An Exploration of Relationships between Culture Images and User Experience of Gesture Interaction

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***Abstract*—The application of gesture changed the mobile interactive process greatly, as well as User Experience (UE). For better UE, it requires information feedback triggered by gesture to accord with users' cognition, which is closely related to their culture and values. Many previous studies have described the differences of interaction under diverse cultural atmospheres, which confirms that cultural factors do affect the interaction process, but does this also hold for mobiles? Whether the UE is good? This study carries out a series of empirical research towards this end. The task flow of 20 apps based on Android was analyzed for extraction of gestures used with higher frequency. The ink-rhyme effect of Chinese calligraphy culture was integrated into interactive feedback to form gradient mode, which is applied to the three most familiar gestures to users— tap, press, slide. The participants judged the mode based on Hassenzahl's surface usability questionnaire to assess UE. The results showed that cultural factors improve the user's emotional experience, but have little impact on the operating experience. It is demonstrated that the integration of cultural factors enhances UE, especially emotional experience, and shows no negative impact on usability.**

Keywords—Culture Images; User Experience; Gesture Interaction; Emotion.

I. INTRODUCTION

Gestures based on touch screen help people get rid of the dependence on traditional input device. They shorten distance between people and equipment, enrich the pleasure of interactions and enhance users' satisfaction. All of these provide infinite advantage for gesture interaction [1][2]. However, damage caused by improper cognition and recognition of gesture in practice will upset users.

The feedback activated by gestures needs users' rational cognition. In order to understand feedback mode better, cultural and value recognition from users are of great importance [1]. In a way, culture can be understood as the medium and tool used to think, work, and study [3]. Many studies have shown that selection, receiving and cognition of information will be affected due to different cultural backgrounds. Thus, the integration of culture and interactive system is very necessary [4]. However, what forms the culture will be absorbed, and whether it has positive influence on UE, are still problems that worth exploring.

In order to further develop our investigation, the following research questions should be taken into account: i) How to choose the object of study in a wide variety of gestures? To answer this first question, the research of 20 apps based on Android helped extract the typical gestures. ii) Which kind of form will cultural factors be blended into interaction? In this part of study, one of the representative of traditional Chinese culture — calligraphy was used as research object. The reason why we did not chose other cultural category is that we know it better than other items among countless cultural items. iii) How to evaluate the UE of interactive system integrated with cultural factors? In older to answer the third question, Hassenzahl's surface usability questionnaire based on semantic scale was used to identify the UE [5].

The study reveals the relationship between feedback merged with culture elements and UE. It showed that better emotional experience was produced by cultural feedback, such as excitement, fun and deep impression. On the other hand, there was no much impact on operational experience, but a bit of cognitive burden for users.

Section 2 of this present study carried out detailed induction and analysis of previous related research, which provided instructional method for the subsequent experiments. In Section 3, 20 apps were used to extract typical gestures used in higher frequency. The ink-rhyme effect of Chinese calligraphy culture developed into two different modes in Section 4. Through the experiment of the fourth section, we understand the relationships between cultural factors and UE of interactive system. Combined with the discussion about the UE in Section 5, the conclusion showed that culture factors had a positive impact on emotional experience, but added a certain cognitive burden to users.

II. RELATED WORK

A. Gesture Interaction

Touch gestures are considered to be the most direct way of human-computer interaction [6]; they have convenient way to input, and reflect abundant semantics [7]. Currently, gestures based on the mobile platform can be subdivided into multi-touch gestures, stroke gestures, and combinational gestures. Even if multi-touch gestures produce an advantage as being more mature, they have not fully realized in

 ISBN: 978-1-61208-306-3

mainstream platforms, except operations related to rotation and scaling [1][8]. Multi-touch gestures, as they were, are mostly applied to a mobile platform, but have no unified standard. Previous Studies have pointed out that, integrating concepts of time and displacement, gesture can be reduced to action unit, which will converse into a basic set of gestures specific to whole system [9]. This research provides basis and reference for extraction of typical gesture based on mobile platforms.

