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Research Article

Study on Construction of Food Safety Information Platform Based on Internet of Things

Wu Zhiyi
Guangdong Institute of Science and Technology, Zhuhai, Guangdong 519090, China

Abstract: In order to avoid the occurrence of food safety events, improve the food safety management level, the corresponding food safety information platform is constructed based on Internet of things. Firstly, the basic theory of Internet of things is analyzed; Secondly, the basic function of food safety information platform based on Internet of things are discussed; Thirdly, Hardware design of food safety management system; then the localization algorithm procession of food safety management system is studied; finally, the application situation of food safety information platform, results show that the food safety information platform is an effective means for food safety management.

Keywords: Food safety information platform, internet of things, localization algorithm

INTRODUCTION

With development of network technology, various industries construct the information management system that suits for their situations and the management system is achieved through office automation and fast transmission, then the management efficiency is improved exponentially. The food safety manage system in China is in the midst of a transformative moment, the food safety management system is not be constructed relative to the high-tech means. During the procession of constructing the food safety management system, the management mode and management work of it should be considered in depth. An effective tool should be found out to construct the food safety information platform. Internet of Things is the extend network based on Internet (Zhang and Liu, 2014). It is a kind of network can that can achieve the intelligent identification, location, tracking, monitoring and managing the system through combing any things and internet according to conventional communicating protocol based on radio RFID (Radio Frequency Identification) technology and other sensing equipments. It is feasible to apply the Internet of Things to construct the food safety information platform. The RFID electronic label is applied in the food production, the food information can be transmitted to computer based on reader, then the production, procession, transportation and sale of food can be monitored effectively (Liu *et al*., 2010). The food safety information platform based on Internet of Things is an effective monitoring network, which has a big advantages and benefits.

BASIC THEORY OF INTERNET OF THINGS

Internet of things is the merged production of intelligent identification technology, communication technology and Internet technology. Internet of things mainly concludes perception layer, network layer and application layer. The perception layer can be achieved based on RFID technology, the network layer mainly concludes sensor network, the critical technology is inspection technology, the critical technology of application layer is intelligent technology and IPv6 address technology, the internet of things can be applied in constructing the food safety information platform (Liu *et al*., 2012).

RFID technology: RFID technology belongs to a kind of intelligent identification technology and applies the non contact method and the radio signal can be used to identify the things automatically and collects the relevant data information. RFID is the electronic label, which can be stuck on the things; it has many advantages, such as, long reading distance of data, high penetration level, no wear, high anti-pollution capacity, high efficiency and massive data information read. The RFID technology can monitor the information of food, then the information management of food safety can be achieved, the food safety events can be avoided effectively.

Sensor network and inspection technology: The sensor is the "sensory organ" that can perceive the material world, which can perceive the thermal, force, light, electricity, sound, displacement and other information, which can offer the original information for processing, transmitting, analyzing and feeding back

the network system. With development of science and technology, the traditional sensor is gradually shifted towards miniaturization, intelligence, informatization and network. It develops in direction of traditional sensor-intelligent sensor-embedded Web sensor. The sensor has wide application in the food safety management.

Intelligent technology: Intelligent technology is the means and technology that can achieve certain object. The intelligent system can be embed in the things, then the things can possess corresponding intelligent level and the communication with customer can be achieved, therefore it is the main parts of Internet of things. In recent years, the food safety management in China is in the stage of development, there are also some disadvantages, for example, capital investments are relative little, advanced devices are relatively scarce and the intelligent degree of device is lack. In order to suit for the real requirement of food safety management, the following aspects should be studied in depth. Firstly, the intelligent detection technology should be developed and the management level of food safety should be improved. Secondly, intelligent and managing system should be developed and then the food safety level can be improved. The intelligent system concludes the central control computer, series of sensor, communication network, field control machine and automatic actuator (Zhu, 2010).

Basic function of food safety information platform based on internet of things: Food safety formation platform can construct the database and analyze and process the massive information based on modern statistical means and grasp the global status of food safety and find out the safety problem of food and confirm the feature, range and degree of it, then establish the controlling measurement. The food safety information platform can monitor the food pollution, food-borne disease and harmful factors in food. The food safety information platform can carry out food safety management based on risk evaluation method and construct the monitoring network of food safety risk (Zhang and Chen, 2010).

In recent years, with the continuous occurrence of food pollution and food poisoning, the food safety problem has been concerned by many people, such excessive pesticide of vegetables, milk poisoning, meat poisoning with high content Clenbuterol and pesticide processing ham. Therefore it is necessary to monitor the food safety risk based on improved food safety information platform.

