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# Wind Speed and Rain Fall Monitoring System for Precision Agriculture using Low Power Consumption Wireless Sensor Network

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***Abstract* – Indian agriculture is beset with several challenges like drudgery, natural uncertainties, low productivities, low profitability, climate change, and low professional esteem. To fight against all challenges Precision Agriculture [PA] / site specific management is needed. Now a days precision agriculture or smart environments, wireless sensor networks (WSN) will play a key role in sensing, collecting, and disseminating information about environmental phenomena. In agriculture sector today's weather forecasting systems accessible based on satellite and RADAR communication. These systems are heavy, difficult to handle and costly. They are sensing barely particular area and its partial range. But in agriculture field ubiquitously not identical environmental conditions of different parameters like humidity, temperature, moisture, light intensity, wind speed, wind direction etc. which affects or sustain quality of crop, hence it is necessary to monitor each and every crops existing environmental circumstance. The real-time environmental parameter which makes a continuous impact on the crop from cultivating till cutting it. Here we are going to monitor Wind speed & Rain fall, which affects overall quality of food and life of crops with the help of low power consumption wireless sensor network.**

***Keywords* – Precision Agriculture [PA], Wireless Sensor Network, Irrigation Management System (IMS) etc.**

## I. INTRODUCTION

Nowadays, agriculture means more than just feeding the growing populations. But Indian agriculture is beset with several challenges. Drudgery, Natural uncertainties, low productivities, low profitability, climate change, and low professional esteem are all driving the cultivators away from agriculture. Integrating sensors, embedded system, control, wireless sensor network and ICT engineering into agriculture is a key enabler for delivering improved food supply and sustainable crop production without increased burden on the limited fertile land-bank. *Precision agriculture* (PA) is defined as an integrated information and production-based farming system that allows the grower to produce more efficiently and realize greater economic gains through controlled use of their input resources [3]. Precision agriculture is most important aspect for production and yield of different crops and use of wireless sensor networks is essential for the implementation of information and control technologies in precision agriculture. Agricultural inputs such as irrigation, fertilizers, pesticides, etc. are applied in precise quantities as determined by modeling of crop growth patterns to maximize the crop yield and to minimize the impact on the environment. *Climate* is the most important dominating factor influencing the suitability of a crop to a particular region. The yield potential of the crop mainly depends on climate. More than 50 per cent of variation of crops is determined by climate. The most important climatic factors that influence growth, development and yield of crops are solar radiation, temperature, relative humidity, rainfall, wind speed etc.

In Precision Agriculture or smart environments, wireless sensor networks (WSN) will play a key role in sensing, collecting, and disseminating information about environmental phenomena. In this paper we will monitor two parameters Wind speed & Rain fall.

## II. WIND AND ITS INFLUENCE ON CROP PRODUCTION

### *Beneficial impact of wind*

Wind increases the turbulence in atmosphere, thus increasing the supply of carbon dioxide to the plants resulting in greater photosynthesis rates and also alters the balance of hormones. Wind increases the ethylene production in barley and rice and decreases gibberillic acid content of roots and shoots in rice. Nitrogen concentration in both barley and rice increase with increase in wind speed.

### *Wind influences crop production in two ways*

1. *Physiological impact*: Wind increases transpiration especially cuticular transpiration than stomatal transpiration. Hot wind accelerates the drying of the plants by replacing humid air by dry air in the inter cellular spaces. For example, rice crop during June-July months shows tip drying. Wind increases turbulence in the atmosphere and availability of CO2 and thereby increased photosynthesis. Beyond a certain wind speed the rate of photosynthesis becomes constant. Wind speed is responsible for spreading of disease from one crop to another.
2. *Mechanical impact on plants*: Strong wind damages the shoots and responsible for lodging (Paddy, Sugarcane, Banana etc.,), Flower and fruit shedding. Crops and trees with shallow roots are uprooted and cold wind causes chilling injuries, causes soil erosion and Soil deposition causes poor aeration in root zone.

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## III. Rainfall and its Influence on Crop Production

Cropping system can be planned by understanding the rainfall pattern. Rainfall analysis helps in taking decisions on time of sowing, scheduling of irrigation, time of harvesting etc., Rain analysis is necessary for designing farm ponds, tanks of irrigation projects. Amount, distribution and intensity of rainfall are the important aspects of rainfall that have considerable influence on crop production.