B. Cultural Factors in Interaction

The effect of culture on interaction has been confirmed by many research institutes [10][34][35], e.g., in image search task, Chinese are more likely to generate search keywords describing the overall properties of the target images than European and Americans (EA); EA assigns more space to the main objects than Chinese [10]. However, how to blend culture factors with interactive system still needs further discussion. Chi-Hsiung Chen and his colleagues, scholars from Taiwan, suggested that culture reflected on three levels: surface layer (visual and material), middle layer (behavior and habits) and inner layer (thoughts and spirit) [11]. In 1993, Ockman proposed the fusion point of culture and design relied on users' tastes, habits and lifestyles [12]. Tien-Li Chen and Pei-Fen Hong also pointed out those cultural images can be divided into two directions, namely, implicit and explicit [13]. Thus the integration of culture and design is from the inside to the outside. It is user-oriented and should consider users' behavior and habits in some kind of conditions, through direct or indirect sensory effects. Then it is showed through the sensory effects directly or indirectly.

Chinese aesthetic culture represented by the calligraphy is becoming a new source of design inspiration [14], the simulation technology of calligraphy effect has been the subject of many studies [15][16][17]. Imitations of calligraphy brush strokes; however, it is a kind of retrieving of outer appearance shape, which is in lack of behavioral interpretation for calligraphy culture. Calligraphists will strengthen the tendency of their creatures by controlling the ink-rhyme [18]. Ink-rhyme is an extremely subtle factor in calligraphy art, but also is directly controlled by the behavior. Taking ink-rhyme effect as a breakthrough point of culture and interactive systems, in conjunction with other conditions, is likely to promote re-creation of artistic context and UE.

C. User Experience

UE is related with the process of interaction, it is a combination of user's behavior, results and emotion [19]. UE take emotion experience as more advanced level, including hedonics, aesthetic and pleasure [5][20]. Sascha Mahlke from Industrial University of Berlin thought UE could be defined from four dimensions: perceived usefulness, ease of use, perceived hedonic quality, perceived visual attractiveness [21]. UE, therefore, is a process of focus on cognition and feelings, based on usability and affection. However, there still exists a question whether cultural factors have a positive effect on UE.

III. STUDY 1: TYPICAL GESTURE EXTRACTION

The purpose of this study was to extract typical one in a wide variety of gestures used in mobile terminal. The intention is to take gestures that users are most familiar with as variables for further research.

A. Material

We used 20 apps based on Android. According to the report that Linda Sui published in Strategy Analytics, which can be found at [28], there were 530000 smartphones supplied in the fourth quarter of 2012, 86% of which were based on Android. The selection of study platform was strongly supported, because the vast majority of the Chinese smartphone users were more familiar with Android. The apps were the top 20 selected from list at the end of May of Peasecod [29], which was reported to occupy more than 50% of mobile apps management market [30]. Table 1 contains the selected apps and games, together with their study IDs and times of installation.

TABLE I APPS WITH THEIR STUDY IDS AND INSTALL TIMES

Apps			Games		
ID	***Name***	***Install Times***	***ID***	***Name***	***Install Times***
1	QQ	110	11	Temple Run	19.61
2	WeChat	98.64	12	Tank ON	0.36
3	Qvod Player	29.09	13	Find Something	12.96
4	QQ Zone	52.15	14	Daddy Was A Thief	0.71
5	UC Browser	70.61	15	Carrot Fantasy	8.95
6	Sogou Input	79.26	16	Shine Runner	0.51
7	TTPOD	38.29	17	Subway Surfers	6.27
8	360 Guard	61.87	18	Angry Birds	21.2
9	Ink Weather	32.02	19	Fruit Ninja	19.03
10	Taobao	40.03	20	Pop Star	8.41

unit: million

B. Variable identification

In order to understand how gestures operate on an interactive system of smartphones, each of the stimuli used for the evaluation was identified. Table 2 contains definition and legend of the gestures, which could be consulted in the touch gesture reference guide provided by Luke Wroblewski [31].

