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Framework for Modelling User Interest using Augmented Shopping Store

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***Abstract*— Recently, it has become difficult for consumers to find items of interest because there is such a vast range of items in the modern world. Consumers search the internet or use information devices in a shop to find their desired item in this information society. However, consumers with an unclear idea about what they want or consumers who are weak at using devices have difficulty finding the item they desire, quickly and easily. Therefore a system is needed that provides information regarding items of clear or spontaneous interest to consumers without demanding an unreasonable amount of time from the consumer. This paper proposes a framework of individual interest modelling used to provide information to consumer and support consumer purchases in a store using ubiquitous devices, such as cameras, sensors and displays. This framework shows a modelling mechanism concerning individual interest in items based on data collected through ubiquitous devices. This framework offers the suggestion that three observation views, Micro, Mezzo and Macro, can be utilized to look at human actions towards items of interest in a store through ubiquitous devices. This paper also describes a personalized shopping store using this framework to create a human friendly environment.**

I. INTRODUCTION

Utilization of computer systems is growing in the fields of marketing to help people make purchases in a store. For example, we can see a floor information system in a department store and a book search system in a big book store.

When people come to buy a specific item, they can locate the desired item by searching for it using an information system in the store. The information system is very useful for the consumer who has a clear image concerning items of interest.

In contrast, when people want to buy an unspecific item suitable for them, they often have trouble deciding what to buy because they do not have a way to search or express the features of the item that they wish to locate when using the information system. Functions of the information system are unsatisfactory for this consumer who hasn't a clear image concerning items of interest.

There are methods, Supervised Learning and Collaborative Filtering, which help an unspecific consumer locate items of interests. Supervised Learning can model consumer interest tendencies concerning items by being taught items in which they are interested, directly. However, this method has drawbacks in that it needs times and patience to make an appropriate model [1]. Collaborative Filtering can provide items, which a consumer may have an interest in, using purchase history of other consumers [2]. This method also has drawbacks in that recommendations sometimes don't match a consumer's interest in items because each consumer has differing interest.

This paper proposes a framework of one possible method that can compensate for some of the drawbacks of the previously described methods by using ubiquitous computing system and modelling interest in items of each consumer. A ubiquitous computing system consists of many devices, such as cameras, displays and sensors, used to observe and interpret human action and operation in a space [3], [4].

This framework discribes a modelling mechanism concerning individual interest in items based on data collected through observing human actions, such as touch and movement, towards items of interest in a space with a ubiquitous computing system. This framework offers the suggestion that three observation views, Micro, Mezzo and Macro, can be used to interpret these human actions towards items of interest.

This paper also describes a personalized shopping store as an application of this framework. The personalized shopping store interprets individual interest in items without users having to input lots of data and attempts to predict items which consumers may have an interest in. The store observes what the user touches or where the user moves in a store using devices and makes an individual interest model concerning items from observed data. The store provides recommandation of item information which may be suitable for the individual using their models to provide item information through displays for advertisement. This store collects data on consumer reaction towards items which consumers may be interested in by observing them and then uses this data to make more reflected models and to recommend personalized item information.

II. FRAMEWORK FOR MODELLING USER INTEREST

This study concerns itself with how consumers act to find an interesting item and how a system can provide information of items in which a consumer has an interest directly to the consumer.

This study assumes that this domain can be devised by considering the following issues.

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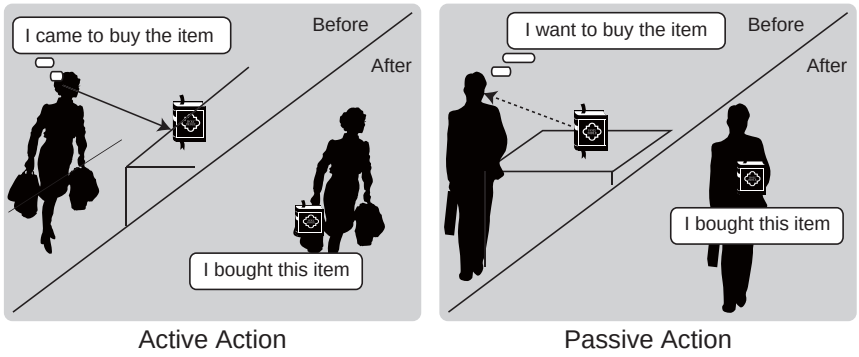

