A Group-Adaptive Advertisement System that Uses Interpersonal Distance for Public Spaces

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Abstract

Advertisement in public spaces does not always attract people because of the content that does not match their preferences. To tackle the problem, research on adaptive advertisement has been conducted recently. However, current adaptive advertisement systems are adaptive only personally and individually. They need additional burden to people such as wearing ID tags or registering personal information. We propose method for adaptive advertisement that uses property of a group of people; interpersonal distance. Usefulness of interpersonal distance to know the kind of a group, a group-adaptive advertisement system that implemented the method and its evaluation are presented.

1. Introduction

Use of large-sized displays for advertisement has become common due to the price reduction of a large-sized display and the development of network technology. They are placed at many places; at railway stations, in commercial buildings, for example. Different from traditional advertisement in printed media, they are able to change their contents. Research on adaptive advertisement in public spaces that use information displays has been conducted accordingly. However, these systems put burden to the user. We propose to use interpersonal distance in a small group of people to know what types of people they are, and design a group-adaptive advertisement system for public spaces.

2. Related research

A proposed system aims to display adaptive advertisement to a group of people in public spaces. There has been research for information display systems in public spaces that are adaptive to users.

The Mirai Tube [1], Interactive Public Ambient Display [2], and Interest Concierge [3] are user-adaptive interactive information display systems in public spaces.

The Mirai Tube is an experimental information display system in a subway station that recognizes a walker. Several visual expressions according to the movement of a walker were prepared and investigated when they were displayed on a long and large public display along the station. This system senses the movement of a user and put visual effects on the content, but does not change the content.

Interactive Public Ambient Display measures the distance between the display system and a user. Details of displayed information change according to the distance. This system displays adaptive information but it is for an individual.

In the Interest Concierge, a user wears an infrared tag by which the user is identified with a profile data. Personalized information for the user is displayed on a large public display as a result. This system requires explicit personal information of a user.

The ubiquitous information display system [4], UBWALL [5], Suipo [6], and Interactive Fliers [7] are information display systems for public spaces that a user should intentionally handle information or the system.

The ubiquitous information display system displays variety of information including advertisement by its large display to the public. A user can get information by sending a request command from his/her mobile device.

UBWALL is a similar system with the ubiquitous information display system, of which large public display has an RFID reader/writer that identifies a personal mobile device.

Suipo is an advertisement system that uses Suica, a popular IC card in Japan and a recent mobile phone can be its equivalent device. A user can get displayed information from a poster with a Suica reader by touching it with a Suica device. These three systems need personal information.

Interactive Fliers is a prototype advertisement system. When a large public display senses that a user is close, advertisement starts with real time communication function by instant messenger between an advertiser and a user.

These information display systems reflect preference of a user. However, many systems assume personal information is given from a user, which is not very probable. They also assume a single user.

3. Proposal of a Group-adaptive advertisement system

As a user-adaptive advertisement system that is easy for a user, we propose GAS, a Group-adaptive Advertisement System. One of the problems of user-adaptive advertisement systems is additional burden

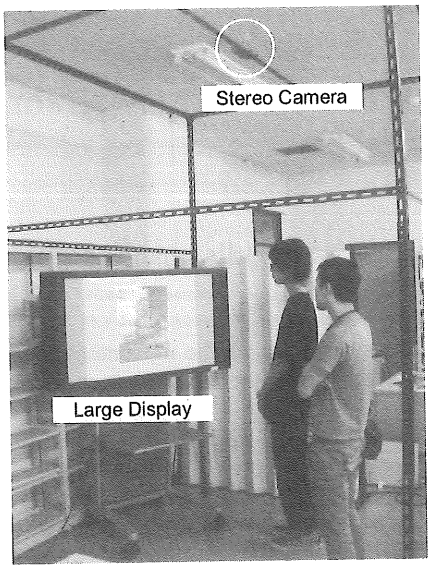

Figure 1. Appearance of the system

to the user. People do not like to provide their personal information, do not like to bring extra ID tags with them, and do not like to do extra things. Without explicit information, we human can somewhat guess who they are when we see a group of people from various keys. Keys may be appearances such as sex and age. Besides, there may be interpersonal distance between each other.

