

Active Tactual Motion of Fingertips in FUUAI Evaluation Of Textile Fabrics

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Abstract : Human uses sight, tactile sense to evaluate Total Hand Value(FUUAI) of textile fabrics. Tactile sense is important factor which decided the Total Hand Value of a textile fabric. When human feels the FUUAI, physical and physiological phenomena are occurred in finger. We first found out physical variable that is happened in fingertip when human is feeling the FUUAI. Such physical variable means characteristic of action tactual motion of finger such as moving range, tactile time, moved distance, speed of finger and applied force by finger. We study the relationship between action tactual motion and the ability in which the human distinguishes the textile fabric. As a result, we could know the characteristics of the tactual motion of fingertip to get high distinguishable ability. The characteristics were different in men and women respectively. In the case of man, touched time and moving range influenced to distinguish, and moving range, and the moving speed of finger influenced, in woman's case.

Keywords : *FUUAI, Tactile sense, Finger movement.*

1. Introduction

The human touches for evaluating the Total Hand Value of the textile fabric. Recently, inclination of research is doing development of tactile sensor to make robot hand that imitate human. To develop such contact sensor, we needed information of motion of finger to be appeared when human evaluates FUUAI. Several researchers and theorists in their areas are working on motion of finger. V.H.Dawes and J.D.Owen point out that the sum total of the sensations expressed when a textile fabric is handled by touching, flexing of the fingers, smoothing and so on. Nishimatsu said that the judgment of the hand of material was influenced by the movement direction of the finger, and by the contact area between the finger and the fabric surface.

In this section, we studied when touched textile fabric between thumb and other fingers to evaluate FUUAI, about characteristic of

fingertip movement on active motion of finger.

In general study, it is known that middle finger is most sensitive. So, in the prevailing theory, people use the middle finger to evaluate FUUAI. Nevertheless, in actuality situation, people touch as gather textile fabrics between fingers to evaluate FUUAI of textile fabrics. So the purpose of this study is analysis of evaluation method as gather textile fabrics between fingers.

To accomplish such purpose, we compared two methods to touch textile fabrics. One is not uses thumb, and the other one uses thumb to evaluate FUUAI of textile fabrics. And we have detected following 6 kind of characteristic in motion of fingers.

- ① Moving range of the applied force
- ② Tactile time
- ③ Speed of finger movement
- ④ Standard deviation of speed of finger movement(S.D.S.F)

- ⑤ Distance of the finger movement
- ⑥ Standard deviation of the applied force

We selected 6 kinds of textile fabrics that surface property is different. And we detected the characteristic of motion of finger when a correct answer rate is good.

2. Experiment

2-1 Experiment device

We use the pressure distribution sensor of NITTA(CO.,LTD), put the textile fabric on upside of sensor, and subject tactile it. In this time, it is recorded load taken in sensor (we call that the fingertip force) by computer. The size of sensor is 9.5×5.3 (width \times length, cm) and the cell(28×50 , ROW \times COL) is arranged in the sensor. Unit size of cell is $0.3627(\text{cm}^2)$. And measurement range of pressure is $0 \sim 350\text{gf}/\text{cm}^2$.

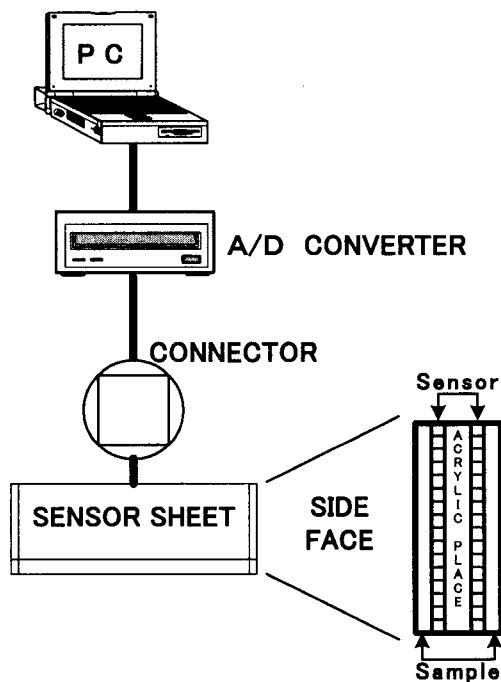


Figure 1 Experiment Equipment

The applied force taken on cell was recorded on computer with 128Hz frequency.

