Smart Store Understanding Consumer's Preference through Behavior Logs

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Abstract. This paper presents a smart store that estimates a preference of consumers concerning products from their behaviors. This paper proposes a method, which is a passive observation and an active observation, to observe two behaviors, direct behaviors and indirect behaviors. The passive observation is a method to observe direct behaviors of customers towards real products through ambient sensors. The active observation is a method to observe indirect behaviors of customers towards information of products through ambient displays. This study explains a purchase experiment using a prototype smart store that has installed the ambient shelves and displays. This study estimates the favorite clothes from their direct and indirect behavior using the smart store. The result of estimation of preference shows that accuracy rate is 87% by leave-one-out cross-validation.

Keywords: Ubiquitous Environment, Ambient Technology, Behavior Analysis, Customer Preference, Retail store.

1 Introduction

Recently, a marketing strategy is changing to one-to-one marketing era from mass marketing era. Many retail stores are collecting preferences of customers from buying histories using a system of customer relationship management (CRM), such as POS (Point of Sales) or reward card.

However, in customer preference, there is a preference not to be saved in purchase log data. As an example of the preferences, there is a window-shopping. Consumers look or touch a product when they have interest in the product. Their behaviors show their preferences but it does not appear in a buying history of the store. Therefore, in order to grasp their preference concerning products, we should assemble not only the preferences like a purchase log but also the preferences like a window-shopping.

In the field of marketing, a salesman walks beside a consumer to observe a behavior of the consumer towards a product to collect the both preference. And then the salesman investigates behaviors before consumer purchases a product [1]. Otherwise, the salesman may ask consumers a reason why they select the product, in a store. These ways force consumers to feel a psychological burden. Moreover, this cannot collect many data in short term.

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As a way to assemble data of people in a store without a psychological burden, there is a ubiquitous environment [8]. The ubiquitous environment is equipped with embedded devices, such as camera or tactile sensor. It can assemble data of human in this environment through the devices. As example of the ubiquitous environment, there is a smart house [7]. The house can assemble location data of a person through cameras and sensors that located floor or kitchen in the house. This paper proposes a smart store that estimates a preference of customers from behavior of customers using a ubiquitous environment technology. This paper also shows a result that estimated a preference from a purchasing experiment using the smart store.

2 Smart Store

The aim of our research is to develop a smart store that can estimate customers' preference from their behaviors. This section explains three things. First are behaviors that we observe to estimate a preference. Second is a way to observe behaviors. Third is a method to estimate a preference from behaviors.

2.1 Direct and Indirect Behavior

In order to develop a smart store that estimates a preference from behaviors, we should detect behaviors related to their preference. In a report of marketing [3], when consumers choose a product in a store, consumers look at the product and pick up it in order to obtain product information such as a color, form and size. They watch and read contents of POP advertisement (Point of purchase advertising) of a product when they are interested in it. This study has assumed that there are two types of behavior based on customers' preference in a store. One is a behavior towards a real product in a store. This study calls this behavior towards a real product as direct behavior. Another is a behavior towards information of a product that is shown in a display or wall. This study calls this behavior towards information as indirect behavior.

Table 1. Example of direct behaviors and indirect behaviors in a retail store

Behavior	Object of Behavior	Example of Behavior
Direct	Real Product	To look at a product To touch a product To take (pick up) a product To check a product and oneself in a mirror
Indirect	Information of product	To watch information of product shown in displays To check information using an information device To ask information of product to a person

We have shown an example of the direct behavior and the indirect behavior in Table.1. This study has assumed that customers have direct towards a product or indirect behaviors towards information of a product when they are interest in it.

2.2 Passive and Active Observation

As the way to observe the customers' direct and indirect behaviors, we propose two observation ways, Passive and Active observation.

