IoT based Automated Irrigation System

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Abstract— India is one of the scarce water resources in 13 countries in the world; due to low utilization of the water resources our country is facing the risk of overheating. In order to effectively reduce the impact of inadequate water resources on India's economy, from modern agricultural cultivation and management perspective, according to the basic principles of Internet, with sensor technology, this article proposes precision agriculture irrigation systems based on the internet of things (IOT) technology, and focuses on the hardware architecture, network architecture and software process control of the precision irrigation system. Preliminary tests showed this system is rational and practical.

Key words: internet of things (IOT), modern agriculture, precision agriculture

I. INTRODUCTION

According to statistics, agriculture uses 85% of available freshwater resources worldwide, and this percentage will continue to be dominant in water consumption because of population growth and increased food demand. There is an urgent need to create strategies based on science and technology for sustainable use of water, including technical, agronomic, managerial, and institutional improvements [1]. Agricultural irrigation based on Internet technology is based on crop water requirement rules. By using Internet technology and sensor network technology to control water-saving irrigation of farmland and to maximize the scientific use of water, not only can greatly improve the utilization of water, and can increase water productivity [2].

II. INTERNET OF THINGS AND AGRICULTURAL IRRIGATION

India is known for the small farms. In India most of the crops depends upon rain. Near about 45% of the land irrigated. And almost half i.e. 55% of total population of India depends on agriculture .Comparing this with US; it is about 2% due of heavy mechanization of agriculture. The fact about Indian agriculture is that, though it is one of the biggest producers of agricultural products, other side it has very low farm productivity. Hence to increase the productivity is today's need and Precision agriculture may provide a way to do it. Precision agriculture (PA), as the name implies, refers to the application of precise and corrects amounts of inputs like water, fertilizers, pesticides etc. at the correct time to the crop for increasing its productivity and maximizing its yields. PA originated in the US and European countries [3]. Gartner, the world's leading information technology research and advisory company, said, in December 2013, that IoT will grow to 26 billion units in 2020, resulting in 1.9$ trillion in global economic value-add through sales into diverse end markets. Hence the statement we can conclude that the IoT is evolving and that it will generate billions of dollars in the upcoming years [4]. Similarly, Cisco also said that it will create, from 2013 to 2022, a 14.4$ Trillion of value at stake for companies and industry [5].

Since we are talking about connecting everything to the Internet, there is an unimaginable amount of business opportunities involved. Industry, logistics and health are some of the sectors in which IoT is involved Because of this we can connect small objects or devices to the Internet, a whole new paradigm will emerge creating a big impact in people's lives. Intelligently connected appliances to the Internet, health-related devices collecting important data and wearable are just an example, and they are all trending. They will, definitely, deliver and improve our quality of life, making everything easier, practical, smarter and reliable. However, there is much work to be done in order for IoT to succeed and truly emerge: standards are needed to provide interoperability, security and confidentiality to protect individuals' data must be implemented and scalability must also be possible. Without these parameters, IoT won't succeed and all we will ever have small "islands" of IoT, not communicating with each other – and that truly is not Internet of Things.

The Internet Engineering Task Force IETF latest work, standards are now being deployed, allowing small embedded devices to connect to the internet, having an IPv6 address (6LoWPAN – IPv6 over Low Power WPAN) [6].This, combined with connectivity to a Web Service designed for constrained network called CoAP (Constrained Application Protocol) created by CoRE, IETF's working group, will empower many IoT applications, at a reduced cost and efficiently [7].

III. RESEARCH ABOUT THE APPLICATION OF PRECISION AGRICULTURE IRRIGATION

A. Hardware Components of Irrigation System for Precision Agriculture Based On the Internet of Things

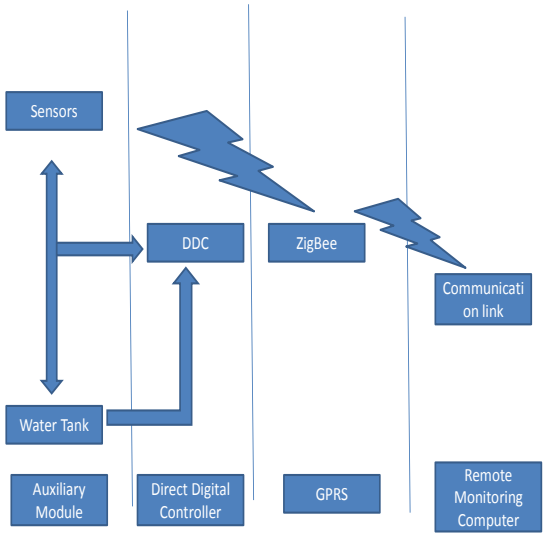

Fig. 1:.Hardware system for precision agriculture irrigation based on the Internet of things

