

# EFFECTS OF NON-CONTACT INTERACTION ON DIGITAL SIGNAGE ADVERTISEMENT

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## ABSTRACT

Nowadays a variety of interaction technologies have been developed and some of them allow a user to interact in non-contact ways such as through body gestures. Such non-contact interactions become to be utilized for wide purposes, including communication with digital signage, which is one of the new types of media and often used as advertisements in public. However, current utilization of non-contact interactions for digital signage advertisements lacks consideration of its effects from the aspect of consumer behaviors. In this paper, we study the effects of non-contact interactions on digital signage advertisements through hypothesis testing in the light of consumer behaviors. Our results suggest the pros and cons of non-contact interactions for digital signage advertisements. We discuss how we can capitalize the strengths of non-contact interactions for digital signage advertisement.

## 1. INTRODUCTION

Thanks to the developments in underlying hardware and algorithms, a variety of interaction technologies have been developed. While traditional technologies require a user to have hand-held devices or touch devices, recent interaction technologies allow the user to interact in non-contact ways. One of the examples is body gesture interaction through image recognition with an RGB-D camera. Such technologies have been utilized for wide purposes, including communication with digital signage. Digital signage is an electronic display which is located in the public area and aims to deliver various information to the public, and often used as an advertisement. The examples of non-contact interactions for digital signage advertisement include swiping hands to change an advertisement content and body gestures to move the advertisement content for fun. However, while many digital signage advertisements with such non-contact interactions have been introduced in the past, consideration of the effects of non-contact interactions on digital signage advertisement has not been extensively made.

For putting the interaction technologies into practice, such consideration of the effects is necessary, particularly in

the case of new interaction technologies. In this context, we study the effects of non-contact interactions on digital signage advertisement through hypothesis testing in the light of consumer behaviors and discuss the pros and cons of non-contact interactions for digital signage advertisement.

## 2. RELATED WORKS

Interaction technologies for digital signage can be divided by whether the interaction is in a contact way or not. In most cases, interaction technologies in contact ways require peripheral hardware, including a keyboard or mouse, and some digital signage systems accompany such devices [1]. Another common technology is a touch display. Compared to a keyboard or mouse, a touch display does not require any extra space, and thus it is often used for digital signage.

A mobile phone is one example of interactions with digital signage in non-contact ways. Ballagas et al. [2] demonstrated the interaction technology to utilize a mobile phone instead of a mouse for more sophisticated manipulation of the content of the digital signage. On the top of that, developments in image recognition with an RGB-D camera, such as Microsoft Kinect, enabled non-contact interactions without requiring any hand-held devices.

While there are some known research findings for the effectiveness of keyboard interactions and touch interactions for digital signage [3], there is few known research attempts to consider the effectiveness of interactions for digital signage. One exception is by Alt et al. [4] and through the experiments they suggested that interactions for digital signage have positive effects on viewers in the point of understandings of the content of digital signage. These research findings give us important insights about the effectiveness of interactions for digital signage. On the other hand, in the experiments they allowed viewers to interact with the digital signage in both contact and non-contact ways, and most importantly, the content of digital signage was not related to advertisement, and thus we cannot simply apply the result to our research.

In the light of consumer behavior, there have been some research attempts to find the effectiveness of digital signage in selling environments [5] [6]. In addition, some studies

tried to make digital signage system automatically evaluate its effectiveness. For example, Yin et al. [7] demonstrated the utilization of image capture devices for tracking viewers and their viewing durations. Though these research attempts can consolidate the importance of digital signage as an advertising tool, they did not take into primary account interactions with digital signage.

### 3. HYPOTHESIS

Our research aim is to investigate the effects of non-contact interactions on digital signage advertisement. In particular, we focus on the effects of body gesture interaction, which is getting more and more common in commercial digital signage systems. We achieve this through hypothesis testing from the aspect of consumer behavior. There are a variety of consumer behavior theories [8][9][10][11], and throughout the theories, we pick up four common aspects of viewer's process of reaction to advertisement:

- to be exposed to the advertisement content,
- to understand the advertisement content,
- to take attitudes towards the advertisement content, and
- to take attitudes towards the product in the advertisement.

In the subsequent sections, we consider how non-contact interactions in digital signage advertisement effect on these four aspects.

#### 3.1. HYPOTHESIS A: EFFECTS ON EXPOSURES TO THE CONTENT

According to the study by Alt et al. [4], non-contact interactions in digital signage have positive effects on understandings of the content. However, the limitation lies in that they only used simple icons as the content of digital signage. In the case of advertisements, more complex contents should be considered, such as a catch phrase of the advertisement and details of the product in the advertisement. In such cases, the interactions might not have direct positive effects on understandings of the content.