Fig. 1. Explanation of Active and Passive action

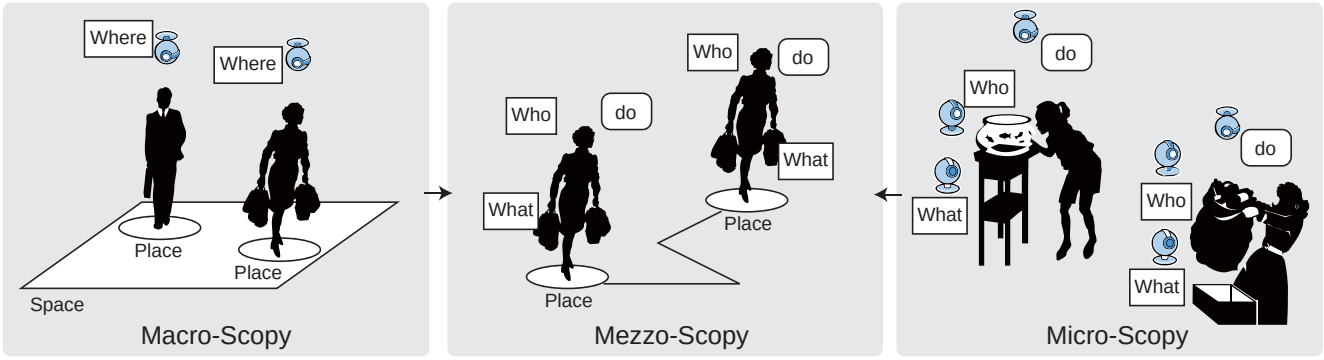

Fig. 2. Explanation of Macro, Mezzo and Micro scopy

1) How do individuals find an item which is suitable for them?
2) How can the system observe the relationship between individual interest in an item and individual actions towards the item?
3) How can the system automatically make a model of this relationship to recommend personalized item information?

A. Active / Passive

To resolve the first issue, this study attempts to define the way in which a consumer chooses an item. Fig.1 shows two ways in which this is done active and passive purchases.

- Active: The consumer has already decided what they desire, so goes directly to the place without reference to information.
- Passive: The consumer has not yet decided what they desire, so refers to some information to help them make a decision.

B. Micro-scopy / Mezzo-scopy / Macro-scopy

For a solution to the second issue, this study proposes the utilization of three observation points: Micro-scopy, Mezzo-scopy and Macro-scopy. They can aid the observation of human active and passive actions towards items of interest in a store.

Micro-scopy is an observation point used to check an individual's identity and individual action around an item. For example, a micro-scopy device checks the consumer's identity by observing their face or by sensing an RF-ID card which belongs to the individual. Micro-scopy also checks consumer actions, for example, when a consumer handles or looks at an item.

Macro-scopy is an observation point used to sense consumer's movements in a space. For example, macro-scopy device recognizes that a consumer is in a place where there are JAZZ CDs through cameras or RF-ID readers. Macro-scopy can also find popular items from counting the amount of consumers who visit the place where the items are stocked.

Mezzo-scopy is an observation point which observes continuous actions of individuals. It observes what a consumer is doing in a space by combining macro-scopy and micro-scopy data in order to estimate the consumer interest. For example, mezzo-scopy device could analyze the trace of an individual movement from a place in which there is a blue shirt to a place in which there are sky blue trousers.

C. Framework

In attempt to solve the third issue, this study defines a framework for modelling individual interest in items. This framework consists of three stages: Observation, Modelling and Feedback, as shown Fig.3

The Observation-stage observes data, which is collected by observing consumer actions towards items and consumer movement between items using macro and micro-scopy devices. For example, a camera as micro-scopy device reports a temporal change, such as difference of observed images.

