An Augmented Reality Based Disclosure Model of Information on Food Safety and Its Application

Peng Min-jing[1] and Li Bo[2]

[1] *School of Economics and Management, Wuyi University*
Dongchen Village, Jiangmen, Guandong, China
[2] *Institute of System Science and Engineering, Wuyi University*
Dongchen Village, Jiangmen, Guandong, China
1peng.mj@joybirds.cn, 2li.b@joybirds.com

Abstract

In order to solve the problem of complex operations for users to obtain food safety information, an augmented reality based information disclosure model for food safety was proposed on the smartphone platform. In the proposed model, the user's instant interest, which was extracted from the real world for consuming and purchasing foods, was employed to obtain the food information that the user was interested in. And then, the technology of augmented reality was used to integrate the "real objects" and the "virtual objects" to architect the food safety information disclosure framework, where the "real objects" stand for users' food recommendations and consumption environment, and the "virtual objects" stand for safety information of the foods which users were interested. Finally, the framework is customized for applying to food recommendation of Jianghai Restaurant Association of Jiangmen City, to verify of the validity of the proposed framework.

Keywords: *Food Safety, Information Disclosure, Augmented Reality, System Framework, Instant User Interest, Mobile Phone*

1. Introduction

Information disclosure is a very important aspect of food safety management, and is an essential prerequisite for transparency, openness of food safety management and increasing consumers' trust [1]. In the context of food safety, information disclosure problem lies in the combination of real scene food consumption with food safety information to form a fusion of food safety application information to make appropriate recommendations to the user.

The technology of augmented reality enables virtual objects to become an integral part of the surrounding real environments in the sense of human perception [2]. Augmented reality enhances the user the perception of the real world and the ability to interact with the real world. In the food safety information disclosure process of this research, the technology of augmented reality will be employed to integrate seamlessly "virtual objects", which represent the information on food safety, and "real objects", which represent the real environments of food recommendation and consumption to form the integrated objects, which would be used for the architecture the information system framework of food safety.

In the second part of this article, food safety behaviors of stakeholders would be analyzed and it would be concluded that food consumers want to convert the experience goods and the credit goods into the search goods, and this conversion needs the presentation information to match with the real environments and processes of consumption. In the third part, the technology of augmented reality would be introduced to propose the augmented reality based

disclosure model of information on food safety. In the fourth part, the proposed model would be extended as a food safety information disclosure framework. And in the following part, the framework would be used in food safety recommendation platform of Jianghai Restaurant Association of Jiangmen to form food safety information disclosure system to verify the effectiveness of the framework.

2. Analysis on Stakeholder Behaviors

In a market economy, as rational economic persons, producers need to maximize their profits, and consumers also seek their own utility maximization [3]. They are of opposing interests in the market gaming. The availability of information on product quality determines the behaviors of the producers and consumers and thus affects the market equilibrium. The information on food safety is usually not sufficient, which results in that the features of food safety are different from other features of product quality: on the one hand, the consumers are reluctant to take the risk of harmfulness; on the other hand, the consumers cannot determine the levels of food safety. Therefore, in market, the information on food safety is asymmetric to the consumers and the produces.

Producers and processers usually know more information on the food safety than consumers, which provide them with self-interest opportunities. Besides, it is difficult to pass the information on food safety to the other members in the food system, such as distributors, retailers, consumers, etc. Therefore, in the field of food safety, the information structure is typically asymmetric and the information is incomplete to the participants. As such, the information is incomplete to consumers, while it is relatively complete to the producers, distributors and retailers [4].

In order to facilitate the analysis, considering the ways of providing consumers with product information, Nelson and Caswell classified goods into three categories: search goods, experience goods and credit goods [5]. Search goods are the products on which consumers have obtained adequate information before purchasing; experience goods are the products that consumers are able to determine the quality only after consumers purchasing them; credit goods are referred as the products that their quality can't be determined even after they were purchased. According to the classification, foods are both experience goods (foods have the features of fresh degree, the amount of juice, flavor, texture, taste and others) and credit goods (foods may contain antibiotics, hormones and pesticides residual), but foods are not search goods.

In the process of purchasing foods, consumers hope to convert experience goods and credit goods into search goods. The key to the conversion is giving more information about experience goods and credit goods to the consumers desiring to purchase the foods. Currently, the technology of augmented reality based on mobile phone can provide technical support for such conversion. Therefore, our research goal is employing augmented reality to the disclosure of information on food safety, expecting to provide practical means of providing users with access to the information on food safety.

