Encouraging People to Interact with Interactive Systems in Public Spaces by Managing Lines of Participants

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Abstract. To attract visitors and encourage them to interact with interactive systems such as digital exhibitions, digital public art, and digital signage in public spaces, this paper proposes a method to not only attract passersby's attention but also maintain their attention until they interact with them by managing the situation in which someone is experiencing it and several people are forming a line. Our proposed method changes the experience time of the interactive system based on the presence of people interacting with the system. The experiments, held in real public spaces, showed that the proposed method counteracted the negative effect of crowded situations (which resulted from attracting many passersby), and increased the number of people who interacted with the system.

Keywords: Interactive media · Public space · Digital signage · Digital public art · Digital museum

1 Introduction

Recently, museums have introduced digital technologies into their exhibition methods to effectively provide supplementary background information regarding their exhibits [1–3]. In digital exhibition methods, interactivity plays an important role in stimulating interest and facilitating learning [4].

Interactive digital art and digital exhibition methods in museums have become popular; additionally, interactive art and entertainment in public spaces are emerging. Digital public art, which combines public art and digital art [5, 6], is gradually increasing in popularity. What distinguishes digital public artwork is its technological ability to explicitly interact with audiences. By importing the concept of interactivity, digital public art can create a vivid picture of the current state of the community or individuals related to the public place, and motivate them to become more positively involved in public concerns.

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Interactive media, not only in the form of exhibitions or artwork, but also in the form of media for advertisement, is coming into widespread use in public spaces. Recently, digital signage and information kiosk machines have added large screens with touch panels. The interactivity of digital signage realizes on-demand provision of information based on user input. Moreover, some of these systems offer to share user-generated content on the screen within groups and communities [7]. This kind of interaction leads to the collection of more information and provides greater value to viewers.

As described above, the interactivity of digital media in public spaces has substantial merits. On the other hand, these merits are provided only to people who interact with these systems in the correct manner. When visitors interact with them incorrectly or do not interact with them at all, they do not obtain the expected benefits. In previous research, researchers carefully observed visitors moving around digital public artwork, and reported that 15 % of visitors paid attention to the artwork but only 5 % interacted with it [8]. Therefore, to ensure that all visitors can benefit, it is necessary to attract visitors and encourage them to interact with interactive media in public spaces.

One direct approach for attracting people to interactive media is to change the method of displaying the content [9, 10]. Display methods are sometimes effective, but the contents themselves might need to be modified to achieve the effect. Therefore, one often strongly constrains the content presented in the media. Another approach is changing the environment such as the space, lighting, sound, and temperature near the interactive media [11–13]. Previous research confirms that this kind of ambient information can trigger behavioral changes in public spaces [11]. However, these methods cannot be realized only using modifications of the interactive media and their content. Therefore, the applicability of this approach is limited to special situations.

As an alternative approach, we focused on the influence of others, i.e., behavioral contagion. Joint attention refers to a social-communicative skill used by humans to share attention directed at interesting objects or events with others via implicit and explicit indications such as gestures and gaze. Because of this joint attention, we tend to be attracted to objects or events that others are looking at. Behavioral contagion is a type of social influence based on this kind of skill; it refers to the propensity for certain behaviors exhibited by one person to be copied by others who are in the vicinity of the original actor. Milgram et al. reported that the larger the size of a stimulus crowd standing on a busy city street looking up at a building, the more frequently passersby adopt the behavior of the crowd [14]. These influences on others can be used for attracting people's attention to particular objects or events. This phenomenon is already utilized for supporting navigation in virtual environments using virtual agents. For example, virtual humans can give directions or transport users to locations [15]. Other research proposed the use of a flock of virtual animals to indicate interesting places in a virtual environment, and confirmed this method's effectiveness [16]. Additionally, to instruct users on how to interact with an exhibit in a museum, a system that records and three-dimensionally superimposes past visitor interactions around the exhibit was proposed [17]. In this system, visitors see the behaviors of previous visitors, and thereby, obtain a better understanding of the exhibit. These related studies focus on a virtual environment, not a real public space.