TABLE II GESTURES WITH THEIR STUDY IDS, LEGEND AND DEFINITION

ID	Legend	Gesture	Description of Action
1		Tap	Gently touch the screen and left
2		Double Tap	Touch the screen twice quickly
3		Press	Touch the screen for a period of time
4		Slide	Move fingertip over surface without losing contact
5		Drag	Hold the object on the screen then slide

6		Zoom	Touch surface with two fingers and bring them closer or apart
7		Rotate	Touch surface with two fingers and move them in a clockwise or counterclockwise direction
8		Press and Slide	Hold the screen with one finger, slide with another one
9		Press and Tap	Press surface with one finger and briefly touch surface with second finger
10		Other Gestures	e.g. shake

C. Task and Paocedure

Firstly, these 20 apps and games were underway of the task flow analysis. After separating the function module of each app, every step of the task was refined to single gesture's application, and marked with circle standing for the gesture ID. Take Tecent QQ [32] as the example: to enter the application, users first need to tap the icon to login, then tap their account and password to input box. After tapping "OK", user will come to QQ's message function module to continue their operation. From such a short task flow, it can be seen that the completion of this task requires at least four taps. Figure 1 shows task flow analysis of QQ on a wider scale. Corresponding to the analysis, type and frequency of gestures used in QQ are counted in Table 3. For the sake of an overall understanding of the whole situation, gesture analysis can be applied to the rest of apps in the same way.

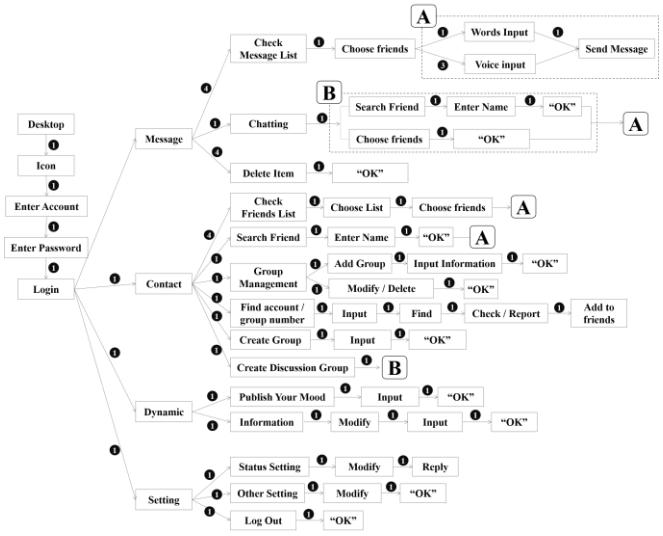

Figure 1 Task flow analysis of QQ

TABLE III GESTURES USED IN QQ WITH THEIR STUDY IDS AND FREQUENCY

ID	Gestures	Frequency	ID	Gestures	Frequency
1	Tap	64	6	Zoom	0
2	Double Tap	0	7	Rotate	0
3	Press	4	8	Press and Slide	0
4	Slide	3	9	Press and Tap	0
5	Drag	0	10	Other Gestures	0

D. Result

All of the 20 apps were analyzed in the method shown in last part, the results were shown in Table 4.

According to the frequency statistics, "tap" was at the highest frequency. The rest of the top four gestures were "slide" (M = 7.2, SD = 2.936), "press" (M = 2.3, SD = 1.567), "drag" (M = 0.2, SD = 0.632). Among them, "tap" was the most favorite gesture with users, as the use of which was far more than other gestures. "Drag" was unusual gesture with the same level of "zoom" and "double tap". "Rotate", "press and slide", while "press and tap" were barely used in smartphone based on Android.