3. Augmented Reality based Disclosure Model of Information on Food Safety

The technology of augmented reality is a hot research topic in recent years, and it has a broad application prospects. As the complement to the real world, virtual objects become an integral part of the surrounding real environments in the sense of human through the technology of augmented reality. Augmented reality enhances the user perception and the ability to interact with the real world. As a kind of fusion technology of integrating "virtual

objects" with "real objects", in the disclosure process of information on food safety, augmented reality technology can be employed to seamlessly integrate "virtual objects" representing food safety information and "real objects" representing the real user food recommendations and consumption environments [6], and thus convert experience goods and credit goods into search goods in the field of the food safety.

Augmented reality is the appropriate technology for the disclosure of information on food safety. The difficulty lying in applying the technology of augmented reality to the disclosure of information on food safety is synchronization of food safety information and real world of food consumption: when the user is moving, the real scene would change and the food safety information also would need immediate updates. How they are integrated is shown in figure 1.

There are two connections between the real objects and virtual objects: (1) the collected information. The data generated in the food producing, processing and distributing in real scene are collected into the virtual object repository of food information; (2) the user's interest on foods. When users are going to purchase foods or enjoy catering services, they would show their interests in the foods. We extract the user's instant interests in foods from the user's behavioral states and scenario, and obtain safety information on the food that the user is interested in from the food information repository.

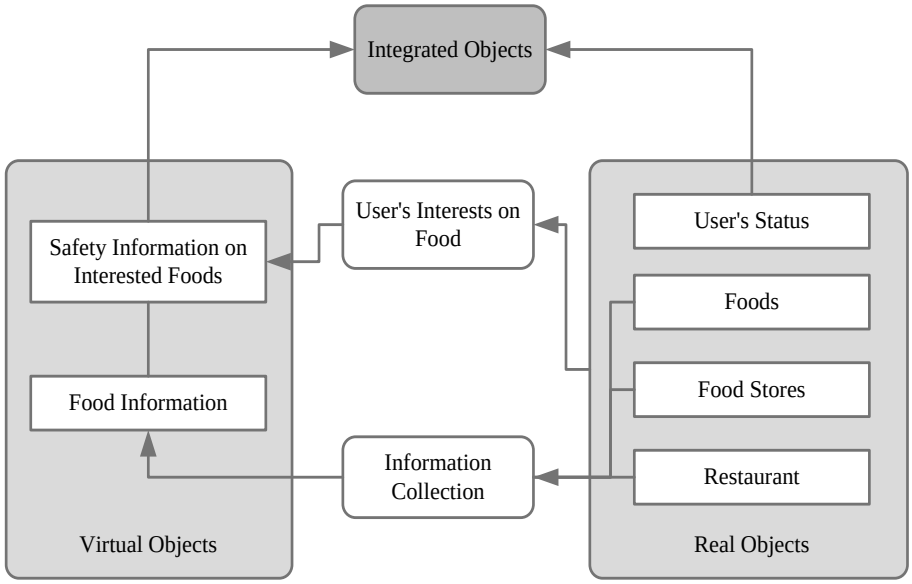


Figure 1. The Integrated Objects based on Augmented Reality

The technology of augmented reality is employed to integrate the information on the food that the user is interested in and the real scene in which the user is, to generate fusion objects by integrating "virtual objects" into the real scene, so that the user can learn more information on the quality of the consumed foods.

4. The Disclosure Framework of Information on Food Safety

According to the proposed model in the third part, the disclosure framework of information on food safety consists of three parts: (a) data collection adaptation pool; (b) the information switching center; (c) the client based on mobile phone. Details of the framework are given in Figure 2.

