An Information Acquisition System for Agricultural Product Origin Safety Based on Android Smartphone

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Abstract. Currently, the data acquisition method for agricultural product origin safety is still lagging behind, thus it is difficult to upload the monitoring data in a timely and convenient way. An information acquisition system for agricultural product origin safety based on Android smartphone was developed. The design of the information acquisition system was based on the C/S architecture, including smartphone APP and server-side software. The smartphone APP can achieve the rapid positioning of the monitoring point, data correction, real-time data transmission and automatic archiving. Demonstration results show that the system has the characteristics of convenient collection, rapid transmission and high efficiency compared with the traditional data acquisition mode. The system is suitable for the data acquisition of grassroots agricultural environmental monitoring station, and it can effectively improve the information acquisition efficiency for agricultural product origin safety, which is helpful to improve the management level of the agricultural product origin safety.

Introduction

In recent years, the agricultural product safety incidents such as the Hunan cadmium rice event have occurred many times, which have aroused wide attention from public opinion. As the source of agricultural production, the environmental safety of the agricultural product origin, such as soil, water and atmosphere, is directly related to agricultural product safety and people's health. The origin safety of agricultural product has become the focus of attention of government officials, experts and scholars [1]. Thus, it is necessary to strengthen the supervision and dynamic monitoring of agricultural product origin [2], and the government departments at each level have done a great deal of works and collected a lot of environmental monitoring data. Especially in recent years, the amount of monitoring data increases exponentially, but the corresponding information system construction is relatively lagging behind. Recently, many scholars have done a great deal of research, including: safety evaluation [3], monitoring and early warning [4], regulatory policy [5], but the above work is mainly focuses on theoretical research, but few applied research, especially the lack of research about the portable information acquisition system or equipment for agricultural origin safety.

Currently, the collection staffs mainly used paper or Excel file for data records, and then these data records in the paper or in the Excel file will be manually audited, processed and entered into the information system. This data acquisition method is not only low efficiency but also easily leading to data errors. As each sampling task involves many monitoring points, the amount of data is very large, thus it is prone to errors for the data collection staffs in the process of data processing. In addition, it is difficult to obtain the safety of agricultural products in a timely and effective way, and thus affect the final management decision, which seriously restricts the improvement of the government’s supervision ability of the agricultural product origin safety. In order to solve the above problems, an
information acquisition system for agricultural product origin safety based on Android smartphone is designed and developed in this paper.

**The Framework of the System**

The following principles such as practicability, progressiveness, openness, adaptability and security were followed in the design of the system. The practicality of the system was considered priority, i.e., the functional modules of the system must meet the practical needs of data acquisition of agricultural origin safety. On this basis, the following principles such as progressiveness, openness, adaptability are emphasized. Last but not least, security should be paid special attention in order to ensure the security of data in the system design. Many security measures such as user access policy, data encryption and secure access authentication, were conducted to ensure the security of data.

The safety data collection system of agricultural products origin consisted of two parts: collecting terminal software (smartphone APP) and server-side program, adopting C/S architecture design. Where the smartphone APP was mainly responsible for data query, data collection and submission; server-side program was mainly responsible for data storage, processing and statistical analysis. Data exchange between smartphone App and server-side program was conducted by calling web service. As shown in Figure 1, the overall architecture of the system was divided into three layers: business application layer, application support layer and database layer.

The server consisted of application server and database server, where application server program was developed by JAVA language (JDK 1.6+), Hibernate 4 and Spring 4 based on Eclipse IDE platform, and database server was mainly responsible for the storage of data, on which the MySQL 5.6 software is running. The smartphone APP was developed using Android Studio IDE based on Android SDK version 6.0 that can compatible with Android version 4.0 above. The rest of the paper will introduce the architecture and functional features of mobile APP in detail.

![Figure 1. The overall design of system architecture.](image)

**Key Technologies**

The smartphone APP was developed based on MVC (Model - View - Controller) architecture, and many advanced information technologies such as two-dimensional code, NFC (Near-Field Communication) [6], RFID (Radio Frequency Identification) [7], 3G/4G were integrated into it. For example, the APP could quickly acquire the identifier of the collected soil sample based on two-dimensional code labels or RFID electronic tags.

The system supported two types of data transmission: mobile Internet real-time transmission, USB data line transmission. Users could either transmit the sampled data through the 3G/4G network or WIFI real-time transmission of sampling data, or save the data on the mobile phone temporarily and then used the USB data line to connect with the computer for transmission.
In the aspect of data security design, the data would be encrypted in the local data storage and data transmission process in order to ensure data security. At the same time, the system supported different granularity of the functions and data authority distribution, which could be flexible to receive provincial, city, county level of management department issued the acquisition task.