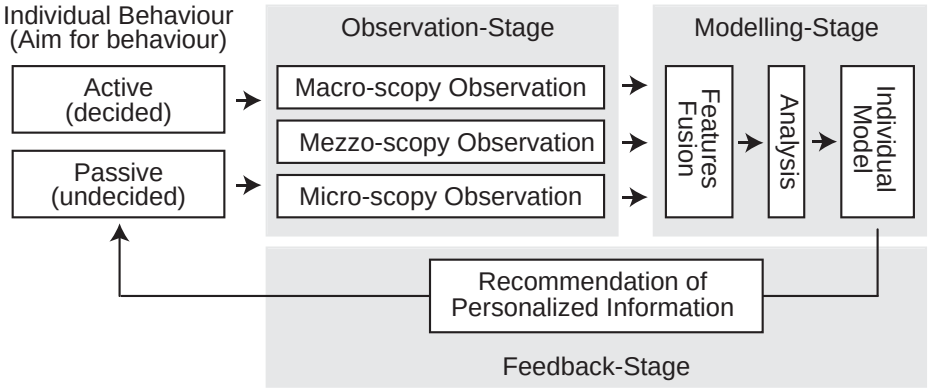

Fig. 3. Framework for Modelling Individual Interest based on Human Action towards Interesting Items

The Modelling-stage makes individual interest models by analyzing the relation between a consumer action towards an item and why the consumer may be interested in the item. Many modelling methods have been proposed, such as statistical analysis or neural networks. For example, we can select a multiple linear regression analysis as a modelling method. This analysis can show a relation between an action towards an item and the item's features, such as colour or shape.

The Feedback-stage provides a consumer with personalized item information and remakes the consumer interest model by analyzing the consumer's active and passive actions towards items. For example, this study remakes an individual interest model by analyzing the collected active and passive action data, using a multiple linear regression analysis.

III. PERSONALIZED SHOPPING STORE

This section will describe a personalized shopping store as an example of a possible application based on the framework of this study.

In the business field, there is a growing need for finding the consumer interest in items [5], [6]. For example, many companies have tried to detect consumer interest in items by analyzing the buying history of consumers through Point of Sale System (POS). However, the POS can not account for interest in items, which consumers did not buy although the customer has shown interest by picking them up and studying them, before they reach the electronic cash register.

Companies use a lot of time, effort and money to attempt to make a well selling item or to promote items because they can not understand consumer's interest. At the same time, when consumers want to buy an unspecific item suitable for them, they often have trouble deciding what to buy because there are so many diverse items in a store. Therefore, the consumer now takes a lot of time for attempting to find an interesting item in a store.

If a consumer support system, such as information device in a store, can understand consumer interest in items and can directly and immediately provide personalized item information to consumers through a display or speaker, consumers will also be happy because they can achieve their desire and receive wanted items. Companies will also be able to easily deliver efficient marketing to consumers.

This study built a personalized shopping store based on the previously described motivation, as shown Fig.4.

A. System Outline

As part of this study a prototype personalized shopping store has been built. This store is 30 square meters and has 6 item shelves with an information display for delivering personalized item information to each consumer. The consumer support system of this store consists of Macro-scopy and Micro-scopy cameras, a Mezzo-scopy server, a Modelling server, a Recommend server and an item database. This system was made on Fedora Core/CentOS Linux by Java, C.

The information display, which is EIZO FlaxScan L365, is linked with Fedora Core Linux and can show item information in the store through a Web browser. The item information is accumulated in PostgresSQL on CentOS Linux, which are called Item database in this study.

The store has 50 cameras with a consumer detection sensor, which are Panasonic Network Camera BL-C31, used as ubiquitous sensor of micro-scopy and macro-scopy, in this store. The cameras have an original IP and are connected by wireless networks, for observing consumer's identity, their place and their actions towards items.

Macro-scopy cameras are set up on the ceiling for observing the floor. The observed image data is used to relate consumer position and an item's position in the store.

Micro-scopy cameras are set up on item shelves for recognizing consumer identity when they touch an item in front of the camera, or for recording observed undefined individuals as new consumers. The recognition of consumer's identity is done by comparing received image features to stacked image features in a database, using a multiple discriminant analysis. Other micro-scopy cameras are concerned with observing items on the shelf to find individual actions to the items. The camera detects consumer actions towards items by monitored image changes.

The shop also has a mezzo-scopy server, which is CentOS Linux, for tracing consumer movements in the store using

data observed by micro-scopy and macro-scopy camera. The mezzo-scopy server receives features data of observed image from each macro and micro-scopy camera and saves the data into a temporal database. The mezzo-scopy server makes trace data of the relation between each consumer's movements and item positions in the store using received data in a temporal database.

