Tactile Image of Different Grasp Types on Rubber Texture Pattern

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This is a generation that emphasizes five-sense experience, we would buy something or not base on real sense experience. The “Hand-touch” products are very popular in recent years, it includes hand-made products or variable texture, that means tactile sense has become more important, and it can bring us some emotions by real touching. It’s worth to discuss the correlation between tactile sense and kansei image. According to the references, material’s texture was related to image, so this study discusses the correlation between texture pattern’s variation and tactile image on rubber handlebar. On the other hand, people use different hand motions while operating the products, but is there a difference to the texture image in different movements? The study is aimed at the tactile image difference between “Fingertip Grip” and “Whole Hand Grasp”.

First of all, define the factor of texture pattern constructions depend on references, include shape, size, configuration, density and concave-convex type, then use “Design of experiment” method to produce sample and make rubber mockup sample. Afterward, use the questionnaire and KJ method to produce 5 final tactile images. Finally, use Paired Sample T test and Quantitative Theory Type I to understand the difference and correlation of two grasp motions. The results of this study:

1. There is no difference to the comfortable, rugged and unique image between two grasp motions, but the reliable and healthy image have significant difference between two grasp motions.
2. The important texture pattern factors of tactile image are unit shape and concave-convex type, furthermore, shape size and configuration are low influence factors.

Key words: Rubber texture pattern, tactile image, grasp types

1. Introduction

This is a generation that emphasizes five-sense experience, people use seeing, touching, hearing, smelling and tasting to feel all of the life, we would buy something or not base on real sense experience(Paco,2009). The “Hand-touch” products are very popular in recent years because the government promotes culture with originality design, it includes hand-made products or variable texture, that means tactile sense has become more important, and it can bring us some emotions by real touching(Wu, Zhao-Yi,2006).

Lu,Ming-Chuan(2002)has ever discuss the correlation between material’s texture pattern and visual-tactile, he use three materials(ABS,PP and Rubber) and six kinds of plastic etching to be the experiment sample, the results showed that, the sense of touch more influential experimental material is rubber. But etching sample is limited by small size, and the pattern has less kinds. Finally, research suggests that for the pattern types for further study.

Therefore, this research hopes to further research product lines to rubber materials and products needed hands to operate for sentimental image of the tactile experience.

2.Literature Review

2.1 Tactile sensation

Tactile sensation is basic sensation of our body, it means the feeling when skin touch something or be afford some object's pressure. When we close the eyes, we could know anything's size, shape, roughness or smooth, soft or hard only by hand touch, People often need to use hand and fingertip touch to receive feedback when use the product. Any parts of hands has difference tactile sensitivity, and skin can determine the minimum separation distance of pressure point is called "Two-point threshold". The fingertip's Two-point threshold is about 1.5mm(Hu, Sheng-Xiong,2004).

Tactile can identify the shape, Chen,Wen-Zhi, You,Wan-Lai (1997) has ever research the radio button shape's tactile identity. The tactile symbols of expression by symbols of depression or a protrusion on the surface and the background plane or wire-frame graphics to texts to be divided into four types: plane-dent, line-dent, plane-bulge and line-bulge. The results showed that, plane-dent and plane-bulge symbols' minimum identifiable width is 4.2mm and 3.7mm.

Frascara(1993) discriminate tactile symbols as point symbol, line symbol and texture symbol, his research gather other scholars' definition: Bentzen (1980) think Point symbols should be difference in shape, size, elevation and outline; Line symbols should be difference in dimension and frequency; Texture symbols should be difference in intensity, density, interval and component. Wiedel and Groves(1969) found that 0.51mm is discriminable elevation for Braille dots, 1.52mm for point symbols, and 1.02mm for line and texture symbols. Frascara(1993) finally sorted out the 11 items of feature classification symbol, include Symbol group, Frequency, Shape, Dimensions, Elevation, Delineation, Configuration, Relationship, Rhythm, Density and Orientation.

