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Agriculture Intelligent Control System Algorithm for Wireless Sensor Networks Based on Internet of Things

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Abstract: In order to improve the agriculture intelligent control efficiency for wireless sensor networks and solve the problem of data transmission, analyzed existing PID algorithm, ensure that one of the core technology for wireless sensor network performance. In this paper, Proposed the agriculture IoT and automatic control system architecture, put forward a pump frequency regulator PID control algorithm. The system provides the details about agriculture intelligent control information for the consumers and a good operation platform for agriculture intelligent control and primary products quality safety monitoring. Application results show that the combined with agricultural automatic control devices which had already been successfully used in the agricultural production. *Copyright © 2013 IFSA.*

Keywords: Internet of Things, Intelligent wireless sensor, Agriculture IoT, Automatic control, PID algorithm.

1. Introduction

In recent years, the Internet of Things (IoT) as an international research hotspot, have obtained broad attention [1]. It's represents the future trend of development of the network, and requires sharing interoperability and information, so as to realize human society, the information space, the physical world ternary comprehensive connectivity and integration as the goal. Therefore, the Internet of things is regarded as the third technological revolution in information field [2].

It integrates sensor technology, embedded computing technology, modern network and wireless communication technology, distributed information processing technology, the micro sensor collaboration of the integrated real-time monitoring, sensing and collecting a variety of environmental or monitoring information, this information is sent by wireless mode, and form a multi hop network transmitted to user terminals, connected to the physical world, the computing world and the world communicates three Yuan human society [3].

IoT as a new communication mode, it is pushing the technological development and social progress, has become a focus of research in information and communication advanced high technology and the commanding point, but also for modernization of agriculture and rural information brings new opportunities [4]. China is a large agricultural country, agricultural applications of wireless sensor networks and demonstration practice [5], for wide-area spatial distribution of agricultural resources, environment and real-time production management information gathering, monitoring, processing, analysis and forecast, optimize resource allocation and production management [6], improve agricultural production science, initiative, reduce wastage of resources invested blindly and pollution on the ecological environment and promote sustainable development of agriculture, has the vital significance.

Agricultural IoT technology as the growth of crops, peasant life, agricultural production and circulation of information access technology [7], through intelligent agricultural information technology to achieve intelligent management of agricultural production in order to enhance agricultural production, management, trade and logistics and other aspects of intelligence for the establishment of modern agriculture, develop the rural economy and increasing farmers' income, improve the grass-roots promotion of agricultural technology and service system, improve the comprehensive agricultural production capacity, promote comprehensive rural reform [8], improve performance, and administrative services in rural areas to promote a new socialist countryside construction.

To sum up, agriculture IoT technology includes not only the digital agriculture sensing technology, including agricultural technology wireless information network transmission, it is to reverse the traditional farming practices, important scientific means to save resources, protect environment, is the main direction of the future development of agriculture. This paper chose to study network system of plant information perception and self organization of agriculture is of great significance, and has great application value.

2. IoT Data Collection System Architecture

2.1. Data Collection System Architecture

IoT to achieve information collection system used for farmland environmental information, information on crop ecology, soil dynamic information acquisition and archiving, analysis function [9]. Its basic features include information perception, sampling and data processing, data storage and other functions. Each sensor nodes deployed in the farmland production site are responsible for collecting environmental information, agricultural meteorological soil water content, soil temperature and crop nutrition information, physiological information around itself [10], between nodes are self-organized networking through active induced networking mode. Get through the network transmission to the rear of the computer, data processing and data storage. And share the data in the network and expert. Experts can through online or offline methods for data mining and analysis. The IoT data collection system architecture is shown in Fig. 1.

In the collection of information system architecture, we can see network information collection consists of three main parts, namely, three levels of information perception, wireless network transmission and data analysis, data storage and data network access.

