Estimation of Agro-information through Wireless Sensor Network

Ashish Thapliyal, Rajendra Kumar
Assistant Professor, Electronics and communication engineering , NIT Kurukshetra
Email: anujthapliyal.32@gmail.com

Abstract— Modern agriculture uses modern techniques to improve productivity and automation of agriculture . One of the modern technology is wireless sensing network. This WSN consist of multiple sensors, deployed in crop field, which senses the environmental parameters and process data in order to make automation in agriculture. Paper focuses on accurate data reception by precision transceivers using appropriate channel estimation technique. An experimental set-up is proposed using least square estimation technique which analyzes the error between the estimated and measured agro-data. Error in signal estimation (prediction) directly decreases the crop-productivity. Hence the paper focuses on different estimation techniques which could be deployed in the hardware realization of the agro-info based sensors, which could improve the reception.

I. INTRODUCTION

To improve the production efficiency and product quality, modern agriculture needs some tools and technologies. Earlier for traditional agriculture It was very inconvenient to collect the data regarding agro information. Traditional agricultural environment monitoring system supplies power and transmits data by cable. Therefore it is very difficult to obtain the real-time information on environmental monitoring, because of laying lines hardly, high investment cost and man-made destruction and so on. In order to solve the problems, we designed a wireless agricultural environmental monitoring system based on wireless sensor network, and the system is used to monitor temperature, humidity, wind speed and many other environmental parameters.

A wireless sensor network is a group of specialized transducers with a communications infrastructure monitoring and recording conditions at diverse locations. Commonly monitored parameters are temperature, humidity, pressure, wind direction and speed, illumination intensity, vibration intensity, sound intensity, power-line voltage, chemical concentrations, pollutant levels and vital body functions.

A sensor network consists of multiple detection station called sensor nodes, each of which is small, lightweight and portable. Every sensor node is equipped with a transducer ,microcomputer, transceiver and power source. The transducer generates electrical signals based on sensed physical effects and phenomena. The microcomputer processes and stores the sensor output. The transceiver receives commands from a central computer and transmits data to that computer. The power for each sensor node is derived from a battery. Failure of sensor nodes in the wireless sensor network may result in problem to make communication among the sensor nodes. When a collection of sensor nodes in the network may unable to make a communication WSN make to improve the efficiency of the network. Communication between sensors and base station is based on radio data transmission, our focus on this paper is to accurate data reception on receiving end of base station. Use of appropriate estimation technique to determine the channel response is necessary . accuracy of data received on receiving end is proportional to the accuracy of channel estimation .

II. SYSTEM ARCHITECTURE

System architecture of wireless sensor network is shown in figure.1. It consist sensor nodes, transmission terminal and monitoring terminal. The system consists of large numbers of wireless sensors which are distributed over agriculture environment in order to acquire reliable data and high precision. Sensor nodes are responsible for collecting data of different parameters such as temperature, humidity pressure, position, velocity etc. Sensor unit convert such measured physical quantities into voltage signal .The collected data is transmitted to sink by directly or by multi hop. Sink node is the powerful node which is responsible for data collection , storing , computing and data integration in large amount.

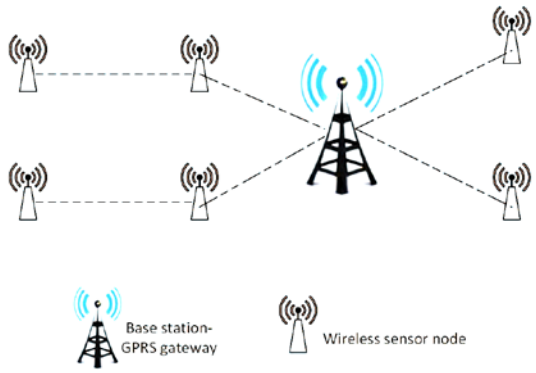


Figure 1. Architecture of Wireless Sensor Network

This wireless sensor network is connected to external world or user from sink node via transmission network. The collected data is shared with client via GPS, GPRS, WI FI or by direct

cable and then client analyze the data for further processing. Processing unit with microcontroller in wireless sensor system control sensors , manage the communication protocol to carryout different tasks. Communication between wireless sensor network node and external network is provided by transceiver unit. Architecture also consist the power unit , which is very crucial provide mandatory power to each node.