## IV. Literature Survey

Wireless Sensor Network (WSN) is type of network which consists of collection of tiny device called sensors nodes. Sensor node has a resource constraint (i.e. battery power, storage and communication capability) are set with radio interface by which they are communicated with one to another [5]. Advances in wireless personal area networks have made the practical deployment of various services possible, which until a few years ago was considered extremely costly or labor intensive. WSN for precision agriculture (PA) where real time data of the climatological and other environmental properties are sensed and relayed to a central repository [1]. The architecture of a WSN system comprises of a set of sensor nodes and a base station that communicate with each other and gather local information to make global decisions about the physical environment [6].

The privileges of wireless sensor network in agriculture are for several causes: high performance, increase the production efficiency while decreasing cost, low-power consumption and collected distributed data [7]. Wireless sensor networks are gaining greater attention from the research community and industrial professionals because these small pieces of smart dust offer great advantages due to their small size, low power consumption, easy integration and support for green applications [10]. Modern agriculture needs tools and technologies that can improve production efficiency, product quality, postharvest operations, and reduce their environmental impact. Automation in agriculture brings about a fundamental contribution to what is now known as precision agriculture (or precision farming). The real-time environmental parameter which makes a continuous impact on the crop from cultivating till cutting it. Such as soil moisture, temperature, humidity, wind speed and direction and PH of soil [12].

Satellite and RADAR communication systems are heavy, difficult to handle and costly and are sensing barely particular area and its partial range. But in agriculture field ubiquitously not identical environmental conditions, it is necessary to monitor each and every crops existing environmental circumstance to sustain the quality of crops [9]. Wireless Sensor Networks (WSNs) have been used for various applications including habitat monitoring, agriculture, nuclear reactor control, security and tactical surveillance.

## V. Objectives of the Project

As we are proposing a design of integrated sensor network for agriculture purpose, to get information about climatic condition like Wind Speed and Rain Fall, may helps to monitor occurrence of diseases on crops. This will be helpful for farmers to increase the yield.

Our design approach is to have high level sensing modeling methodologies for design and development of low cost integrated sensors network which helps to monitor different climatic conditions. Our aim is to design and develop wireless sensor network to increase the coverage and to reduce power consumption. Our proposed system will help to farmer for the entire crop quality monitoring. The detail objectives are as below.

- To record the data on weather parameters like Wind Speed and Rain Fall.
- Development of modeling methodologies to sense these parameters.
- Design and develop wireless sensor nodes with high coverage & low power consumption.
- To test the developed model.
- Analysis of sensed parameter which was collected through WSN.

*Proposed System Architecture configuration*

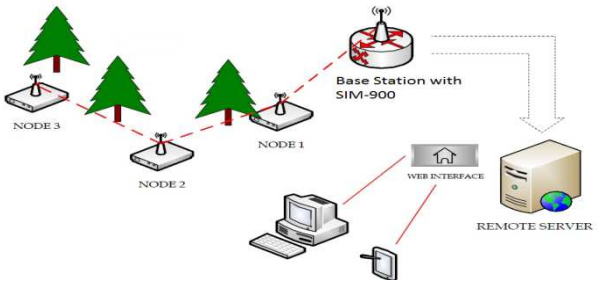


Fig. 1. System Architecture of Wireless Sensor Network for Precision Agriculture.

## VI. Hardware

To develop sophisticated embedded Wind speed & Rain fall monitoring system for agricultural applications, may be classified into or comprises of following two sections.

1. Wireless Sensor Nodes 2. Base Station with SIM-900

### A. *Wireless Sensor Node*

The basic requirements towards the proposed system are:

- Provision of environmental information in real time;
- Ability to set Wind Speed and/or Rain Fall limits;
- Raising the alarm in excess of the limits of Wind Speed and/or Rain Fall;
- Opportunity to review the archived Wind Speed and/or Rain Fall data for week;

These nodes are mainly concerned with or responsible for sensing of environmental parameters namely Wind Speed and Rain Fall through sensor and then conditioning circuit will send it in to appropriate form to microcontroller MSP430F24xx,which in turn sends the data to Master node at remote location using cc2500-Low-Cost Low-Power 2.4 GHz RF Transceiver wirelessly.

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The proposed block diagram Master and Slave node of WSN is as below.