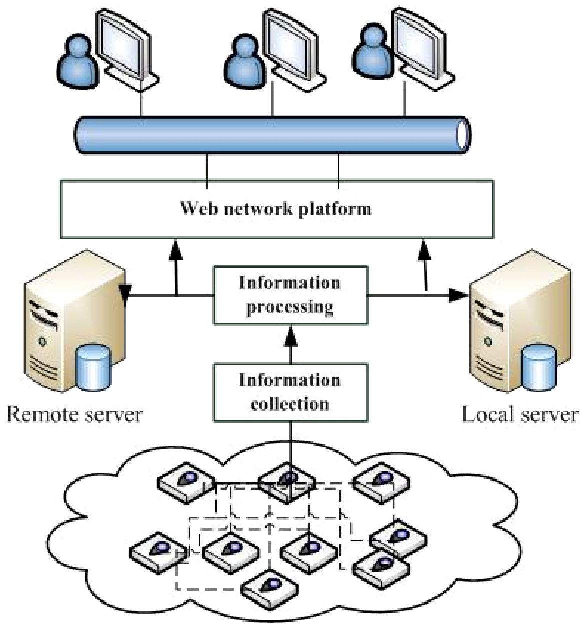

Fig. 1. Data collection system architecture.

2.2. IoT Data Storage and Remote Access Mode Analysis

IoT field data collected on-site and remote access to the monitoring data access area can be divided into on-site and remote in two ways. In performing the initialization configuration and maintenance tasks, need carries on the scene debugging on the system, researchers can live through the PDA query network data content, direct sensor nodes running parameters in the system as well as other debugging. During system operation, remote control site can access via Internet/Intranet and control of sensor nodes, in addition to install and mobile nodes do not need to manage and maintain The IoT information collection interface and network interface as shown in Fig. 2.

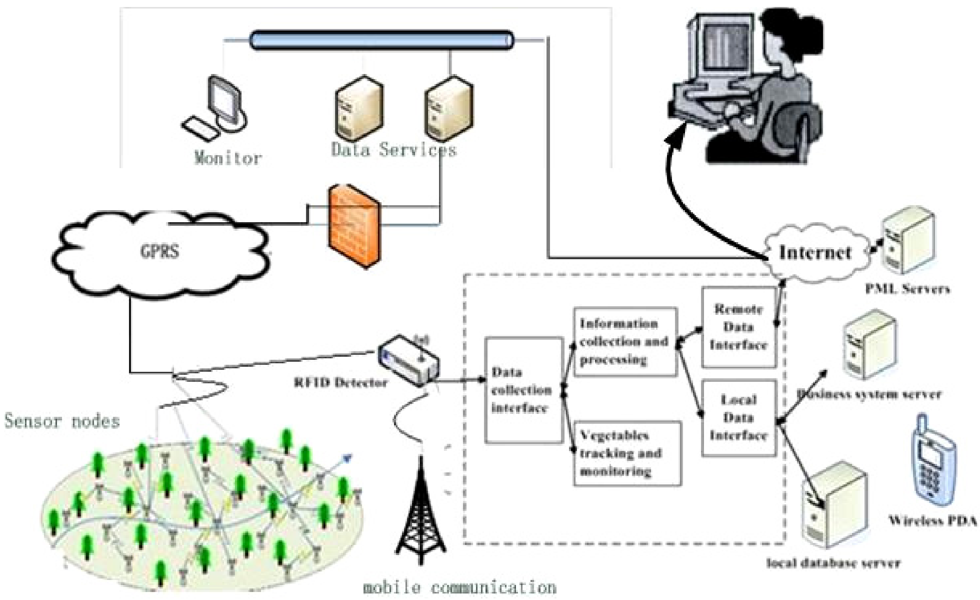

Fig. 2. IoT data storage and remote access mode.

3. Agriculture IoT Backend Control Architectures and Control Model

3.1. IoT Control Structure of Agriculture

The function of agricultural IoT back-end control system mainly include environmental regulation, agricultural production of fertilizer and water management and pest control.

According to the different conditions of farmland facilities can be divided into agricultural production environment field, greenhouse, and greenhouse environment. Overall, the agricultural production mainly includes automatic irrigation control, automatic control, automatic spraying fertilizer control and intelligent control of greenhouse environment control.

Different control modes of several are from the information to the data processing, and then to the decision system sends commands to control. Network information and control system with the combination of system architecture as shown in Fig. 3.