Experiment equipment of the applied force like Figure 1, attach sensor to Acryl place both, and attached sample over. Tactile method is 2 kinds. Among them, one is method A (Figure 2) that 4 fingers (index finger, middle finger, fourth finger, little finger) use to evaluate FUUAI of textile Fabrics. Other one is method B that subject contacts both side of textile fabrics using together 4 fingers and thumb. We define that the former is one side evaluate method and the latter is both side evaluate method.

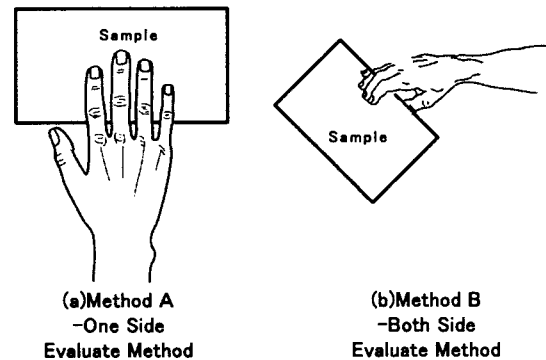


Figure 2 Tactile Method

2-2 Samples

We used 6 kinds of textile fabrics, property of surface are different. The characteristic of samples explained Table 1. The table 1 shows MMD(deviation of coefficient of friction) and MIU(value of the coefficient of friction) that measured by KES-system. Size of sample is 14.5×6 (width \times length, cm). Subject is 10 peoples consisted of 5 men and 5 women and age of subject is consisted of college students between 30 years old since 20 years old.

3. Method and Analysis

We observed in motion of fingertip to be appeared when subject distinguish from

samples. Experiment order is divided by a studying experiment and a distinction experiment. In a studying experiment, subject studied to know property of surface of 6 kinds of samples. Maximum tactile time is 10 seconds in a studying experiment. But even if it was within 10 seconds, in case subject finished studying of surface of one sample, stopped an experiment at that time. So, time of a studying experiment is different individually. After studying experiment, subject distinguished kind of sample with close eye. In this distinction experiment, subject should distinguish to be selected textile fabric of 6 kinds of samples and 2 kinds of contact methods at random. Tactile time is 10 seconds as a studying experiment, but in case distinction ended, an experiment is stopped in the state. In a studying experiment and a distinction experiment, we measured applied force to be taken in pressure sensor and recorded on computer. We could know the characteristic of motion of fingertip by transform of preservation data.

Table 1 Samples

	Material	Yarn Count	MMD	MIU	Special Quality
A	Protein Mix 100%	warf : 30D weft : 70D	0.162 0.237	0.0073 0.0138	Shiny Silk
	B	Polyester 100%	warf : 60D weft : 75D	0.269 0.348	0.0133 0.0159
C		Nylon 100%	warf : 70D	0.187	0.0242
	weft : 155D		0.190	0.0181	
D	Nylon 84% Spandex 16%	Nylon: 50D	0.212	0.0256	Material of Swimming Suit
		Spandex:40D	0.414	0.0258	
E	Triacetate 75%	T A: 75D P E: 30D	0.384 0.350	0.0110 0.009	Surface of VELVET
	Polyester 25%				
	Polyester 70%				
F	Polyurethane 30%	Non Woven	0.465	0.0120	Synthetic Leather
		Fabric	0.428	0.0165	

4. Results and Conclusions

Figure 3 shows change of the applied force of C textile fabric by time.

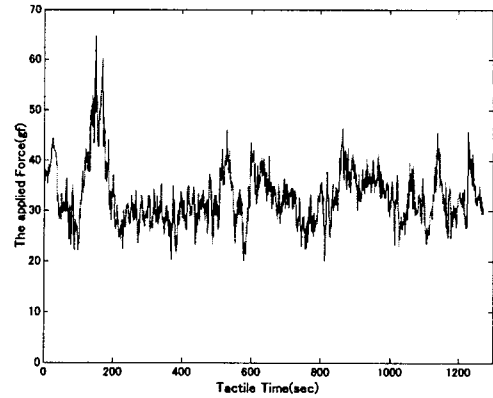


Figure 3 Change of Fingertip Force

4-1 About the contact method

Figure 6 shows characteristic of motion of fingertip by tactile method. In a distinction experiment, a correct answer rate was seldom difference. As a Table 2, it is 68.33% in case of contact method A, and 66.67% in case of contact method B. But, in the Figure 6, Characteristic variable of contact method A is higher than in case of B, except contact time. From this result, we could conjecture that thumb is doing important part by tactile sensor.