2.2 Hand motions

Our hands can do many things, according to the products of different functions and form, we will use different gestures to use the product. Napier(1956) distinguish between human grip posture into Power Grip and Precision Grip, the former refers to the object is gripped by palm and curved finger; the latter refers to the object is squeezed only by fingers. Taylor and Schwartz (1955)distinguish grasp into six types: cylindrical, spherical, hook, fingertip, palmer and lareral。

This study investigated the texture patterns are mostly used by grip, so integrating hand movements literature, define "Fingertip grip" and "Whole Hand grasp," two kinds of tactile way, to understand both in the same objects and patterns, image whether there are differences. Fingertip grip means only simple finger movements, including the thumb and other four fingers of the finger part of the pressure on the objects pinch action; whole hand grasp means both palm and fingers powerful grasp to the objects.

About handle size, Zhong, Yin-Jun (2007) conclude from the literature, 30 ~ 40mm diameter's handlebar and more comfortable, more than 40mm diameter both in force on the handle or comfort are no better. Konz(1990) think the suitable handlebar length is 100~125mm。

This study refer to aboved-mentioned reference definition and classification, as the basis to construct rubber texture pattern and make samples.

3.Methods and Steps

3.1 Choice the Kansei image

Kansei image gathered grip-related adjectives from reference literature and book, initial screening of the 72 vocabulary, then let 32 subjects (age 20 to 35 years old, male 17, female 15) touch three cylindrical handlebar which constituted by the rules of the geometry first, then check for 10 images that suitable describe tactile texture patterns. Finally, choice the one-third of vocabulary, and commission three experts who background with 5 years of industrial design, carry out the KJ method, are the ultimate representatives of 5 images were comfortable, reliable, rugged, healthy and unique.

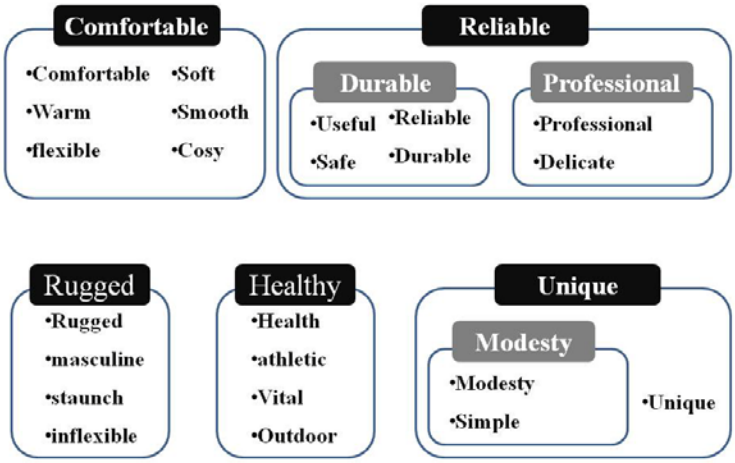


Figure.1 KJ method

3.2 Texture Pattern Construction

Refer to tactile references and observe the existing product's texture pattern style, this study defines five factor items to construct texture pattern: including unit shape, shape size, configuration, density and dent-bulge type.

Unit shape: Because it`s hard to comprehensive discuss three types of shapes(point, line, texture surface), this study aims to explore the surface shapes, select common basic geometric shapes, including circle, oval, triangle, diamond, square, rectangle, which oval-shaped ratio of 1:2 by measure existing handlebar; rectangle in order to different to the square, define ratio of 1:3; diamond was a square rotated 45 degrees. All shapes are non-rounding, but the other two circle and oval shapes, observed on the market often have a different surface of the cambered design, so increased in one of unit shapes.

Figure.2 8 kinds of unit shape

Shape size: The way to fixed every shape dimension the same, divide into two kinds of small and large. Small dimension according to Chen,Wen-Zhi, You,Wan-Lai (1997) research, the face symbol identifiable minimum average about 4mm, so define 4mm diameter circle dimension (about 12.5mm2)as the base; large dimension is double of small dimension, which is about 25 mm2. Because this study discusses fingertip grip and whole hand grip in the same time, the shape dimension should not more than one finger width as principle. Therefore, no longer define the shape of a much larger dimension.