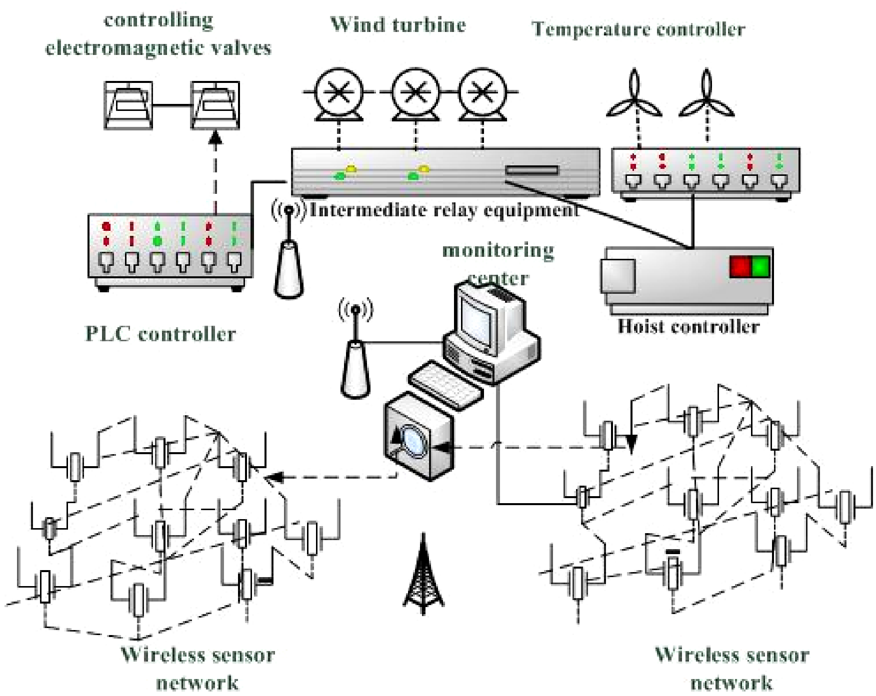

Fig. 3. IoT control structure of agriculture.

Network control system in the back by the PLC programmable controller as the core, control model is mainly based on analog signal output, output frequency signal, PWM signal output and the output switch to realize agricultural electrification equipment control. Inverter controlled by PLC program, the control terminal of PLC has two, namely the control cabinet of the industrial touch operation state can control the whole system, the computer can also control the running state of the system. In addition, the communication of computer and control cabinet can be wired communication, can also be wireless communication.

The main function of the control system includes: water pump frequency control, constant pressure water supply control, intelligent control, automatic control, automatic irrigation fertilization control and automatic spray control. Real time information based on the Internet of things collected by the control system to judge the comprehensive analysis, control strategy enable different model, also can be introduced into the knowledge base of the expert system as the control strategy of reference. The system architecture is shown in Fig. 4.

From the control characteristic of the control system, automatic irrigation control, automatic control, automatic spraying fertilizer control for pipeline fluid flow control, fluid control will involve two issues, namely, the pipeline pressure control, flow control. Therefore, the main research field of automatic irrigation, fertilizer, and automatic spray flow and pressure control and greenhouse environmental control.

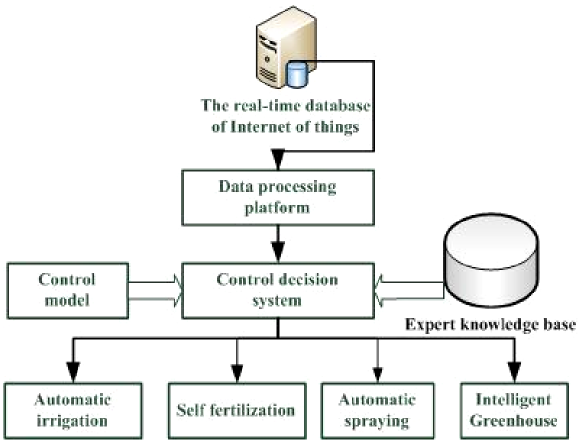

Fig. 4. Agriculture IoT backend control architectures and control model.