Hardware system for precision agriculture irrigation based on the Internet of things consists of six modules, namely information collection module, the site irrigation module, irrigation controller (low position machine), GPRS (general the packet radio service) module, the central control computer (on position machine), and the auxiliary module. Structure of the system as shown in Figure 1.

1) Information Collection Module

In the precision irrigation systems, spatial distribution of information about crop growth needs to obtain in finer spatial scales; usually the information need to be acquired is field crops production distribution information, farm distribution information system information on environment, agricultural soils information, in which the soil moisture environment is the main basis for the development of precision irrigation [8].

In the precision agriculture irrigation systems, wireless sensors undertake information collection mainly. Wireless sensor network is composed of a large number of microsensor nodes deployed within the monitoring area; it forms a self-organizing network system by wireless communication. The wireless sensor network real-time monitor environment change, collection data such as soil temperature, humidity, atmospheric barometric pressure, wind speed, crops growth situation, and carry on processing to these information's, it provides the main data pool and the parameters for agronomist to decide and formulate the farmland variable work prescription.

2) The Site Irrigation Module

The site irrigation module is mainly composed of fine valve tube switches and irrigation pipes erected in the site, sensing element input the analog signals or digital signals which be the site detected to the irrigation controller (low position machine),the low position machine transmits output control signals to the implementation of components such as relays and regulators to control the scene accusation equipment.

3) Irrigation Controller (Low Position Machine)

The site irrigation controller is also called the lower position machine, mainly undertakes three parts of functions. One, the scene irrigation controller carries on the periodic data acquisition, the analysis, the adjustment and processing to the sensor to its outputs controlling and executing commands to the site devices to determine the operational status of field devices according the processing control information. Three, it connects the first equipment through the wireless network, carries on the data exchange with on position machine, transmits each gathering data and the equipment running status information upwardly, at the same time receiving real time control instructions of the PC. The irrigation monitor controller controls the soil moisture sensor whether gathers the data as well as the solenoid valve whether opens. Because the farmland area is big, the soil moisture sensors and the solenoid valves needed to control are many, therefore the method of the district control is adopted, and each controlled area is equipped with an irrigation monitor controller. When the sensor in a control area measured soil moisture exceeds the setting irrigation thresholds, irrigation monitoring controller controls that the solenoid valve is open or closed.

4) GPRS Module

GPRS module mainly includes three parts of data processing module, communication module, and analog-to-digital conversion module. Data processing module contains the CPU chip, CPU is used for processing and communication modules, analog to digital conversion module, and data transfer between the displays modules. Communications module uses DTPS05Ci, its kernel is a dual-frequency of Siemens industrial mobile module, supports the EGSM900/GSM1800 band, embeds TCP/IP Protocol, can provide kinds of communication of voice, SMS, FAX, GPRS. Analog to digitalconversion module has the function of level shifting and serial port communication.

5) The Central Control Computer (On Position Machine)

Remote monitoring computer allows the user to remotely monitor and control irrigation conditions in the field, it communicates with the irrigation monitoring via GPRS.As an information exchange platform for a user and precision irrigation systems, whether computer monitoring software of the remote monitoring and control system is good or bad decisions whether the system can accurately execute irrigating according to established irrigation schemes. PC inputs control instructions, monitors systems work, checks system information through the user interface. The lower position machine uses programmable logic controller (plc) as a site controller to output control commands and control actuator operation.

6) The Auxiliary Module

It includes water sources (irrigation water tank) and system power. The water source mainly considers whether water tank size and hydraulic pressure conforms to the requirement. Power supply section need to primary consideration is to adopt the supply of solar panels, energy-saving strategies and the corresponding optimized to solve the power consumption problem.

