STUDY ON APPLICATION OF WIRELESS SENSOR NETWORKS FOR PRECISION AGRICULTURE

Xu Gang, Chen Liping*, Zhang Ruirui, Guo Jianhua, Wang Yanji

National Engineering Research Center for Information Technology in Agriculture, Beijing 100097, China

ABSTRACT

The use of sensor network to achieve soil moisture real-time detection can provide the decision-making basis for precision irrigation systems. In this paper, a wireless sensor networks system was designed and developed to collect information of field such as soil moisture、light intensity、voltage and temperature of sensor node and RSSI(received signal strength indication), which can direct fertilization and irrigation. For the improved communication protocol stack and dormant/synchronization algorithm have been developed for sensor node, the system can run ceaselessly for over a year with four AA batteries as power supply. Collected data is sent to the server by sink node. Apparently deviant data caused by communication faults or sensor temperature drifts can be dealt with by filter. Statistical analysis would be carried out upon collected data to realize the relationship between characters of the field. Finally, this system has been deployed to Beijing and Xinjiang. According to analysis of collected data, the relationship among characters of corn field and cotton field was obtained, and some issues on optimizing efficiency of irrigation were provided.

Keywords: wireless sensor networks; soil moisture detection; precision irrigation; corn field; cotton field

INTRODUCTION

Connecting the Internet with various types of information sensors and equipment such as RFID equipment, GPS devices and others to develop a massive network is called the internet of things. The Smarter Planet, launched by IBM has included smarter food and smarter water management. Smarter food is tracing the whole growth and Logistics period from fields to supermarkets. Smarter water management could provide an advice to optimize the utility of water resources[1]. The wireless sensor network is the basis for internet of things. For the application of the sensor network in agriculture, there are also made numerous achievements and come up with a lot of creative ideas[2, 3]. Some researchers have used the sensor network to collect the acoustic emission for crop water stress to obtain the crop water requirement information[4].

In this study, a field wireless sensor networks system was designed and developed to collect information from field such as soil moisture, air

temperature and humidity, light intensity, voltage and temperature of sensor node and RSSI(received signal strength indication), which can be combined with information like weather conditions, videos recording crop growth and others to direct fertilization and irrigation. Research focus of general sensor network lies in the design of sensor nodes and the network, but the core of sensor network is data; equally important are the acquisition and analysis of data.

RESULTS AND CONCLUSIONS

This system has been deployed to Beijing and Xinjiang in china. From June 10 2009 to Oct. 10 2009, wireless sensor network system worked 4 months over almost whole growth period of cotton in Xinjiang and the whole growth period of corn in Beijing.

Many problems had been identified from the collected data. According to the curve of temperature, light intensity and soil moisture, the relationship among cotton, soil and field film could be revealed, and the data can be used to improve the growth model of cotton with field film. The data from different nodes in same field could be put together for comparison to reveal the tiny difference in the field.

