A Tactile Emotional and Sensory Study on Generative Textures of Product Design

Kai-Wei Hsieh*, Yinghsiu Huang**

** Kai-Wei Hsieh, Department of Industrial Design, Tung-Hai University, Taiwan, reddo74@yahoo.com.tw*

*** Yinghsiu Huang, Department of Industrial Design, National Kaohsiung Normal University, Taiwan, yinghsiu.huang@gmail.com*

Abstract: People sense and their preferences and uses of product through various sensory perceptions such as visual, auditory, and tactile senses. However, the operation and design of products primarily considers visual cognition and feelings. Moreover, apart from addressing tactile design concepts that assist visually impaired people, there are currently a substantial number of products that require the consideration of tactile concerns in product design. For example, smart phones and cases, handheld tool handles, bicycle handlebars, and ball grips. The surface texture not only affects the comfort, but it also has affects the function and use of a product. Because people generally rely on visual senses and neglect tactile senses, they tend to underestimate the ability of tactile senses to convey sensory information. Regardless of whether a person is visually impaired or otherwise, all people are dependent on their tactile senses because it allows them to perceive the attributes of an object, such as its material, shape, and size. When using a product, various perceptual senses are interactive, the process of which involves a series of complex physiological and psychological activities comprising primarily sensory and cognitive processes. Cognitive models further to response action are a process of message passing and handling.

Keywords: tactile images, smart phone, emotional design, semantic differential, sense of texture

1. Introduction

Tactile sense is the most important function of the skin because it allows people to feel objects and environmental conditions. People can feel heat, cold, pain, and touch because their cutaneous receptors generate a feeling upon contact with a stimulus. The cutaneous receptors react when an object comes into contact with the body and it assists people in determining the shape, size, and texture of an object, as well as whether an object is mobile, stationary, or versatile. However, in the process of product design, the majority of product design considerations concern the model and function, and the sense of touch is showed through different materials; However, the particle size, depth, shape, and density of a product surface causes various tactile responses. In the field of generative design, people design products by using 3D software applications such as “Rhinoceros” to generate various 3D graphics. Certain studies on product design have modified various parameters to create various product models. However, few studies have discussed the tactile sense, whereas studies related to the application of emotional imagery are popular. In addition, the visual senses are a very crucial source of acquiring information; thus, the research of the visual perception typically focuses on visual imagery. However, people receive experience in addition 65% from the visual sense, as well as 10% from the tactile sense; therefore, this

study focuses on tactile aspects of product design to fill this research gap.

This study discusses how to apply lines and roughness to a surface after computer parameterization to examine users' tactile feelings of various lines. In addition, we the collection of related adjectives about tactile senses is included. The purpose of this study is to examine how the texture of a product's surface corresponds with a user's feelings and preferences of tactile perception. This study uses the software application "Rhinoceros" to generate various surface lines, and conducts a tactile cognitive experiment to elucidate the relationship between product surface and user preference.

2. Literature Review

This research main is from hand Department tactile identification form features of views, discussion products form features and user contact by cognitive found of relationship, and the literature review discusses three primary concepts. First, we examine user hand Department tactile touch products of form features of psychological cognitive relationship sexual. Second is from hand Department tactile fundamentals do discussion, from Physiology and human workers learn area to, tactile sensory in physiological Shang of basic characteristics with identification objects of principle, and finishing tactile related both of research. Third we examine case studies of smart phone users to identify user preferences for surface textures.