Passive Observation. The passive observation is a method to observe behavior that people have affected to an environment. In the case of a retail store, the passive observation observes voluntary action of customers towards products based on their preference. In this study, we assume that direct behaviors are a part of voluntary action. We observe the direct behavior using a way of the passive observation. As direct behavior to observe through the passive observation, this study has selected two direct behaviors, which are to touch and to take (pick up). After the customer found the product in which he/she had interest, the customer touches the product to get outline information of the product. And then, if the product matches his/her preference, he/she takes the product to investigate detail of it. From the above reason, we assume that to touch and to take a product is related to a preference of a customer. On the other hand, to touch and to take a product only happens at a shelf, which has put a product, in a retail store. If we equip ambient sensors on shelves in various locations, we can perform the passive observation concerning direct behavior of customers towards real products using the sensor-equipped shelves.

As a device for the passive observation, this study has developed a camera-equipped shelf. The camera-equipped shelf can detect changes of products on this shelf through using the Open CV library [4] of image processing. We convert observed data through the shelf into two direct behaviors of customers as shown in Table.2. In this study, to touch a product is small movements of a product's position or small changes of the form on a shelf. To take a product is large changes of a product, such as a product disappears from a shelf. For example, if a little change of a product on a shelf has happened 10 seconds, we convert the observed data to the behavior data that a customer has touched the product 10 seconds.

Active Observation. The active observation is a method to observe behaviors that people has been affected from environment. In the case of a retail store, the active observation actively offers information to customers through ambient device, such as a speaker and an electric display, and observes reaction of the customers concerning the information. In this study, we assume that indirect behaviors are a part of reaction. We observe the indirect behaviors using a way of the active observation. As indirect behavior to observe through the active observation, this study has selected one direct behavior, which is to watch. If a customer has interest in an advertisement of a product, the customer watches the advertisement for a while. The customer does not watch or looks aside from the advertisement if it does not match the preference of customer. From the above reason, we assume that to watch information of a product is related to a preference of a customer.

As a device for the active observation, there is an ambient display. Reitberger et al. [2] also has developed an ambient display that shows customers activity for distinct regions in the store using data of camera in the store. We have developed an ambient display that has installed a function to detect a face. We have used the Open CV library to detect a face. Our ambient display does not only offer information to customers but also observes that a customer watches an advertisement of a product or

does not it through an equipped camera. For example, the ambient display, which has put on near by products, offers product information when a customer has touched or took the product. And then, the ambient display observes that the customer watches or does not watch the information for a while.

We convert observed data through the display into one direct behavior of customers as shown in Table.2. To watch an advertisement is that the face of a consumer is in front of the display. For example, if there is the face of a consumer in front of the display during 20 seconds, we convert the observed data to the behavior data that a customer watches an advertisement of a product in 20 seconds.

Table 2. The passive and active observation way of behavior of a consumer towards a product by a camera-equipped shelf or display

Observation method	Behavior	Observed behaviors through ubiquitous devices
Passive	Touch	A small movement of a product's position on a shelf A small change of the form on a shelf
	Take	A product disappears from a shelf
Active	Watch	A face of consumer is in front of an electric display

2.3 Estimation of Customer Preference

Using the active and the passive observation, we have assembled data of the time when consumers have direct and indirect behaviors. We make a model to estimate that a product is a favorite one or unfavorite one using the data of the time. We use support vector machine (SVM) using an RBF kernel to make the model. The SVM algorithm was performed using the kernlab in R [6]. Explanation variables for the SVM are the time of touching and taking products and the time of watching an advertisement of products on the display.

2.4 Smart Store

We have developed a smart store. The smart store has composed of the camera-equipped ambient shelves for the passive observation and the camera-equipped ambient displays for active observation. The advantage of our smart store is that a customer does not use a device, such as a touch-screen information appliance. There is the Metro future store [5] that assembles data of customers' preference using the shopping trolley that is equipped with a mini-computer and sensors. The Metro future store can assemble data correctly if customers use the trolley. If a customer does not want to bring the trolley, the system cannot collect data from the customer. Moreover, customer needs to learn the usage of the system. If a customer is poor at information appliance, the customer does not use the appliance.

