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Tribological analysis of touch experience about various fabrics

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ABSTRACT – Touch feeling is closely related with several of surface properties of human skin and materials. For example, the surface topography, such as roughness, fineness affects to tactile sensibility of people, and also the compatibility between skin and surfaces are important factor determining the frictional characteristics and emotional perception. In this paper, finger friction measurements on some fabric surfaces were made. In addition, emotional feedbacks are also studied. The relation between above two are studied with statistical method and this paper suggested that experimental results can explain how people recognize many different signatures of material surfaces.

1. INTRODUCTION

Increasing interest in investigating how experimental/physical parameters are related to the estimation of consumer's satisfaction gives more motivation to researchers. Development of a friction model based on physical properties of surface composing material can make the product developer to control the consumer tactile feel. The development of guidelines, which will enable industry to predict and optimize the emotional qualities has recently become the subject of tribological research, as previous study [1-3].

2. METHODOLOGY

2.1 Sample Surfaces

The friction measurements were performed on 6 sample fabric surfaces (see Figure 1). The fabrics include linen, canvas, felt, silk, velvet, and cotton. These fabrics do not have uniform surface roughness or similar finish. The sample size was about 15*50mm.

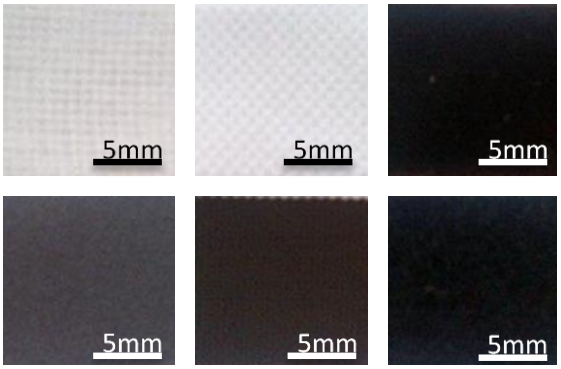

Figure 1 linen, canvas, felt, silk, velvet, cotton.

2.2 Friction Measurement

The experiments were conducted with the index fingers of one experimenter who was a 24-year-old man. The laboratory atmosphere conditions were maintained within a narrow range. The average sliding speed was specified as 15mm/s. In addition, apparent contact area was observed through glass (see Figure 2) sliding and it was varied between $2cm^2 \sim 2.3cm^2$. There were 5-minute time intervals after each set of experiments, and each set was composed of 8 down strokes, as previous study [4].

Figure 2 Friction measurement device.

2.3 Psychophysical Ratio Scaling Method

In a magnitude estimation experiment, participants were asked to scale perceived sensibility, such as rough, flat, stiff, hard, and comfort. Magnitude estimation is the most common psycho-physical ratio scaling method. The method is based on the hypothesis that people can make direct numerical estimations of their intensity of impression of a stimulus and avoids biased numerical judgments. In this study, each participant was permitted to use 7-point scale to describe their tactile feeling.

The participants were instructed to assign a number that corresponded to the perceived magnitude of each sensibility for each presented fabric sample. When touch feeling, which the sample surface gives, can be described by a given adjective, higher number scoring is possible. They were also told to feel the fabrics by stroking only their dominant index finger towards the body. The participants were also asked to use the same index finger, same speed and same load during the experiments.

3. RESULTS AND DISCUSSION

3.1 Friction Measurements with Different Sample Surfaces

Table 1 shows the results from the sliding test by single experimenter about 6 sample surfaces. In this study, the values of linear regression coefficient and friction

slope are considered with the magnitude and σ of friction coefficient, to characterize the tribological behavior of each fabric surfaces. It seems that when the friction measured from the finger friction measurement over the surface has high magnitude of friction slope, surface is likely to be hard or stiff. Following passage will discuss the tactile sensibility which survey participants feel, and then two studied result will be interrelated to predict how the general consumer feel the surfaces.

Table 1 Friction measurement.

Parameter	Linen.	Canvas	Felt
C_0	-0.106	-0.203	-0.181
C_1	-0.802	-0.789	-0.764
CoF	3.269	2.906	2.854
σ	0.1513	0.1025	0.1222
	Silk	**Velvet**	**Cotton**
C_0	0.07	-0.147	0.212
C_1	-0.8	-0.839	-0.84
CoF	3.887	3.331	4.778
σ	0.1611	0.0526	0.1992

3.2 Magnitude Estimation: Tactile Response Survey

Using semantic differential scale, magnitude estimation surveys were done to about 50 undergraduate students. In this study, the adjective, such as rough, bumpy, stiff, hard, and comfort, are investigated. To describe the participant response, average and mode values are summarized with each sample fabrics (See Table 2).

Table 2 Magnitude estimation survey results.

Adjective	Linen.	Canvas	Felt
Rough	6.32	3.81	2.94
Bumpy	6.25	3.97	3.02
Stiff	6.25	3.76	1.95
Hard	5.90	4.06	1.86
Comfort	2.46	4.29	5.24
	Silk	**Velvet**	**Cotton**
Rough	2.84	2.98	6.22
Bumpy	2.97	4.49	6.33
Stiff	2.98	3.76	4.89
Hard	4.14	4.76	2.86
Comfort	4.97	4.32	2.87

3.3 Correlation Model between the Experimental and Emotional Parameters

Some statistical analysis methods are applied. As a result, four emotive adjectives can be estimated numerically when experimental parameters are known from the finger friction measurements. Each estimation model does not include all parameters which previous body introduced. For example, rough feeling can be explained with friction slope and friction coefficient at the normal load condition of 0.2N. Others are summarized in table 3.

Table 3 Estimation model about emotive adjectives.

Adjective	Equation
Rough	$2.61+.606\text{Slope}(@.2N)-1.18\text{CoF}(@.2N)$
Bumpy	$(-1.44635-0.056C_0+0.19\text{CoF}(@.2N)^{-2}$
Stiff	$-1.69+0.56\text{Slope}(@.2N)-6.36C_0$
Comfort	$(45.48+21.95C_0+34.2\sigma(@.2N))^{0.5}$

4. CONCLUSIONS

This paper discussed several parameters from the finger friction measurement. These are C_1, C_0, friction coefficient, friction slope and standard deviation. It was found that different surfaces show significantly different tribological results. In addition, through the investigation of user experience feedback quantitatively, we can evaluation the user response with our tribological database. To make the relation between the tactile response and experimental parameters, this paper suggested the estimation model about user response using statistical methods.

5. ACKNOWLEDGEMENT

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