

Applicability of Affordance Concept in User-Computer Interaction

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Abstract—The aim of this study is to explore whether the intuitive-corresponding relation between users and physical objects presented by affordance concept alike exists in interaction between users and virtual buttons. In this study, a type of virtual button is used as the test sample. The intuitive judgments and practical operations to the test sample were carried out to find out whether users could directly pick up the affordances presented by the test sample through the virtual-perceptual information and then make appropriate decisions based on usability. The results show that the users could perceive directly the affordances presented by the virtual button by looking at them and approximately know what sizes of the virtual button are appropriate for usability. That is, the intuitive-corresponding relation described by affordance concept exists in interaction between users and virtual button. The results could serve to explain the rationality of affordance concept in application on GUI design.

Index Terms—Affordance, Interaction Design, User-Computer Interaction.

I. INTRODUCTION

The viewpoint of direct perception and interaction emphasized by affordance concept as a design idiom would often be mentioned in product interface design. In Gibson's affordance [1], it describes the corresponding relationship between animals and objects in the ecological environment. In the ecological environment, animal can perceive instinctively the behavioral possibilities to the objects presented by their physical properties. For instance, the four properties of a terrestrial surface, horizontal, flat, extended and grid can support animals to walk, jump or run on it [1]. Affordance in the physical world is an intuitive notion, easily described and understood through examples [2]. As Norman [3] illustrates how affordance concept applies to everyday objects, such as, just by looking at them, users know that plates can be pushed using hands, and knobs can be turned with fingers. The affordance concept seems to be an ideal design principle for interface design. However, this perspective of affordance has limitations on application of design practice and could not completely explain user-product interaction. While designing

user interfaces, designers may not only employ physical properties but also some techniques, such as signs and texts.

The affordance concept is not totally mature in design [4] and it has various manifestations in current design practice. Some related works say that affordance is determined in part by observers' cultures and experiences [5, 6, 7, 8]; whereas some researchers think that affordance in design is the physical-behavioral relationship between users and objects [9, 10]. Thus, the affordance concept in design seems to be open to criticism. The behavioral-physical notion of affordance points out a intuitive way for user-product interaction in which users can perceive instinctively behavioral possibilities and functions provided by objects without requiring users' memory, inference and further interpretation. For example, a button on a product with round shape and fitting size for users' fingers indicates the pressing operation for users. Based on the perspective, the virtual buttons on screen are always designed as real button for strongly suggesting users to click on it.

However, the argument about affordance in design stated by Norman [11] claim that it is not application of affordance to use images and icons to communicate a product's functions. Affordance concept seems deeply has the limitation on applicability of user-computer interaction design. This study starts with exploring the rationality of affordance concept in application on GUI design. Thus, the aim of this study is to find out whether users could directly pick up the affordances presented by the virtual icons through their visual-perceptual information and then make appropriate decisions based on the intuitive-corresponding relation emphasized by affordance concept. The results could positively explain whether affordance concept is applicable for user-computer interaction design.

II. AFFORDANCE IN DESIGN

A. Perception of Affordance

McGrenere and Ho [12] clearly illustrated the way of perceiving affordance in their study (see Figure 1). Human vision plays a significant factor for picking up information of objects in the environment. Fig. 1 shows the relation between

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affordance and perceptual information. Direct perception is possible when there is an affordance and when there is information in the environment that uniquely specifies that affordance. Furthermore, direction perception depends on the user's picking up the information that specifies the affordance and may depend on the user's experiences and culture [12]. For GUI design, the shapes and features of virtual icons on product screens as the perceptual information can effectively present products' functions and operations.

B. The Intuitive-Corresponding Ration of Affordance

Affordance is the intrinsically behavioral relationship between users and objects [10]. It is relative to the capability and size of individual and form, material and size of objects. For example, something being knee-high for a child is not the same as knee-high for an adult [1]. Warren [13] explored the relationship between physical properties of environment and properties of humans to represent the affordance of stair climbability between the stair height (H) and the climber's leg length (L) (Fig. 2). The results show that users can intuitively determine what height of the stair is most appropriate for climbing with their capabilities (leg length and motor ability).