3.2. Agricultural Production and Water Pressure Control Method

Agricultural use of water, fertilizer or medication commonly used motor pumps the water, fertilizer, medicine and other agricultural supplies transported to farmland. When the pump is turned on, the pipeline valve in the automatic or manual control mode there may be fully closed the case, the traditional water pump switch control line pressure often prone to leaving the motor overloading and excessive damage or burst pipe to happen farmland, seriously affecting agricultural safety as. Therefore, the application of frequency conversion control technology, first-line fluid pressure control at a set pressure constant voltage control or voltage control, adjustable pressure does not exceed the upper limit of the ceiling pipes and pump pressure, this paper uses PID control algorithm pump for frequency control. Frequency applications in the fields of water supply environment, to improve the pump motor speed control sensitivity, accuracy and stability in the conventional position paper on the basis of type PID formula has been improved. The PID control hydraulic schematics as shown in Fig. 5.

The conventional position type PID formula expressed as follows:

$$u(k) = k_p e(k) + k_i \sum_{j=0}^{k} e(j) +, k_j [e(k) - e(k-1)] \quad (1)$$

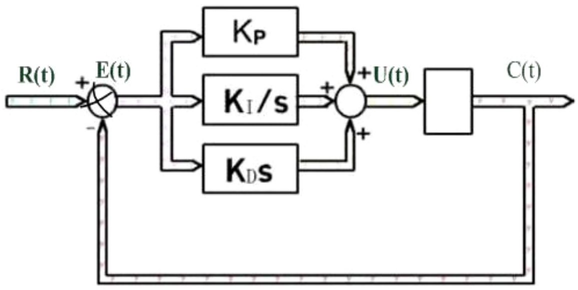

Fig. 5. PID control hydraulic schematics.

In the formula (1), k is the sampling number, k=O, 1,2,..,n, $u(k)$ is the calculate the output value of the k sampling time computer; $e(k)$ is the deviation of the k sampling input values; $e(k-1)$ is the k deviation of sampling time input the value ; k_i is the integral coefficient, $k_i = \frac{K_p T}{T_j}$; k_p is the differential coefficient $k_d = \frac{K_p T_D}{T_j}$.

According to the control characteristic of variable load frequency constant pressure water supply system, the PID algorithm is improved as follows:

By introducing integral, integral region in PID algorithm. Set a threshold of e , $e > 0$, When $|e(k)| > \varepsilon$, Both the deviation $|e(k)|$ is relatively large. Using PID control algorithm, can avoid overshoot overshoot, but also allows the system to have a faster response.

PID algorithm is improved (EPID) for the:

$$u(t) = K_p[e(t) + \frac{1}{T_1}\int_0^t e(\tau)d\tau + T_D\frac{d(e(t))}{dt}] \quad (2)$$

Improved pid process algorithm shown in Fig. 6.

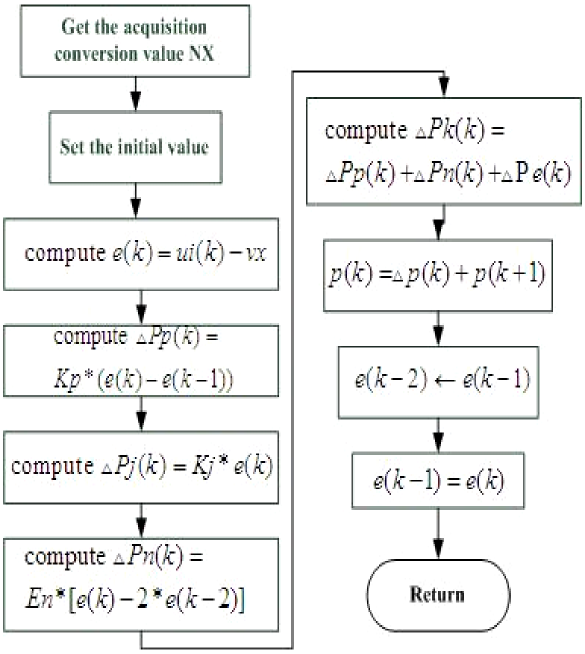

Fig. 6. Improved PID process algorithm.