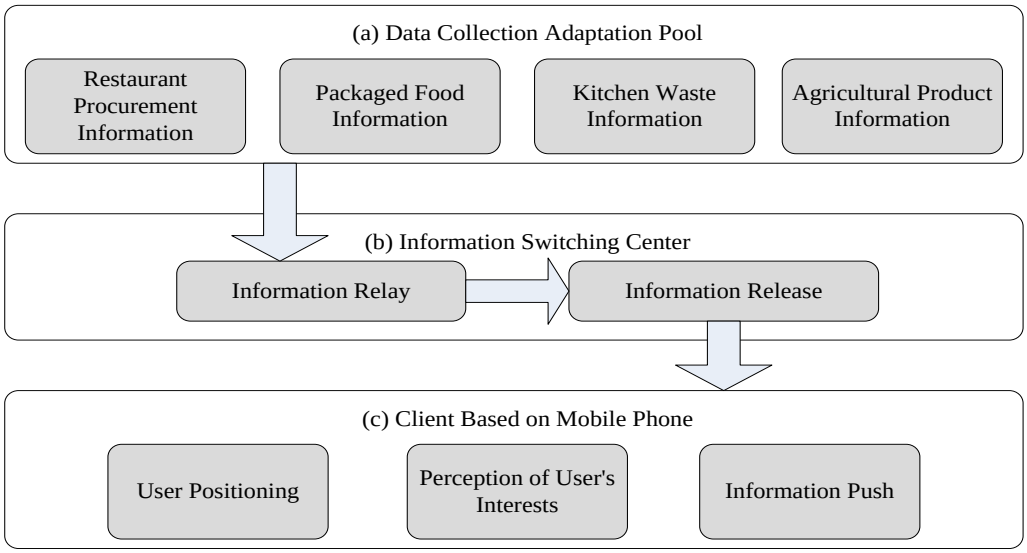


Figure 2. The Disclosure Framework of Information on Food Safety

4.1. Data Collection Adaptation Pool

Data collection is the key step to information disclosure. To collect data, an inexpensive, manageable and flexible, scalable and adaptable pool must be built for adapters of data collection. Data collection adapters for a variety of businesses can be configured and installed in the pool[7]. These adapters consist of information collection adapters of restaurant procurement, information collection adapters of packaged food distribution, information collection adapters of kitchen waste and information collection adapters of agricultural products.

Information collection adapters for restaurant procurement are used for collecting procurement information of oil and other ingredients. Through these adapters, restaurants release information on their food oil procurement and some other data, making its food processing operations and other processes transparent, increasing consumer confidence on the restaurants, and thus improving its market reputation and competitiveness.

Information collection adapters for packaged food distribution are used for collecting information on packaged foods in various aspects of distribution. As long as the distribution is started, all wholesale and retail businesses collect production batch (production date), stores that sell the product and purchase date or delivery date, to help consumers learn circulation flow path of the interested food and identify the food.

Information collection adapters for kitchen waste are used for collecting the information on collection and circulation of kitchen waste. The information includes waste producing kitchen, shipped ledger entry from the kitchen, produced ledger entry from the waste collection organization, shipped ledger entry from the waste collection organization and purchasing ledger entry from the waste reuse companies.

4.2. Information Switching Center

Information switching center is used for receiving the information collected from the adapters, and releasing information to mobile phones. It has two functions: receiving information and releasing information.

The function of receiving information is developed based on the web service standard. It can be used for receiving data from different platforms and different information sources. It can fit with all kinds of data collection adapters in the data collection pool and be used for receiving information on procurement of restaurant and circulation of packaged foods, collecting kitchen wastes and inspecting on the quality of agricultural products.

The module of information release is located in the information switching center. The information is sent to the information release module through wired or wireless network. In the module, the information in the form of video, picture or text is reorganized according to the target user's interests, location, time and other circumstances, *i.e.*, the speed, the way of travel, and network quality. In this way, a chain of information from collection to release is established through the network and can be employed to release personalized information on food safety to the whole network. This enables the information release safe, accurate and fast.

4.3. Client Based on Mobile Phones or Pads

The interaction between the target users and the system is implemented on the mobile phones or the pads. The key functions of this module include user positioning, user's interest extraction and multi-channel interaction.

4.3.1. User Positioning

User positioning is realized based on mobile positioning technologies. In this research, the unified positioning model consists of the outdoor positioning and the indoor positioning.

Outdoor positioning is implemented through GPS combined with base stations of cellular network [8]. System combines the two technologies of Assisted GPS (A-GPS) and advanced forward link trilateration (AFLT) to achieve positioning with high precision, high availability and high speed. When A-GPS positioning technology cannot be used, it will automatically switch to AFLT to ensure the positioning successful and accurate [9].

A-GPS technology simplifies the work of mobile phones and pads. It transfers the heaviest works such as scanning and positioning computation from the mobile phone or pad side to the network side. The positioning server at the network side is allocated to complete the works. This not only improves the receive gain, sensitivity and cold start speed of the terminals, but also reduces the power consumption of the terminals, which overcomes the problem of over-reliance on terminal performance of traditional GPS technology. In traditional GPS technology, the burdens of satellite scanning, capturing, pseudorange positioning signal receiving and positioning computing are carried by terminals, which results in low sensitivity, high power-consumption and other defects to positioning terminals.

Since GPS signals cannot penetrate walls of buildings, so in the task of indoor positioning, GPS cannot work well. In this research, wireless local area network (WLAN) is employed to obtain the position indoor [10].