In design, the term physical affordance proposed by Hartson [14] states the form, material, and size of objects should correspond to users' sizes and capabilities. An example in everyday object as door handles, its appropriate dimension (diameter of tube, length) and shape imply a grasping fitness for users. It is worth to further explore whether the physical-corresponding relation of affordance exists between users and virtual icons on product screens.

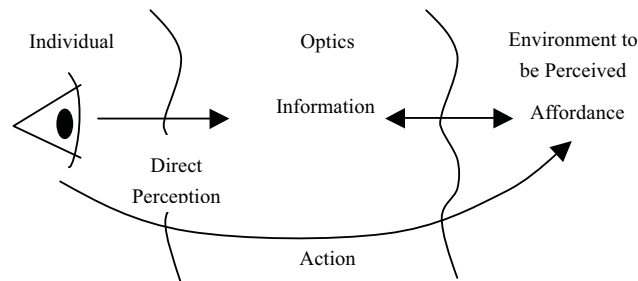


Fig. 1. Mode of perceiving affordance [12]

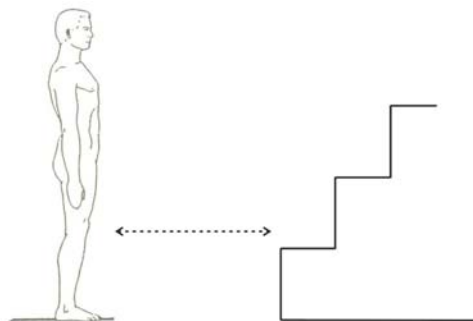


Fig. 2. Corresponding relation between human and stair

III. METHOD

In order to find out whether users could directly pick up the affordances presented by the virtual icons and then make appropriate decisions based on the intuitive-corresponding relation of affordance concept, we firstly carried out users' intuitive judgments to the test sample based on usability and then the users actually operated the test sample with a task set in this study. This study used a type of virtual button as the test sample (see Fig. 3) and it was redrawn in black line style with the drawing software.

A. Procedure

As Fig. 4 shows, the interface of the experiment is set as a computer screen. The test sample was illustrated with six different sizes and the six test samples were respectively put on the interface. That is, six interfaces were made and randomly arranged on a picture as the test picture for the experiment (see Fig. 5). In order to make the test picture more realistic, we used a digital camera to respectively take the photos of the six interfaces. First, the subjects were asked to watch the test picture that projected to a white screen by a projector. Simultaneously, they needed to intuitively determine the order of usability within the six interfaces according to the specific task set up in this study, 1 for quite easy and 6 for quite difficult.

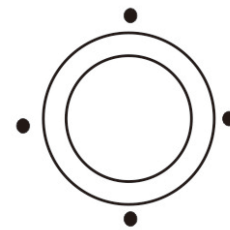


Fig. 3. Test sample

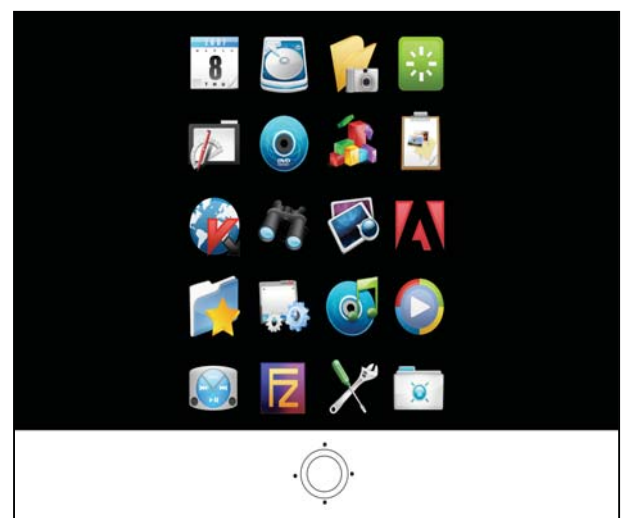


Fig. 4. Interface of experiment



Fig. 5. Test picture

After the subjects' intuitive determinations, they were asked to sit in front of a 19-inch touchscreen and then complete the task as soon as possible with a stylus. The six test interfaces were separately and randomly presented on the touchscreen. The test interfaces can be practically operated by clicking the buttons with the stylus and they are programmed for recording the operation time of completing the task.