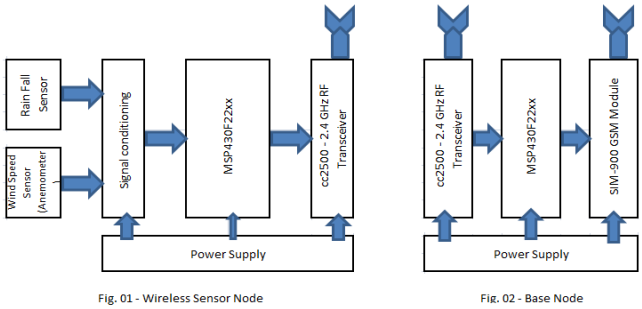


Fig. 01 - Wireless Sensor Node  Fig. 02 - Base Node

Fig. 2. Block diagram of Master/Base and Slave Node of Wireless Sensor Network.

*Master Node*

This node is mainly concerned with or responsible for gathering sensed data or information from all the slave nodes to microcontroller MSP430F24xx, which in turn sends the data to Web server or any handheld gadget through SIM-900. Both the devices sensor node and master node are operated at dc voltage source.

At the web server or desktop data is stored for every one hour and system will monitor if any of the environmental parameter exceeds predefined limit SMS will be sent to farmer about the same. Furthermore we are planning to develop a system with a DATA MODEL which defines growth of disease due to susceptible environmental factors. System will monitor all parameters with DATA MODEL and real time data, accordingly inform it to the farmer about the possibility of occurrence of disease at the very beginning stage. Which in terms help the farmer to take necessary care to avoid further inception and / or growth of disease. This system works on the principle of "Prevention is better than Cure".

Following components have been used to design monitoring system for rain fall and wind speed.

1. *Rain Fall Sensor*: The Rain Bird® RSD Series Rain Sensor device suitable for 24VAC residential and commercial applications. This high quality product saves water by automatically measuring precipitation amounts and suspends irrigation cycles when watering is unnecessary.

Table 1. Irrigation Site Conditions & Rainfall Setting

| Irrigation Site Conditions | Rainfall Setting |
|---|---|
| • Sensor receives long periods of direct sun | 1/8" to 1/4" (3mm to 6mm) |
| • Clay-type soils | |
| • Frequent, heavy rains | 1/2" to 3/4" (13mm to 20mm) |
| • Sensor mounted in a mostly shady area | |
| • Sandy soils | |

2. *Wind speed Sensor (Anemometer)*: Wind speed, or wind velocity, is a fundamental atmospheric rate. Wind speed is caused by air moving from high pressure to low pressure. An anemometer or wind meter is a device used for measuring wind speed, and is a common weather station instrument.
3. *cc2500-Low-Cost Low-Power 2.4 GHz RF Transceiver*: The CC2500 is a low-cost 2.4 GHz transceiver designed for very low-power wireless applications. The circuit is intended for the 2400-2483.5 MHz ISM (Industrial, Scientific and Medical) and RD (Short Range Device) frequency band. The RF transceiver is integrated with a highly configurable baseband modem with data rate up to 500 kBaud.
4. *SIM-900*: The SIM900 is a complete Quad-band GSM/GPRS solution in a SMT module which can be embedded in the customer applications. Featuring an industry-standard interface, the SIM900 delivers GSM/GPRS 850/900/1800/1900MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption.
5. *MSP430f2274IRHAR*: The Texas Instruments MSP430™ family of ultra-low-power microcontrollers consist of architecture, combined with five low-power modes optimized to achieve extended battery life in portable measurement applications. The device features a powerful 16-bit RISC CPU, 16-bit registers, and constant generators that contribute to maximum code efficiency. The digitally controlled oscillator (DCO) allows wake-up from low-power modes to active mode in less than 1 µs. The MSP430F22x4 is an ultra-low-power mixed signal microcontroller with two built-in 16- bit timers, a universal serial communication interface, 10-bit A/D converter with integrated reference and data transfer controller (DTC), two general-purpose operational amplifiers in the MSP430F22x4 devices, and 32 I/O pins.