Before understanding the content, a viewer needs to be exposed to the content. In this context, we consider that non-contact interactions in digital signage advertisement have positive effects on viewer's exposures to the content, instead of viewer's understandings of the content. The effect can be larger when a viewer interacts more. This can be restated as Hypothesis, as follows:

- **Hypothesis A: The more a viewer interacts with digital signage advertisement in non-contact ways, the more the viewer is exposed to the content.**

#### 3.2. HYPOTHESIS B: EFFECTS ON UNDERSTANDINGS OF THE CONTENT

In non-contact interactions such as body gestures, a viewer is required to move dynamically rather than in traditional contact interactions such as a touch display. In such case, viewers need to pay much more attention to moving their bodies. This means that moving bodies can be a cognitive load for viewers compared to traditional contact interactions such as touching a display, which requires less movements to viewers.

Bettman [11] proposed the information processing theory of consumer behavior, where Bettman pointed out the limitation and the capacity of information processing of a human. This means that a human cannot focus on everything but selectively, which is supported by previous research [12].

Based on this idea, because non-contact interactions can be a cognitive load for a viewer, when a viewer is concentrating upon non-contact interactions, a viewer may not pay attention to the content or may not understand the content, even if the viewer is exposed to the content. This can be summarized as Hypothesis B, as follows:

- **Hypothesis B: The more a viewer concentrates upon non-contact interactions in digital signage advertisement, the less the viewer understands the content in the advertisement.**

#### 3.3. HYPOTHESIS C: EFFECTS ON ATTITUDES TOWARDS THE CONTENT

As demonstrated by Microsoft Kinect for TV games, moving body itself can have positive effects on the mood of the person. Thus, while non-contact interactions can be a cognitive load for a viewer, non-contact interactions itself can have positive effects on the mood of the viewer, or when the interaction is not interesting, non-contact interactions can have negative effects on it. This means that a viewer takes his own *attitude towards interactions*, which is a main idea of ours.

While there are few known research efforts into considering attitudes towards interactions, there have been some related research findings. Boushra [13] got further into the effects of interactivity in websites and suggested that *positive attitudes towards a website* have positive effects on the visitor's *attitudes towards the content of the website* and *attitudes towards the brand of the website*. In this context, we take into account effects of attitude towards interactions as follows:

- **Hypothesis C1: A viewer's positive attitude towards the non-contact interactions in digital signage advertisement has positive effects on the**



Figure 1: Our experiment environment with the digital signage advertisement

Table 1: The detail of questions in the questionnaire

Category of questions	Subcategory of questions	Cronbach's $\alpha$
Attitude towards the interaction	1-1: evaluations of the suitability of the interactions	<b>0.868</b>
	1-2: evaluations of the enjoyment of the interactions	
	1-3: evaluations of the usability of the interactions	
Attitude towards the content	2-1: evaluations of the quality of the advertisement content	<b>0.721</b>
	2-2: emotions to the advertisement content	
	2-3: evaluations of the comprehensibility of the advertisement content	
Attitude towards the product	3-1: evaluations of the quality of the advertising product	<b>0.764</b>
	3-2: feelings to the advertising product	

**viewer's attitude towards the content of the digital signage advertisement.**

- **Hypothesis C2: A viewer's positive attitude towards the non-contact interactions in digital signage advertisement has positive effects on the viewer's attitude towards the product in the digital signage advertisement.**

#### 4. EXPERIMENTS

To verify these four hypotheses, we made the laboratory experiment. We made two digital signage advertisement systems with non-contact interactions using Microsoft Kinect V2. One is digital signage with few interactive content (DS1) and the other is with many interactive contents (DS2). The laboratory experiment was made in the following manner:

1. ask a subject to view one of the digital signage systems (DS1 or DS2),

2. record the movements of the subjects with the video camera while the subject is watching the digital signage, and

3. ask the subject to answer the questionnaire.

In the subsequent sections, the details of the setting and the result will be described.

##### 4.1. SETTING

We used the virtual food product as the content of digital signage advertisement. For DS1, we implemented left-hand swipe gesture recognition for interacting with the content. For DS2, we implemented left-hand swipe gesture, right-hand swipe gesture, and body up-and-down gesture recognitions for interacting with the content.