Table 2 Correct Answer Rate of Sample

Sample	Correct of Answer Rate of Sample(%)			Average	
	Method A	Method B			
A	70	80	58. 75	Group I	
B	70	50			
C	80	70			
D	20	30			
E	90	90	85	Group II	
F	80	80			
Average(%)	68.33	66. 67	67.5		

4-2 About the distinction of gender

Figure 5 shows the characteristic of motion of fingertip by gender. Correct answer rate of

woman is higher than it of man. But in the men, the characteristic of motion of fingertip is higher than woman. Specially, the man is higher than the woman in the moving range of the applied force, the tactile time, the distance of finger movement. But result of T-test, it has not difference in the speed of finger movement, the standard deviation of speed of finger movement, the standard deviation of the applied force. Namely, the characteristic of motion of fingertip is different according to the gender.

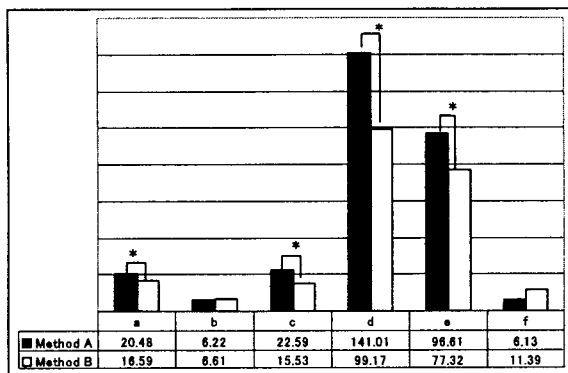


Figure 6 About the contact method

(a; Moving range of the applied force(cm²), b; Tactile time(sec), c; Speed of finger movement(cm/sec), d; Distance of the finger movement(cm), e; S.D.S.F(cm/sec), f; Standard deviation of the applied force(gf), *p<0.05)

4-3. About the correct answer rate

Table 2 shows result by correct answer rate of samples. Sample E and sample F have high correct answer rate of sample as average 85%, Sample A,B,C and sample D have low correct answer rate of sample as average 59%. This is result by difference of deviation of coefficient of friction. According to the correct answer rate, sample was divided to two groups. Sample A,B,C,D are Group I and sample E,F are Group II. We could know characteristic of motion of finger from fingertip force to get to tactile sample Group I and Group II. That is showed in Figure 4. We could know it has

difference in the result by T-test. When touched textile fabric by 2 kinds of tactile method, the characteristic variable of Group I is higher than Group II. Being touched low correct answer rate of sample(Sample Group I which distinction is difficult), characteristic variable(moving range of the applied force, tactile time and distance of finger movement) is high. We could know tactual disposition of subject that it is more wider range and more long tactile time when difficult sample in distinction is touched. Other characteristic variable has not difference.

Table 3 Correct Answer Rate of Gender

	Man		Woman	
	Method A	Method B	Method A	Method B
Correct Answer Rate(%)	60	60	76.67	73.33
Average (%)	60		75	

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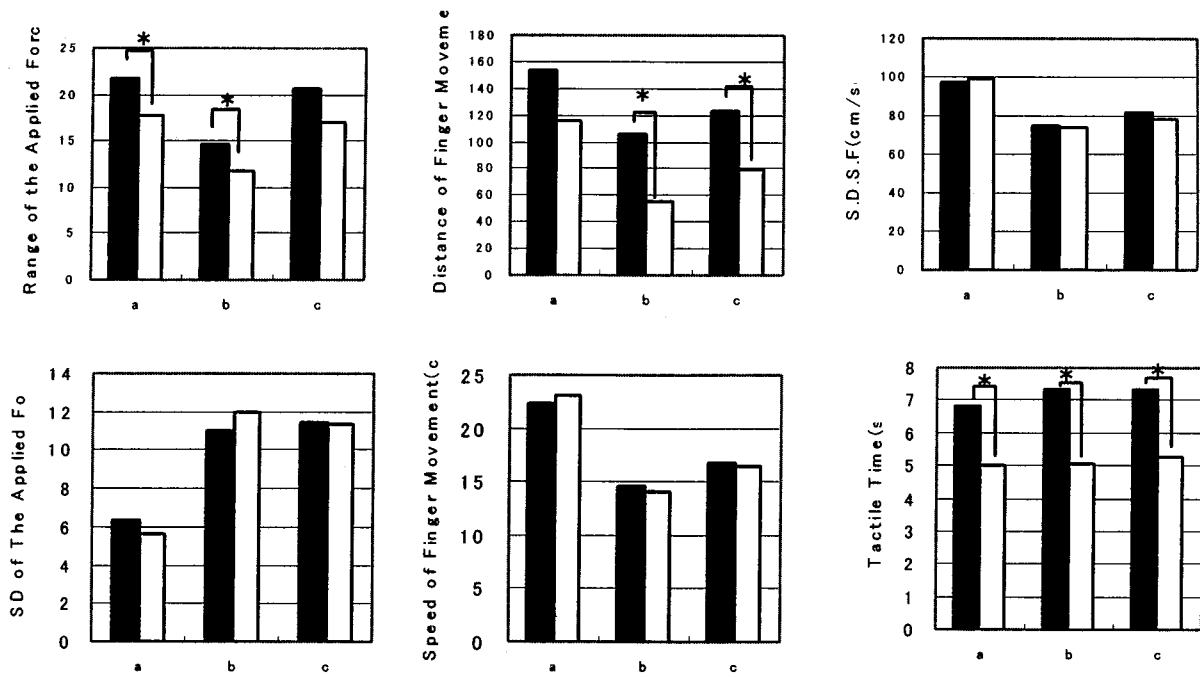


