2016 International Conference on Materials, Manufacturing and Mechanical Engineering (MMME 2016)
ISBN: 978-1-60595-413-4

A Corn Warehouse Monitoring System Based on IOT

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Keywords: Warehouse management system, Corn, IOT.

Abstract. The increasing demand for food safety from both the government and consumers make corn warehouse management system monitoring corn quality in real-time more and more necessary. In this paper a novel corn warehouse management system based on Internet of things (IOT) is proposed to provide real-time visibility of the condition of corn products in order to reduce waste and improve quality. The system architecture as well as main network entity is introduced. Wireless nodes as well as result are also issued.

Introduction

Though world agriculture produces enough food to meet the energy needs of all the nearly 6 billion people who are alive today, there are still worries that food security is in danger because of increased population, water shortage, and environmental change. Corn is main food source for most Chinese. It still is a problem that how to ensure food quality of corn which is stored in a warehouse. Moreover, in order to survive and develop in the more and more competition environment, corn warehouses need decrease cost at a large extent while ensure corn quality. In order to make sure that corn products in warehouse can meet the requirements from government and consumers, not only planning and control of warehouse facilities are crucial, but also monitor corn quality in warehouse in real time is essential in order to make sure the corn is qualified for production or selling, especially for corn which has time restrictions.

Corn warehouse monitoring systems are employed to monitor all relevant information related to corn quality. Among those information, temperature and humidity information are crucial to corn products. In the past, sensors are generally wired. Therefore, they are usually difficult to deploy and maintain. IOT (Internet of Things) techniques can be applied to solve this problem.

As one of the IOT technique, wireless sensor networks have some characteristics which are suitable for corn warehouse monitoring systems. First, the development of battery technique provides wireless nodes with battery have enough network lifetimes. Second, wireless sensor networks can be deployed at random because wireless nodes can generate dynamic topology through communicate with each other. Wireless sensor network used in warehouse has drawn more and more attentions both from academic and enterprises. For example, paper [1] proposed a system to locate transport vehicles such as forklift trucks or pallet jacks with wireless sensor networks. The tracking of transport vehicles is realized by range measurements and trilateration using the Extended Kalman Filter. Paper [2] introduced hardware and software of warehouse logistics control and management system based on RFID (Radio Frequency Identification). Paper [5] proposed a warehouse management system using IPS (Indoor Positioning System) under Bluetooth environment which can make material management, job control management and location management using Tag information. Papers [6] present a new type of logistics tracking and inventory management system that can track back location of each commodity applying IOT.

Although IOT technologies have been deployed to monitor warehouse, it is still limited. This study is focused on how to monitor corn quality information in real time in order to make sure corn is stored

properly stored in warehouse. Moreover, architecture of the system, wireless sensor nodes and software interface is introduced.

The remainder of the paper is organized as follows. Section II introduces the proposed system architecture. Section III described wireless sensor nodes used in this system. Section IV issued results. Finally, conclusion and future works are given in the end.

System Architecture

The corn warehouse monitoring system proposed is used to control corn products with the tags into, within, and out of a warehouse. Besides, the system is provided with location and quality of corn products with tag in real-time, too.

The system architecture structure is showed as Figure 1. As shown in Figure 1, there are some key networks entities in the framework.

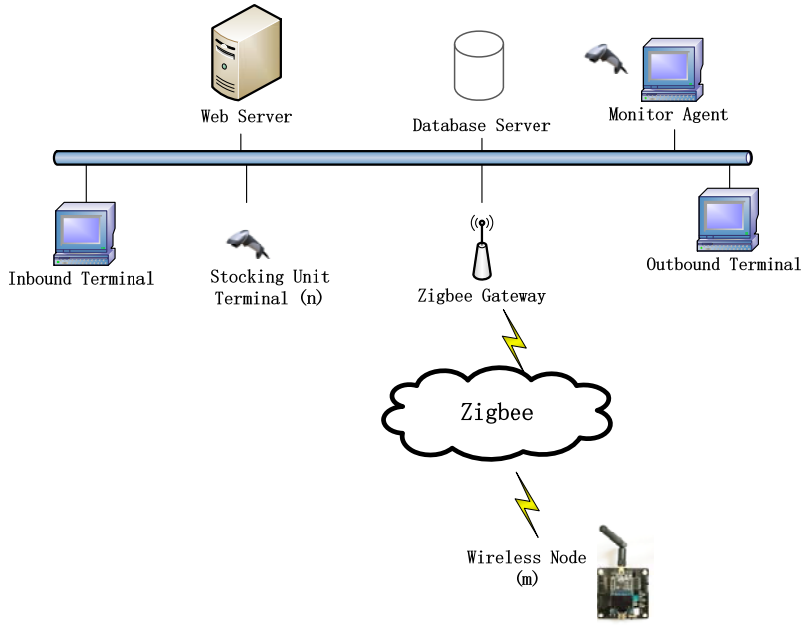


Figure 1. System Architecture.

1) Inbound Terminal: It consists of a PC and a tag reader. It identifies the corn products by reading the electronic tag through tag reader. Secondly, it provides available stock unit which can store inbound corn products for operator to choose. At last, it saves corn products information such as producing address, inbound date into the database through intranet.

2) Outbound Terminal: It consists of a PC and a tag reader. It identifies the corn products by reading the electronic tag through tag reader. Secondly, it changes the status information of stock unit which stored outbound corn products. At last, it saves corn products information such as outbound client, outbound address, and outbound date into the database through intranet.

3) Monitor agent: It consists of a PC and a tag reader. It provides GUI (Graphical User Interface) to query information such as quality, location and alert information about corn products, stock unit in the corn warehouse. It provides operators to setup threshold value of the temperature and moisture, when occurrence, it will alarm to alert the authorized operators immediately.