The technology of indoor positioning is used to estimate the location of the wireless terminal devices. Attributes of typical applications include Received Signal Strength (RSS) received from the access point, Angle of Arrival (AOA) of received signal, Time of Arrival of received signal (TOA), Time Difference of Arrival (TDOA) of received signal. In all of these attributes, RSS is the only attribute that is reasonably priced and can be hardware measured [11]. In a laboratory environment, RSS of WLAN signal is linear with the logarithm of the distance. In a two-dimensional space, RSS signal of three access points can be used to determine the location of a label, which stands for a mobile phone or a pad of a user, by the method of triangulation. However, in practice, the physical objects in the building, such as, the wall, the elevator, the furniture and moving people, will affect the value of RSS [12]. In

this framework, the solution of real time positioning based on RSSI values proposed by Mazuelas is used [13].

4.3.2. User's Interest Identification

In a mobile-commerce environment, for effectiveness of the recommendation of information on food safety, real-time identification of user interest is very important for providing products and services to users to meet their instant needs. Such interests directly affect trade of these products and services as well as reception of information and acceptance of information contents.

Since the user's instant interests are affected by living habits, time, location, weather, working plans and other ambient factors, its forecasting is very complicated. And what makes forecasting more difficult is that the user's instant interests are completely personalized, the historical data of other users cannot be used to learn from to forecast the instant interests of another user.

To solve the above problem, we propose a user instant interest model based on SVDD schedule model. In the proposed model, Schedule was used as a basis of evaluating the state of the user, and SVDD were applied to determine whether the user is currently deviated from the schedule. And then, an agent is architected residing in mobile phones or pads to determine the instant interests, which solves the problem of nonlinearity, coupling and time-variability. And the method of human-computer interaction is applied to solve the problem of confirming personalized instant interests.

At first, the agent uses Support Vector Data Description (SVDD) to determine whether the user is deviated from the schedule [13], as what is given in Figure 3.

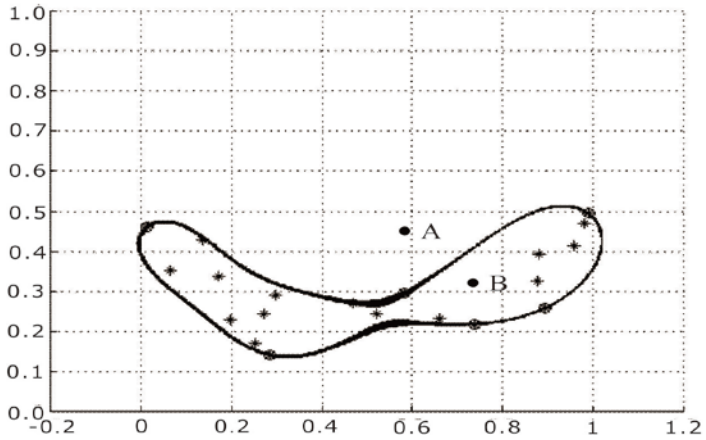


Figure 3. The SVDD Boundary for Determining the Deviated Behavior from the Schedule

If the object was out of the boundary, it would be a deviated behavior. Otherwise, it would be an adherent behavior. In Figure 3, the object "A" is out of the boundary, so it represents a deviated behavior, and the object "B", which is inside the boundary, represents an adherent behavior [14].

And then, the agent needs to determine the user's action status. The agent will confirm the user is in normal, in emergency or in leisure, in order to interact with the user through the application residing in the mobile phone or in the pad. The detailed process is given in Figure 4.

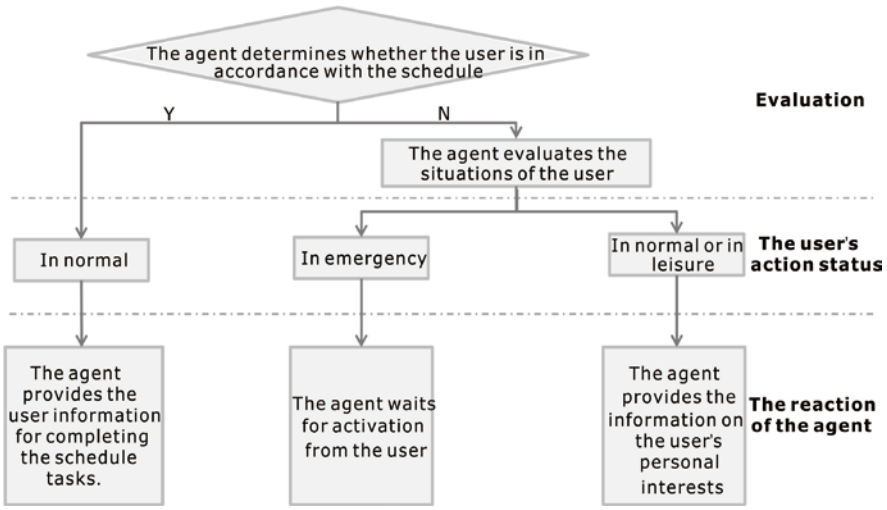


Figure 4. The Process of Determining User's Status

4.3.3. Multi-channel Interaction

Mobile phones or pads are the tools for users to accept the information on food safety. These phones and pads provide users with several ways of interaction: touch, vibration, sound vision and others [15], which are shown in Figure 5.