3.1. Interpersonal distance

We consciously or unconsciously sense and adjust interpersonal distance to other people in our daily life. The interpersonal distance reflects relationship of each other [8]. From this social psychological finding, we thought that interpersonal distance between members of a small group also reflects their relationships. In other words, if we know the interpersonal distance, then we may guess their relationships, which can be another key to adaptive advertisement.

3.2. Targeted advertisement

Advertisement has a target group or target groups generally. It is known that people who belong to a family or a reference group are affected by them in their attitude formation and purchase behavior. Here a reference group is formed according to human relationships, workplace, income level, favorite name brands, and so on. Human relationships are categorized as of formal group and of informal group. Examples of formal groups are classmates and colleagues, and of informal groups are lovers, friends, and neighbors [9-11]. By using these groups as targets, adaptive advertisement can be more effective than non-adaptive one.

3.3. Design of GAS

GAS has been designed considering 3.1 and 3.2. Appearance of the system is shown in Figure 1. Advertisement is displayed on a large display. The system is assumed to be placed near the elevator where people wait a minute.

4. Judgment of relationship

4.1. Category

Following 5 categories were applied in reference to 3.2.

- lover / couple
- friend
- family
- business
- individual

4.2. Judgment of relationship from the sample data

We collected and examined 208 samples of a small group in front of an elevator [12]. 2 or 3 observers took notes about interpersonal distance and judged relationship of groups. For the distance measurement, they measured distances between surrounding objects in advance and used them. They also made practice so that precision is less than 10cm.

From the 208 samples, 20 samples were randomly picked up as the test data that is used for evaluation, and other 188 samples were used for the relationship judgment.

In addition to the interpersonal distance, number of the members of a group and the height of each member were examined.

Table 1 shows the relation between the categories and the interpersonal distances. (Hereafter the interpersonal distance is the averaged distances between 2 nearest members in a group.) Five categories are differentiated into "lover / couple," "friend / family," "business," and "individual" in interpersonal distance [13]. Less than 40cm distance is most likely to be "lover / couple". 41cm-80cm distance is most likely to be "friend / family". 81cm-110cm distance is most likely to be "business". More than 111cm distance is most likely to be "individual".

Table 2 shows the relation between the categories and the number of a group. Among the 5 categories, "friend," "business," and "individual" could not be statistically differentiated. All of "lover / couple" was 2 people, and most of "family" was more than 3 people.

When we set 140cm in height the distinction between an adult and a child, 10 samples include children and all the samples were "family".

Table 3 shows the ratio of each category in each combination of interpersonal distance, numbers, with / without child. When combination of data concerning a

Table 1. Relation between the categories and the interpersonal distances (%)

interpersonal distance (cm) / relationship	<40	41-80	81-110	>111
lover / couple	48	19	2	0
friend / family	34	62	29	2
business	18	17	40	12
individual	0	2	29	85

Table 2. Relation between the categories and the number of a group (%)

number / relationship	2	3	4	>5
lover / couple	50	0	0	0
friend / business / individual	34	39	30	16
family	17	62	70	84

Table 3. Ratio of each category for each combination of data (%)

distance (cm)	<40						41-80					
number of a group	1		2		>3		1		2		>3	
with/without child	with	with out	with	with out	with	with out	with	with out	with	with out	with	with out
lover / couple	0	0	0	55	0	0	0	0	0	31	0	0
friend	0	0	0	13	0	0	0	0	0	34	0	47
family	0	0	100	11	0	100	0	0	100	11	100	44
business	0	0	0	21	0	0	0	0	0	24	0	9
individual	100	100	0	0	0	0	100	100	0	0	0	0

distance (cm)	81-110						>111					
number of a group	1		2		>3		1		2		>3	
with/without chil	with	with out	with	with out	with	with out	with	with out	with	with out	with	with out
lover / couple	0	0	0	3	0	0	0	0	0	0	0	0
friend	0	0	0	11	0	29	0	0	0	4	0	0
family	0	0	0	13	100	0	0	0	0	0	0	0
business	0	0	0	38	0	52	0	0	0	11	0	13
individual	100	100	0	35	0	19	100	100	0	85	0	87

group of people is given, category that shows the highest ratio to the data in this table is selected as the category of the group of people. Cases where there is no sample data are judged as "family" because all the cases are with child.