Individual interest models are made by analyzing the relation between individual action towards items and feature data of items of interest from fused data of macro-scopy, micro-scopy camera and mezzo-scopy server, on the modelling server. This study uses a multiple linear regression analysis as an analyzing method. These models are accumulated in a consumer database with an original ID.

A recommendation server with an item database selects personalized item information, which is assumed to be suitable for a consumer by the consumer's model. Then, the recommendation server provides personalized item information to the consumer through the display, which is nearest to the consumer.

The store collects data from consumer reactions to the personalized item information on the recommendation display and uses this data to make a more reflected model of individual interest. For example, this study assumes that a consumer views the personalized item information on the recommendation display and then goes to the place where the item the consumer likes is. The store collects data on the reaction as an action towards an item of interest.

B. Algorithm for Modelling Individual Interest

The personalized shopping store makes an individual model about items as follows.

1) It checks the place of a consumer by Macro-scopy camera and identifies the consumer by Micro-scopy camera.
2) It accumulates data on the consumer's actions towards items with his/her identity and information on these items using Micro-scopy cameras.
3) It finds common features of items, in which this consumer showed interest, by analyzing features of accumulated data. These common features are called an interest model in this study.
4) It recommends personalized item information to the consumer based on his/her interest model.
5) It collects data on the consumer reaction towards a recommended item in order to find further item features used to remodel.

First, a Macro-scopy camera makes a monochrome difference image from observed images about a consumer position (Fig.5). The, Macro-scopy camera judges that there is a consumer in the space if it receives many white rates from the monochrome difference image. This Macro-scopy camera transmits a number, which expresses that a consumer is in this space, with the place ID and observed time to a mezzo-scopy server. The Micro-scopy camera calculates data on identity feature by observing the consumer's face images. For example, this study use a sum, average and variance of

Fig. 5. Example of Observed and Difference Image by macro-scopy Camera

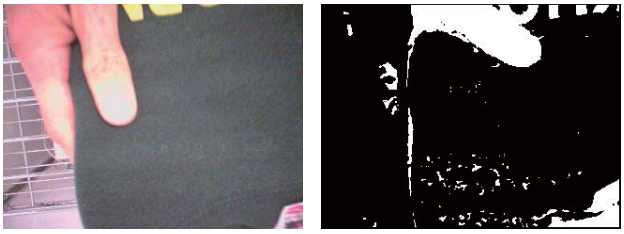

Fig. 6. Example of Observed and Difference Image by micro-scopy Camera

R,G,B in a image. The consumer database already has data on identity features of consumers stored with an original ID referred to as taught identity feature data. The Micro-scopy camera compares the observed identity feature data to taught identity feature data. This study uses a discriminant analysis for the comparison. If the observed identity feature matches the taught identity data, a Micro-scopy camera recognizes observed images as actions of the numbered consumer. Then, this Micro-scopy camera transmits the original ID of the observed consumer to a mezzo- scopy server. However, if the observed identity data does not match taught identity data, a Micro-scopy camera records the newly gathered identity as data of a new consumer with an original ID in the consumer database.

Second, the Macro-scopy camera for item also makes a monochrome difference image from observed images concerning a consumer action towards an item (Fig.6). Then, this Macro-scopy camera judges a consumer action towards an item as significant if it gets many white rates from the monochrome difference image. This Macro-scopy camera transmits a number, which expresses that a consumer has done an action to an item, with the item ID and observed time, to mezzo- scopy server. For example, a micro-scopy camera sends a number 1 to report that the consumer touched the item if it received monochrome difference images of high white rates.

Third, the Mezzo-scopy server retrieves items features data using the item database based on sent data from each micro and macro-scopy camera. Then, the Modelling server makes an individual interest model using the common image features of items. The item database has feature data on every item with an original item ID. Therefore, the Mezzo-scopy server finds common image features of items in relation to the retrieved image of the item to which a consumer showed