III. HARDWARE IMPLEMENTATION

A. Energy efficient network

Network which consume less energy is important for efficient data collection network . the base station and sensors used for collection and processing of data should be energy efficient . based on modern wireless technology multiple hardware present for same purpose . according to requirement the appropriate hardware is selected for data collection network formation . list of few of available hardware is following

1) MC13224V (microchip Zigbee): It work on IEEE 802.15.4 standard with data rate of 250 kbps. Output power of the device is -30 dBm to +4 dBm in frequency band of 2.4 GHz ISM band.

2) *CC1120* : It work on IEEE 802.15.4g standard with data rate of 0 to 200 kbps. Output power of the device is -40 dBm to +16 dBm in frequency band of 170, 868 MHz ISM/SRD band .

B. Sensor station

Sensor station consist of sensor to sense the agricultural environment parameter such as temperature, moisture, humidity , wind speed etc. this sensor network is integrated in wireless hardware such as CC1120. This part also consist power supply. Sensor node block diagram is shown in figure. 2

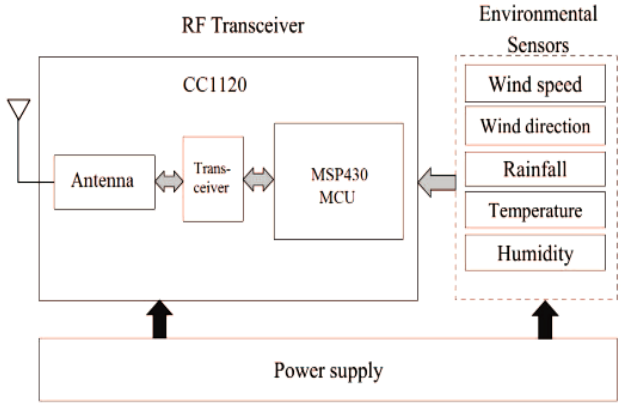


Figure 2. Block diagram of Sensor Network

C. Base station

a) Base station consist of communication system between base station and user , and also consist sensor network which senses and collect data of different parameters from agricultural environment. Two methods are used to communicate between base station and remote user . one is module FT232, and other is direct use of GPRS .

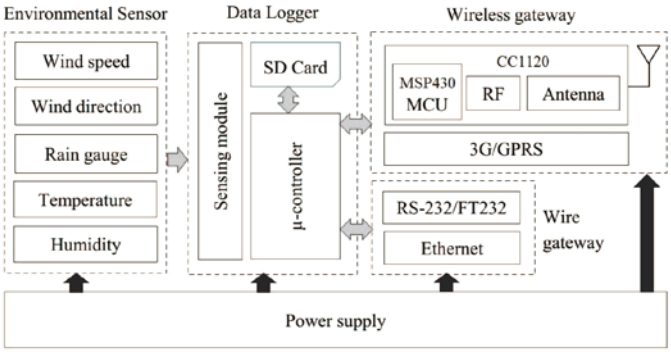


Figure 3. Block diagram of Base station

1) Power management in base station: power management in wireless sensor network is very essential for long term operation. For extreme weather condition in long operation power need to be manage in such a way that system work properly for whole day operation . some alternative for power efficiency is achieved by using solar energy system . as our radio transceivers are high energy consumption devices , so managing power distribution for radio transceiver is highly important for accurate operation.