Configuration: Observing existing products, found that there are “rule” and “stagger” two kinds of arrangement. Rule arrangement means each shape of center that arranged aligned, and the gap is caused by smooth lines; Stagger arrangement means second column shape center align in the middle of first column two units, the resulting gap is not smooth.

Concave-convex type: Divided into two types, ”Concave” and “Convex”. This study don’t discuss the height variation, so according to the reference, define concave depth and convex height both are 1mm.

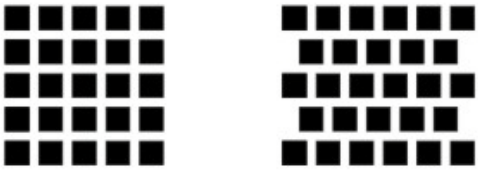


Figure.3 Configuration (Left-Rule ; Right-Stagger)

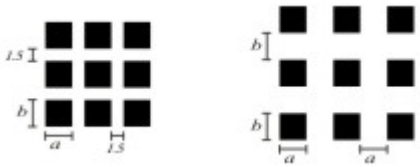


Figure.4 Density (Left-Narrow ; Right-Wide)

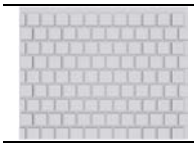
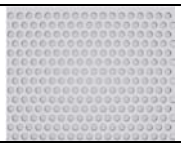
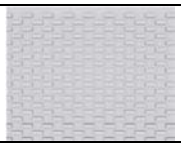
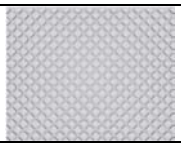
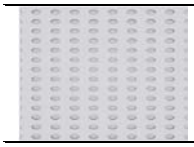
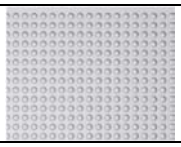
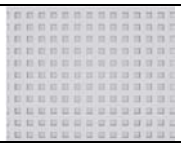
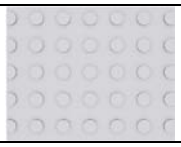
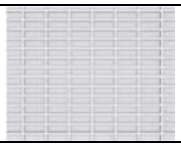
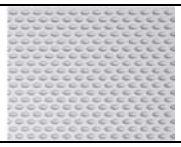
Table 1. Texture pattern construction

Item	Category	
A-Unit shape	A1－Square	A5－Circle
	A2－Rectangle	A6－Oval
	A3－Diamond	A7－Cambered Circle
	A4－Triangle	A8－Cambered Oval
B-Shape size	B1－Small (12.5mm^2)	
	B2－Large (25mm^2)	
C-Configuration	C1－Rule	
	C2－Stagger	
D-Density	D1－Narrow(1.5mm)	
	D2－Wide(same width of unit shape)	
E- Concave-convex type	E1－Convex	
	E2－Concave	

3.3 Make Samples

According to the texture pattern construction, produce 16 samples by “Design of experiment”. In order to increase sample, produce 1 sample of every unit shapes, totally 24 samples, then make 3D model. Every sample is length 100mm, width 80mm and thickness 4mm, then make by CNC, and turn to rubber material.

Table 2. All samples(3D)

1	2	3	4	5	6
					
7	8	9	10	11	12
					
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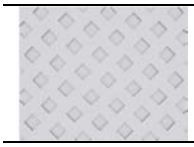
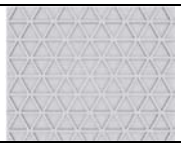
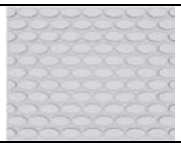
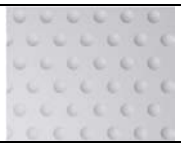
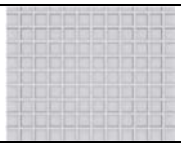
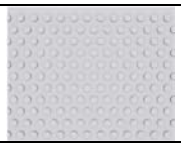
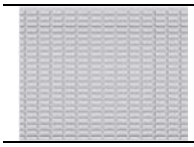
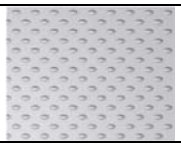
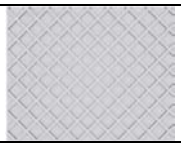
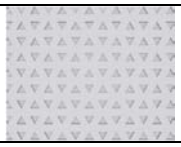
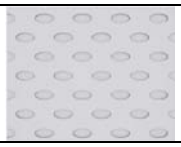
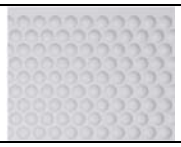
					
19	20	21	22	23	24
					

Rubber’s color is black. Finally, let the completion of rubber affixed cover on the 22mm diameter tube, the completed sample size is diameter 30mm and length 100mm.