TABLE IV GESTURES WITH THEIR APPLICATION MEAN AND SD

Gesture	Tap	Double Tap	Press	Slide	Drag	Zoom	Others
Mean	65.100	0.200	2.300	7.200	0.300	0.200	0.200
SD	15.300	0.421	1.567	2.936	0.675	0.632	0.422

The results may be due to the following points: i) The hardware limitations, e.g., the size of the screen limits the operations by two or more fingers, because of bad usability. It is proven in this view that some apps, like Meitu [33] use combination of tap and slide instead of rotation or zooming. ii) The standard of gesture design is faultiness. It will be easy to be accepted if the design meets users' mental model and daily habits [1]. Intensive mapping is generated between gestures and computer mouse: the function of tap is similar with the left mouse button and press likes the right button.

In summary, we took "tap", "press", and "slide" as stimuli in Study 2 to explore cultural factors effects on interactive UE.

IV. STUDY 2: CULTURE FACTORS AND USER EXPERIENCE

The purpose of Study 2 is to investigate the impacts of two different feedback models on UE.

A. Participants

40 participants, 20 males and 20 females were involved in this study. Two persons (males) gave invalid responses. Therefore, there were 38 valid responses from participants aged ranging from 20 to 34 years old. Thirty one (31) were undergraduate and postgraduate students from department of industrial design, while four were professionals with education, logistics and engineering. All of them were skilled users of Android and influenced by Chinese culture since childhood.

B. Stimuli

There were three experiments based on tap, press and slide, while included two contrast feedbacks in each group

experiment. The independent variables were different feedback modes: gradient mode and flat mode. Gradient mode was dynamical feedback for integrating with ink–rhyme effect. Flat mode was a kind of feedback that responded directly after users' action.

The dependent variable was UE, which was measured by surface usability questionnaire. In previous studies, surface usability was gained through semantic scale. This method was developed by Hassenzahl in 7 aspects: intelligibility, predictability, clarity, dependability, controllability, familiarity [22]. In fact, emotion was also an important factor that affected UE, such as pleasure, innovation, impression and fun. Taking all of these into account, 11 items would be used to measure.

The dependent variable would be influenced by plenty of other aspects. In this experiment, interfacial elements, interactive action, results of feedback were all the same, to shield the UE differences caused by them. Thus, feedback mode could be regarded as the main reason for perceptive diversity.

C. Material

Materials were three groups including six interfaces designed on independent variables and controlled variables. Each interface corresponded to one feedback mode. Experiments were performed on the same mobile phone, with 4.3 inch IPS screen, which had a resolution of 1280 * 720 pixels, 342 ppi per inch.

D. Task and Procedure

Participants were first made to read an information sheet outlining the aim of the study. By agreeing to participate, a demographic form was filled. The main study was conducted in the second part. In this part, participants needed to enter the Task 1 according to the cue on the interface, tap the number "1" that appeared randomly on the screen. By this time, the background of the number changed from 10% black to 60% black directly. This task was repeated 10 times, in order to deepen the experience of feedback. When Task 1 was finished, participants had to give a ranking score on printed questionnaire for the stimulus they had just felt to its feedback effect. Task 2 was a contrast experiment with Task 1. The only difference between them was the gradient feedback mode with ink-rhyme effect. Task 3 and Task 4 were for "press". The interface background of the former one deepened directly with the confirm button's appear, tapped "OK" to go on the experiment. The latter one inherited from the gradient mode. In sliding experiments, the sequence of "1-2-3-4-5" appeared randomly, which required participants to connect numbers in sequence. Feedback modes of Task 5 and Task 6 were flat and gradient feedback.

In order to exclude the influence caused by position and order, controls and tasks appeared randomly in the experiment.