Figure 4 About the correct answer rate. a: 4 Fingers in Method A, b: Thumb in Method B c: 4 Fingers in Method B, ■:Sample A,B,C,D □:Sample E,F *: $p < 0.05$

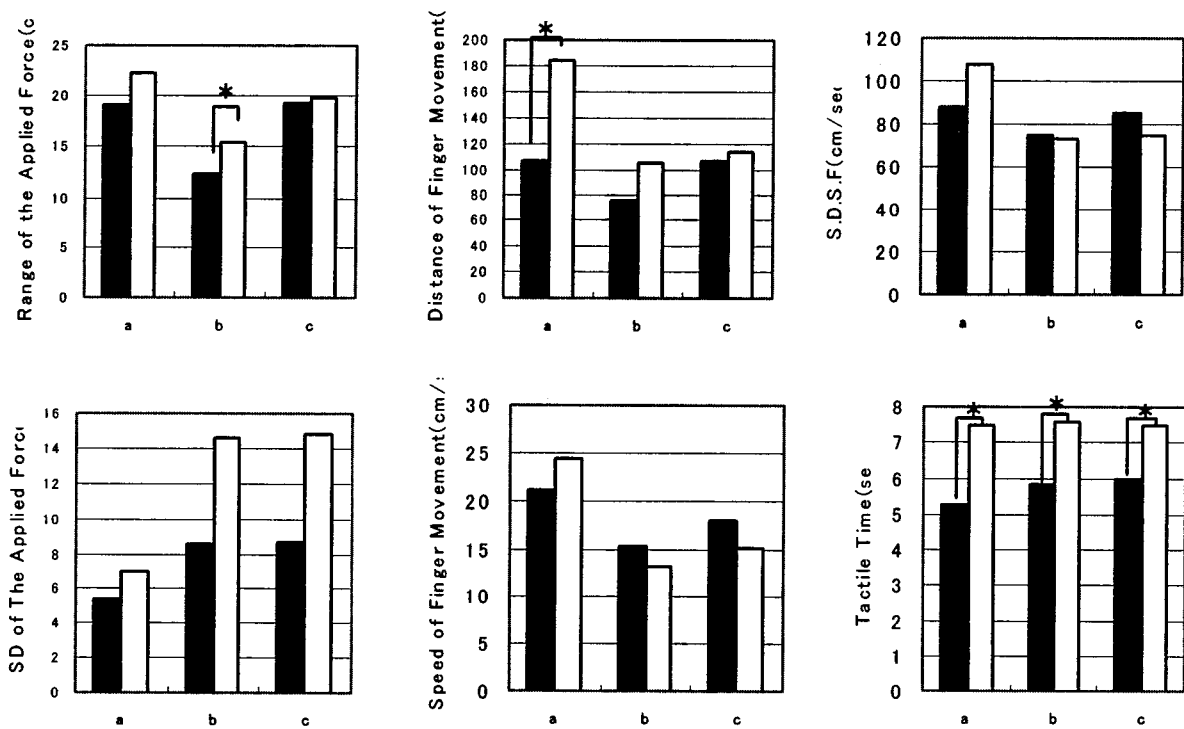


Figure 5 About the distinction of gender. a: 4 Fingers in Method A, b: Thumb in Method B c: 4 Fingers in Method B, ■:Woman □:Man *: $p < 0.05$