3.4 Tactile image experiment

(1)Subjects: Consideration of elder’s tactile sensitivity are lower, this study as 20 to 35 years of age as subjects, including 17 men and women, totally 34 subjects.

(2)Equipment and the Environment: A dark glasses (paste the translucent plastic piece on front side) and a table (length 100cm width 40 cm).

(3)Steps: At first, explain the whole process to the subject, and wear the dark glasses. Then start “Fingertip grip” experiment: just only use fingertips to touch and grip the handlebar, then tell subject one image (ex: comfortable). Divided all samples into high, medium and low three big groups depend on image feeling, and then from all major groups in accordance with the same perception subdivided into three small groups, and finally get the nine-level clustering. Images representing the highest level group get 9 points, followed by 8 points, and so, the lowest level group get 1 point. After every image, subject would take a rest in 2~3 minutes. Finish the “Fingertip grip” part, next start “Whole hand grasp” experiment, use whole hand to powerfully grasp the handlebar, and repeat the follow steps.

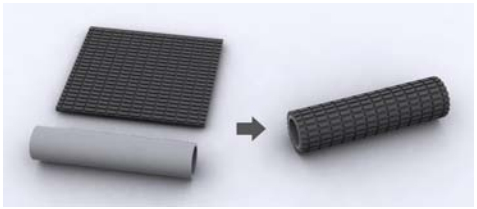


Figure.5 Sample making method

Figure.6 Experimental conditions

4. Results and Discussion

At first, use Paired Sample T test in order to understand the difference of tactile image between Fingertip grip and Whole hand grasp. Next use Quantitative Theory Type I on purpose to clarify the correlation of texture pattern factor and kansei image, then find the most important factor of each image and compare with two kinds of grasp types. Finally use Paired Sample T test again to find significant differences sample from each images, and explore the reasons for the differences.

4.1 The difference of image between grasp types

Turn image evaluative point into Paired Sample T test, the results showed that, different grasp types has significant difference in “reliable” and “healthy” image. Observing the process of experiment, most of subjects spent much time in these two images, conjecture subjects need to think what kind of products to applied, and everybody’s thinking are different, result two kinds of motions have some differences in evaluation criteria. On the other hand, ”comfortable”, ”rugged” and “unique” has no significant difference, subjects spent less time, they could feel and evaluate intuitively, it’s easier to find the evaluation criteria.

Table 3. Paired Sample T test

	Paired Differences					t	Sig.
	mean	Std.	Std.Error Mean	95%			
				lower	upper		
Comfortable	-0.09	0.61	0.13	-0.35	0.17	-0.72	0.479
Reliable	-0.38	0.41	0.08	-0.55	-0.21	-4.51	0.000
Rugged	0.07	0.46	0.10	-0.12	0.27	0.75	0.46
Healthy	-0.25	0.54	0.11	-0.48	-0.02	-2.28	0.032
Unique	0.05	0.40	0.08	-0.12	0.22	0.61	0.548

4.2 Correlation of texture pattern factor and image

Use Quantitative Theory Type I on purpose to clarify the correlation of texture pattern factor and kansei image. The method is deconstruct 24 samples of texture pattern to the form factor as independent variables, the average scores of the experimental evaluation as dependent variables, obtained the relationship between the two. If “R2”more come close to 1，represent the result of image more explainable. If“Partial coefficient of correlation”higher, represent that item is more important. If “Category Score” greater, represent subjects think this category will help to increase the level of image. The category score’s absolute value more greater, then more influential.

