Numbers Generation with Vibration Flow to avoid Shoulder Surfing Attack

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***Abstract*— Sensitive data leakage via shoulder surfing has drawn concern from the public. Many solutions that limit screen visibility has been proposed to protect privacy. However, loopholes still exist in these solutions as information remain visible. Hence, we present a novel sensitive data protection method which generates digits haptically using vibration flows. The user study conducted showed that users could identify the digits using the proposed solution with high accuracy (83.5%).**

I. Introduction

Shoulder surfing is the act of looking into other people's screen without their consent [1]. In order to protect privacy of users, many researches have been conducted. Ragozin *et al.* built a system that that would only show where the user is looking [2]. Zhang *et al.* adjusted the screen display to reduce visibility of content when being viewed from distance of bystanders [3]. Yet, the risk of data leakage persists as long as the information are visually conveyed. To reduce this risk, haptic information can be a solution. Dhandapani *et al.* proposed a system that generates haptic Morse code to read the digit [4]. This paper proposes a solution that generates digits following writing sequence of digit using vibration flow to be understandable by public.

II. Solution Design

Vibration flow can be generated by taking advantage of funneling effect on human haptic perception [5]. When two vibration motors are operated simultaneously for a short period, human perceives the vibrations as one between the two vibration motors. By changing the amplitude of two motors and vibrates them at the same timing, an illusion of vibration flow can be generated (Figure 1(a)). In order to generate vibration flow that are able to represent all digits (0 to 9), we allocate six vibration motors (JAHWA JHV-10R1) as shown in Figure 1(b). The digits are generated with a combination of vibration flows following the writing sequence. Figure 1(c) illustrates rendering case of digit 2.

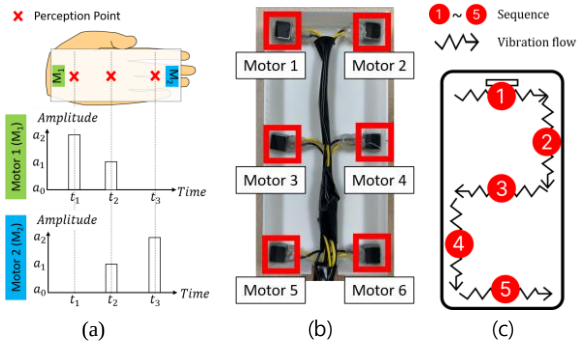

Figure 1. (a) Generation of vibration flow (b) Prototype with 6 vibration motor distributed on left and right (c) Generation sequence of digit 2

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III. Experiment

We recruited 10 participants (6 males, 4 females; average age 28.1, std 4.65) to investigate whether users can identify the generated digits. A basic training for the participants to feel the vibrotactile sensation was done before the experiment is conducted. The average accuracy of digit identification is 83.5%. Table 1 shows the accuracy for each digit.

TABLE I. User Study Results

	0	**1**	**2**	**3**	**4**	**Avg.**
Accuracy (%)	70.0	95.0	90.0	85.0	90.0	83.5
	5	**6**	**7**	**8**	**9**	
Accuracy (%)	90.0	75.0	85.0	85.0	70.0	

IV. Conclusion

We explored the possibility of generating digits using the vibration flows and the results show that users are able to identify digits generated with high accuracy (83.5%). We will work further to improve accuracy for more confusing digits (Eg. 0,6,9) and to verify the efficiency of this solution on prevention of data leakage via shoulder surfing.

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