The food safety information platform can upload the food information in time and store the information in the service database of food enterprise and screen the important data to be uploaded to the central database. The food safety information platform concludes 5 applications, which are raw materials management, processing management, storing management, logistics management and forewarning management and the every support module can offer the corresponding service. The raw materials management mainly is responsible for collection of raw materials, record the critical data; the processing management mainly record the critical data of food procession; the storing management mainly is responsible for procedures of food in storage aspects; logistics management can record a series of data during the procession of food logistics; forewarning management can carry out routine monitoring for production and sale of food and evaluate the necessary risk and status of suspicious events. When the event may appear abnormal, the corresponding alarm is issued in time, the objective event can be controlled effectively, then the risk can be eliminated.

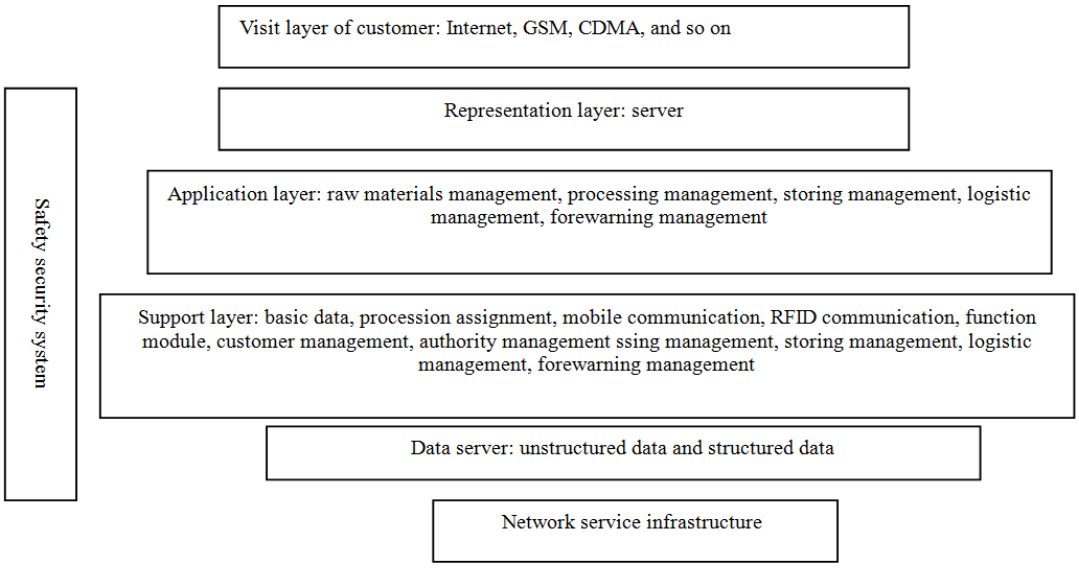

Fig. 1: Structural framework of food safety information platform

The RFID technology can be applied to connect the five application layers and offer the effective data for the food safety management system (Zhou and Chen, 2011). Data service layer concludes two kinds of data structures, which are unstructured data and structured data. The unstructured data is the other data out of system procession and structured data can serve the whole system. The outer interfaces are provided by API, Web service and so on. The corresponding data can be searched through many kinds of means. The food safety information platform is designed according to the relevant laws and standards. The basic structure of the food safety information platform is shown in Fig. 1.

METHODOLOGY

Hardware design of food safety management system: The food safety management system applied RFID electronic label to monitor the production, procession, transportation and sale of food and the application scene concludes raw materials, additives, packing materials, sticking and writing of box label, RFID application of warehouse management, RFID logistics distribution of sales and other functions. The food safety information platform can track the batch of food and manage the search of flow information for food (Xie *et al*., 2012).

Design of electronic label: The ID number and fixed information of card can be shown in the "data" column through clicking the "reading card" button in the interface of system. The RFID electronic label of food can be obtained through using the close wireless intelligent cell phone with the reading function RFID, the search platform can be visited through Web service and cell phone message. The searching content can be encapsulated in a searching service and the basic information of food can be obtained through a time search.

Design of tracking sub system: The tracking information of food concludes basic information of food, processing record of food, inspection report, Qualification information of food enterprise, the adding record of additives and raw materials in food, purchase record of raw materials, record of sales, except for the information of food and enterprise, other records can be obtained through processing batch. In addition, the additive is sub class of raw materials, therefore they can be designed in the same table. After taking the adding record of additives and raw materials, the standard maximum permitted additive amount should be judged.