*Software*

1. IAR Embedded Workbench for MSP430 V4.09A KickStart.
2. Code Composer Essentials 2.0.
3. MultiSim Simulator.
4. Altim 11.0, Ckt and PCB design
5. MSP430 Debugger

## VII Results and Discussion

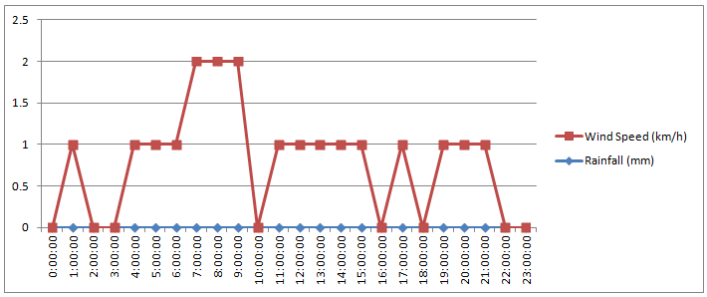


Fig. 3. Wind speed & Rainfall with respect to Time (Hourly)

With the help of Rain fall and wind speed monitoring system, it is observed that increase and / or decrease beyond normal level in both environmental parameter have adverse impact on crops. Rainfall analysis helps in taking decisions on time of sowing, scheduling of irrigation, time of harvesting etc. whereas wind speed is responsible for spreading of disease. This system helps farmer to alarm danger zone of increase and/or decrease in

rain fall and wind speed respectively, so they can take sufficient measures to avoid impact of environmental parameter on overall yield of crops. Here readings are taken on hourly basis and observed for 24 hours from mid-night to mid-night.

## VIII. Conclusion

In this paper we have developed architecture for Precision agriculture based on wireless sensor networks. The architecture comprises of three distinct components: (a) Intelligent nodes with sensors/actuators (b) The wireless network for communication and (c) The control and actuation. The WSN design is made based on the parameters to be sensed for the most common types of crops. We have enlisted two parameters, wind speed and rain fall. The design of the control and actuation is made based on the available hardware in the market. The control decisions work on the sensed parameters through the rules housed in the central repository.

If farmers will use proposed system, then it will give them a weather record and probability of disease infection and / or impacts of rain fall and wind speed remotely. They can take decisions on time of sowing, scheduling of irrigation, time of harvesting etc. Also start spraying pesticides if disease probability is severed or take all other precautionary measures. By using proposed system they can detect and prevent the disease remotely from any location. This system serves the purpose "Prevention is better than cure". It avoids excessive spreading of pesticides and increases overall yield of crops.

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## Author's Profile

**Prof. Pawar Bhalchandra B.** is research scholar working for Ph.D on application of Wireless Sensor Networks in agriculture at the school of Physical Science, SRTMU Nanded. He obtained master degree from SRTM University, Nanded. His area of research is the development of Wireless Sensor Network for High-Tech agriculture. He has 11 years teaching experience for under-graduate and postgraduate students. Currently working as Assistant Professor in MIT ACSc College, Alandi, Pune and His research interest include computer Network, Wireless Sensor Network, Agriculture problem solving.

**Dr. G. N. Shinde** is Pro-Vice Chancellor, SRTM University, Nanded, Maharashtra, INDIA. He has received "Ideal State Teacher Award" from Government of Maharashtra, India for 2008-09 and "Best Principal Award" for 2009-2010 from S.R.T.M. University, Nanded, Maharashtra. He has received M. Sc. & Ph.D. degree from Dr. B.A.M. University, Aurangabad. He has awarded Benjonji Jalnawala award for securing highest marks at B.Sc. Thirteen research scholars were awarded Ph.D. degree under his guidance. He has published more than 75 papers in the International Journals and presented more than 50 papers in International Conferences. He was the Chairperson for F-9 session of "International Conference on Computational and Experimental Science & Engineering" (ICCES2008) which was held at Honolulu, U.S.A & Development and Application of Web 2.0 Technology for Education Purpose session of "International Conference on Multimedia & ICT in Education (m-ICT2009)", April 24, 2009, (Hall 1), Lisbon (Portugal) and "Wave Propagation and Wave Interaction with media" Progress In Electromagnetic Research Symposium (PIERS), March 25, 2010, Session 3A4 (Room D**)** Xian, China. In his account one book is published, which is reference book for different courses. He is also member of different academic & professional bodies such as IAENG (Hon Kong), ANAS (Jordan).He is in reviewer panel for different Journals such as IEEE (Transactions on Neural Networks), International Journal of Physical Sciences (U.S.A.), Journal of Electromagnetic Waves and Applications (JEMWA, U.S.A.).His abroad Visit includes U.S.A., Thailand, Portugal, Germany, Swizerland, Italy, Vatican City, Monaco, France, Maldives, SriLanka, U. K., Scotland, China and New Zealand. He was Chairman of Grievances Committee and member of Management Council & Senate of S.R.T.M. University, Nanded, INDIA. His research interest includes Filters, Wireless Sensor Network System, Image processing and Multimedia analysis and retrieval system.