2.1 Human Sensation

A sensation occurs when the body's internal or external environment experiences a state of change, and human both inside and outside of message and stimulus and produced feel, and collection these message of device called receives Manager, this is nerve cells to due to should purpose and special differentiation out, and Dang from receives Manager convey to central nervous system last by brain made appropriate of explained, individual by body sensory (ear, and accounts, and mouth, and nasal, and skin,) and environment in the of stimulus contact Shi by collection to of information, turn distinguished out the stimulus features of course (Zhang, 2009). People experience feelings based on their perceptions of sight, hearing, smell, taste, skin sense (touch, pressure sensation, pain, temperature, sleep, etc), balance, and motion, all of which comprise seven senses. The sensory system can assist people in perceiving varying forms and degrees of stimulation. Upon achieving a threshold of intensity (such as radio voice to reach certain intensity can hear above), a person experiences feelings. Emotional feelings refer to the ability of the sensory acceptance, which is referred by sense impressions. The sense of feeling can be described as identifying or being stimulated by a specific quality or texture. A feeling contains special properties associated with a material, and the human sense of the surface after processing. In other words, texture refers to material objects based on qualities such as color, gloss, texture, weight, thickness, transparency, and other external characteristics. Is caused by a sense of texture, but in visual art, human use of transfer by the tactile experience with a different visual perception of texture. Dang hand mouse, and light knocking keyboard, and browse computer screen Shang of picture Shi, hand will "feel" to mouse and keyboard of exists and they of surface trait, eyes also will was screen picture of stimulus and "feel" to picture in the objects of exists, aroused these feel of main factors is as mouse and keyboard, objects above of "is texture" (actual texture) and screen picture of "mimicry texture" (simulated texture), again plus artist imagine in the of " Fictitious texture "(invented texture)

into three. Texture is a real thing; that is, it looks and feels like a real surface. Mimicry texture refers to an elaborate simulation of a textured surface, and could refer to any type of surface that be reproduce specific characteristics of light, shade, and reflection. Imaginary sense refers to a texture that there is no entity reference can be created out of the texture; it is a texture that is created entirely from the imagination of an artist.

2.2 Touch as an adjective

Tactile perception is any sensation that is experienced through the skin (including pain, pressure, and temperature) and is based on previous experiences surface particle density, thickness, and sharp-edged, soft and hard, shape, arranging objects and quality level and surface temperature, will affect the tactile sense of the nature of the object. A person's visual perception is typically defined through their experience, and it is derived from a visual effect. If there is a visual experience, direct access to the Visual textures. Tactile sensations occur when a person's skin comes into contact with a surface, such as when using a product, often through the knuckles of the hand or finger touch to receive messages back. Haptic (tactile sensations) and feel (pressure), refers to objects that place pressure on the surface of the skin, or the feeling of touching, press sleep again three segments (Richard Levinson, 1991). The sensation of touch is a tactile response to energy within an area beneath the surface of the skin, which is caused by irritation. Stress is the tactile response of the skin within a specific area, and it is caused by secondary stress. Compared with the sensation of touch, stress can last a long time, it can be strong, and it requires only a minor effect to cause a substantial change to a comparatively large area. The sensation of shaking is caused by rapidly repeating signals. Regular contact can be categorized as (a) active touch, which describes an action such as reaching out to touch objects, and (b) passive touch, which describes pressure caused by an object placed against the skin. When a person's finger touches an object, they can determine the shape of the object, which is called an entity. Tactile and pressure sensations on the morphology of the correct knowledge, subject to many restrictions, the most simple circle with a triangle, for example, and cognitive patterns 4–5 seconds, the correct rate of 80% and morphology of most often mistaken for square. NPCs generally rely on their visual senses while ignoring their tactile senses, underestimated Department sleep by can convey feel message of capacity, although it is generally rare for people to rely entirely on their tactile senses to perceive an object's material, shape, or size. Although the tactile senses do not provide visual secondary Xia, another a information receives and passed of secondary tools, to industrial design of angle, dang operation or using equipment Shi, if can through objects surface of material shape size, message to Office General its features differences, would help to improve ease of operation and safety of products.

2.3 Kansei Engineering Research

The semantic differential method is used to contrast and assess bipolar adjectives, which can be measured based on a person's reaction to an object or concept. It is a method for studying perceived meaning, and usually refers to how people understand sensory or psychological concepts, is a common sense research, when my door some sort of sensory stimulation ten feeling. The primary purpose is to assist researchers in understanding a concept, image, or feeling, and it is usually applied to evaluate measured data. When attempting to understand the meaning of sensual language, the process is met with the construction of the entire concept of the system and address the

complexity of perceptual language when evaluating methods, as constructed design concept sensuous language meaning data library system interface of the foundation; thus, the process involves the evaluation of semantic concepts and expressions.