E. Results

Measure of concentricity and difference tendency were used here to analyze the general level and discrete case dependent variable. Table 5 was the results of the dependent variable descriptive statistics from UE experiment. It revealed that the experience of gradient was significantly higher than flat's for the average level of innovation, excitement, impression, fun had clear differences between different feedback models. In addition, "press" task was showed stronger sense of operation from gradient feedback, which was not familiar with the users yet. Flat feedback of "slide" task seemed not easy to understand. As a whole, the variance of flat feedback being higher than gradient's, indicated that users' understanding of experience of gradient mode tended to be consistent.

TABLE V RESULTS OF DEPENDENT VARIABLE DESCRIPTIVE STATISTICS

Feedback		Easy-understanding	Clean	Clear	Trust	Control	Familiarity	Easy- operating	Innovation	Excitement	Impression	Fun
Tap Flat	M	4.03	4.34	4.13	3.55	3.97	3.63	4.05	2.52	2.26	2.60	2.44
	D	.891	.393	.604	.578	.513	.942	.484	.472	.415	.408	.578
Tap Gradient	M	4.11	4.24	4.00	3.68	3.97	3.53	4.03	3.21	3.05	3.37	3.21
	D	.475	.348	.378	.438	.621	.472	.459	.387	.430	.563	.333
Press Flat	M	3.66	3.37	3.50	3.71	3.16	3.39	2.87	2.87	2.32	3.08	2.50
	D	.909	1.13	.893	.956	.973	.887	.906	.777	.739	.784	.604
Press Gradient	M	3.79	3.61	3.89	3.76	3.68	2.84	3.50	4.13	3.95	4.08	3.87
	D	.843	.887	.863	.751	.775	.823	.797	.529	.567	.587	.529
Slide Flat	M	3.71	3.52	3.53	3.61	3.13	3.59	3.08	2.95	2.84	2.97	2.79
	D	1.08	.905	.797	.840	.874	.791	.831	.700	.515	.459	.711
Slide Gradient	M	4.03	3.74	3.89	3.76	3.50	3.63	3.61	3.76	3.71	3.87	3.74
	D	.459	.632	.475	.402	.635	.347	.786	.294	.427	.388	.415

M stands for Mean; D stands for Variance

Although the 11 items covered nearly all aspects of the UE, they were likely to have ranging overlap. Consequently, principal component analysis was applied to extract factors from three sets of data. Expression of principal component was obtained after rotation of Varimax with Kaiser Normalization, which is a kind of data rotation method. The results were as follows in Table 6. From the table, we can

 ISBN: 978-1-61208-306-3

know that at the tapping comparative experiments, four pairs of factors (innovation, excitement, impression, fun) had a high degree of positive correlation with Factor_1, which was named emotional factor as it reflected the emotional experience of users. Three pairs of factors (control, easy-operating, clean) were found to have positive impact on Factor 2, which mainly showed the operational experience. Rest of items had significantly higher load on Factor 3, which stood for the subjects' cognitive level. Thus Factor 2 and Factor 3 were named operational factor and cognitive factor. In comparative experiments of press and slide, emotional factor had similar state to experiments of tap, but operational and cognitive factors were not apart, indicating that emotional experience of subject was more obvious than the other two.