Our smart store estimates a preference of customers from assembled data, as shown in Fig. 1. First, the smart store assembles data of two direct behaviors from devices for passive observation. The smart store also assembles data of one indirect behavior from devices for passive observation. Second, the smart store converts the observed data to the behavior data based on convert rules. Thirds, the smart store has made a model of a preference concerning products from data of two direct behaviors and one indirect behavior using SVM. The smart store estimates preference towards a product using the preference model from observed direct and indirect behaviors.

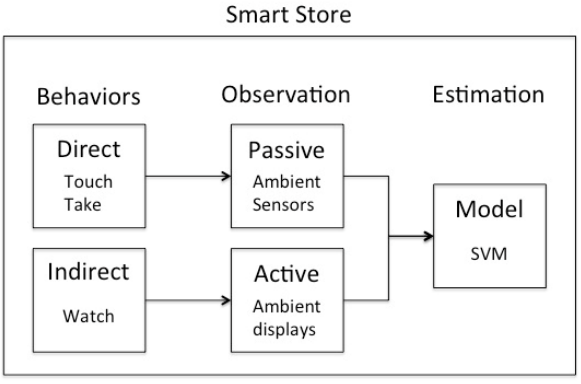

Fig. 1. Estimation process of preference in the smart store

3 Experiment

We have developed a prototype smart store in our laboratory. The prototype smart store has put six camera-equipped ambient shelves and ambient displays. One camera has observed a change, such as a movement of the product, of one product on a shelf. The one shelf has observed four clothes. The one ambient display is placed in the one shelf, as shown in Fig.2. The ambient display offered the detail information of clothes, such as shown in Fig.3, to a person when the person acts to the clothes on the shelf. For example, the ambient display, which has been put on the shelf X, has offered the detail information of the clothes A when a person has taken the clothes A from the shelf X.

We have carried out a purchase experiment of clothes by 20 examinees in the prototype smart store. The examinees have purchased favorite clothes from 8 clothes (T-shits) in the prototype smart store. One examinee has gone into the smart store alone and has selected one favorite product.

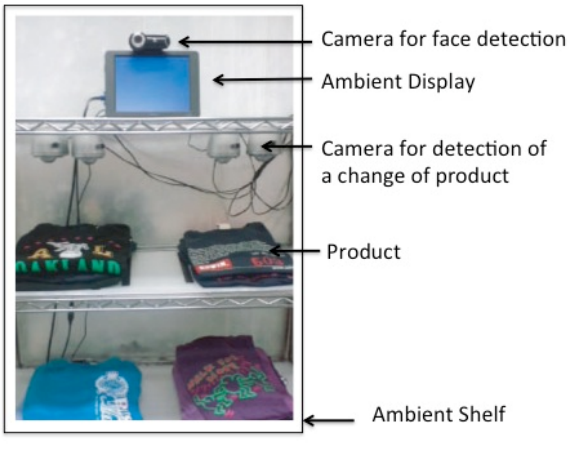

Fig. 2. The ambient shelf and the ambient display that our smart store installed

Fig. 3. This is an example of information. The information of a product offered to a person through the ambient display when the person act to the product on the shelf.

After a purchasing experiment, we have carried out an impression experiment that an examinee answers likes and dislikes of 8 clothes, which has been placed in the smart store, by a rating scale of 5 degrees. We have used rating data of the impression experiment to evaluate results that has been estimated from behaviors. We have categorized the rating data to two classes (C1 and C2) because we have assumed that the grade of over 4 indicates clear interest of examinees. The C1 is a class of favorite product and it has composed of products marked the grade over 4. The C2 is a class of unfavorite product and it has composed of products marked the grade of under 3.

