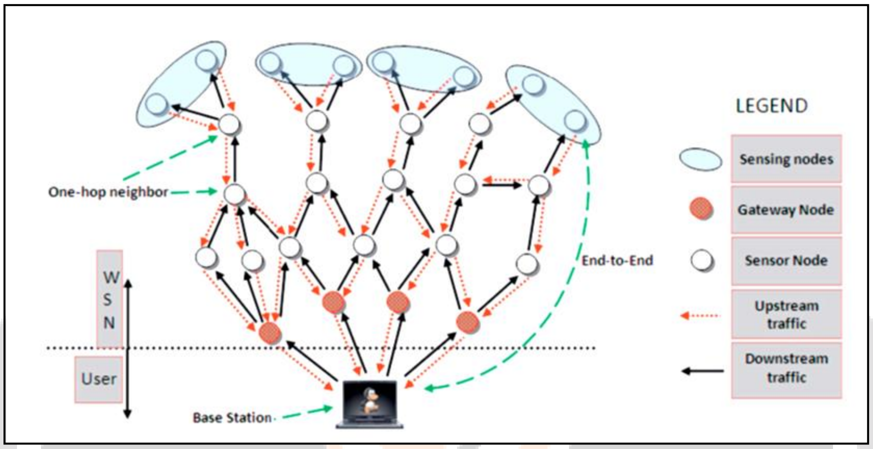

Fig -1: Generic Architecture for Wireless Sensor Networks

As per **Fig-1** Normally Wireless Sensor Network follows the architecture where numbers of Nodes/Sensors are deployed in the field and they transfer data to the base station.
User at the base station can view the data and take necessary actions form that data. Many times automation based on the collected data can reduce the human errors and enhances the system performance.
This architecture can be named as **fixed node architecture**.

2.2 DISADVANTAGES OF FIXED NODE ARCHITECTURE.

- Overall project becomes very expensive to implement as each node has the necessary sensors fitted.
- After implementation, Maintenance of the system requires much efforts, time and money.
- Nodes might drag out with the flow of water or it might change its place because of heavy wind.
- Aggregating large amount of data, storage and process of that data requires good hardware efficiencies and processing power.
- Considering harsh environmental changes, nodes have to be designed rugged enough to withstand the condition and delicate sensor can maintain their health.

These are major disadvantages in the fixed node architecture so here we present our research of precision agriculture.

3. FOCUS OF OUR RESEARCH

In available researches we found the Wireless Nodes / Sensors are stationary. In these cases the cost of setting up the wireless sensor network becomes very high. We tried out a totally different solution for overcoming the disadvantages.

Only one mobile node / Autonomous Rover (as per farm requirement) and a receiver (Base station). Where the node will analyze the field using various climate sensors and send the data to the base station. Base station will process that data and send it to the farmer via GSM module.