4) Database Server: It provides data definition, update, retrieval and administration of the information about corn products, stock unit in the corn warehouse.

5) Web Server: It provides a B/S (Browser/Server) structure for other networks entities in the system to communicate with each other. The most advantage of the structure of B/S is that other networks entities don't need install any special software but can operate in anyplace. The operator of different terminal can access the system only if system administrator creates a username and a password to them.

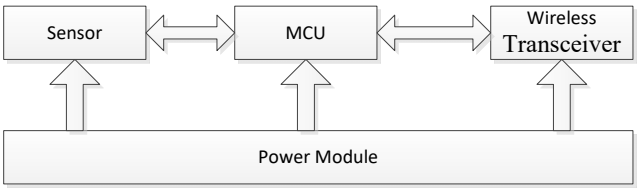
6) Stocking Unit Terminal: It is a WIFI tag Reader which can save corn products which is stored in the stock unit.

7) Wireless sensor nodes: They are designed to realize three functions. First, it gathers temperature and moisture information of corn products in the stock unit and report them interval or daily. Second, it compares gathered information with values which have been set by monitor before. If temperature and moisture information exceed required threshold, it will send alarm to store terminal. So that warehouse operators can handle it. At last, all of them cooperate to transfer required information to ZigBee Gateway. All of them equipped with a ZigBee module.

8) ZigBee Gateway: It is a specialized wireless sensor node. It not only has the functions as other wireless sensor node, but also it saves the temperature and moisture information in different stock unit gathered by wireless sensor nodes.

Wireless Sensor Node

In general, an IOT is often composed by a large number of tiny and cheap wireless sensor nodes. Wireless sensor nodes usually powered by battery. Wireless sensor nodes are easy to deploy than wired sensors because they can communicate with each other through wireless. In general, wireless sensor nodes have information processing and environment sensing modules. In this study, wireless sensor nodes are composed by a MCU, wireless transceiver, sensor, power module as shown in Figure 2. Each module of this platform is described as followed.



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The MCU in this study is MSP430 which is featured by its ultra low power, low voltage, strong signal processing capability [3]. The wireless transceiver we used in this study is CC2420 which is also featured in its low power and supports short range wireless communication such as Zigbee [4]. The PRY layer and MAC layer of CC2420 comply with IEEE 802.15.4. It supports data rates as high as 250kbps and multipoint to multipoint communication.

The humidity sensor used in this study is an HIH 4000 humidity sensor. An instrumentation amplifier is added because the output voltage of HIH 4000 humidity sensor is between 0.959V and 3.7143V while ADC has a maximum input voltage of 5V and minimum of 0V.

The temperature sensing circuit in this study is the LM 35 precision centigrade temperature sensor. It has an analog voltage output and it has an error of +/- 0.5 degrees Celsius.

Results

Corn warehouse monitoring systems is a system which is able to monitor corn products in warehouse. This research helps corn warehouse to ensure quality of corn products in warehouse. This method is aim to reduce costs by making use of IOT.

Figure 3 shows the GUI (Graphics User Interface) of Monitor agent. It is notable that the GUI is shown after operator go through login system and query the corn product by electronic tag. Such as real-time humidity, temperature as well as stock unit and so on are shown in the page.

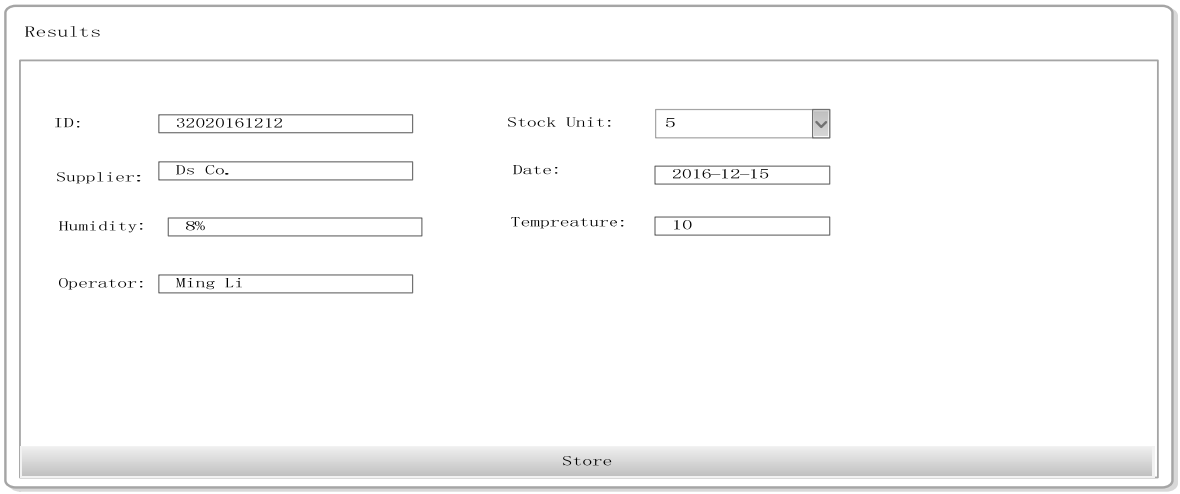

Figure 3. Monitor agent GUI.

Conclusion

In this paper, a novel corn warehouse management system based on Internet of things (IOT) is proposed to provide real-time visibility of the condition of corn products in order to reduce waste and improve quality. The system architecture as well as main network entity is introduced. Wireless nodes are also issued. Future work will concentrate on improving sensing environment status accuracy and software.

Acknowledgement

This research was financially supported by Shanghai key project for agricultural scientific and technological Grant from Shanghai Municipal Agricultural Commission (Grant No. 2014 7-4-1).

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