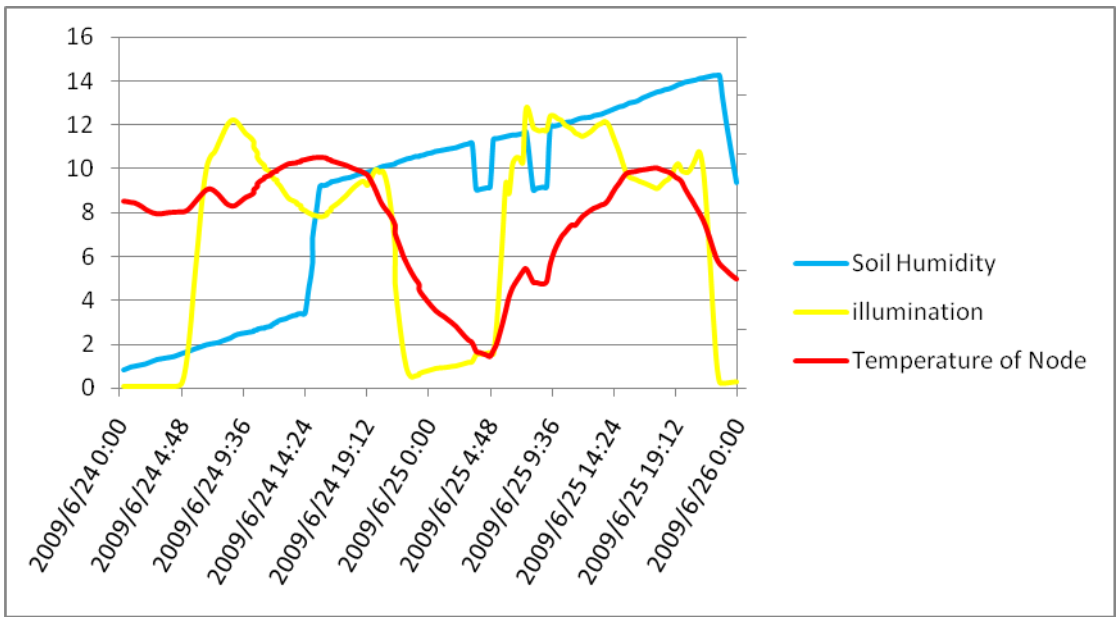
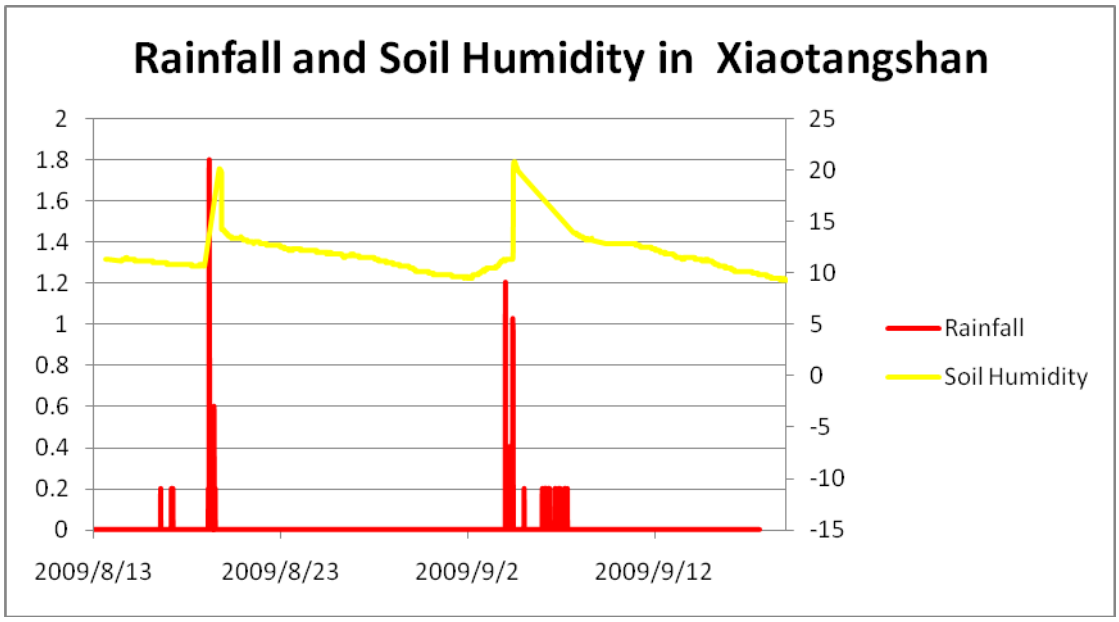


Figure 1 Soil Moisture-Illumination-Temperature chart

The chart registers the change of node temperature, soil moisture and light intensity from June 24 to June 25. A rainfall took place in the daytime of June 24, leaving there a valley on the light curve; precipitation increased around 15 o'clock when temperature dropped sharply and the soil water content increased markedly. Other relatively even curves seem to represent the slow pervasion process of water in the soil.



The graph shows comparisons between the soil moisture curve and the precipitation curve from Aug. 13 to Sep.17 at Beijing. Several rainfalls took place from Aug. 15 to 19 and from Sep. 5 to 9. Since the sensors mainly measure soil moisture at the depth of 10-30cm, we can see from the chart that soil moisture shows obvious time lag. During heavy rainfalls, moisture got saturated rapidly; after the rainfalls, water infiltrated quickly so the moisture decreased fast; when the gap of moisture between the upper layer and the lower layer narrowed, the moisture curve turned flat gradually.

Data is sent to server in Beijing through GPRS gateway. The server would process the data automatically, such as categorizing data or deleting errors; then the data would be released on the internet where users can access the data through three means: First, browser/server, through websites, users can use google map on which nodes are clearly marked to locate the nodes and see the latest data in a convenient manner; second, mobile client/server, users can check the working status and all nodes data through mobile phone internet; simple curves can be drawn by the analysis function and nodes can be located by embedded GPS during deployment, then position of the nodes can be uploaded to the server; third, desktop client/server, more and better data analysis functions and graphics formation services are provided at the client terminals.

REFERENCES

[1] IBM. Smarter Planet. www.ibm.com/smarterplanet/us/en/

[2] Han Antai,Guo Xiaohua etc.Quality of service management in wireless sensor networks for greenhouse environmental control[J].Transactions of the CSAE,2010,26(1):216~220

[3] Yin Ling,Liu Xingcai,etc.Design of system for monitoring dairy cattle’s behavioral features based on wireless sensor networks[J].Transactions of the CSAE,2010,26(3):203~208

[4] Gao Feng,Yu Li,Zhang Wen’an,Xu Qingxiang and Jiang Qingchen.Preliminary study on precision irrigation system based on wireless sensor networks of acoustic emission technique for crop water stress[J].Transactions of the CSAE,2008,24(1):60~63