B. Task and subjects

The task set up in this study is to click the button with the stylus to move the selected icon from left-up icon to right-bottom icon and then move back to the starting icon. At the start of every operation, the six interfaces' selected icons are set at left-up position. Sixty-five subjects participated in this study (mean age=21.8, SD=2.7). All subjects have had experiences using electronic products.

IV. RESULTS AND DISCUSSIONS

By comparing the results of order of usability from the subjects' intuitive judgments and the time of completing task, whether users could directly pick up the affordances presented by the virtual icons through their visual-perceptual information and then make appropriate decisions could be analyzed.

A. The Subjects' Intuitive Judgments

The data of order of usability from the sixty-five subjects' intuitive judgments was analyzed with Kendall's coefficient of concordance in SPSS software to examine the significance level among the six interfaces. As shown in Table 1, the order of usability of the six interfaces reaches a significant difference ($p=0.000$). The usability order from easy to difficult is No.3, 4, 2, 1, 5 and 6.

B. The Subjects' Practical Operation

The data of operation time from the sixty-five subjects was analyzed with ANOVA in SPSS software to examine the significance level among the six interfaces. As shown in Table 2, the mean of operation time of the six interfaces reaches a significant difference ($p=0.000$). The order of mean of the six interfaces' operation time is No.4<3<2<5<6<1. Furthermore, with the results of ANOVA's Post Hoc, the mean of operation time between the test interfaces No. 3 and No. 1, 2 and 6 reaches significant differences, as well as between No. 4 and No. 1, 2 and 6.

Based on the results, the subjects' intuitive judgments on the six interfaces' usability tend to consist with their practical operations to the interfaces. The subjects generally think that the usability of No. 3 and 4 is proper for the task, and in fact, their operation time presents the identical situation. Thus, the subjects can directly pick up the affordances presented by the virtual icons through their visual-perceptual information and then make appropriate decisions.

TABLE I. KENDALL'S COEFFICIENT OF CONCORDANCE

Items	N	Mean Rank	SD	Kendall's W	chi-square	F	p
1	65	3.62	1.59	0.477	155.040	5	0.000
2	65	2.69	1.34				
3	65	2.25	0.97				
4	65	2.55	1.26				
5	65	4.20	1.33				
6	65	5.68	0.79				

TABLE II. ANOVA TEST

Items	Mean	SD	N	Post Hoc	p
1	25.37	19.57	65	* 3, 4	0.000
2	20.84	10.25	65	* 3, 4	
3	17.50	10.88	65	* 1, 2, 6	
4	16.67	13.41	65	* 1, 2, 6	
5	22.14	37.14	65		
6	22.29	14.09	65	* 3, 4	

V. CONCLUSIONS

The results of this study show that the intuitive-corresponding relation of affordance concept certainly exists in interaction between users and virtual button. It could serve to explain the rationality of affordance concept in application on user-computer interaction design. For design of graphic user interface, designers can consider users' occasions of visual psychology to facilitate the usability and intuitive interaction of product interfaces.

This study used a virtual button as the test sample. The results show that the test interfaces No. 3 and 4 present better usability for users and they actually make users have better performance for the tasks. For further studies, other types of virtual buttons are worthy to further investigate. Furthermore, this study only considers the affordance presented by visual-perceptual information. The affordances presented by other types of perceptual information might be worthy to consider for further studies, such as sounds.

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