3. Research Methodology

To achieve the objective of this study, we have divided the methodology into following three steps (shown in Fig.1): (a) identify various types of surface textures; (b) identify descriptive tactile vocabulary; and (c) conduct experiments to measure the cognition of the tactile senses. First, we use the 3D software application "Rhinoceros" to produce objects of various sizes, depths, shapes, densities, and lines. We employ surface textures and rapid prototyping output for the subsequent experiments. Second, based on the literature review, we employ a survey to collect data for 24 representative tactile imagery adjectives, semantic differences (SD), and conduct the experimental assessment of tactile perception. Third, we parameterize the entity CNC surface texture, SD the semantics differences in law, to assess how the participants perceive various lines, and then assess their usage of tactile adjectives. Finally, further analysis of the various patterns and user preferences relationship. Currently, the contact material, in the case of not via visual aids, simply based on the tactile experience of the material associative relationship adjectives. Finally, by comparing the aggregate association results of the questionnaire, we can determine which factors might assist in the design of products, thereby providing a reference for future researchers and product designers.

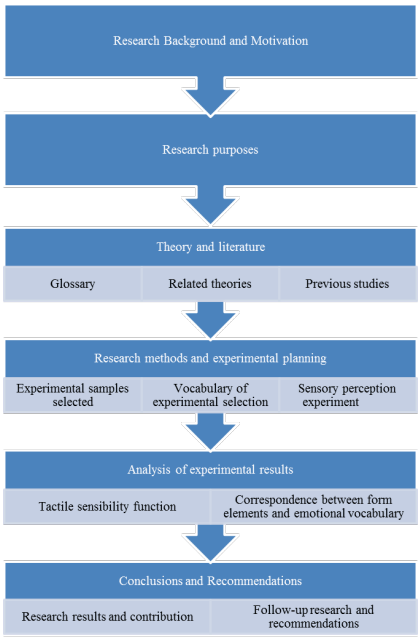

Figure.1 Research flowchart

3.1 Survey respondents

Smartphone ethnic interviewed face-to-face SD between abnormal survey questionnaire tactile touch cognitive experiments. The research sample comprised 20 people (10 men and 10 women). The degree of the strength of the feeling on the adjective shows the inner substance of imagery feelings.

3.2 Derivative Design Samples

The survey sample: We used Rhinoceros to produce nine different lines with various particle sizes, depths, shapes, and surface densities; CNC Rapid Prototyping output entity. Entities to produce samples with new samples by the intersection of the chosen shape and material characteristics to clarify the form of the materials and the overall image of the association; therefore, by selecting the strongest combination of morphological features, the presentation of each image and the subsequent material analysis can be easily, size and shape, the center position, radius size, density considerations, and different surface depth lines, considering the area of the contact normal subjects hand, it is 6 x 12 cm thickness 2 mm-generation wood substrate at the surface to produce different tactile texture in school factory the CNC production entity sample.

3.3 Representative Adjectives

Physical level: the feelings are divided into sensory and susceptibility to memories of previous experience; that is, when people come into contact with a surface, through association, by various physical properties of the material of the sense organs feel turn produce their feelings. Psychological level: in the shape of composition used by the different texture of the material texture, shape the visual or tactile feeling is also different, because the texture of the material or the texture changes a person's psychological and emotional response.