Table 4 Comfortable- Quantitative Theory Type I

Item	Category	Fingertip		Whole Hand	
		Category score	Partial c. c.	Category score	Partial c. c.
Unit shape	1 Square	-0.306	0.834	-0.570	0.857
	2 Rectangle	-1.800		-2.178	
	3 Diamond	-1.483		-1.168	
	4 Triangle	-1.308		-1.485	
	5 Circle	-1.154		-0.962	
	6 Oval	-0.161		-0.020	
	7 Cambered Circle	3.347		3.570	
	8 Cambered Oval	2.865		2.812	
Shape size	1 Small	0.239	0.19	0.062	0.053
	2 Large	-0.239		-0.062	
Config-uration	1 Rule	0.467	0.348	0.356	0.287
	2 Stagger	-0.467		-0.356	
Density	1 Narrow	-0.072	0.058	-0.311	0.259
	2 Wide	0.072		0.311	
Concave-convex	1 Convex	-0.807	0.544	-0.737	0.533
	2 Concave	0.807		0.737	
		R =0.846 R^2 = 0.716 constant=4.877		R =0.868 R^2 = 0.753 constant =4.967	

Table 5 Reliable- Quantitative Theory Type I

Item	Category	Fingertip		Whole Hand	
		Category score	Partial c. c.	Category score	Partial c. c.
Unit shape	1 Square	-0.227	0.563	0.036	0.67
	2 Rectangle	0.925		1.068	
	3 Diamond	0.577		0.399	
	4 Triangle	0.546		0.5	
	5 Circle	0.195		0.665	
	6 Oval	-0.075		-0.171	
	7 Cambered Circle	-0.98		-1.309	
	8 Cambered Oval	-0.962		-1.188	
Shape size	1 Small	0.025	0.026	0.044	0.049
	2 Large	-0.025		-0.044	
Config-uration	1 Rule	-0.015	0.016	0.052	0.058
	2 Stagger	0.015		-0.052	
Density	1 Narrow	0.773	0.626	0.799	0.669
	2 Wide	-0.773		-0.799	
Concave-convex	1 Convex	0.673	0.572	0.849	0.69
	2 Concave	-0.673		-0.849	
		R =0.788 R^2 = 0.621 constant =4.678		R =0.851 R^2 = 0.724 constant =5.056	

Table 6 Rugged- Quantitative Theory Type I

Item	Category	Fingertip		Whole Hand	
		Category score	Partial c. c.	Category score	Partial c. c.
Unit shape	1 Square	0.034	0.774	0.381	0.808
	2 Rectangle	2.003		1.911	
	3 Diamond	0.907		1.048	
	4 Triangle	1.566		1.458	
	5 Circle	1.282		1.096	
	6 Oval	0.176		0.087	
	7 Cambered Circle	-3.132		-3.215	
	8 Cambered Oval	-2.835		-2.767	
Shape size	1 Small	-0.294	0.192	-0.072	0.054
	2 Large	0.294		0.072	
Config-uration	1 Rule	-0.321	0.207	-0.381	0.273
	2 Stagger	0.321		0.381	
Density	1 Narrow	0.446	0.286	0.528	0.373
	2 Wide	-0.446		-0.528	
Concave-convex	1 Convex	0.929	0.526	1.146	0.654
	2 Concave	-0.929		-1.146	
		R =0.804 R^2 = 0.646 constant =4.989		R =0.849 R^2 = 0.721 constant =4.918	

Table 7 Healthy- Quantitative Theory Type I

Item	Category	Fingertip		Whole Hand	
		Category score	Partial c. c.	Category score	Partial c. c.
Unit shape	1 Square	-0.632	0.405	-0.27	0.224
	2 Rectangle	-0.228		0.063	
	3 Diamond	-0.015		0.112	
	4 Triangle	-0.126		0.112	
	5 Circle	0.248		0.302	
	6 Oval	-0.382		-0.158	
	7 Cambered Circle	0.731		0.145	
	8 Cambered Oval	0.404		-0.306	
Shape size	1 Small	-0.01	0.011	0.039	0.043
	2 Large	0.01		-0.039	
Config-uration	1 Rule	0.095	0.101	0.056	0.061
	2 Stagger	-0.095		-0.056	
Density	1 Narrow	0.368	0.37	0.45	0.444
	2 Wide	-0.368		-0.45	
Concave-convex	1 Convex	0.844	0.667	0.86	0.687
	2 Concave	-0.844		-0.86	
		R =0.767 R^2 = 0.589 constant =4.844		R =0.753 R^2 = 0.568 constant =5.097	