In this research, we propose a method of attracting passersby's attention to interactive systems in a public space by creating a situation in which someone is experiencing it and several people are forming a line. As mentioned above, people tend to more frequently direct their attention to interactive systems when they see that someone else is interacting with it. On the other hand, if the line for experiencing the system is too long, the system will no longer be able to maintain their attention and interest. Therefore, in our method, we focus on managing the length of the line by changing the duration of each interactive experience provided by the interactive system. In this paper, we investigate the effect of the viewing situation of people around an interactive system on passersby's behavior through an experiment at a mall, and evaluate the effect of the proposed method, which manages the viewing situation around the system.

2 Investigation of the Effect of Viewing Situation of People Around an Interactive System on Passersby's Behavior

2.1 Experimental Setup

In this chapter, we describe an experiment used to investigate the effect of the viewing situation of people around an interactive system on passersby's behavior. For this experiment, we installed a digital public artwork at GRAND FRONT OSAKA. GRAND FRONT OSAKA is a commercial complex in Osaka, Japan.

The artwork used was "Sharelog 3D," which is an extended version of interactive artwork "Sharelog" [8] that utilizes the IC card for a train fare system as an interaction device in a public space and visualizes the history of the trains that the user has taken (Fig. 1). The IC card for the train fare system in Japan is popular; it can even act as a personal ID. In a previous study, we confirmed that interaction using the IC card for the fare system is accepted socially, although personal travel records are (anonymously) exposed to the public [8].

Fig. 1. Sharelog 3D, Exhibited at GRAND FRONT OSAKA

In this experimental exhibition, Sharelog 3D visualizes a travel path on a local city map on a 200-in. public glasses-free 3D display [18]. Each IC card has records of up to 20 recent transactions for train travel. A migration path for each participant is generated based on records stored on his/her IC card.

Initially, the display only shows the map. When a participant put his/her IC card on the installation, the travel path is visualized as a trajectory of light spots on the map. This process takes 30 to 60 s. The time required to draw the pathways depends on the number of travel records stored. After all of the pathways have been drawn, they are shown for 180 s, and then, fade out.

We analyzed the relationship between the behavior of passersby in the mall and the situation surrounding the interactive artwork. Over the course of two days, 2,527 people were observed.

2.2 Hypothesis

In the analysis, we categorized the behavior of passersby into five stages. The first stage is “Passing”: the passerby only passes by the artwork. The second stage is “Looking”: s/he looks at the artwork. The third stage is “Stopping”: s/he stops in front of the artwork. The fourth stage is “Approaching”: s/he moves closer to the artwork. The fifth stage is “Experiencing”: s/he interacts with the artwork. These stages are based on the step-by-step procedures for interacting with an interactive system, and a lower step is included in an upper step. Then if the passerby saw the artwork, stopped in front of it, and approached to it, his/her behavior is categorized as “Approaching.” If the passerby saw the artwork and approached to it without stopping, his/her behavior is also categorized as “Approaching.”

We also categorized the situation surrounding the artwork into four categories. The first category is the situation in which there is only one passerby near the artwork and it shows only the map (NoOne). The second category is the situation in which there is only one passerby near the artwork but it shows the trajectory of others who previously interacted with it (Trace). The third category is the situation in which another person is looking at the artwork when s/he arrives (OtherLooking). The fourth category is the situation in which another person is interacting with the artwork by touching his/her IC card when s/he arrives (OtherExperiencing).

People will more frequently direct their attention to interactive systems when they see someone else trying it. Therefore, we hypothesized that the number of Looking/Stopping/Approaching/Experiencing people would increase under the OtherLooking/OtherExperiencing conditions, relative to under the NoOne condition (Hypothesis 1). We also hypothesized that the Trace condition would have a weak effect that increases the number of Looking/Stopping/Approaching/Experiencing people, relative to under the NoOne condition, because the drawn trajectory attracts the attention of passersby (Hypothesis 2).