A. Hold the level of physical

(1) Smooth–rough

(2) Awkward–comfortable

(3) Sharp–sleek

(4) Rough–delicate

(5) Geometry–organic

(6) Lively–dull

B. Gripping psychological level

(1) Warm–cold

(2) Nasty-Favorite

(3) Rational–emotional

(4) Masculine–feminine

(5) Cheap–advanced

(6) Casual – formal

The SD difference analysis examines the adjective groups by using a 5-point Likert scale (1 = strongly disagree, 5 = strongly disagree) to elucidate the feelings of the experimenter of mixed material samples divided from left to right. Establish a correspondence between morphological characteristics of the discussed image words, including the contribution of the morphological characteristics of the image, the relationship between the degree of morphological characteristics and preferences, visual imagery related to predicting the sample imagery. Summarize how previous researchers have described the shape and material by using the vocabulary of imagery by sorting the vocabulary of descriptive morphology and material lines image. In this study, direct reference to the recent the township shut institute sensual vocabulary and summarizing as experiments of this study. In this study, in the form of material imagery vocabulary of selected respectively reference Lui (2002), the difference of visual

and tactile imagery - plastic bite spent an example and Choy (2004), as the, acumen morphology and material on the product image impact, the preliminary screening adjectives. The vocabulary extraction principle is selected vocabulary differences to a large, tactile imagery suitable descriptive. Dominated by the party's main vocabulary, contrary or different vocabulary selected from the other reference vocabulary in order to understand the subject's preferences circumstances, adding "like" vocabulary.

4. Experimental Rules

Nine samples were placed in a black box, and the 20 participants were requested to touch each evaluation, and then each person touch a single sample to feel the tactile image, and the image words.

4.1. Tactile Samples Adjective Analysis

The questionnaire was designed to assess each participant's perceptions of specific textures, and the results were compared using a one-sample *t* test based on the adjective ratings. Table.1 (1–5) shows the designed sample case, and the adjective group used for the *t* test. The test used three dark gray bottom, and the level of significance was set at $p = .01$. In the case of each design, the *t* test considered the top three groups of adjectives. The top three responses for Case 1 are Q1 (rough–smooth), Q2 (sharp–sleek) and Q7 (awkward–comfortable). The top three responses for Case 2 are Q2 (sharp–sleek), Q3 (geometric–organic), and Q4 (cold–warm). The top three responses for Case 3 are Q2 (sharp–sleek), Q5 (rational–emotional), and Q11 (masculine–feminine). The top three responses for Case 4 are Q2 (sharp–sleek), Q7 (awkward–comfortable), and Q8 (rough–delicate). The top three responses for Case 5 are Q2 (sharp–sleek), Q3 (geometric–organic), and Q4 (cold–warm). The responses for Cases 2 and 5 included less than three negative feeling more strongly tactile products.

Table.1 Single Sample t test of Design Cases 1–5





	sample 01			sample 02			sample 03			sample 04			sample 05		
	mean	t-test	Sig. (2-tailed)	mean	t-test	Sig. (2-tailed)	mean	t-test	Sig. (2-tailed)	mean	t-test	Sig. (2-tailed)	mean	t-test	Sig. (2-tailed)
Q1	4.50	13.077	.000*	2.85	-.590	.562	2.70	-1.064	.301	4.15	5.205	.000*	2.00	-4.595	.000*
Q2	4.75	14.226	.000*	1.10	-27.606	.000*	2.25	-6.097	.000*	4.65	15.079	.000*	1.30	-16.170	.000*
Q3	3.40	1.285	.214	1.30	-13.309	.000*	1.75	-5.000	.000*	3.95	4.790	.000*	1.65	-6.899	.000*
Q4	4.10	6.850	.000*	1.50	-9.747	.000*	2.00	-5.627	.000*	3.90	5.604	.000*	1.50	-13.077	.000*
Q5	4.05	6.185	.000*	2.50	-1.949	.066	1.30	-16.170	.000*	3.75	4.628	.000*	2.30	-3.390	.003*
Q6	3.00	.000	1.000	2.85	-.900	.379	3.35	1.505	.149	3.40	2.990	.008*	2.90	-.567	.577
Q7	4.35	9.000	.000*	1.80	-7.712	.000*	2.60	-2.629	.017	4.30	6.296	.000*	2.00	-4.359	.000*
Q8	3.70	3.907	.001*	2.35	-2.221	.039	2.65	-1.584	.130	4.25	6.571	.000*	2.45	-1.993	.061
Q9	2.25	-3.470	.003*	2.30	-3.621	.002*	3.50	2.032	.056	2.05	-3.866	.001*	2.55	-1.831	.083
Q10	3.65	3.901	.001*	2.35	-2.942	.008*	3.35	1.926	.069	4.05	6.185	.000*	2.50	-2.703	.014
Q11	3.65	5.940	.000*	1.70	-7.935	.000*	1.80	-6.439	.000*	3.90	5.107	.000*	1.95	-6.842	.000*
Q12	2.05	-5.596	.000*	2.85	-.825	.419	3.60	2.449	.024	2.35	-3.577	.002*	2.75	-2.032	.056