B. Network Constitution of Irrigation System for Precision Agriculture Based On the IoT

For the actual environment of the agricultural production, precision irrigation network system of modern agriculture based on the Internet of things is mainly made up of 3 levels. Namely, The network sensation and the key-course, the monitor control transmission network level and the data terminal processing level, in which first floor is the network sensation and the key-course, the intermediate level is monitors the data and the control command transmission network level, high-level is the data terminal processing level. The system shown in Figure 2. Network-aware and control layer soil moisture information collection is the foundation and assurance of the agricultural water-saving irrigation and optimal control. It mainly carries on the quantification through the data to the soil, the main factor affected crop growth is water, wireless temperature and humidity sensor nodes located in every corner of the monitored area monitor the regional soil moisture regularly and the collected information is transmitted to the wireless routing nodes, while wireless solenoid valve receives control commands from the wireless routing nodes, to open the solenoid valve for irrigation in dry soil. Wireless temperature and humidity sensors and wireless solenoid valve network technology are used in the water-saving irrigation control systems; its central technology is the ZigBee wireless communication. ZigBee is a bidirectional wireless communication technology of high reliability, low power consumption, large network capacity, composed by

the using layer, network layer, medium access control layer and physical layer. Zigbee network system can be a mixed network, the bottom are several-zigbee monitoring and control networks, as monitoring data collected and the solenoid valve to open. Each ZigBee monitoring network has several radio magnetic valves and soil temperature, and humidity data acquisition nodes. The system has the automatic network function, the wireless gateway is in the monitor shape unceasingly, the new increase wireless sensor and the control node will be detected automatically by the network, the wireless route will send nodes information to the wireless gateway for addressing and calculating the routing information.

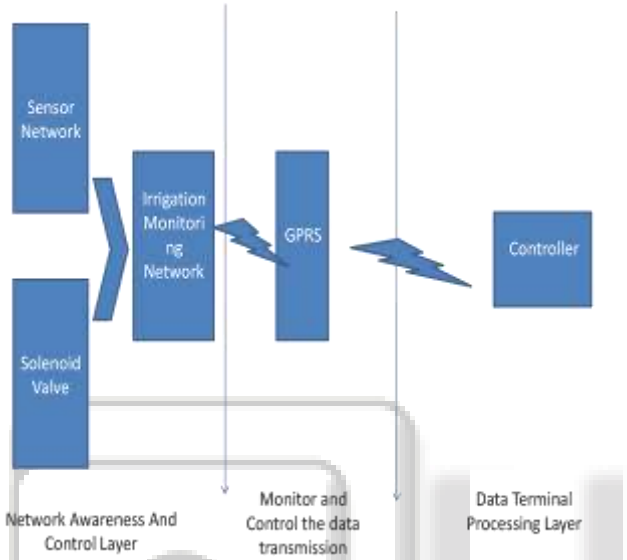

Fig. 2: Network constitution of irrigation system for precision agriculture

The monitor control data transmission network level. The function of the transport layer is to transmit the information received from monitoring station to the remote monitoring control center safely and reliably by GPRS and with reasonable and efficient routing protocols and network security protocols. The communication of the water-saving irrigation control system based on the Internet of Things is built on the basis of the zigbee wireless communication technology and GPRS. ZigBee has three kinds of task-band of 2.4GHz, 915MHz, 868MHz. The system may use the global general frequency band which the current sensor network first chooses (2.4GHz), the transmission speed is 250KB/S. Wireless gateway is part of the sensor network system, a wireless gateway with zigbee wireless module, GPRS module, rs232 interface, Ethernet interface, can achieve the conversion of any two communication bus. In the case of the interface is not match in the industrial areas, the wireless gateway can facilitate the interconnection of the various interface devices. At the same time, when the site of the wiring is not convenient, ZigBee can be used in communicating to transmit field bus data to control center wirelessly, and the data can be sent to the public network by GRPS to facilitate the long-distance control. The wireless gateway is the ideal choice for the connecting of LAN and remote control center; it makes the LAN easily access the public network. Data terminal processing level is the computer system of guiding the control center, the host computer system. The control center of the system will process the collected data, the users determine whether it is necessary to soil for irrigation according the data while opening the automatic irrigation system, that is, the system does not need the manual intervention, when the soil moisture is insufficient, the system will send orders automatically to open the solenoid valves for irrigation. According to different ways of the irrigates flows, the facilities of the precision agricultural irrigation may divide into four ways of the drip irrigation, infiltrate fills, the micro spray irrigation, the pulse irrigates .Its main characteristic is relying on field irrigation network, and to supply water and nutrients directly to the roots of plants with the slow and accurate flow through the emitter.