5. Implementation of the system

5.1. System setup

Schematic diagram of the system is shown in Figure 2. Image of the users is taken by a stereo camera (BumbleBee2, Point Grey Research). Users are free from additional burden such as bringing special equipments. A PC (CPU: Intel Celeron3.06GHz, OS: Windows XP Professional) is used for image processing and as the advertisement server. A 50 inch plasma display (PDP-502MX, Pioneer) is used as a display.

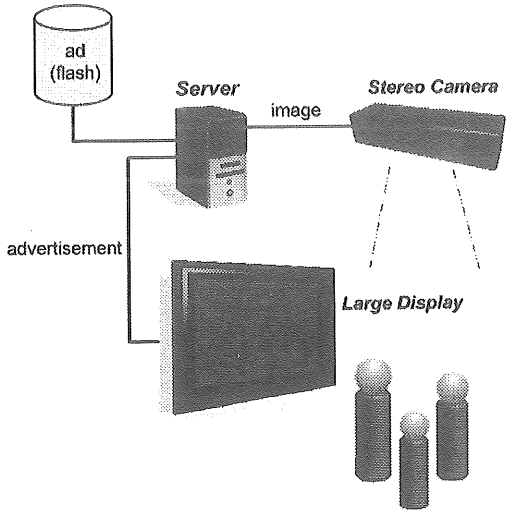

Figure 2. Schematic diagram of the system

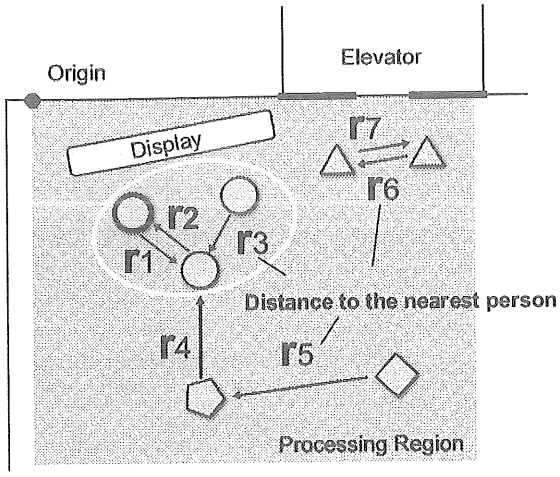

Figure 3. Target group determination

5.2. Software

Software development has been conducted with Visual C++ by Microsoft and Censys3D People Tracking System by Point Grey Research.

The system software has 3 modules; the sensing module, the relationship judgment module, the display module. First, interpersonal distances, number of people, and heights of the each person in the image are taken from the sensing module. Then, the target group is determined from the data. The relationship is judged from the data set of the group in the relationship judgment module. Lastly, advertisement for the judged relationship is displayed by the display module.

5.3. Judgment of relationship of a group

The relationship judgment module determines the target group from all the people in the image. The target group is defined as the nearest group to the display. The target group is determined by the following steps (Figure 3).

1. Segmentation distance R is set as the average of r_i times constant alpha, where r_i is the distance from the person i to the nearest person, and alpha can be adjusted according to the crowdedness.
2. Set the nearest person to the origin as the base person. Here the display is placed close enough to the origin point of the sensing area.
3. Search the person whose distance from the base person is less than R.
4. When the person found, set the person the new base person.
5. Repeat step 3 as long as the new person is found

The relationship is judged from the data set of the group by applying Table 3.

6. Evaluation: judgment of relationship

Accuracy of the relationship judgment was evaluated. The accuracy by the interpersonal distance, the accuracy by the number in a group, the accuracy by the existence of a child, and the accuracy by the combination of these were evaluated.

6.1. Method

Cross validation method was applied with the 20 test data, which was described in 4.2. In the test data were 4 "lover / couple," 6 "friend," 3 "family," 3 "business," 4 "individual".

6.2. Result

The results are shown in Table 4 – 7.

Table 4 is the result of the accuracy by the interpersonal distance. As described in 4.2, 5 categories can be differentiated by 4 classes ("lover / couple," "friend / family," "business," and "individual") when used interpersonal distance. The accuracy to the 4 classes was 70%. 14 samples were correctly judged out of 20 samples.