Table.2 shows the *t* test results for Design Cases 6–10. The top three responses for Case 6 are Q4 (cold–warm), Q5 (rational–emotional) and Q10 (hate–favorite). The top three responses for Case 7 are Q2 (sharp–sleek), Q8 (rough–delicate), and Q10 (nasty–favorite). The top three responses for Case 8 are Q2 (sharp–sleek), Q4 (cold–warm) and Q7 (awkward–comfortable). The top three responses for Case 9 are Q2 (sharp–sleek), Q5 (rational–emotional) and Q10 (hate–favorite). Cases 6 and 9 just in the middle of the value of feeling are less obvious factor.

Table.2 Single Sample t test for Design Cases 6–9




	sample 06			sample 07			sample 08			sample 09		
	mean	t-test	Sig. (2-tailed)	mean	t-test	Sig. (2-tailed)	mean	t-test	Sig. (2-tailed)	mean	t-test	Sig. (2-tailed)
Q1	2.90	-.384	.705	4.20	4.857	.000*	1.95	-4.472	.000*	2.90	-.317	.755
Q2	2.95	-.295	.772	4.25	6.571	.000*	1.45	-11.461	.000*	3.50	2.703	.014
Q3	2.50	-1.751	.096	3.45	2.015	.058	2.25	-3.000	.007*	2.85	-.471	.643
Q4	2.50	-2.517	.021	3.75	3.135	.005*	1.80	-7.712	.000*	2.75	-1.157	.262
Q5	2.30	-2.774	.012	3.80	3.387	.003*	2.30	-3.199	.005*	2.55	-1.831	.083
Q6	3.50	2.703	.014	3.60	3.040	.007*	2.95	-.224	.825	3.40	1.633	.119
Q7	3.10	.384	.705	3.95	4.046	.001*	2.05	-5.596	.000*	3.05	.181	.858
Q8	2.85	-.590	.562	4.50	8.816	.000*	3.15	.497	.625	3.20	.777	.447
Q9	3.00	.000	1.000	2.80	-.809	.428	2.45	-2.773	.012	2.85	-.679	.505
Q10	3.50	3.249	.004*	3.95	5.596	.000*	2.85	-.767	.453	3.45	2.438	.025
Q11	2.55	-2.438	.025	3.80	4.000	.001*	2.25	-3.943	.001*	3.05	.237	.815
Q12	3.55	2.342	.030	2.45	-2.065	.053	3.15	.719	.481	3.45	1.690	.107

4.2 Additional Tactile Adjectives

The *t* test results show that the statistically significant adjectives are marked with a V in Table.3. The table shows that each sample has several significant adjectives. Every adjective in several samples were statistically significant, and illustration. Following the analysis for each designed case, each adjective group that had significant factor was organized into Table.3. In 12 adjective groups, Q6 (cheap–advanced) and Q12 (casual–formal) were non-significant; thus, smart phone users do not consider these two factors to be important as the tactile product qualities for Q2 (sharp–sleek), Q4 (cold–warm), and Q11 (nasty–favorite). In nine cases, seven cases were statistically significant. The analysis from a direction perpendicular to Table.3, we can see each case in each adjective group's remarkable design Case 6 and Case 9. The 12 adjectives group is less than five, whereas the remaining are greater than five, said this study use tactile designed case has a certain significance, smartphone users from the case or see the tactile style mode.