The environment is shown in Figure 1. The subjects were undergraduate and graduate students. The total number of the subjects was 104 (DS1: 46, DS2: 58). We measured viewing time of each subject, times each subject interacted with, and answers to the questionnaire. The questionnaire includes the three categories of the questions, which detail

Table 2: The result of regression analysis for Hypothesis A

(a) The result of the analysis for DS1

	Unstandardized coefficients	Standard error	Standardized coefficients	<i>t</i> -value	<i>p</i> -value
(Constant)	30.61	5.50		5.57	0.000
The number of times of each viewer's non-contact interactions	4.11	0.78	<b>0.62</b>	5.28	<b>0.000</b>

(b) The result of the analysis for DS2

	Unstandardized coefficients	Standard error	Standardized coefficients	<i>t</i> -value	<i>p</i> -value
(Constant)	21.02	6.55		3.21	0.002
The number of times of each viewer's non-contact interactions	4.06	0.59	<b>0.68</b>	6.89	<b>0.000</b>

Table 3: The result of regression analysis for Hypothesis B

(a) The result of the analysis for DS1

	Unstandardized coefficients	Standard error	Standardized coefficients	<i>t</i> -value	<i>p</i> -value
(Constant)	1.77	0.34		5.17	0.000
Viewer's non-concentration upon the non-contact interactions	0.06	0.03	<b>0.31</b>	2.17	<b>0.035</b>

(b) The result of the analysis for DS2

	Unstandardized coefficients	Standard error	Standardized coefficients	<i>t</i> -value	<i>p</i> -value
(Constant)	1.47	0.38		3.89	0.000
Viewer's non-concentration upon the non-contact interactions	0.10	0.05	<b>0.27</b>	2.11	<b>0.040</b>

is in Table 1 and answers to the questions are used for testing Hypothesis C1 and C2. These questions were based on previous research [14] and have seven points Likert scale. In addition to the questions, the questionnaire also includes questions about the details of the content for considering viewers' understandings of the content.

Cronbach's  $\alpha$  for the questions for attitude towards the interactions (1-1, 1-2, 1-3) was 0.868, Cronbach's  $\alpha$  for the questions for attitude towards the content (2-1, 2-2, 2-3) was 0.721, and Cronbach's  $\alpha$  for the questions for attitude towards the product (3-1, 3-2) was 0.764. These values indicate a certain validity of the questions for the analysis [15].

## 4.2. RESULT

Firstly, we did manipulation check for DS1 and DS2. Average numbers of times of viewers' non-contact interactions

were 5.93 (DS1) and 9.71 (DS2). The result of *t*-test was  $t = 3.96, p < 0.01$ . We can confirm that DS1 and DS2 are set separately.

We carried out the regression analysis for testing Hypothesis A through IBM SPSS Statistics Version 22. As a dependent variable for the regression analysis, we used the viewing time of each subject, which indicates the subject's exposure to the content. As an independent variable, we used the numbers of times of each subject's non-contact interactions. Standardized coefficients were 0.62 (DS1,  $t = 5.28, p < 0.01$ ) and 0.68 (DS2,  $t = 6.89, p < 0.01$ ). The details are tabulated in Table 2, from where we see Hypothesis A is supported both in DS1 and DS2 at significance level 0.01.

In the same way as testing Hypothesis A, we carried out the regression analysis for testing Hypothesis B. As a dependent variable for the regression analysis, we used the number of questions about the details of the content