We have gained 160 behavior data (8 clothes * 20 men) from both experiment of a purchasing and impression. Table 3 shows a part of data concerning time (seconds) of examinee's behaviors. For example, the No.1 of examinee has touched the product B for 2 seconds and taken it for 7 seconds. The examinee also has watched the detail information of product B for 6 seconds.

Table 3. A part of examinee's behavior towards products in the temporary retail store for this experiment

Examinee No.	Product ID.	Time (seconds) of Behavior			Class	Rate
		Touch	Take	Watch		
1	A	2	9	6	C2	3
1	B	2	7	6	C1	4
…						
1	H	0	0	0	C2	1
~						
9	G	7	0	0	C1	4
9	H	3	5	4	C1	5
~						

The examinee has marked the degree of four to the product B in the impression experiment and it is classified as the C1, which is the favorite class, in this experiment.

We have made 7 models, which is combination of two direct behaviors and one indirect behavior, to estimate a preference of clothes (T-shirts). The 7 models have been made by the SVM using an RBF kernel in kernlab of R. We have evaluated an accuracy rate of 7 models using leave-one-out cross validation. Table 3 shows the accuracy rate of each model.

We have defined the models using only direct behavior as DB. We have made three types of the DB that are the To, the Ta and the To-Ta that is combination of To and Ta. The error rate of estimation using the three types of DB (To, Ta, and To-Ta) is from about 29% (DB(To)) to about 17%(DB(To, To-Ta)), as shown in Table 3. The result indicates that a person touches a product when the product does not match preference of the person. To touch a product shows the uncertain interest of the person to the product. To take a product shows that a customer has more interest in the product. Therefore, if a product that a customer has touched, one of feature in the product may match a preference of the person. Moreover, when a customer has taken a product, the person may have had interest in a few feature of the product.

We have defined the models using only indirect behavior as IB. The IB (W) is about 16% and is better than the model of DB. A customer watches information of a product to get detail of the product. Therefore, to watch needs time that a customer reads contents. Therefore, if a customer cannot get information that has matched his/her preference, the customer stops watching soon. To watch indicates interest in a product of which an ambient display shows information.

We have defined the models using direct and indirect behavior as DIB. There are the To-W, the Ta-W and To-Ta-W in the DIB. The DIB(To-W) and DIB(Ta-W) are same error rate of the model of ID(W). However, The DIB(To-Ta-W) model has been the lowest error rate (13%) than other models. This result indicates that combination of direct and indirect behavior is effective to estimate preference of customer concerning products. We can detect clue of preference from direct behaviors and make sure the preference from indirect behavior.

Table 4. Estimation error of preference of customer concerning clothes using each model based on direct and indirect behavior

Behavior	Touch	Take	Touch & Take	Watch	Touch & Watch	Take &Watch	Touch & Watch & Take
	DB(To)	DB(Ta)	DB(To-Ta)	IB(W)	DIB(To-W)	DIB(Ta-W)	DIB(To-Ta-W)
Cross Validation Error	0.288	0.169	0.169	0.156	0.156	0.156	0.131

4 Conclusion

We have presented a smart store that estimates a preference of customers from behaviors of the customers. As a method to observe direct behavior towards a product and indirect behavior towards information of a product, we have proposed a passive observation and an active observation. The passive observation is a method to observe

voluntary actions of customers towards products based on their preference. As a device for the passive observation, this study has developed a camera-equipped ambient shelf. The active observation is a method to observe reaction of people concerning information from which an environment offered. As a device for the active observation, this study has developed a camera-equipped ambient display. We have developed a prototype smart store that has installed the ambient devices. The experiment using the smart store has indicated that the smart store can assemble direct and indirect behavior.

We have made models to estimate customer preference of product from the time data of two direct behaviors and one indirect behavior towards products. The estimation result has shown that a model, which is put together with direct and indirect behavior, is the accuracy rate (87%). The rate is higher than a model of only direct behavior and only indirect behavior. The result has indicated that the combination model of direct and indirect behavior could estimate preference of customer concerning products.

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