Table.3 significant analysis

	Case 01	Case 02	Case 03	Case 04	Case 05	Case 06	Case 07	Case 08	Case 09	
Q1	v			v	v		v	v		5
Q2	v	v	v	v	v		v	v		7
Q3		v	v	v	v			v		5
Q4	v	v	v	v	v		v	v		7
Q5	v		v	v	v		v	v		6
Q6							v			1
Q7	v	v		v	v		v	v		6
Q8	v			v			v			3
Q9	v	v		v						3
Q10	v	v		v		v	v			5
Q11	v	v	v	v	v		v	v		7
Q12	v			v						2
	10	7	5	11	7	1	9	7	0	

4.3 Discussion

The semantic differential method used in this study evaluated various samples of nine touch. The analysis shows that Q2 (sharp–sleek), Q4 (cold–warm), and Q11 (hate–favorite) has most often qualities, whereas Q6 (cheap–advanced) and Q12 (leisure–formal) with the product than unrelated. On the other hand, the participants were interested in various design case assessment. Among the 12 adjectives used to nine cases, seven cases were statistically significant. However, only for smartphones shell in this study as a representative product of tactile style, and proposed an analytical products tactile style mode. Future research should consider employing this framework based on the tactile style of other product types to develop a more complete product tactile style mode.

This study proposes tactile form of identification on product style, product prototype phenomenon. Whether the reason for the previous product style identification is just from the form, when linked to the identification of the tactile style retains the style of the prototype concept or licenses more widely explored tactile style and design style relationship touch to recognize the faces of members of the design style, tactile style applications in the broader field can be continued in future studies

5. Conclusion

The results of this study propose a set of computer parameterization to generate the degree of surface lines and roughness, and through users' direct touch of an object's surface to analyze the relation between the surface lines and preference of tactile perception. The relation between tactile sense and products is a critical concept regarding the use of a product; thus, this study can be used as a reference for product designers. The research results of this study can be used as reference basis and influence the perceptive on the tactile user interface and product orientation relationship in the industrial design field.

Limitations of the study: (1) human message pipe there are many, but the product form image sensory, visual and tactile cognitive model different styling features for the same product, the perceived image differences. Still visually dominated; (2) to fully understand the product form elements and emotional relationships, and the corresponding relations used in design practice, it is based on Kansei engineering method, and anticipates to identify the relationship between factors that influence product images; (3) tactile experiments must actually touch ready-made objects to tactile information, given time, manpower limitations, geographical and funding for some

special material and shape of the cell phone shell samples achieved however, there are still difficulties.

Based on the findings of this study, we offer the following recommendations for future research: (1) in this study, smartphones shell typical products, explore tactile style, and proposes a mode of analysis products tactile style. Future studies that employ this framework should examine tactile styles of other types of products to construct a more complete product tactile style mode; and (2) the proposed tactile form of identification on product style, product prototype phenomenon. Whether the reason for the previous product style identification is just from the form, when linked to the identification of the tactile style retains the style of the prototype concept or licenses more widely explored tactile style and design style relationship touch to recognize the faces of members of the design style, tactile style applications in the broader field can be continued in future studies.

ACKNOWLEDGMENTS

The research was sponsored by the National Science Council (NSC-100-2511-S-017-007-MY2). We thank the NSC for partially funding this research and for providing the resources required to complete this paper, as well as all of the participants who provided their user experiences for this project.

6. Reference

[1] Li venson (1991), *anatomy and physiology, China apricot Press,* Taipei in Chinese.

[2] Li Jiaxun (2002), *the interactive media - explore sensory multi-modal interface design of man-machine interaction in digital design environment and application examples, Thesis, National Cheng Kung University Institute of Architecture.* in Chinese.

[3] Hsieh Cheng-Feng (2002), *the product form property features user sensory imagery - a mobile phone, for example. Thesis, National Yunlin University of Science and Technology, Institute of Industrial Design* in Chinese.

[4] Lui Ming Quan (2002), *visual and tactile imagery differences - plastic etching, for example, Master Thesis, Institute of Industrial Design, National Cheng Kung University* in Chinese.