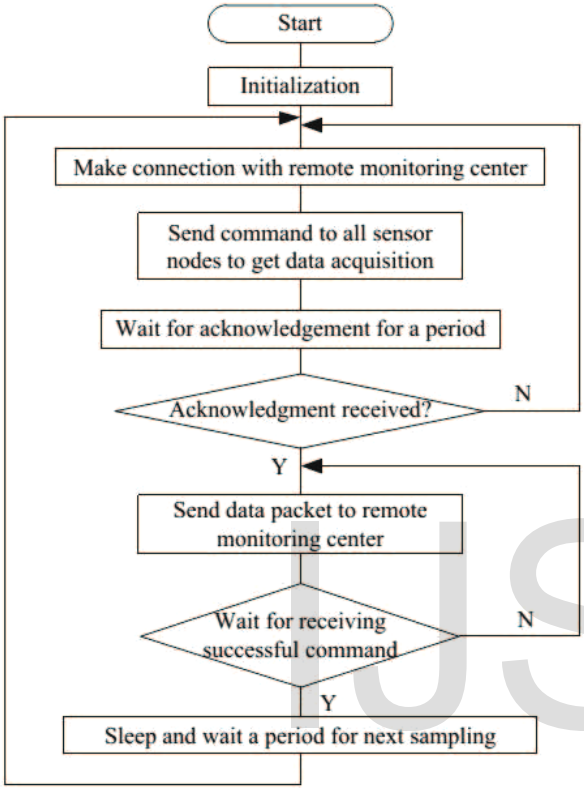
2) Environment sensors: A different types of sensors are available in now a days for different parameter sensing. Few of them are wind speed sensor, wind direction sensor, temperature sensors, humidity, rain gauge , conductivity and temperature sensor are shown in following.

3) *Data logger*: D data logger is a device used to collect and store data for a long time using a SD card module integrated on it. It consist a analog to digital converter with several input output peripherals to connect different sensors to device. RS-232 module , USB, and Ethernet on the gateway module use to communicate device with external devices.

IV. SOFTWARE IMPLEMENTATION

Data collection and transmission in wireless sensor network mainly based on a particular algorithm . all the sensors collect data and transmit to sink node. In order to this particular operation firstly sensors are initiated , then these sensors sense parameter from external environment which then processed further by activation communication module .

after this sensor node again turn to rest mode. As the radio transceiver consume most of the power so duty cycle of radio transceiver is kept low for power efficient operation. Algorithm which is followed in whole process is as follows:



V. ESTIMATION IN WSN

Aim of this paper is to focus on transmitting and receiving the wireless data from radio transceiver operation. As for sensitive operations, accurate signal reception is very important by transceiver . This paper focused on estimation techniques used for reception of radio signal , it uses different estimation techniques to analyze appropriate estimation technique for the same operation. To receive accurate signal at receiver end it is necessary to determine the channel response between transmitter and receiving devices . For area of application on agricultural environment , external factor such as high wind speed, humidity , rain etc will affect the channel between sender and receiver , to receive signal accurately despite of distortion through external environment a good estimation technique is necessary . in this paper as an example LS estimation technique is used.

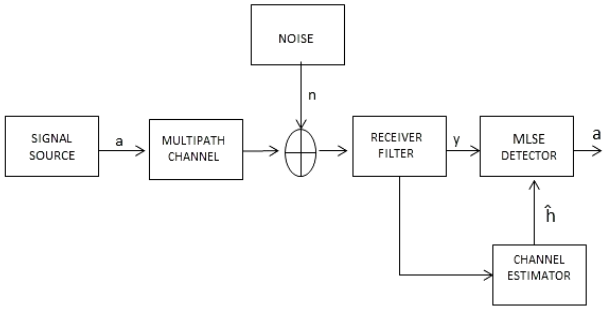


Figure 4. Block diagram of channel estimation

A. Least square (LS) channel estimation:

Signal corrupted by noise between the channels is received as

$$Y = M h + n \quad (1)$$

Where M is transmitted signal from transmitter, h is channel response and n is additive white Gaussian noise

For accurate reception of receiving data channel response h is necessary to obtain . from least square estimation technique channel response is obtain as

$$\hat{h} = \arg_h \min \|y - Mh\|^2 \quad (2)$$

after obtaining channel response h , transmitted data can be calculated easily

$$\acute{M} = y / \hat{h} \quad (3)$$

Error in estimation is given by

$$e = [M - \acute{M}] \quad (4)$$

VI. EXPERIMENTAL RESULTS

Our results are based on experimental temperature measured by radio transceiver at receiving end compared with actual temperature measured with thermometer. Test results are shown Below

s.no.	Real temperature ˚C	Measured temperature ˚C	Error
1	-12.20	-12.70	0.50
2	-07.40	-07.10	0.30
3	8.90	8.70	0.20

4	15.55	15.20	0.35

This shows that error in data estimation is very less using least square estimation . This can further reduced by using some other modified estimation techniques .There are multiple estimation techniques such as Least square estimation, Minimum mean square estimation, Complete channel state information[11] etc. comparison in these techniques for Bit error rate is shown in figure 5.