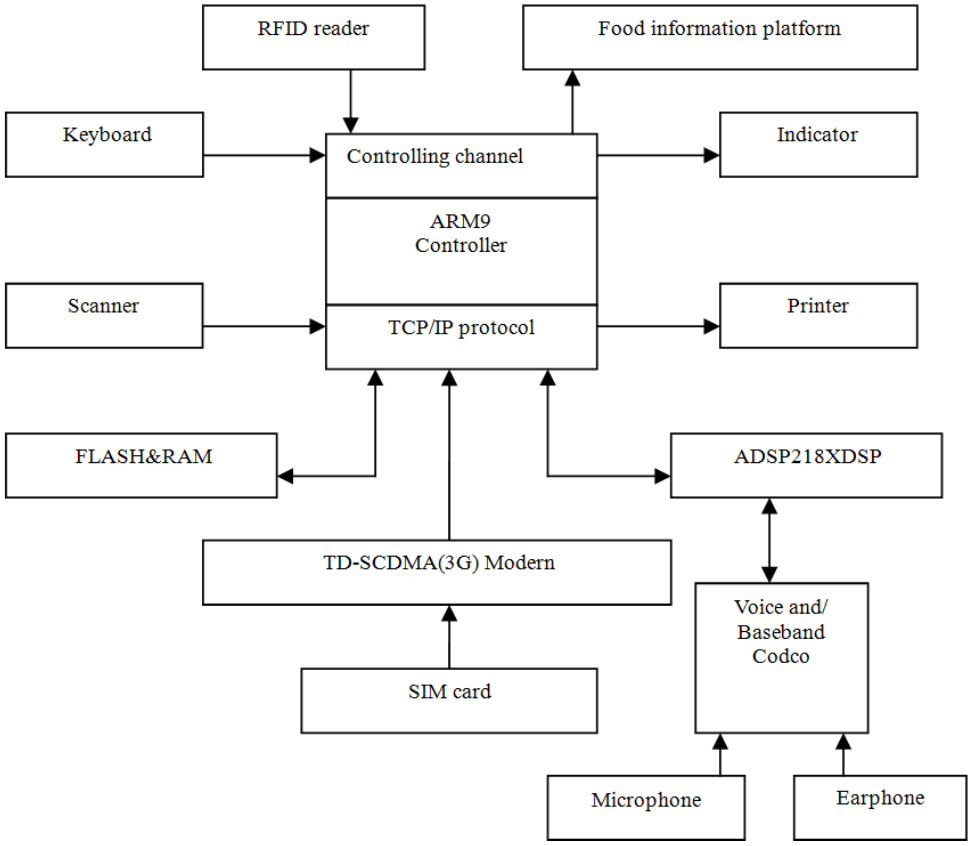

Fig. 2: Framework diagram of terminal system

Generation of tracking information report: The function of the food tacking information is to write the information searched into PDF fiel and offer the corresponding data flow to the browser for uploading by customer. The former can be achieved though writing the tracking information into PDF file based on iText and is bund in the given data flow. Based on Struts framework inputs the information to browser and the corresponding prompt of uploading will be transmitted to customer.

Terminal structure of food safety information platform: The diagram of terminal system is shown in Fig. 2.

As seen from Fig. 2, the terminal applies TD-SCDMA/3G wireless communication module and ARM microprocessor, the RFID reader can input the code of electronic label of food to ARM microprocessor, ARM microprocessor CAN search this food in food safety information platform of terminal internal storage and searched food safety information can be transmitted to indicator, printer and audio system and other output devices. The terminal can exchange data with food safety information platform and the data can be updated in time.

Design of bar code for food: One dimensional bar code is made up of empty, bar and corresponding character. The basic theory of one dimensional bar code is listed as follows: the information of the bar code corresponding to the stored bar code in advanced is obtained from the database of system, however this method has some disadvantages, it only identifies the food, does not identify the detail information of food, it relies on the database of computer. When the database or the network is lack, the one dimensional bar code does not be used. Therefore the two dimensional bar code is used in the food safety information platform in this research, which has the big capacity and high density. When the food is processed, the two dimensional bar code is stuck to the packing box; the food can be announced and anti-counterfeited.

Synchronic of data: The food safety information platform concludes the whole data from raw materials to final production of food, the platform should satisfy the searching requirement of customer at any moment and location, therefore the whole data can be updated in time and the data synchronism between application fore-end and terminal server can be achieved. The data synchronic method based on Socket communication is applied in the food safety information platform. The socket data can achieve the network answer and request based on character stream with form "socket", in order to achieve the data synchronism, the two sides of communication must explain and encapsulate data under agreed data element format.