The terminal-human interaction is bidirectional: from the terminal to the user or from the user to the terminal. There are three ways of interaction from the terminal to the user: vibration, sound, screen. For these three interactions, the user senses the signals using touch, hearing and vision. And there are also three ways of interaction from the user to the terminal, the user can use gesture, voice and touch to transfer information to the terminal and the terminal receives the information using the three devices: the camera, the microphone and the touch screen.

Through using the interactive modes of touch, voice, gesture, vibration, sound and vision, the information on food safety the user needs or is interested in is a part of the real environment of food purchase or restaurant services, which enhances the user's perception of the real world, forming the multi-channel information pushing architecture of food safety.

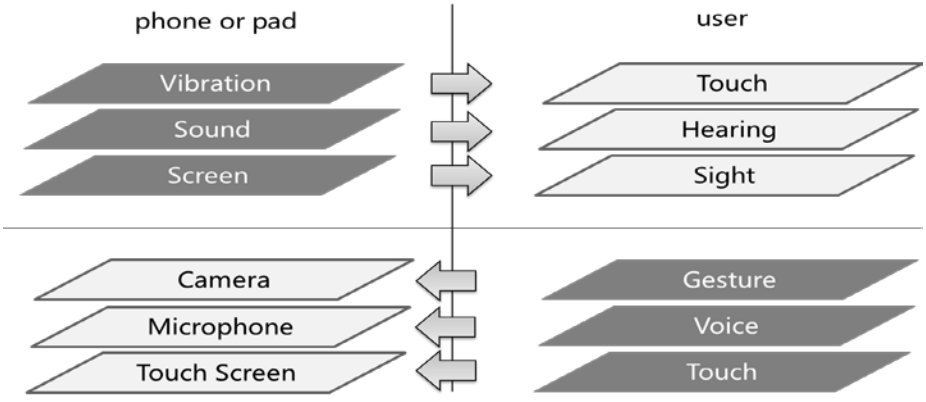


Figure 5. Interactions between Phones/Pads and Users

5. An application: The Disclosure System of Information on Food Safety for Food Industry Association

This application is run by the restaurant association of Jianghai and tens of catering enterprises in Jianghai, Jiangmen. It is named as “the food safety supervision and information release system”, and is designed as an integrated information system of food safety to receive data from the related businesses and provide information on food safety to the public. The information would be released in public and personalized channels to increase public trust in enterprises of the catering industry, to improve the competitiveness of the enterprises and achieve healthy competition among catering enterprises and the win-win situation of enterprises and consumers.

5.1. Application Background

The food safety supervision and information release system consists of several network services, which provide information services for the restaurant association, catering enterprises, the public and regulators. The workers of the restaurant association enter the purchase information into the system. The catering enterprises enter the information on kitchen waste. And the data analyzers of the restaurant association are responsible for analyzing and integrating the data entered by the restaurant association and the catering enterprises, and releasing the information the public through the mobile phones or pads. In this way, the public would be able to share food safety information.

5.2. Architecture and Implementation

The architecture of the information system of food safety consists of three layers: data collection layer, data repository layer and information presenting layer. The details of the architecture are shown in Figure 6.

There are four roles involving in the application of the system. They are stores selling packaged foods, restaurants serving customers with catering services, the restaurant association analyzing and integrating the entered data, and users receiving the recommended information on food safety.

In data collection layer, information on packaged foods, kitchen waste and raw materials of restaurants are entered into the data collection repository. The information are then analyzed and integrated into the information release repository by the analyzers of the catering industry association. The data collection repository and the information release repository belong to the data repository layer. In information presenting layer, user interests are exacted from the environmental data of location, speed, direction, time, network quality and schedule. And the exacted interests are employed to retrieve data from the information release repository and used to interact with users through the method of multi-channel interaction.