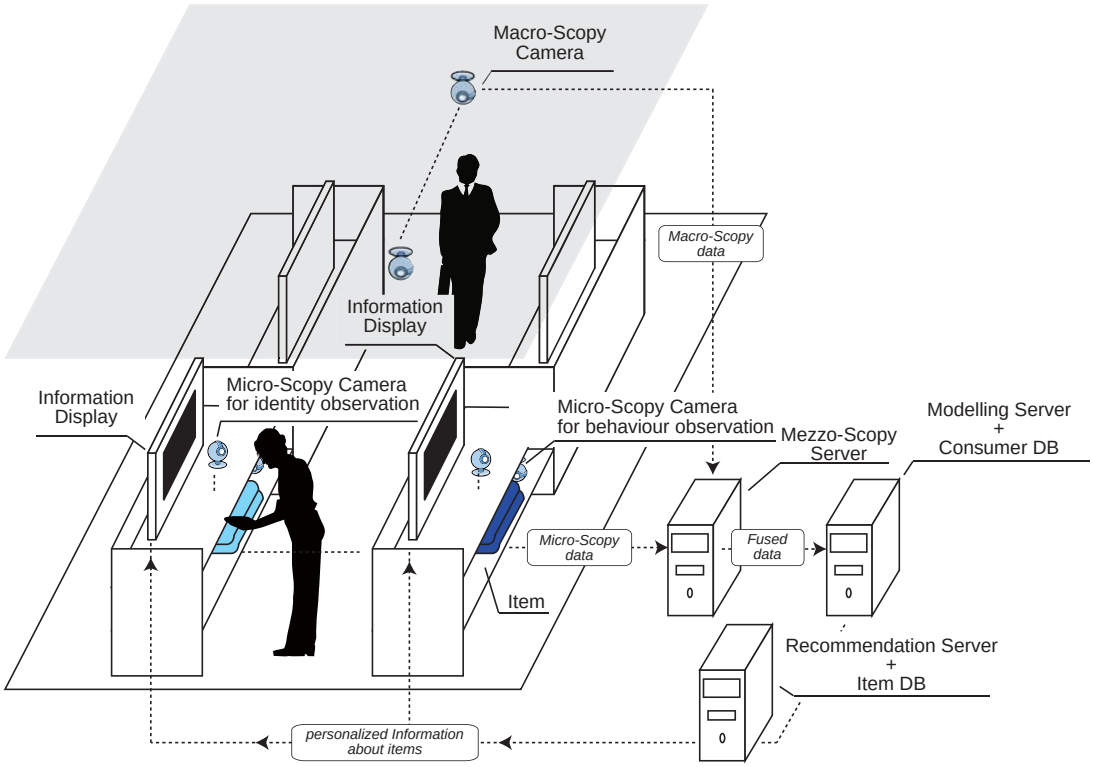

Fig. 4. Example of Personalized Shopping Store

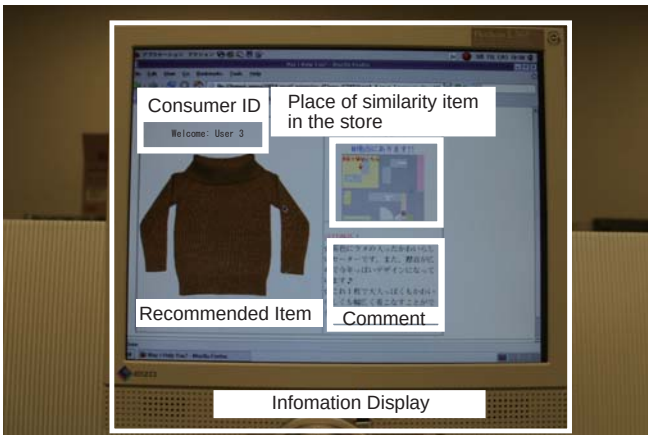

Fig. 7. Example of Personalized Recommendation

interest in. For example, if a consumer touched blue category of clothes at some time, the server considers the consumer to have an interest in blue origin features.

Fourth, The Recommendation server delivers personalized item information, which have similar features based on personal common item features, on an information display in front of the consumer. The display is decided by data on identity and the position of a consumer from Macro-scopy and Micro-scopy camera. Information on this display shows an image of the recommended item, the item place in this store, comments on the item and the consumer ID as shown Fig.7.

Fifth, Macro and Micro-scopy cameras then collect a passive action of this consumer to a recommended item. If a consumer shows interest in the item, such as looking at an item for a long time, and goes to the place in which the recommended item is, the colour or texture features of the item are considered important to the consumer. The observed features found by observing consumer reaction to the displayed item are used to remake the individual interest model. The shop continues to collect and analyze Macro, Micro and Mezzo-scopy data in order to find the interest tendencies for each consumer. The shop can also provide personalized services to each consumer.