2.3 Results and Discussion

The results of passerby observations organized in terms of the behavioral stages and the situation around the artwork are shown in Fig. 2. We used the chi-square test for the percentage of each behavioral stage by the situation surrounding the artwork. This test revealed that there is a significant difference in the distribution of behavioral stages among all conditions, except between NoOne and Trace conditions ($p < 0.01$). Residual analysis revealed that the number of Looking/Stopping people increases under the OtherLooking/OtherExperiencing conditions, relative to that under the NoOne/Trace conditions ($p < 0.01$). There is no significant difference in the number of Approaching/Experiencing people, regardless of situation. The analysis also reveals that the state transition probability between Passing and Stopping increases under the OtherLooking/OtherExperiencing conditions ($p < 0.01$). On the other hand, the analysis also revealed that the probability of changing between Stopping and Approaching decreases under the OtherLooking/OtherExperiencing conditions ($p < 0.01$).

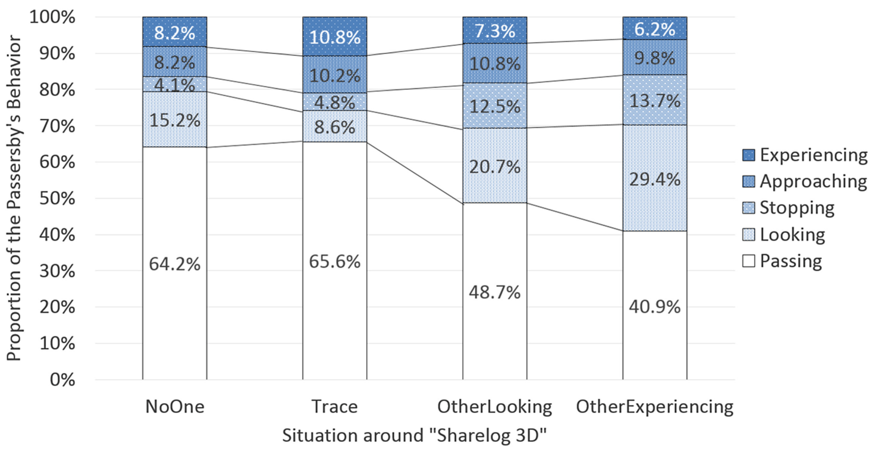


Fig. 2. Passersby's behavior toward the digital public artwork based on the surrounding situation. (Color figure online)

Hypothesis 2 was rejected based on the results of this experiment. Although some clues as to the kind of experience were provided, passersby did not pay attention to them. Therefore, showing the traces that resulted from previous interactions is not sufficient to attract attention to the work in a public space.

As we assumed in Hypothesis 1, passersby were more frequently attracted to the artwork when they saw someone else interacting with it. However, only the number of Looking/Stopping people increased under the OtherLooking/OtherExperiencing conditions; the number of Experiencing people did not increase, although the passersby were attracted to the artwork. This phenomenon may be caused by loss of interest. If a passerby has an interest in experiencing the artwork when s/he watches another person trying it, s/he must wait until the person who is experiencing it finishes and moves away. The more passersby that are interested in the artwork, the longer the waiting time for the experience. If the line for experiencing it is too long, the work will no longer be able to maintain their attention and interest. In this case, the number of people who experienced the work did not increase, although passersby were attracted to the artwork. Therefore, a method for managing the length of the line based on the situation around the interactive system is required for avoiding losing passersby's interest and increasing the number of people who can experience the work.

3 Encouraging People to Interact with Interactive Systems in Public Spaces by Managing the Viewing Situation of People Around Them

3.1 Balancing the Social Effect of Attracting People and Encouraging Them to Interact Based on Adaptive Control of Experience Duration

The results of the experiment described in the previous chapter indicated that the presence of others who are interacting with the interactive systems has the advantage of enhancing the interest of people around them, but also has to the disadvantage of decreasing the number of people who can interact with it overall, because of the long waiting time. Therefore, it is useful to balance these social effects and thereby increase the number of people who interact with the system.