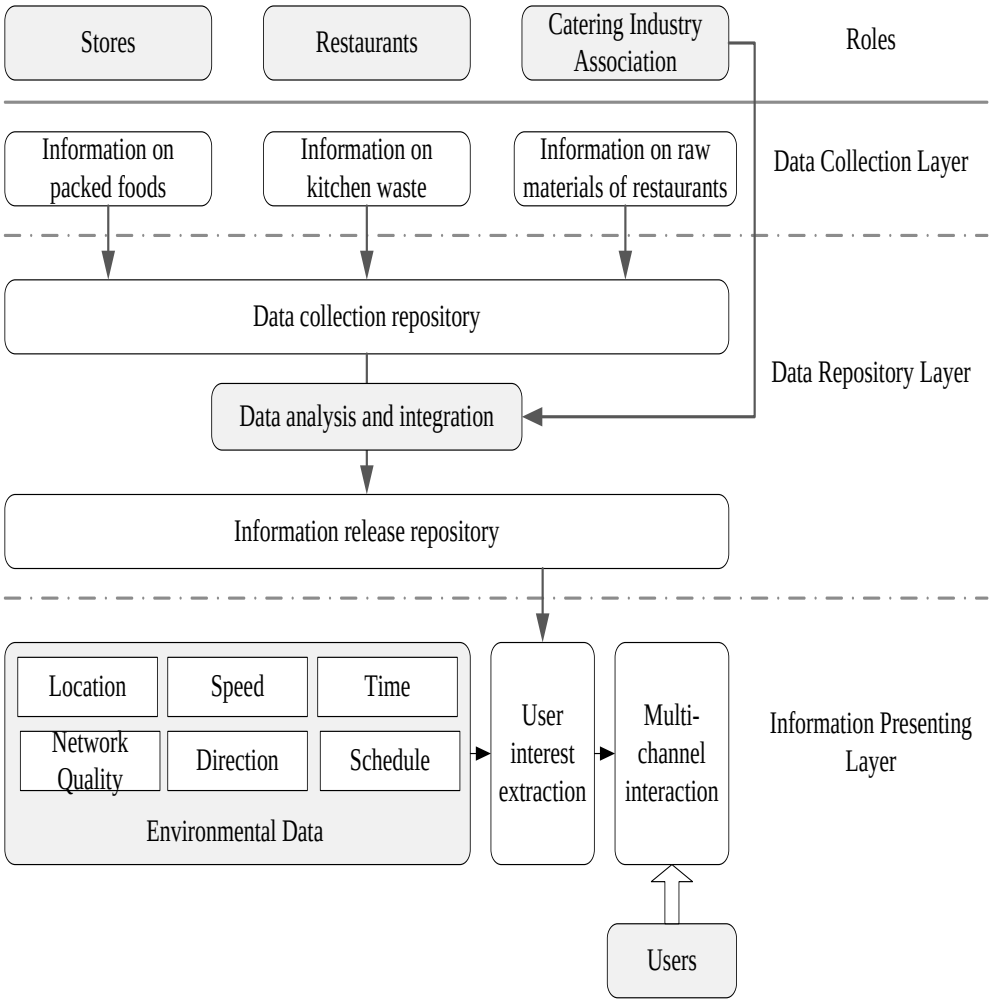


Figure 6. Architecture of the Disclosure System of Information on Food Safety

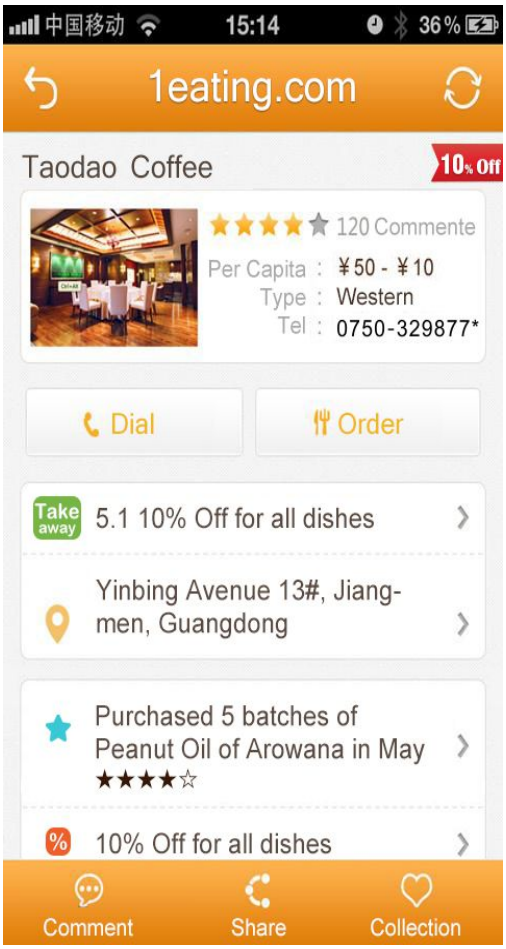
Some interfaces of the application are shown in Figure 7. In Figure 7, picture (a) shows the iPad interface that indicates the information food safety by saying “purchased 5 batches of peanut oil in May, 2013”; picture (b) shows the iPhone interface that indicates the level of food safety by saying “purchased 5 batches of peanut oil in May, 2013”; picture (c) shows the iPhone interface that indicates the food safety index by showing the semitransparent window.