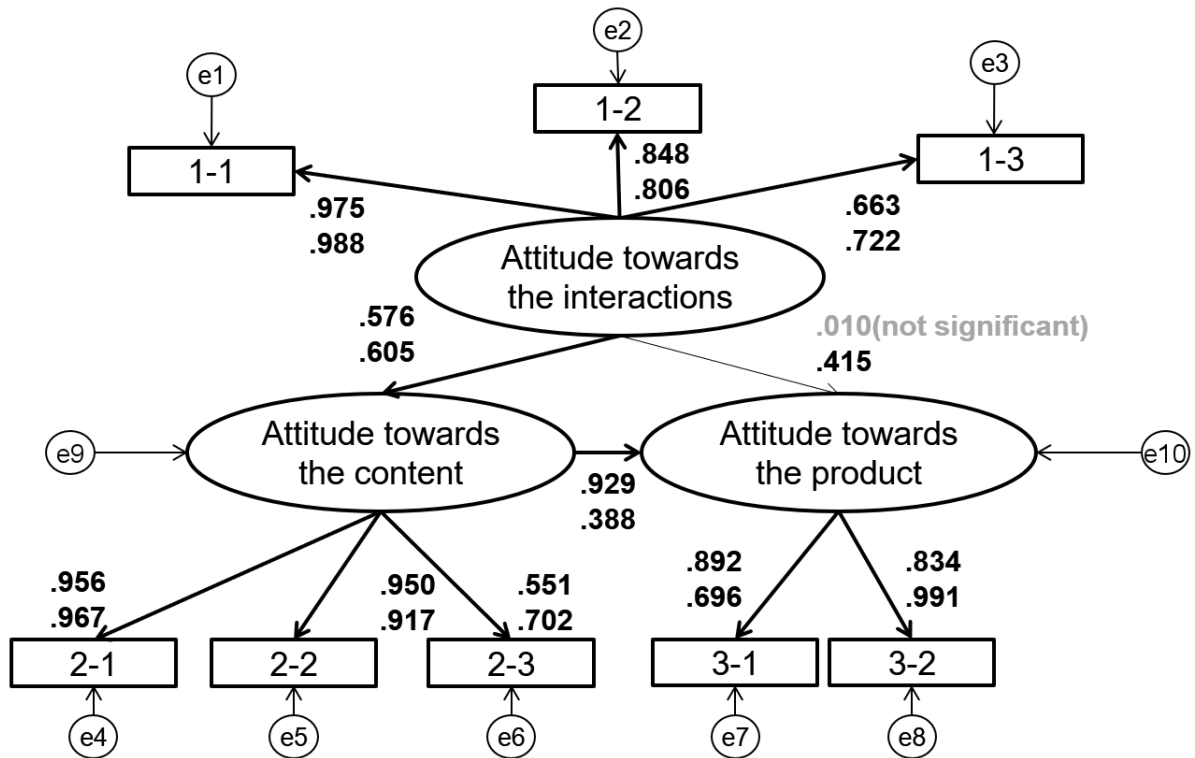


Figure 2: The result of covariance structure analysis for Hypothesis C1 and C2 (Upper: DS1, Lower: DS2,  $p < 0.01$ )

which each subject can correctly answer. The number indicates understandings of the content of each subject. As an independent variable which indicates each subject's non-concentration upon the non-contact interactions in digital signage advertisement, we used the following value: the viewing time of each subject divided by the number of times of each subject's non-contact interactions. When the value is low, the viewer is concentrating upon the interactions. Standardized coefficients were 0.31 (DS1,  $t = 2.17, p < 0.05$ ) and 0.27 (DS2,  $t = 2.11, p < 0.05$ ), and the details are tabulated in Table 3. Hypothesis B is supported both in DS1 and DS2 at significance level 0.05, while the effects are limited to a certain amount.

For testing Hypothesis C1 and C2, we carried out covariance structure analysis through IBM SPSS Amos Version 22. We used variables from the questionnaires which are tabulated in Table 1. The detailed result of the covariance structure analysis is depicted in Figure 2, where  $ek$  ( $k = 1, \dots, 10$ ) mean error variables of the corresponding values. Goodness of fit index was 0.909 and adjusted goodness of fit index was 0.807. These values indicate a certain fitness of the covariance structure analysis. From Figure 2, it can be argued that at significance level 0.01 Hypothesis C1 is supported both in DS1 and DS2, while Hypothesis C2 is supported only in DS2.

## 5. DISCUSSIONS

Because Hypothesis A is supported, it can be suggested that when an advertisement provider wants a viewer to be exposed to the content, the provider should prepare the digital signage system with non-contact interactivity contents, which are expected to induce many interactions from a viewer. On the other hand, the result of testing Hypothesis B suggests when an advertisement provider wants a viewer to remember the content in detail, the provider should prepare the digital signage system with few interactive content, in the case of utilizing non-contact interactions.

The reason why Hypothesis C2 is not supported in DS1 can be explained as because when digital signage has few interactive content, a viewer would not take enough attitude towards the interactions. The result suggests that in the case of utilizing non-contact interactions, the digital signage system with few interactive content should not be made for the purpose of creating attitude towards the product. In contrast, in the digital signage system with a certain amount of interactive contents, a viewer directly takes attitude towards the product through the experience of the non-contact interactions. Therefore, a provider should prepare interaction designs whose impression is similar to the impression which the provider wants a viewer to have for the product. In par-

ticular, non-contact interactions may give a viewer good impression of modern technology. This means that these types of interactive digital signage system are suitable for advertising innovative products.

## 6. CONCLUSION

In this paper, we studied the effects of non-contact interactions on digital signage advertisements, whose consideration is missed by current utilization of non-contact interactions. Our results suggest the pros and cons of non-contact interactions for digital signage advertisements and we discussed how we can capitalize the strengths of non-contact interactions for digital signage advertisements.

As for the future work, because there can be multiple viewers of digital signage advertisement, we can also consider interactions among viewers and its effectiveness. In addition, we used only one product for digital signage advertisement. On the other hand, the type of the advertising product can influence the effects of non-contact interaction on digital signage. Through utilizing other types of products, such as expensive products and widely common products, for digital signage advertisement, we can consider the relationships between types of advertising product and the effects of non-contact interactions.

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