

PRIMARY FRAMEWORK OF DIAGNOSIS AND MANAGEMENT FOR WHEAT PRODUCTION BASED ON THE ONLINE TELEMONITORING NETWORKS

Sun Zhong-fu, Du Ke-ming, Zhang Yan, Liang Ju-bao

*Inst. of Environ. & Sustainable Develop. in Agriculture (IEDA)
Chinese Academy of Agricultural Sciences (CAAS)
Beijing, P. R. China, 100081
E-mail: sunzf@263.net, sunzhongfu@gmail.com*

ABSTRACT

China is a large country in wheat production both for yield and for cultivated areas, at present time, it has become the second place of the major food crops in China. Due to the frequent influence of various environmental stress and meteorological disasters during the wheat seedling period, a web-based system will be designed to provide service of decision support and diagnosis as well as management for wheat growth and development. In wheat seedling phase, the hazards are particularly occurred such as drought, chilling injury and frost damage because of warm-cold season alternation from spring to winter or winter to spring, which tremendously have impacts on wheat growth and development as well as on yield and quality, no doubt it is very important for developing a monitoring and diagnosing system for wheat production specially in seedling period.

In this paper a web-based telemonitoring network has been designed mainly on the basis of Wireless Sensor Networks(WSN) that are expected to deploy and set up in major cultivated areas in China for monitoring crucial data from the meteorology-soil-crop continuous system. Through connection of mobile network(e.g. GPRS/3G) and INTERNET, the real-time data can be transmitted to the central database server, on the basis, web-based database was developed to provide remote calls and shared analysis. According to the different symptoms and characters occurred and validated, the systematic indicators for diagnosing wheat status could be established. Through mining and analyzing the database, and combining with the relationship to expert knowledge and crop indexes of stress and hazards, the system of remote diagnosis and management can be constructed that may provide more technical support for stress and disaster prevention and optimal management.

Key word: data acquisition, wheat seedling, mobile networks, Zigbee, diagnosis and management system

INTRODUCTION

Wheat is the second largest food crop cultivated in China, which plans in a wide range area and has different bio-characteristics for different variety. Up to now its planting area and yield account for 1 / 4 or more of the total grain yield, accounting for 1 / 5 of food provision. The statistics showed that the yield of winter wheat accounts for about 85 % ~ 90% of the national wheat production. The growth and development of wheat not only undergoes during the long winter, but also suffers from hot and cold alternation in early spring, drought and Waterlogging, dry heat wind (foehn) and other factors in the whole spring. It can be seen from this that the environment condition during wheat growing is particularly complicated and vulnerable. Almost every year, China suffers a large mount loss caused by different hazards. For whole stage of growth and development, the seedling stage is much special that determines the late crop and yield formation, so the public has the saying that " good seedlings and good yield", that is the truth.

As we all know, modern agricultural precise management and control technology are more and more dependent on the information directly from crop field, therefore it is the inevitable trend that new methods and tools have to be developed and widely used for acquiring various kind of agricultural data, such as the data of meteorology, soil and crops. In about last thirty years many countries have made remarkable achievements in agricultural data and information monitoring with the rapid development of computer, communication and network, and so on., which has greatly promoted the precision agriculture in production management and control. Through using the computer network technologies, people will quickly exchange various information, share resources, and farmers can easily obtain information about weather, markets, production, decision-making and a variety of other services.

Unfortunately, At present time, the most first hand information and data affected to wheat growth and development come from the labor forces for investigation in wheat field, sometimes remote sensing technology also plays an very important role. But it is well known that RS is relatively low in spatial resolution and difficult for all-weather conditions. Therefore, once time the extreme meteorological events occurred, the government usually has to dispatch a lot of researchers and technician to make investigation. On the other hand, with rapid development and popularization of network and information technology, it has been completely possible to establish network systems for monitoring wheat seedlings. In this paper, the main purpose is to design a basic framework for monitoring wheat production especially emphasizing on seedling period. Integrated INTERNET, mobile communications, all data can be transmitted to the central database server, a web-based system of decision-making and management can be developed for wheat production.

1. WHEAT CULTIVATION AREAS IN CHINA AND MAIN PROBLEMS

In China, wheat cultivation has been divided into 4 main regions according to the eco-climatologic feature(See Fig. 1): (I) Spring and winter

mixed region: including most part of north-eastern China and north-western China, where spring wheat are more popular than winter wheat due to extreme cold during winter time, (II) winter wheat region: mainly including the valley of the Yellow River and Huai-he river, (III) winter wheat region: mainly including the valley of the middle-downstream of Yangtze River. In each region, different wheat varieties are grown to adapt the local climate features and to overcome various meteorological hazards, such as low temperature stress (frost and chilling damage), drought, Farmland Waterlogging, foehn wind, and hazards caused by plant diseases and insect pests. In fact, the problems are much different in each region. In region I, the most great threats come from low temperature in early spring for spring wheat and in winter time for some winter wheat, in other hand, drought influence usually exists for the whole growing period in most part of the north-western China. In region II, the most serious problems are usually drought and low temperature happened together in early spring when winter wheat are undergoing green-turning and jointing stage. In region III, drought and low temperature, waterlogging, etc. are often occurred. In recent years, due to climate change and global warming influence, warm winter phenomenon frequently appear to cause excessive growth and green-turning ahead of time, therefore, some possible potential threats are increased if suffering low temperature in late spring. Every year, the sensitive period of wheat seedling stage is about in December to May in the following year, various level governments or farmers give much attention to wheat production problems caused by meteorological hazards. Usually, with advantages of covering large areas, satellite remote sensing (RS) has been the main method, which is useful to provide a lot of information for making decision and prediction. In addition, public weather services also provide routine information. But as a matter of fact, the methods have been lagging behind actual requirements. Firstly, satellite RS are evidently limited by weather conditions such as heavy cloud or rain, low atmosphere transparency or sandy and dusty storm, etc, in addition, it is not easy to get data timely and quickly. As for public weather information, it most come from a standard meteorological observation station, which can not reflect the real field environmental condition, which is influenced by local underlying surface, such as local topology, crop density and distribution, as well as other natural factors, etc.