5.3. Experiments

This system is tested on two functions: the user’s behavior deviation detection and the user’s instant eating interest extraction. The computation is implemented by agents residing in mobile phones or pads.

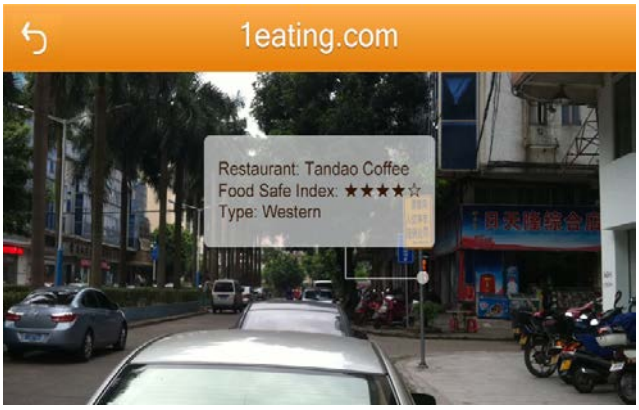
5.3.1. Behavior Deviation Detection

30 users of the system input their working schedules with only their working tasks on their working days. The algorithm of SVDD based deviation detection was implemented in the user’s mobile phone. 5 checkpoints were setup to check adherent behaviors to schedule and 5 checkpoints were setup to check deviated behaviors from schedule for each user.



(b) Information on food safety on iPhone interface

(a) Information on food safety on iPad interface



(c) Information on the level of food safety on iPhone interface

Figure 7. The Interfaces Showing Information on Food Safety

In the 150 adherent checkpoints of activities, there were only 3 errors occurring. And in the 150 deviated checkpoints of activities, there was 17 errors occurring. The error rates of detection are 2.00% and 11.33%.

In accuracy, the function can be barely acceptable. And it needs to be improved.

5.3.2. Instant Eating Interest Extraction Detection

Seven factors were considered in forecasting the instant interest of eating for users. They include: location, speed, time, network quality, direction, and schedule. And the forecasting algorithm was implemented based on Support Vector Machine (SVM) [16]. When the user was out of schedule or deviated from the schedule, and it was time for dinner, the agent residing in the mobile would decide whether it was needed to recommend a restaurant for each 5 minutes. The purpose of the test is finding whether it is the right time to recommend the restaurant.

5 checkpoints were selected for 30 users. And after the recommendation, the users were asked for levels of their satisfactions with the recommendation. The results were in 5 levels.

The higher level indicated the more satisfied the user was. The detailed satisfaction levels are shown in Table 1.

5.4. Discussions

The functions of behavior deviation detection and instant eating interest extraction have been implemented in the information system of food safety. And they need to be improved.

Because the key to the error rate of behavior deviation detection is the parameters of Gaussian kernel in SVDD. There is much to do with adjusting the parameters.

To optimize the satisfaction of recommendation, we need more historical data to train the SVM for forecasting the eating interest of users.

Table 1. The Satisfaction Level with the Recommendation

Level	Users	Percentage
0	2	6.67
1	1	3.33
2	3	10.00
3	13	43.33
4	10	33.33
5	1	3.33

6. Conclusions

The information system of food safety was developed based on the technology of augmented reality by integrating with a meal system. It overcame the difficult of complex operations of obtaining food safety information. In the proposed model, based on the detection of deviation behaviors from the schedule, the user's instant interest, which was extracted from the real world for consuming and purchasing foods, was employed to obtain the food information that the user was interested in. The information was send to users through multi-channel interfaces of mobile phones or pads. An application system was implemented according to the model. And some experiments were conducted to verify the usability of the system.

Two key functions, which are behavior deviation detection and instant eating interest extraction, have problems in algorithms or parameters and need further optimization.

Acknowledgement

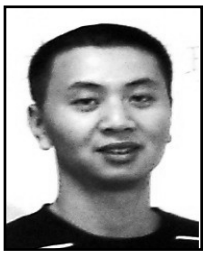
This research is supported by Natural Science Foundation of Guangdong Province, P.R.China (10452902001004947).