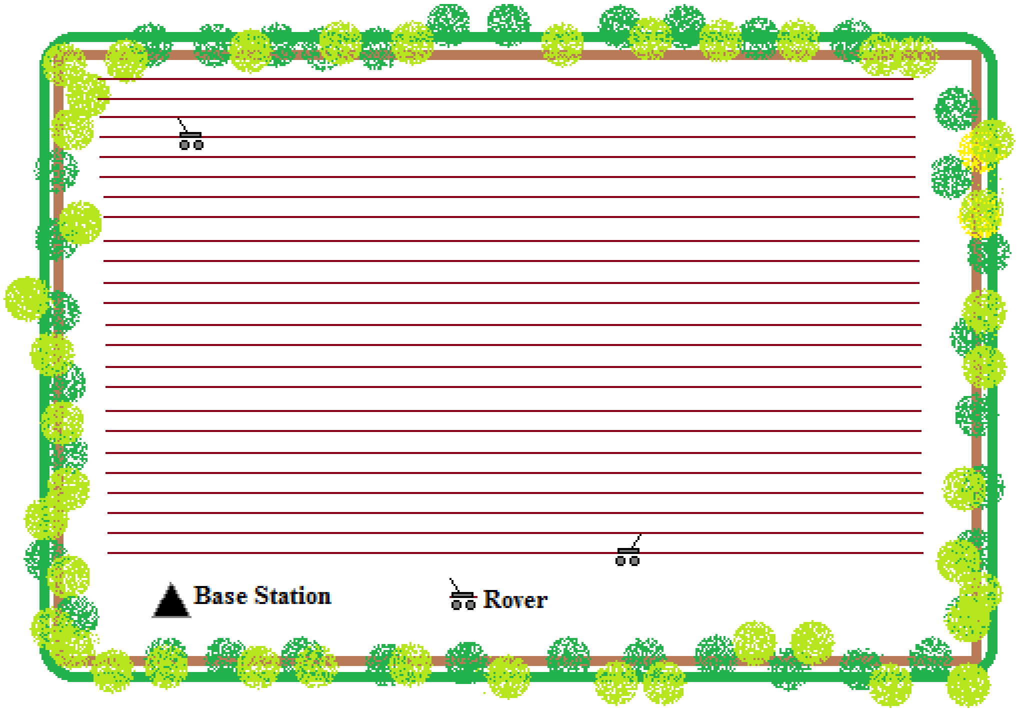

Fig -2: Mobile architecture using Wireless Sensor Rover

3.3 MATERIALS/COMPONENTS USED

3.3.1 FOR NODE

a) AT mega 328 microcontroller unit
b) Xbee PRO (R) trans receiver module (2.4 GHz)
c) 9 V lithium ion power supply
d) SENSORS:
- "LM 35" temperature sensor
- Humidity sensor
- Ammonia sensor
- Piezoelectric sensor for soil moisture detection
- Distance sensor for obstacle management

e) Digital smell cartridge and control elements
f) Rover/Autonomous Robot car.
g) PCBs for circuit connection

3.3.2 FOR BASE STATION

a) ARM 7 series microcontroller (with hi processing power)
b) Xbee PRO(R) trans receiver module (2.4 GHz)
c) GSM module and a SIM card
d) Wall power device
e) Charging point for mobile node
f) PCB's for designing the board

3.4 CONSTRUCTION AND WORKING

Sensors mounted on an autonomous rover car as shown in **Fig-3**. Rover has a Trans receiver that is communicating with Base station on specific time interval.

This rover has a number of necessary sensors which are following:

a) A temperature sensor to monitor the ambient temperature and humidity of the farm
b) The soil moisture would also be measured using the humidity sensor.
c) These two data can then be collaborated with suitable algorithms
d) This would indicate the need for irrigation at any specific instance.
e) An ammonia detector is mounted which measures the level in the soil and informs about the need of fertilization.

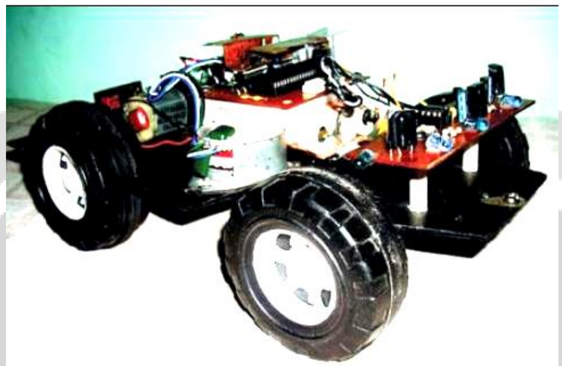

Fig -3: Autonomous robot car with Sensors

3.5 SPECIFIC REVOLUTIONARY RESEARCH

1. Usage of the latest digital smell technology in farming
2. IR sensors would be used to detect the increase in number of harmful pests in the farm.
3. With the help of a digital signal from the controller the pheromones which are intoxicating to these pests can be emitted.
4. In this way pest control can be achieved without using harmful pesticides.
5. The digital smell module consists of a cartridge containing a set of 128 chemicals.
6. These chemicals can be mixed according to desired smell indicated by the controller.
7. The cartridge is easy to maintain and replicable.
8. Further this technology can be used to attract the essential insects required for pollination of flowers in fruit farms.

3.6 PROCESSING OF SIGNALS AT THE BASE STATION

A. All these inputs which are gathered by the node are transmitted to the base station which is located in the range of the autonomous vehicle.
B. The base station has ARM processor which can aggregate the data and do necessary process.
C. Base station sends the data with help the GSM/GPRS module which sends the TEXT message to the user.
D. If the interface at user is ANDROID then the base station sends the data in the mapping format eg: temperature/humidity map of the farm. Demo maps shown with different profiles of Temperature which is collected by Rover in **Fig-4.**
E. Calculations and analysis of data is very helpful for control of irrigation systems.