Therefore, in this work, we propose a method for managing the length of the line by controlling the experience duration based on the situation surrounding the interactive system so as to avoid losing passerby interest, and thus, increase the number of people who experience the work. To investigate the feasibility of the proposed method, we modified the Sharelog 3D system to allow control of the experience duration. This modification enable us to change the display time for the pathways with three levels: Slow (×1.8), Normal (×1.0), and Fast (×0.6).

Fast drawing shortens the experience duration, and decreases the waiting time for people waiting in line. On the other hand, if the passersby gather around the work sparsely, the chance of showing another user's interaction also decreases. Then, in some cases, it loses the social effect of attracting people to the work.

Our proposed method changes the drawing speed based on the situation of people around the system. If there are passersby who are waiting to experience the work, the system changes the display time to Fast (×0.6), and thus, shortens the experience duration. On the other hand, if there is no passerby around the work, the system changes the display time to Slow (×1.8), and thus, lengthens the experience duration. By doing so, the system aims to increase the chance of showing the other user's interaction to passersby.

3.2 Evaluation of the Balancing Method in a Public Spaces

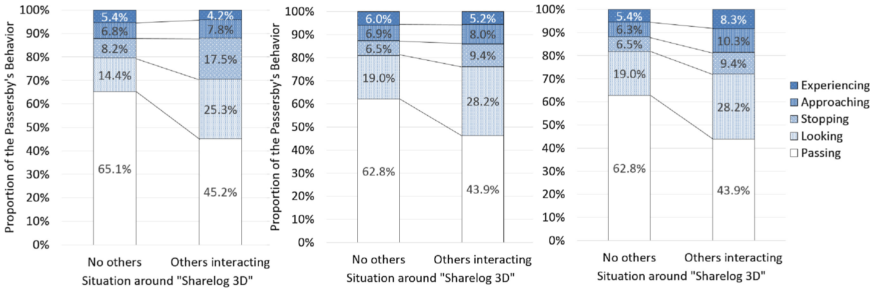
To evaluate the effect of the proposed method, we performed an experiment in a public space. The experimental setup is almost the same as that described in Sect. 2.1. We compared the three conditions of display time: Normal (×1.0), Fast (×0.6), and

Adaptive (the proposed method, switching the display time based on the situation). The Normal condition is same as in the previous experiment. The Fast condition always uses the shorter display time (×0.6). The Adaptive condition changes the display time to Fast (×0.6) when there is a waiting line and to Slow (×1.8) when there is no waiting line. To describe the situation around the work and have it influence the display time, instead of using computer-vision-based analysis, an experimenter observed the people around the work and manually input the exact situation into the system via a wireless keyboard.

We investigated whether the display-time conditions affect the change in behavior of passersby in the mall by comparing the proportion of the passersby's behavior between the case in which there are others who were interacting with the artwork and the case in which there is no one. Over four days, 3,835 people were observed.

3.3 Results and Discussion

The results of observation of passersby organized based on the behavioral stages and the presence of others interacting with the system are shown in Fig. 3. We used the chi-square test to obtain the percentage of each behavioral stage under each display-time condition based on the presence of other users interacting. This test revealed that there is a significant difference in the distribution of behavioral stages under the Normal condition ($p < 0.01$); residual analysis revealed that the number of Looking/Stopping people increases when others are interacting with the system, as found in the previous experiment ($p < 0.05$). The test revealed that there is no significant difference in the distribution of behavioral stages under the Fast condition. The test also revealed that there is a significant difference in the distribution of behavioral stages under the Adaptive condition; residual analysis revealed that the number of Looking/Stopping/Approaching/Experiencing people increases when others are interacting with the system ($p < 0.05$). These analyses show that the proposed method increases not only the number of people who are attracted to the system but also the number of people who interact with the system. To increase the number of people who interact with the system, it is not necessary to increase the efficiency of the experience cycle, but instead the situation around the work should employ adaptive control of the experience time.