Table 8 Unique- Quantitative Theory Type I

Item	Category	Fingertip		Whole Hand	
		Category score	Partial c. c.	Category score	Partial c. c.
Unit shape	1 Square	-0.485	0.646	-0.085	0.683
	2 Rectangle	1.132		1.104	
	3 Diamond	0.878		0.739	
	4 Triangle	0.974		1.012	
	5 Circle	0.745		0.965	
	6 Oval	-0.225		-0.234	
	7 Cambered Circle	-1.42		-1.701	
	8 Cambered Oval	-1.599		-1.8	
Shape size	1 Small	-0.742	0.52	-0.555	0.421
	2 Large	0.742		0.555	
Config-uration	1 Rule	-0.306	0.24	-0.212	0.172
	2 Stagger	0.306		0.212	
Density	1 Narrow	-0.26	0.21	-0.115	0.096
	2 Wide	0.26		0.115	
Concave-convex	1 Convex	0.862	0.578	0.874	0.591
	2 Concave	-0.862		-0.874	
		R =0.76 R^2 = 0.577 constant =5.037		R =0.761 R^2 = 0.579 constant =4.987	

Table 9. Importance sequence of items

	image	Importance sequence
Fingertip	Comfortable	**A** > **E** > C > B > D
	Reliable	**D** > **E** > **A** > B > C
	Rugged	**A** > **E** > D > C > B
	Healthy	**E** > A > D > C > B
	Unique	**A** > **E** > **B** > C > D
Whole Hand	Comfortable	**A** > **E** > C > D > B
	Reliable	**E** > **A** > **D** > C > B
	Rugged	**A** > **E** > D > C > B
	Healthy	**E** > D > A > C > B
	Unique	**A** > **E** > B > C > D

According to R2, 5 images' explain ability is: Fingertip Grip: Comfortable > Rugged > Reliable > Healthy > Unique；Whole Hand Grasp: Comfortable > Reliable > Rugged > Unique > Healthy. All the R2 of images are over and above 0.5, "comfortable" is the highest explanatory ability of images, which is above 0.7; "healthy" and "unique" have low explanatory ability, both less than 0.6, conjecture the subjects think of this two images of evaluation criteria in different grasp motions are not the same.

5 texture pattern construction items: A-Unit shape, B-Shape size, C-Configuration, D-Density and E-Concave-convex type. According to the Partial coefficient of correlation, sort value high to low as table 9. The results showed that, A-Unit shape and E-Concave-convex type are important factors to influence tactile image, D-Density is secondary, B-Shape size and C-Configuration are low influence factors.

According to the Category Score, discuss each construction items:

Unit shape: [Square] can enhance rugged feeling by whole hand grasp, but has no reliable, comfortable, healthy and unique feeling by fingertip grip. [Rectangle] , [Diamond] , [Triangle] can reduce comfortable feeling no matter which motions, but can enhance reliable, rugged and unique feeling. [Circle] can reduce comfortable feeling by both grasp motions, but have rugged, healthy and unique feeling, enhance reliable feeling by whole hand grasp. [Oval] has no unique feeling and no healthy feeling by fingertip grip. [Cambered Circle] and [Cambered Oval] because of grasp smoothly and have massage effect through the fingertip, they can enhance comfortable feeling by both motions and healthy feeling by fingertip grip. The results showed that, cambered

surface or not will influence rugged and comfortable feeling, and kinds of many corners and edges shape just like Triangle and Rectangle will give us more reliable and rugged image.