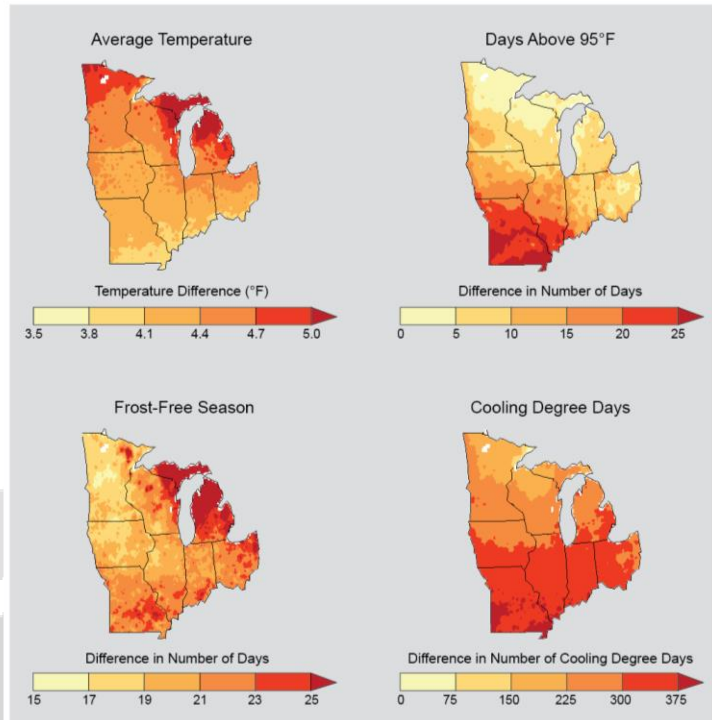

Fig - 4: Autonomous robot car with

3.7 SPECIFICATION OF AUTONOMOUS ROVER

- The ROVER is able to cover 1 km x 1 km area in a week.
- Again the farm can be divided into several parts/phases and user can monitor the result in each phase.
- Dividing in several phases ensures robustness and reliability.

3.8 PROGRAMMING AUTONOMOUS ROBOT CAR

In Programming we used AVR programmer for Rover node and ARM Burner LPC Expresso Kit for the base station as shown in **Fig-5**. ZIGBEE protocols in order to program wireless Transmitter and Receiver.

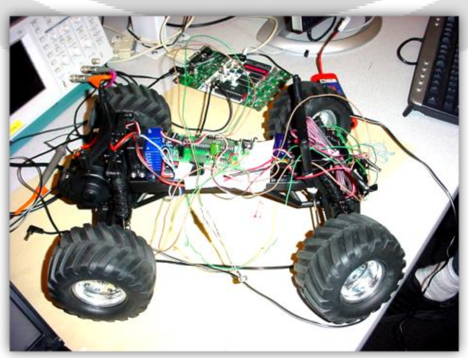

Fig -5: Autonomous robot car on programming desk with AVR programmer

4. ADVANTAGES IN OUR MECHANISM

- Rover node and a base station becomes inexpensive then multiple nodes.
- Scaling up the rover number as per requirement becomes easy and less change required on base station programming.
- Faster data collection and real time system updates is possible because of less data handling.
- Maintenance becomes less time consuming and effective.
- No cabling is necessary which results in cost and power saving.

5. CONCLUSIONS

By using this technique farm production can be increased. The quality of output can be maintained and profit levels can be increased with the available resources. Crop health can be maintained easily and effectively. Project focuses to help farmers by providing a robust mechanism along with a fairly reasonable cost. Unnecessary usage of natural resources can be minimized.

5. ACKNOWLEDGEMENT

We are thankful our head of department Prof. J.T Patankar, who gave us proper guidance to move ahead in this project. Our friends and family, who always gave us support & inspiration for this project. Dr. Sachin Gajjer (Nirma University) & Prof. Sandip Mehta (Nirma University) who gave us knowledge about sensors and wireless communication also helped in calculating efficiency of our product. Prof. S.V. Jain (Nirma University) & Prof. A.M. Lakadawala (Nirma University), who gave information about robot mechanics & Car design.

Last but not the least, on the list are Dr. Namrata Bajaj, who helped us to prepare this report and improve our format for preparing the report.

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