(A) Normal (B) Fast (C) Adaptive (proposed)

Fig. 3. Changes in passersby's behavior based on display-time conditions (Color figure online)

We calculated the odds ratios (ORs) between situations around the artwork under each display-time condition. An OR is defined as the ratio between the odds of an event occurring in one group and the odds of it occurring in another group. In this analysis, an OR of close to 1 means that the presence of others interacting with the work has no significant impact on the transition probability of passersby's behavior. An OR of larger than 1 means that the presence of others interacting with the work has the power to encourage people to change their behavior to the next step. On the other hand, an OR of less than 1 means that another user's presence has a negative effect, discouraging them from further behavior changes.

ORs between Passing to Looking and Stopping to Approaching under each display-time condition are shown in Fig. 4. ORs between Passing and Looking under the Normal and Adaptive conditions are significantly higher than that under the Fast condition ($p < 0.01$). This result shows that the presence of others interacting with the work encouraged the passersby to pay attention to the work under the Normal and Adaptive conditions. There is no significant difference in ORs between Stopping and Approaching among most conditions; only the OR under the Normal condition is less than 1 (i.e., it shows a negative tendency). This result indicates that the proposed method counteracted the negative effect of crowded situations that resulted from attracting many passersby, and thus, increased the number of people who interacted with the system.

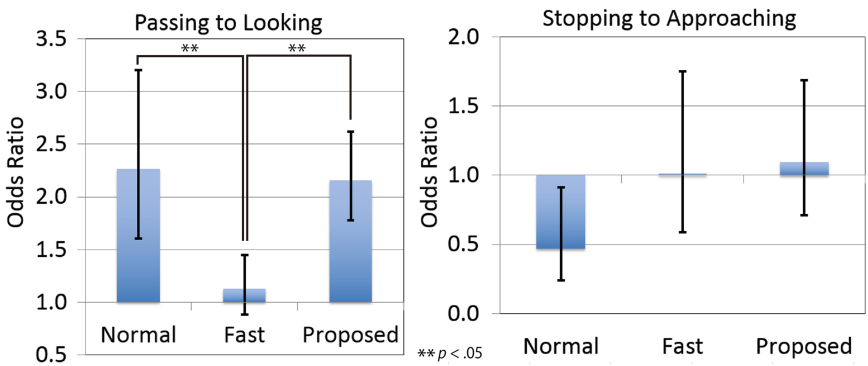


Fig. 4. Odds ratios [Passing to Looking (Left) and Stopping to Approaching (Right)] for display-time conditions

4 Conclusion

In this paper, we attempted to attract visitors and encourage them to interact with interactive systems in public spaces. We focused on utilizing the influence of others to draw the attention of passersby in public spaces, and proposed a method to not only attract passersby's attention but also maintain their attention until they had interacted with these systems by creating a situation in which one user is experiencing it and several people form a line. Our proposed method changes the experience time of the interactive system based on the situation of people around the system. In this method, if there are passersby who are waiting to experience the work, the system makes the display time faster (×0.6), and thereby shortens the experience duration. On the other hand, if there is no passerby near the work, the system makes the display time slower (×1.8), and thereby lengthens the experience duration. By doing so, the system attempts to decrease the waiting time for people waiting in line and increases the chance of showing the other user's interaction to passersby. The experiments, held in real public spaces, showed that the proposed method counteracted the negative effect of crowded situations as a consequence of attracting many passersby, and thus increased the number of people who interacted with the system.

The proposed method is only applicable to limited interactive systems that can manage the interaction duration. For example, interactive kiosks, which provide information to visitors using movies, can use the proposed method directly by changing the length or playback speed of the movies. The model of this work can be generalized to increase its applicability. Therefore, in future work, we will apply this method to other types of interactive systems in public spaces.

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