Shape size: [Small size] has more comfortable feeling by fingertip grip, but has no rugged and unique feeling. [Large size] has rugged and unique feeling by fingertip grip, and has no comfortable feeling, but to the whole hand grasp have little unique feeling. Conjecture maybe fingertip could include small shape, fell more comfortable, and palm's Two-point threshold more larger, it hard to feel small shape, but large shape.

Configuration: No matter what kinds of grasp motions, [Rule] can enhance comfortable feeling because it touched smoothly, have no rugged and unique feeling. People often used to smooth things,

[Stagger] touched no smoothly, so it has rugged and unique feeling.

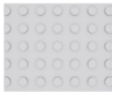
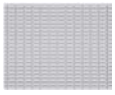
Density: [Narrow] can enhance reliable, rugged and healthy feeling in both motions, but no comfortable by whole hand grasp and no unique feeling by fingertip grip. Conjecture [narrow] would produce more grid spacing and crack, feel more resistance, so have reliable and rugged image. [Wide] can reduce reliable, rugged and healthy feeling in both motions, but have comfortable by whole hand grasp, unique feeling by fingertip grip.

Concave-convex type: [Convex type] can enhance reliable, rugged, healthy and unique feeling, but have no comfortable feeling by both motions. [Concave] has more comfortable feeling, conjecture subjects couldn't feel the concave shape clearly, just like smooth plane.

Table 10. Importance sequence of items

sample	type	Mean	Std.	Paired Sample T test Sig.
No.1	finger	4.53	1.86	**0.009**
	hand	5.74	2.04	
No.10	finger	4.44	2.31	**0.008**
	hand	5.65	1.94	
No.18	finger	6.09	3.24	**0.023**
	hand	7.06	2.55	
No.19	finger	6.18	2.24	**0.013**
	hand	7.09	2.19	

Table 11. Reliable-samples and constructions

Sample		Construction
1		Square, Large, Stagger, Narrow, Convex
10		Circle, Large, Rule, Wide, Convex
18		Circle, Small, Stagger, Wide, Convex
19		Rectangle, Small, Rule, Narrow, Convex

In reliable image have 4 significant differences samples, all are convex type, whole hand grasp can enhance more reliable feeling. [No.1] Large square may feel more normal by fingertip touch, and narrow arrangement feels closing to the smooth surface, reliable feeling is lower. [No.19] is exactly the result predicted the most reliable image of texture pattern in Quantitative Theory Type I by whole hand grasp, probably because of small rectangular corner caused a lot of space with close packing, so that resistance be stronger when whole hand grasp. [No.10] and [No.18] both are convex circle, whole hand grasp's reliable more higher, and small circle is better than large circle, Probably because of fingertip feel for the circle more obvious, and rounded edges has no reliable feeling. The circle just like a lot of bumps or octopus suckers by whole hand grasp, people think that have non-slip features.

Table 12. Healthy- Paired Sample T test

sample	type	Mean	Std.	Paired Sample T test Sig.
No.4	finger	4.59	3.04	**0.037**
	hand	3.65	2.93	
No.14	finger	5.03	1.93	**0.041**
	hand	5.71	1.85	
No.17	finger	4.79	2.17	**0.041**
	hand	5.44	2.00	
No.20	finger	8.09	1.68	**0.03**
	hand	7.24	2.15	
No.23	finger	3.12	1.92	**0.028**
	hand	3.85	1.71	

Table 13. Healthy-samples and constructions

Sample	Construction
4	Cambered Oval, Large, Rule, Wide, Convex
14	Triangle, Large, Rule, Narrow, Concave
17	Square, Large, Rule, Narrow, Concave
20	Cambered Oval, Small, Stagger, Wide, Convex
23	Oval, Large, Stagger, Wide, Concave

K In healthy image have 5 Significant differences samples, all of these sample only in unit shape item's category score has bigger difference. [No.4] and [No.20] healthy feeling higher by fingertip grip, probably because fingertip could feel convex cambered oval more excited, but feel smoothly by whole hand grasp. [No.14] , [No.17] and [No.23] composed by triangle, square and oval, maybe for fingertip grip, just circle, cambered circle and cambered oval these three shapes provide massage function so that have healthy feeling.