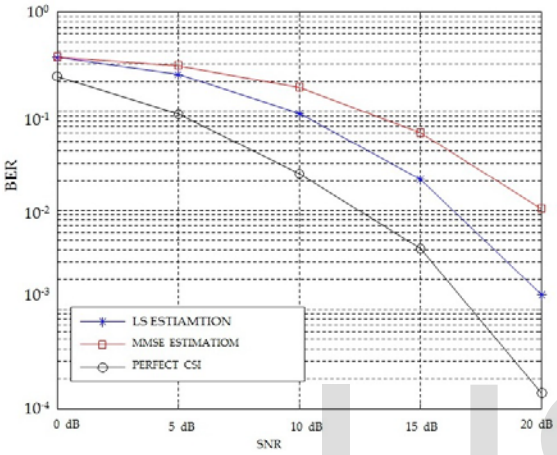


Figure 5. Bit Error Rate

VII. CONCLUSION

In ths paper , we have shown that an accurate estimation of data received at receiving end with the help of appropriate estimation model can improve the sensing and subsequently can improve the production.. Here least square estimation technique is used to reduce the error in channel estimation. Data sensed by sensors are highly susceptible to external environment in the process of data transmission. Sensors sense the environmental parameter such as , temperature , humidity , wind speed , velocity . Collected data is further processed and used by client as receiving end for better productivity and automation in agricultural field . So it is highly desirable to receive accurate value of sensor data. For the same operation an experiment is shown in paper which shows that accurate estimation is large area of research and still various methods can be discovered for accurate estimation.

VIII. REFERENCES

[1] A. Bagula, M. Zennaro, G. Inggs, S. Scott, and D. Gascon, "Ubiquitous sensor networking for development (usn4d): An application to pollution monitoring," Sensors, vol. 12, no. 1, pp. 391–414, 2012.
[2] A. Ghobakhlou, S. Zandi, and P. Sallis, "Development of environmental monitoring system with wireless sensor networks," 2011.
[3] Shahadat Hossain, Rohan Monteiro, Allaa R. Hilal, and Otman Basir, "Fault Tolerant Wireless Sensor Networks using Adaptive Partitioning", rocedia Computer Science 10 (2012) 927 – 932.
[4] Bill C. P Lau, Edan. W .M. A, Tommy W. S , Chow, " Probabilistic fault detector for Wireless Sensor Network", Journal of Expert System with Applications 41(2014) 3703- 3711.
[5] Jhuria, M.; Kumar, A; Borse, R., "Image processing for smart farming: Detection of disease and fruit grading," Image Information Processing (ICIIP), 2013 IEEE Second International Conference on , vol., no., pp.521,526, 9-11 Dec. 2013
[6] Castello C.C., Fan J., Davari A. and Ruei-Xi Chen, "Optimal sensor placement strategy for environmental monitoring using Wireless Sensor Networks," System Theory (SSST), 2010 42nd Southeastern Symposium on , vol., no., pp.275,279, 7-9 March 2010
[7] Lei Xiao; Lejiang Guo, "The realization of precision agriculture monitoring system based on wireless sensor network," Computer and Communication Technologies in Agriculture Engineering (CCTAE), International Conference On , vol.3, no., pp.89,92, 12-13 June2010
[8] R. Nallusamy and K. Duraiswamy, "Solar powered wireless sensor networks for environmental applications with energy efficient routing concepts: A review," Information technology journal, vol. 10, no. 1, pp. 1–10, 2011.
[9] Jiber, Y.; Harroud, H.; Karmouch, A, "Precision agriculture monitoring framework based on WSN," Wireless Communications and Mobile Computing Conference (IWCMC), 2011 7th International , vol., no., pp.2015,2020, 4-8 July 2011.
[10] M. Nicoli, S. Ferrara, and U. Spagnolini, "Soft-iterative channel estima-tion: Methods and performance analysis," IEEE Trans. Signal Process., vol. 55, no. 6, pp. 2993–3006, Jun. 2007
[11] O. Edfords, M. Sandell, J.J. Van de Beek, S.K. Wilson, and P.O. Borjesson, "OFDM Channel estimation by singu- lar value decomposition," *IEEE Trans. on Commun.*, vol.46, pp. 931-938 July 1998