[5] Jong-Shyong Chen (2004), i*ntegration of generative systems in case-based system designed for mobile phones. Thesis, National Yunlin University of Science and Technology, Institute of Design Computing* in Chinese.

[6] Choy encyclical (2004), *depending on the shape and materials of the tactile impact of product imagery. Thesis, National Yunlin University of Science and Technology, Institute of Industrial Design* in Chinese.

[7] Chung Yeh (2004), *the hand tactile morphological feature recognition and orientation cognitive relations, Thesis, National Yunlin University of Science and Technology Industrial Design Institute* in Chinese.

[8] Lindong Long, Zhang Wenyu (2005), *the mixed material as the tactile differences. Kaohsiung Normal University* 2005,19,1-15. in Chinese.

[9] Luo Yiling (2006), *the hand of the elderly tactile roughness distinguish, relationship. Thesis, National Yunlin University of Science and Technology, Institute of Industrial Design.* in Chinese.

[10] Lin Jiajun (2007), t*he relationship between tactile morphological characteristics and operating direction of cognitive research. Thesis, practice and Design Institute of Architecture.* in Chinese.

[11] Wu Zheng Bin (2007), *application vibrator design tactile messages by mobile communications device. Thesis, Institute of Industrial Design, National Cheng Kung University.* in Chinese.

[12] Pan Yanjun (2007), *a pressure-sensitive dynamic cortex - the tactile nature of design media dynamic architectural space. Thesis, National Yunlin University of Science and Technology, Institute of Design Computing.* in Chinese.

[13] Chen Ying River (2007), *the use of information marked to enhance tactile map identification performance studies. Thesis, Institute of Industrial Design, Tatung University.* in Chinese.

[14] Shi Yuliang (2008), *the use of the the parametric feature Knowledge Base automation derivative design. Thesis, National Yunlin University of Science and Technology, Institute of Industrial Design.* in Chinese.

[15] CHEN Yu Cheng (2008), *the disadvantaged groups Product tactile cognitive design evaluation of the case study. PhD thesis, National Cheng Kung University Department of Industrial Design.* in Chinese.

[16] OF INTEGRATED (2009), *the visually impaired recognition of tactile figures. Thesis, Institute of Industrial Design, Tatung University.* in Chinese.

[17] Du Mingrui (2009), *the visually impaired action tactile maps and navigation message design. Thesis, Institute of Industrial Design, Tatung University.* in Chinese.

[18] Zhang Chunxing (2009), *modern psychology: modern scientific study their own problems.: Donghua.* in Chinese.

[19] Weibo Lun (2009), *tactile memory of creative research. Thesis, Institute of Industrial Design, Tunghai University.* in Chinese.

[20] Chen Junjie (2009), *product modeling imagery knowledge base with automatic derivative system. Thesis, National Yunlin University of Science and Technology, Institute of Industrial Design.* in Chinese.

[21] The Jack (2009), *the study of the impact of the grooves for tactile symbols recognition performance, Thesis, Tatung University Industrial Design Institute*. in Chinese.

[22] Zhang Yao (2010), t*he product of tactile style - grip cup. Thesis, Institute of Applied Arts, National Chiao Tung University.* in Chinese.

[23] Lin ten thousand (2011), *electric tactile mouse and visual feedback of the study of interactive devices. Thesis, National Chiao Tung University Institute of Precision and Automation Engineering Program special class.* in Chinese.

[24] Su Yi Xiang (2011), *folder hanging Bluetooth headset tactile interface applicability. Thesis, Mingzhi University of Science and Technology of Industrial Engineering and Management Institute.* in Chinese.

[25] Chen Zihao (2010), *free forms the epidermis manufacturing improvements. Thesis, National Chiao Tung University Institute of Architecture.* in Chinese.

[26] Huang Shengyang (2011), *scale variation in systems integration - construction of the qualitative and quantitative design methods as the interface of people and the environment integrated design strategy. Thesis, National Chiao Tung University Institute of Architecture.* in Chinese.