TABLE VI EXPRESSION OF PRINCIPAL COMPONENT

Gesture	Component Score Coefficient Expression
Tap	FAC_1=-0.098*tap_1-0.046*tap_2-0.045*tap_3+0.057*tap_4+0.052*tap_5-0.119*tap_6+0.040*tap_7+0.281*tap_8+0.276*tap_9+0.279*tap_10+0.295*tap_11;
	FAC_2=-0.184*tap_1+0.326*tap_2-0.037*tap_3+0.096*tap_4+0.382*tap_5-0.006*tap_6+0.375*tap_7-0.032*tap_8+0.000*tap_9+0.058*tap_10-0.030*tap_11;
	FAC_3=0.652*tap_1-0.001*tap_2+0.487*tap_3+0.230*tap_4-0.142*tap_5+0.©214*tap_6-0.118*tap_7-0.006*tap_8+0.017*tap_9-0.086*tap_10-0.068*tap_11;
Press	FAC_1=0.258*press_1+0.222*press_2+0.216*press_3+0.201*press_4+0.17*press_5+0.21*press_6+0.132*press_7-0.054*press_8-0.054*press_9-0.025*press_10-0.025*press_11
	FAC_2=-0.083*press_1-0.044*press_2-0.002*press_3-0.022*press_4+0.045*press_5-0.18*press_6+0.081*press_7+0.259*press_8+0.268*press_9+0.222*press_10+0.258*press_11
Slide	FAC_1=0.243*slide_1+0.261*slide_2+0.180*slide_3+0.146*slide_4+0.210*slide_5+0.236*slide_6+0.176*slide_7-0.076*slide_8-0.072*slide_9-0.078*slide_10-0.059*slide_11;
	FAC_2=-0.075*slide_1-0.092*slide_2+0.017*slide_3+0.042*slide_4-0.045*slide_5-0.111*slide_6+0.041*slide_7+0.269*slide_8+0.294*slide_9+0.289*slide_10+0.274*slide_11;

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization

Combined with the results of descriptive statistics, emotional experience of gradient mode was clearly stronger than the flat one, namely, users considered gradient feedback more innovative and interesting, to create more passion and leave deeper impression. In contrast with experiment of tap, users thought there was no difference of operational and cognitive experience according to two feedback modes. Compared to experiment of press and slide, users got better cognition, but poorer operational experience of flat feedback than the gradient one. It is believed that the impact on UE of two different feedback modes was mainly focused on emotional experience. The gradient feedback improved UE to some extent, meantime, it increased users' cognitive load, which was primarily caused by unfamiliarity.

V. DISCUSSION

The overall objective of this paper was to investigate the relationships between cultural factors in interactive systems and UE. In review of related work (Section 2), the application of cultural factors in design was considered as deep sense of users' behavior or habits expressed by sensory effect directly or indirectly. In study 2 (Section 4), ink-rhyme effect was applied to mobile interactive feedback model, the results proved that interaction with cultural meaning feedback had an impact on the UE. On the emotional experience, the cultural element had a positive influence, but no significant improvement of operational experience. The application of cultural factors was so creative that it was unfamiliar to users, as a result, it caused some cognitive burden.

UE is a complex sensory, consists of a comprehensive experience, which is highly susceptible to environment, users' emotions and external factors. Emotional experience serves as one of the most important parts of UE; however, traditional human-computer interaction research is still concentrated upon functional usability [23]. With increasing concerns about emotional experience [24][25][26], feedback integrated with cultural elements has been proved to have better emotional experience. All of these offer much food for thought and different choices to designers. Combining cultural factors to interaction will help users to understand their cultural images, significance, stories and emotion [27], as well as usability.

VI. CONCLUSION

In this paper, two studies were used to evaluate the relationships between feedback of cultural meaning and UE. Study 1 helped to extract typical gestures those were familiar to users. Study 2 was the experiment of UE measurement, which made us understand the complex relationships between feedback of cultural meaning and UE.

The results showed that gradient mode had a positive correlation with emotional experience, users thought it more innovative and interesting in creating more passion and leaving deeper impression. Data also suggested that the integration of cultural factors did not affect the operational experience of interaction, but added a certain amount of cognitive load, which primarily caused by unfamiliarity.

The direction of further research will focus on the application of ink-rhyme to practical interactive systems, which will be investigated in more complex interaction processes. We also hope to expand cultural factors to have a method or model to extract the elements from culture.

ACKNOWLEDGMENT

This paper was supported by high-level international course construction project of Huazhong University of Science and Technology and Fundamental Research Funds for the Central Universities (2013QN011).

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 ISBN: 978-1-61208-306-3