3.3. Automatic Control Mode of Agricultural Irrigation

Automatic management of agricultural fertilizer, spraying management and automatic irrigation principle is similar. Automatic irrigation system is a complex control system, which is not the only input variable soil moisture, but also time, temperature, humidity, crop varieties, crop seasons. Traditional automatic irrigation program usually lasts for or timing manipulation, when to start irrigation, irrigation is often based on how long people's experience. Used as a soil moisture sensor control device of automatic irrigation systems can be done after the crops need water, they can automatically open water, began to irrigation, water-saving irrigation to achieve timely. This article focuses on networking information under automatic irrigation control methods. To achieve automatic control of irrigation, have to get real-time dynamic information field soil water content, water content in the information obtained can be implemented according to a variety of automatic control mode automatic irrigation. Implementation of automatic irrigation block diagram shown in Fig. 7.

Farmland automatic irrigation control has three control modes that are namely timed irrigation, automatic control, manual control modes. Timing irrigation practical application is very extensive, especially for soilless culture more meaningful.

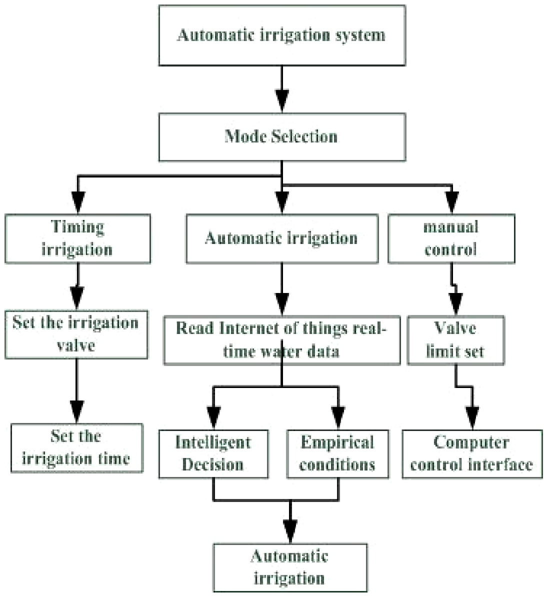

Fig. 7. The agriculture of IoT and transmission construction.

4. Simulation and Performance Analysis

To verify the particle swarm optimization algorithm PID controller performance, simulation studies on the following objects:

Simulation parameters are as follows: the number of particles is 20; the inertia weight W from the beginning of 1.2 with the iterative algebraic gradually decreasing to 0.1; v_{max} is set the range of parameters for the width; Learning factor C_1 and C_2 equal to 2; the iteration number is 100; A= 0.9.The Fig. 8 is an iteration of the optimization process. As can be seen by the above simulation, particle swarm optimization algorithm can within a limited evolution algebra two objects are be satisfied with the PID parameters, the system overshoot, rise time and settling time compared with the ZN method were obtained varying degrees of improvement from evolutionary algorithms solvable algebra with evolutionary changes can be seen that EPID fast convergence.

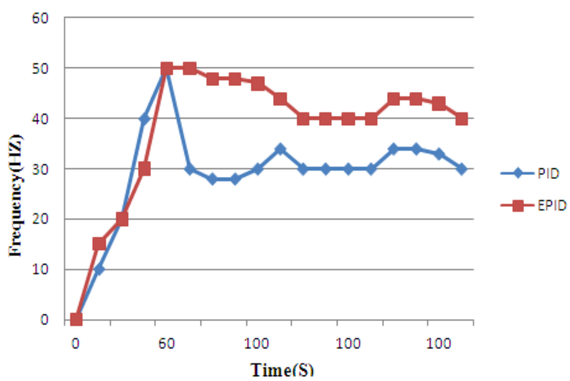

Fig. 8. The diagram of differences controlled by improved PID and original PID.

5. Conclusions

This paper analyzes the IoT intelligent networking system technical architecture, the network structure of the variation of the potential failure types. Put forward agriculture IoT and automatic control system of combined application of the principle and implementation method. Proposed pump frequency regulator PID control algorithm, analyzes information systems and networking basic framework of automatic control system and on this basis to achieve agricultural Things agricultural park system integrated application and demonstration.

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