References

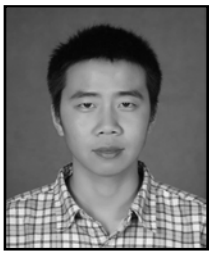
[1] D. and J. Green, "Food Safety and Consumers: Constructions of Choice and Risk", Social Policy & Administration, vol. 6, no. 36, **(2002)**, pp. 610-625.
[2] R. T. Azuma, "A Survey of Augmented Reality", Teleoperators and Virtual Environments, vol. 6, no. 4, **(1997)**, pp. 355-385.
[3] J. A. Caswell, "Valuing the Benefits and Costs of Improved Food Safety and Nutrition", Australian Journal of Agricultural and Resource Economics, vol. 4, no. 42, **(1998)**, pp. 409-424.
[4] D. Barling, T. Lang and M. Caraher, "Joined-up Food Policy? The Trials of Governance, Public Policy and the Food System", Social Policy &Administration, vol. 6, no. 36, **(2002)**, pp. 556-574.

[5] S. Assmann, "Reassessing Food Safety, Risk and Globalization in China and Japan: An Overview of Emerging Research Trends", Food, Culture and Society: An International Journal of Multidisciplinary Research, vol. 1, no. 16, **(2013)**, pp. 7-19.
[6] H. Chang, H. Wu and Y. Hsu, "Integrating a Mobile Augmented Reality Activity to Contextualize Student Learning of a Socioscientific Issue", British Journal of Educational Technology, vol. 3, no. 44, **(2013)**, pp. E95-E99.
[7] M. G. Aguiar, G. S. Elias, L. G. Franco, M. L. Paraiso and M. D. Sylos, "Automated Availability Data Collection and Reporting for System Management Environments", U.S. Patent 20,130,054,777, **(2013)** February 28.
[8] N. Kohtake, S. Morimoto, S. Kogure and D. Manandhar, "Indoor and Outdoor Seamless Positioning using Indoor Messaging System and GPS", Proceedings of 2011 International Conference on Indoor Positioning and Indoor Navigation, Guimarães, Portugal, **(2011)** September 21-23.
[9] W. Ren, G. Li and J. Lv, "Analysis of Adopting Mobile Position System Based on GPSOne Technique in VTS System", Proceedings of Intelligent System Design and Engineering Application, Changsha, China, **(2010)** October 13-14.
[10] N. M. Drawil, H. M. Amar and O. A. Basir, "GPS Localization Accuracy Classification: A Context-Based Approach", IEEE Transactions on Intelligent Transportation Systems, vol. 1, no. 14, **(2013)**, pp. 262-273.
[11] G. Qiao, X. Li and J. Zeng, "Design and Implement of RSSI Positioning System on TinyOS Platform", Electronic Science and Technology, vol. 2, no. 26, **(2013)**, pp. 90-93.
[12] X. Wang, S. Song and M. Li, "Design of Personnel Position System of Mine based on the Average of RSSI", Proceedings of 2012 IEEE International Conference on Automation and Logistics, Zhengzhou, China, **(2012)** August 15-17.
[13] S. Mazuelas, A. Bahillo, R. M. Lorenzo, P. Fernandez, F. A. Lago, E. Garcia, J. Blas and E. J. Abril, "Robust Indoor Positioning Provided by Real-Time RSSI Values in Unmodified WLAN Networks", IEEE Journal of Selected Topics in Signal Processing, vol. 5, no. 3, **(2009)**, pp. 821-831.
[14] D. M. J. Tax and R. P. W. Duin, "Support Vector Domain Description", Pattern Recognition Letters, vol. 11-13, no. 20, **(1999)**, pp. 1191-1199.
[15] J. Lin and M. Peng, "Interactive Early Warning Technique based on SVDD", Journal of Systems Engineering and Electronics, vol. 3, no. 18, **(2007)**, pp. 527-533.
[16] J. Ruiz, Y. Li, E. Lank, "User-defined Motion Gestures for Mobile Interaction", Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Vancouver, Canada, **(2011)** May 7-12.
[17] X. Zhang, X. Chen and Z. He, "An ACO-based Algorithm for Parameter Optimization of Support Vector Machines", Expert Systems with Applications, vol. 9, no. 37, **(2010)**, pp. 6618-6628.

Authors



Min-jing Peng received his M.Sc. in Management (2004) from Jinan University and Ph.D. in Management (2008) from South China University of Technology. Now he is an associate professor of Management at E-commerce Department, Wuyi University. His current research interests include different aspects of Electronic Commerce and Mobile Commerce.



Bo Li received his B.Sc. in Management (2011) from Zhengzhou University. Now he is a student working for his M.Sc. in System Engineering at Wuyi University. His current research interests include different aspects of Artificial Intelligence and Electronic Commerce.