5. Conclusion

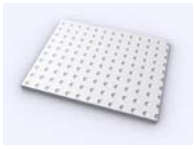
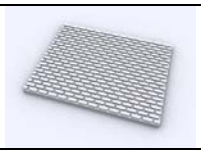
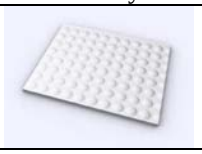
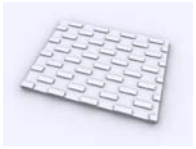
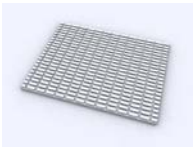
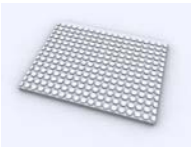
This study discuss tactile image of different grasp motions on rubber texture pattern, according to the reference, define construction item and category, start experiment. Use Paired Sample T test to know the difference of tactile image between two motions, and use Quantitative Theory Type I to clarify the correlation and important degree. Conclusions and suggestions, such as the following:

1. This study construct 5 items of texture pattern, include Unit shape, Shape size, Density, Configuration and Concave-convex type, this can be the principle to design the texture pattern in the future. Unit shape and Concave-convex type are important factors to influence tactile image, Density is secondary, Shape size and Configuration are low influence factors. It could aim to more shapes and shape height or depth in the future.

2. "Comfortable", "rugged" and "unique" has no significant difference between fingertip grip and whole hand grasp, but"reliable"and"healthy" image has significant difference because subjects need to think what kind of products to applied, and everybody's thinking are different, result two kinds of motions have some differences in evaluation criteria. Maybe next time could experiment on real product, to know the tactile image by real action.

3. According to the result of Quantitative Theory Type I, choice the highest category score from every items, then remake forecast best texture patterns. In the future, comfortable pattern could applied to the products which has long using time or don't need more power on it, just like bike handlebar; reliable pattern could applied to the product which need power to use or big motion, just like hammer handlebar; rugged pattern could applied to man's products; healthy pattern could applied to products about excise or leisure; unique pattern could applied designer to design special texture pattern as consultant.

Table 13. Healthy-samples and constructions

	Comfortable	Reliable	Rugged	Healthy	Unique
Fingertip grip					
Whole Hand grasp					

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6. References

[1] Paco Underhill (2009).*Why We Buy: The Science of Shopping--Updated and Revised for the Internet, the Global Consumer, and Beyond*. New York: Simon & schuster,Inc.

[2] Lu,Ming-Chuan (2002)。*The influence of image on the sense of sight and touch-A case study of plastics material etching*(Master`s thesis)。Retrieved from http://etdncku.lib.ncku.edu.tw/

[3] Wu, Zhao-Yi (2006)。手感經濟－感覺的時尚。Taipei:Commonwealth。

[4] Chen,Wenzhi, You,Man-lai (1997)。*The Study on Discriminability of Tactile Symbols of Radio Cassette Recorder Controllers*。Journal of Special Education，Vol 12, p.41-61。

[5] Xu,Sheng-Xiong, Peng,You, Wu,Shui-Pi (2004)。*Human Factors in Engineering and Design,7th Edition*。Tsang Hai Book Publishing co.。

[6] Zhong,Yin-Jun(2007)。*A Study on Handle Design of the Different Bike Form by Handle Contact Pressure* (Master`s thesis)。Retrieved from http://ethesys.library.ttu.edu.tw/ETD-db/。

[7] Frascara, Jorge and Takach, Bonnie Sadler. (1993). *The design of tactile map symbols for visually impaired people*, Information Design Journal 7/1, p.67-75

[8] J. R. NAPIER. (1956). *The Prehensile Movements of The Human Hand*, The Journal of Bone and Joint Surgery, Vol. 38 B, NO. 4.

[9] Konz, S. (1990). *Work Design: Industrial Ergonomics*, Publishing Horizons, Inc., Worthington, Ohio, USA.

[10] Taylor, C. L. and R. J. Schwartz. (1955). The anatomy and mechanics of the human hand, Artificial Limbs, 2, 22-35.