IV. EVALUATION

This study evaluated the accuracy of an individual interest model based on our framework by examinees having their active and passive actions observed when purchasing items of interest in the personalized shopping store. The evaluation experiment of modelling individual interest was conducted by using 19 examinees acting as consumer three times. The implementation interval of this experiment was 3 days.

1) No use of this study's recommendation system
2) This study's recommendation system was used based on interest model made during the first experiment.
3) This study's recommendation system was used based on interest model remade during the second experiment.

The examinees came to the experimental clothes store independently and bought clothes which they were interested

TABLE I

NUMBER-OF-TIMES AND AVERAGE ABOUT HUMAN REACTION TO RECOMMENDED PERSONALIZED INFORMATION

	Moved	Not Moved
ExamineeA	4	4
ExamineeB	6	3
ExamineeC	2	3
ExamineeD	3	2
ExamineeE	3	2
ExamineeF	4	2
ExamineeG	0	1
ExamineeH	7	5
ExamineeI	2	2

	Moved	Not Moved
ExamineeJ	4	2
ExamineeK	4	1
ExamineeL	3	1
ExamineeM	5	1
ExamineeN	1	3
ExamineeO	1	1
ExamineeP	1	5
ExamineeQ	5	3
ExamineeR	0	0
ExamineeS	5	2

Recomandedation	Human Action	Number of Action Times	Rate
Personalized information	Movement to the place of recommended item	60	58.3%
Not Personalized information	Movement to the place of recommended item	43	41.7%

in. The examinee can feel free to move in the store. The personalized shopping store registered the identity of each examinee in a consumer database before starting the experiment.

In the first experiment, this study checked consumer's interests and movements. Then, the store made an individual model of each examinee by observing their actions towards clothes and analyzing common feature of the clothes in which they showed interest though their actions.

In the second and third experiment, this store gave personalized recommendation of clothing items through information on a display and accumulated data on consumer's passive action to the recommended information. Clothes items in the shop were replaced after the second and third experiment.

The recommended information about clothes was decided by the individual interest model for each examinee, which was made during the first experiment. The store displayed the personalized recommendation information on clothes using the information display in front of the examinee, when it observed human identity or presence by Micro-scopy and Macro-scopy camera. The experiment gave questionnaires to each examinee about their satisfaction with the personalized recommendations.

The experiment evaluated the accuracy of the individual interest model concerning clothes for each examinee. Therefore, this study defined that the model was considered a success if the recommended information detailing the place of the clothes in the store could direct the examinee to the detailed place in the store.

Table I shows the passive action results of each examinee and their average response to recommended information. In a successful case, this study could confirm that the examinees moved to the place in the store on the basis of their personalized recommendation. On average about 60% of examinees reacted to their personalized recommendation. This study found that this store is good for examinees that have firm criteria to select interesting items by questionnaire after the experiment. Consumer who gave a clear basis for recommendations, for example searching items based on colour or size, where able to receive information with which they were satisfied. However, consumer who didn't provide a clear basis for recommendation were not satisfied with provided information in this experiment.

V. CONCLUSIONS

This paper has proposed a design framework for modelling individual interest in items in order to build a human friendly environment with ubiquitous computing.

The design framework is a modelling mechanism concerning individual interest in items which collects data by observing human's active and passive action towards items through ubiquitous devices, which are based on three observation points: macro-scopy, micro-scopy and mezzo-scopy

This study describes a new idea for detecting individual interest in items: Classifying human actions as Active and Passive. This study makes an individual interest model by using data provided by an observing active and passive action towards an item.

This study has proposed the utilization of three observation points: Micro-scopy, Mezzo-scopy and Macro-scopy. This is for collecting data on active and passive actions towards items of interest. This study has shown that these observation points are beneficial in observing human identity and action to items and analyzing common feature of items in which the individual has shown interest.

This study also built a prototype personalized shopping store for applying this framework. This store detected interest or actions of the consumer before the consumer reached an electronic cash register.

This study has shown that this framework is applicable in making a human friendly environment where consumer can receive information on items of interest without having to spend an unreasonable amount of time inputting information into a device.

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