C. Software Components of Irrigation System for Precision Agriculture

The software of precision irrigation system based on the internet of things mainly is composed by five parts of software procedures of data acquisition nodes, lower position machine control nodes, wireless route nodes, wireless gateway nodes and client side. The task of the software of data acquisition nodes includes regularly informing the gateway nodes the current network status, timing the collection of soil information and uploading it to the wireless routing nodes. The task of the software of the lower position machine control nodes includes regularly informing the wireless routing nodes the current network status, and receiving the command that controlled the valve opening and closing of the wireless routing nodes. The tasks of the software of wireless routing nodes includes formatting networks, informing the wireless gateway the current network status regularly, accepting the soil information sent by sensor nodes of the ad hoc networks regularly, sending regularly the soil information of each node in the group network to the wireless gateway and receiving control commands from the wireless gateway. The wireless gateway node in the network is mainly responsible for establishing and network management, it allows denies any of the sensing node into the network, and sends the data of the sensor nodes to the Internet, then monitoring client read and record data by the internet.

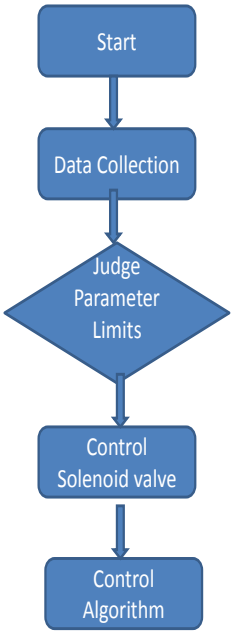

Fig. 3: Control flow chart of the system software running

The gateway node has been in the state and will not sleep. The course of its work is generally divided into waiting for the monitoring command, networking, joining the nodes, waiting for the data, sending the data. The primary mission of the client software is displaying the data of the remote monitoring and control, sending control commands according the appropriate algorithms for displaying the system operation, the flow chart of the control program while the system is running as shown in Figure 3.

IV. CONCLUSION

The application of agriculture networking technology is need of the modern agricultural development, also but also an important symbol of the future level of agricultural development; it will be the future direction of agricultural development. after building the agricultural water irrigation system hardware and analyzing and researching the network hierarchy features, functionality and the corresponding software architecture of precision agriculture water irrigation systems, actually applying the internet of things to the highly effective and safe agricultural production has a significant impact on ensuring the efficient use of water resources as well as ensuring the efficiency and stability of the agricultural production.

REFERENCES

[1] Joaquín Gutiérrez, Juan Francisco Villa-Medina, Alejandra Nieto-Garibay, and Miguel Ángel Porta-Gándara-Automated Irrigation System Using a Wireless Sensor Network and GPRS Module
[2] Sanbo Li-Application of the internet of things technology in precision agriculture irrigation systems
[3] Precision Agriculture Could Start a Green Revolution in India - http://www.huffingtonpost.in/dr-anil-k-rajvanshi/precision-agriculture-can_b_6845378.html
[4] Gartner Press Release, STAMFORD, Conn., December 12, 2013. Available online at: http://www.gartner.com/newsroom/id/2636073. [consulted on February 2014]
[5] Joseph Bradley, Joel Barbier, Doug Handler: "Embracing the Internet of Everything To Capture Your Share of $14.4Trillion". Available online at: http://www.cisco.com/web/about/ac79/docs/innov/IoE_Economy.pdf [consulted on February 2014]
[6] Z. Shelby, Ed, S. Chakrabarti, E. Nordmark and C. Bormann:"RFC 6775- Neighbor Discovery Optimization forIPv6 over Low-Power Wireless Personal Area Networks (6LoWPANs)", November 2012 [online], Available at: http://tools.ietf.org/html/rfc6775 [consulted on February 2014]. November 2012.
[7] Constrained Application Protocol http://en.wikipedia.org/wiki/Constrained_Application_Protocol
[8] Amardeo C,Sarma J G.Identities in the Future Internet of Things[J]. Wireless Pers Commun 2009(49):353-363. [Fund] Zhejiang Province education department Scientific research projects (Y201121982); Lishui Vocational Institute of Technology Development Fund (NO.LZYA201003)