In addition, the system provided efficient and practical local image storage index coding mode. When the system uploaded the picture, the system would use lossless compression algorithm [8] to compress the picture, which effectively improved the transmission efficiency of the system. The system could use LBS (Location Based Services) [9] service for monitoring the entire information acquisition process, which could effectively prevent data fraud.

System Modules

The main function modules of the system included: pollution source management, monitoring data collection, questionnaire management and system configuration, as shown in Figure 2. and Figure 3.

![Figure 2. The detail of the pollution source.](image)

![Figure 3. Data collection of monitoring point.](image)

Pollution Source Management

This module that was developed based on AMAP which was one of China's leading providers of digital map content of China, was mainly used for marking pollution sources on the map. The user could visually mark two types of pollution sources such as polluting enterprises and sewage irrigation area on the map, and fill in the text description or pictures about each pollution source and submit it for verification, where the text description of the polluting enterprise includes: enterprise name, address and its latitude and longitude, major pollution type and pollutants, the operation status and so on; where the text description of the sewage irrigation area includes: main pollution water, sewage source, irrigation mode, irrigation years, irrigation status and so on.

In addition, this function module also provided LBS-based data query interface. When the user reached a certain monitoring point, the system would automatically list the pollution source around the monitoring point and use the different icons with different shapes and colors to display them on the map, as shown in Figure 2. The shape of the icon was used to distinguish the type of pollution source (industrial and mining enterprises or sewage irrigation area), and the icon color was used to distinguish the certification state of the pollution source (not certified or certified). The detailed information about the pollution source could be real-time obtained by clicking the icon on the map.

Monitoring Data Collection

This module was mainly used for the relevant information collection of sampling point, including three sub modules: farmland plot information, sample collection, live picture upload. The workflow of the monitoring data collection was shown in Figure 4. First, logged into the system and got the sampling task of the current user from the server; Then, clicked on the sampling task to get the list of
monitoring points of each task; Next, samples of soil or agricultural product at the designated monitoring point were collected and the description information or pictures about the monitoring point were filled in; Finally, the sampling data was submitted online based on the 4G network or WIFI, or the sampling data was temporarily saved to the local storage card and then was submitted to the information system by USB data line.

Figure 4. The workflow of the monitoring data collection.

Farmland plot information. The following information such as the location information of the monitoring point, the surrounding pollution sources, irrigation method, the area of the land and its contractor, were filled in on the smartphone, as shown in Figure 3 (a).

Sample collection. The following information such as the sample ID, soil name, the PH of the soil, sampling depth, were filled in on the smartphone, as shown in Figure 3 (b). The sample ID code could be entered into the system by using smartphone scanning two-dimensional code label or RFID electronic tag, and the sample ID would be associated with the monitoring point automatically.

Live picture upload. Users needed to take at least 3 photos of the sampling and upload. When uploading pictures, lossless compression algorithm was used for compressing the pictures to reduce the amount of data transferred [8], so the response speed of the system was efficiently improved. At the same time, watermark including current time, current location and its latitude and longitude, was added on each uploaded picture automatically. Thus, the uploaded pictures were not only prevented from being tampered with, but also were convenient for archiving and viewing for the future.

In addition, the supervision and assessment function of the acquisition process was provided in the system. When a user started a data acquisition task, the system would automatically get the longitude and latitude of the current location. If the latitude and longitude of the current location were very different from the latitude and longitude of the current monitoring point, the system would block data submission and give the error prompt. By this way, the managers could view the data acquisition personnel's trajectory, which could be used for monitoring the sampling process and effectively preventing the data acquisition fraud.

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Questionnaire Management

This module was mainly used for the survey in the management decision of agricultural product origin safety. When the investigator entered into the system, the questionnaires would be downloaded automatically, and the investigator selected the current questionnaire and started the answer. The system supported multiple types of questions, e.g., multiple choices question, single-choice question, blank-fill question, scoring question. When submitting a questionnaire, the system would validate the data automatically. Compared with the traditional paper questionnaire, the module has the characteristics of flexibility and convenience, automatic data filtering and aggregation and report generation. As a result, the convenience, efficiency and accuracy of the way of the questionnaire were much better than those of the traditional paper-based questionnaire.

System Configuration

This module was mainly used for user information maintenance, system configuration and parameter configuration, such as offline map configuration, Web Service address and port configuration.

Conclusion

In this paper, an information acquisition system for agricultural product origin safety based on Android smartphone is designed and developed according to the actual work demand. The system has the advantages of convenient carrying, friendly interface, convenient operation and fast response. At present, the system has been demonstrated in Xiangtan city which is in Hunan province of China.

For future research, the decision support system [10] for management of agricultural product origin safety will be developed, so that the data can be analyzed deeply, and the decision support for the origin safety supervision of the agricultural product will be provided.

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