LOCALIZATION ALGORITHM PROCESSION OF FOOD SAFETY MANAGEMENT SYSTEM

For different clustering, data transmission between cluster head node and sensor node can be achieved through a jump. However, time of accepting data for cluster head node is long and the more energy should be consumed. If the cluster head node fails, the monitoring data does not be transmitted, the mobile Agent node can deal with this problem and good algorithm should be applied to confirm the beat route, which is the localization algorithm. In order to improve precision of localization algorithm and reduce the localization error of node, the DV-Hop algorithm can be applied and the corresponding algorithm procession is listed as follows (Li and Feng, 2012).

Determination of node hops: Transmit data in cluster head node or Agent node of Internet of things is defined by (*id*, *x*, *y*, *hop*), id denotes the order number of Agent node, *x*, *y* denotes the horizontal coordinate and longitudinal coordinate of node location, respectively, *hop* denotes the number of hops. If the node accept this data firstly, this data can be stored and the number of hops add 1, if the node accepts the data package of cluster head or Agent node secondly. Comparing the current hops and existing hops, if the current hops is less than the existing hops, the current data can replaces the original data and retransmission is carried out, if the whole cluster head or Agent nodes do not change, this step is over.

Solving the mean hops: The mean hops between i^{th} cluster head or Agent node and other N-1 cluster heads or Agent nodes can be calculated by the following expression:

$$hopV_i = \frac{\sum_{j=1}^{N-1} d(a_i, a_j)}{\sum_{j=1}^{N-1} hop_{ij}} \quad (1)$$

where, $hopV_i$ denotes the mean value of distance per hop, d (a_i, a_j) denotes the distance between i^{th} cluster head or Agent nodes and j^{th} cluster head or Agent node, $\sum_{j=1}^{N-1} hop_{ij}$ denotes the sum of hops between i^{th} cluster head or Agent node and j^{th} cluster head or Agent node.

When the mean hops of all cluster heads or Agent nodes are solved, data can be transmitted in Internet of things and then the first data accepted by different node can be stored.

Localization mode of node: The multilateral localization method is used to evaluate the coordinate of nodes, the coordinate of positioning node is defined by (a_x, a_y), the coordinates of cluster head or Agent

Table 1: Food safety monitoring results based on information platform

Variety of food	Sampling batches	Qualified batches	Qualified rate (%)
Bean sprout	12	12	100.0
Pepper products	68	68	100.0
Prepared food	240	238	99.2
Rice products	45	44	97.8
Meat	200	200	100.0
Aquatic product	35	34	97.0
Condiment	85	85	100.0
Edible oil	55	54	98.2
Pastry	120	117	97.5
Flour product	90	88	97.8
Vegetables	220	220	100.0
Rice dumpling	160	157	98.1
Dairy product	120	116	96.7

nodes are defined by (a_{1x}, a_{1y}), (a_{2x}, a_{2y}), …, (a_{nx}, a_{ny}), the coordination of positioning nodes can be calculated by the following expression:

$$\begin{cases} \sqrt{(a_x - a_{1x})^2 + (a_y - a_{1y})^2} = d_1 \\ \sqrt{(a_x - a_{2x})^2 + (a_y - a_{2y})^2} = d_2 \\ \cdots \\ \sqrt{(a_x - a_{nx})^2 + (a_y - a_{ny})^2} = d_n \end{cases} \quad (2)$$

The error of positioning node (a_x, a_y) in x and y direction can be defined by (e_x, e_y), the corresponding equation is expressed as follows:

$$f(a_x, a_y) = \sqrt{(a_x - a_{nx})^2 + (a_y - a_{ny})^2} \quad (3)$$

The iteration calculation is carried out based on Taylor's series, the error (e_x, e_y) can be obtained through the Taylor calculation for Eq. (3) in (a_x, a_y), the cycle operation is carried out, when the precision is satisfied, the calculation is over, then the optimal coordinate (a_x, a_y) is obtained.

APPLICATION SITUATION OF FOOD SAFETY INFORMATION PLATFORM

In 2012-2013, 1250 batches of food are monitored from the angle of safety, there are 10 kinds of food, the total qualified rate of monitored food is 98.23%, the monitoring results are listed in Table 1.

As seen from Table 1, the food safety information platform can improve the monitoring range and variety of food and find our risk of food, then improve the qualified rate of food. The platform can grasp the safety risk of food and deal with the food safety risk effectively and offer the food safety guarantee for people.

CONCLUSION

The Internet of things is applied in constructing the food safety information platform, which monitor the food safety risk effectively. The food safety management system can grasp the situation of food safety, monitor all parts of food production, it is a feasible tool for collecting and issuing the critical data of food safety, which has a certain innovativeness and practical value.

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