In this research, a field-based network monitoring system has been designed, which intends to acquire the data directly, in this way, the first-hand information can be achieved to compensate the weakness as mentioned above, further precision decision can be made by using real-time data and analysis of historical data.



Fig.1 Wheat Distribution in China

2. PRIMARY FRAMEWORK OF DIAGNOSIS AND MANAGEMENT SYSTEM

According to the requirements on wheat status monitoring, a systematic solution was designed with integration of mobile wireless communication and computer network technologies. The system logically consist of 3 parts (See Fig.2): (1) data acquisition system deployed in the field, (2) data transmission system, (3) web-based system for data publish, management and analysis. The first part adopts various modes depending on the actual condition, several options can be made, such as Wireless Sensor Network(WSN), single data logger linked multiple sensors with wired cable, satellite remote sensing system, etc. The Zigbee based WSN is a very useful mode for establishing data acquisition system especially in crop field, which is a low-cost, low-power, wireless mesh networking proprietary standard. The low cost allows the technology to be widely deployed in wireless control and monitoring applications, the low power-usage allows longer life with smaller batteries, and the mesh networking provides high reliability and larger range, so it has wide future prospects in agricultural application. In order for realizing remote transmission of the data, mobile wireless communication technology is used such as GPRS/CDMA or 3G to get connection with INTERNET for transmitting the field data to the central database server. The Web-based system is responsible for data processing and management, as well as for information publish, especially serving as a platform for data sharing and remote calls.

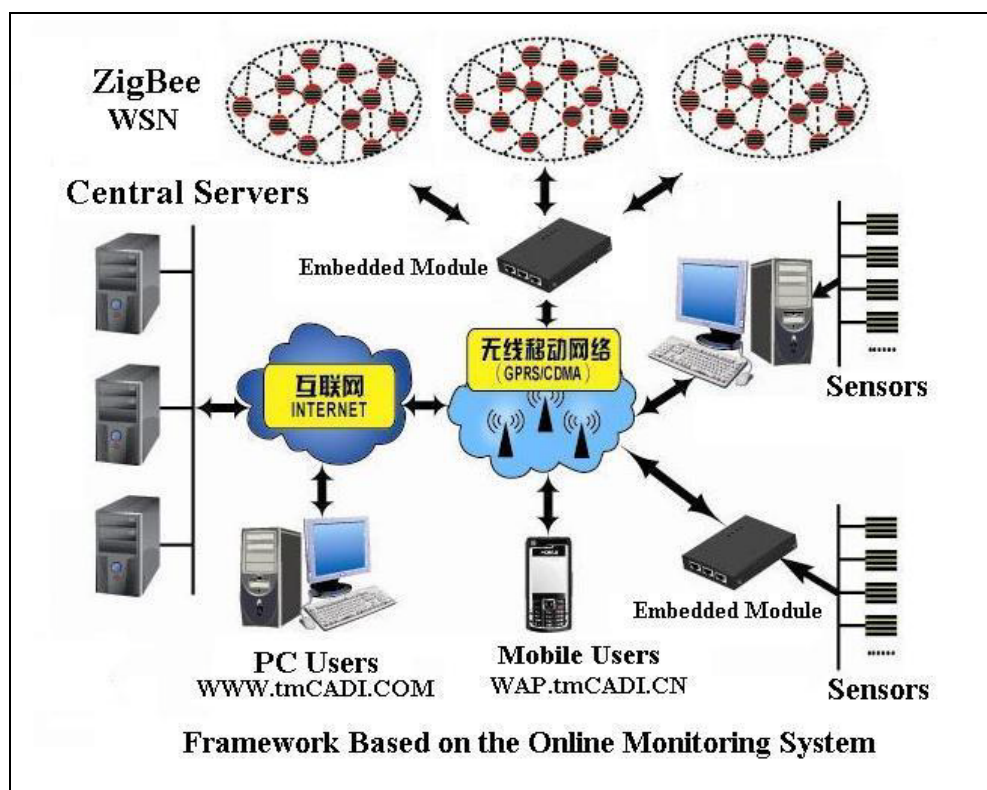


Fig. 2 Framework Based on the Online Monitoring System

3. RESULTS AND DISCUSSION

This project was supported by Ministry of Agriculture People's Republic of China and Ministry of Finance People's Republic of China from 2009 to 2013, which started near the end of the year 2009. The objective was to establish a monitoring network with the concept of the Internet of Things and M2M, which can form a wide network to realize communication from Machine to Machine(M2M). Combined with the acquired data and expert's knowledge and experience, a web-based system is expected to provide services for telediagnosis and decision-making for wheat seedling period, of course, also for the whole growth period. According to the planned scheme of the project, about more than 100 sub-networks will be established in the 4 wheat regions, with combination of satellite RS data, which may covers most typical wheat areas, and the data can further increase representativeness for reflecting wheat growth and development.

With completion of the framework design, the next step is to deploy more data acquisition devices mainly using WSN technology. At the same time, more research has been made to investigate the critical index of meteorological and biological factors how to influence wheat growth and development. It still has long way to go to finish that task.

(References omitted)

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