Table 5 is the result of the accuracy by the number in a group. As described in 4.2, 5 categories can be differentiated by 3 classes ("lover / couple," "friend / business / individual," and "family") when used the number of members in a group.

Table 6 is the result of the accuracy by the existence of a child. Five categories can be differentiated by 2 classes ("family" or "non-family"), and the accuracy was 100%.

Table 7 is the result of the accuracy by the combination of the interpersonal distance, the number of members in a group, and the existence of a child. Each of the 5 categories can be differentiated by this combination.

Table 4. Result of the accuracy by the interpersonal distance

Category	Judgment (Correct / All)
lover / couple	2/4
friend / family	6/9
business	2/3
individual	4/4
Total	14/20 (70%)

Table 5. Result of the accuracy by the number of members in a group

Category	Judgment (Correct / All)
lover / couple	4/4
friend / business / individual	0/13
family	2/3
Total	6/20 (30%)

Table 6. Result of the accuracy by the existence of a child

Category	Judgment (Correct / All)
family	3/3
non-family	17/17
Total	20/20 (100%)

Table 7. Result of the accuracy by the combination of the interpersonal distance, the number of members in a group, and the existence of a child

Category	Judgment (Correct / All)
lover / couple	2/4
friend	4/6
family	3/3
business	2/3
individual	4/4
Total	15/20 (75%)

The accuracy was 75%. 15 samples were correctly judged out of 20 samples.

Examples that were not correctly judged include "lover / couple" judged as "friend", "friend" judged as "lover / couple", and "business" judged as "individual".

7. Evaluation: advertising effectiveness

Targeted advertisement is very common. However advertising effectiveness of group-adaptive advertisement is not known yet, and was experimentally examined.

7.1. Method

Relationships that can be differentiated by the interpersonal distance "lover / couple", "friend", "family", and "business" were used. Advertisements were displayed on a 50 inch plasma display at a shopping mall, and evaluation was gained from groups of people at the mall. A snapshot of the experiment is shown in Figure 4.

Both group-adapted and group-maladapted advertisements were prepared, which were 36 images.

The number of the subjects was 82, and more detailed profiles are given in Table 8.

Table 8. Result of the advertisement effectiveness

Category	Age	Number	Proportion (%)		Averaged score (min 1, max 5)		Wilcoxon test p-value
			Male	Female	adapted ad	maladapted ad	
lover / couple	34.8	26	50	50	3.4	3.3	0.234
friend	20.6	29	31	69	3.3	3.0	0.004
family	33.1	27	22	78	3.5	3.0	0.000
business	32.5	17	82	18	3.0	2.7	0.017

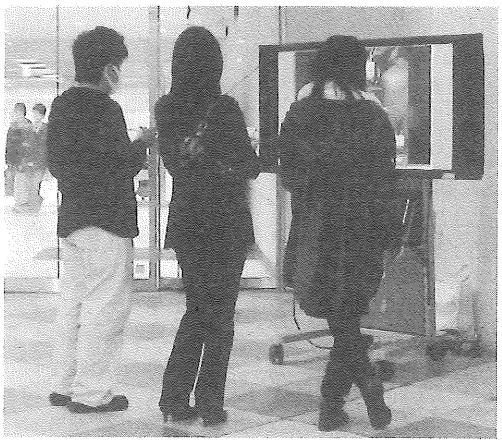

Figure 4. Snapshot of the experiment

The subjects were not explained the intention of the experiment. They were asked to fill out the survey sheets on the degree of interest to each advertisement. 9 adapted and 9 maladapted advertisements were shown to each group. Five point Likert scale was used for the evaluation.

7.2. Result

The result is shown in Table 8. Adapted advertisements to "friend", "family", and "business" were more interested than maladapted advertisements.

8. Conclusion

In this paper, a group-adaptive advertisement system named GAS was presented. This system senses the interpersonal distance between members of a small group of people, judges their relationships, and displays the advertisements that are adapted to the relationships.

Currently, accuracy of the judgment is 70% by interpersonal distance only, and 75% by the combination of interpersonal distance, the number of members in a group, and the existence of a child.

Advertisement effectiveness of this type of group-adapted advertisement was confirmed from the field experiment.

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