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NETWORK ENVIRONMENT OF VIRTUAL CALLIGRAPHY AT REMOTE PLACES BY USING 2-DOF HAPTIC DEVICES

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ABSTRACT

Haptic representations at remote places are utilized in various areas. However, communication between remote locations increases network latency. The delay causes serious problem such as out of control of haptic device. This paper describes the communication delay and the guideline of improvement of the delay when haptic representation in a remote place. Then we focus on virtual calligraphy content between remote places as the application. We developed some contents that allows the users to learn "Kanji"(Chinese character) by using haptic representation. This study aims to decrease the communication delay in haptic representation. In addition, using the virtual calligraphy content they can teach Japanese to people all around the world.

1. INTRODUCTION

1.1. Network Environment

Network environment of haptic representation is mainly used in the field of medical area, educational content and entertainment [1][2][3]. One of the typical problem in remote haptic representation is network latency [4]. The network delay will confuse the control system of haptic device and, in the worst case, will cause the control failure. Because human sense of haptic is very sensitive organ, only a few network delays cause serious problems in haptic representation content. Since we had the opportunity to conduct communication experiments between Spain and Japan, we investigated the influence on haptic communication due to communication delay. Furthermore, we examined communication delay and improvement method in haptic representation.

2. SYSTEMS

2.1. 2-DoF Haptic Display

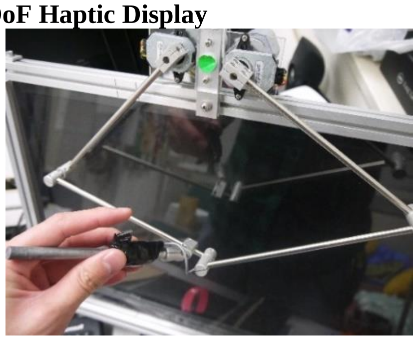

Fig.1 2-DoF Haptic Display

We utilized 2-DoF haptic devices for remote haptic environment (see Fig.1). This device consists of two motors and two encoders, mounted on the LCD monitor. Pen type grip and single button switch are equipped on the end effector of the link structure. The devices enable the user to interact with both visual and haptic information.

2.2. Server-Client Communication Program

We implemented a server-client communication environment with the haptic display above mentioned. Both server program and client one send/receive the position of end effector each other. As a result, server and client move synchronously (Fig.2). We confirmed that the servo ratio between server and client was 1[kHz] through the local area network (Fig.3 right).

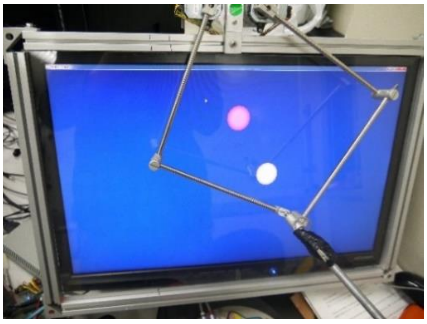

Fig.2 Server-Client Communication Program

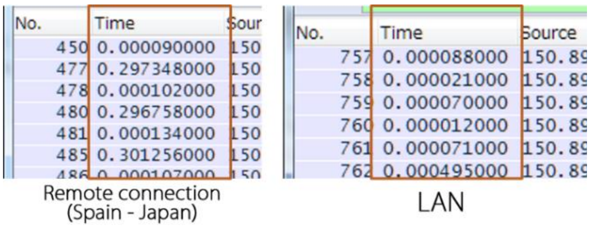

Fig.3 Network Capturing Data

2.3. Communication Experiment

We conducted an experiment on communication speed between Japan and Spain using the communication program described in 2.2. We prepared several conditions shown in Fig.4 for this experiment. Condition A is a normal P2P communication. Condition C consist of two threads which are separated to the pair of send/recv process of Condition A. Each condition B and D are using separated port number of TCP compared to condition A and C. Condition E also consists of two threads that perform dual server-client communications each other. All conditions are examined the performance from the viewpoint of communication ratio.

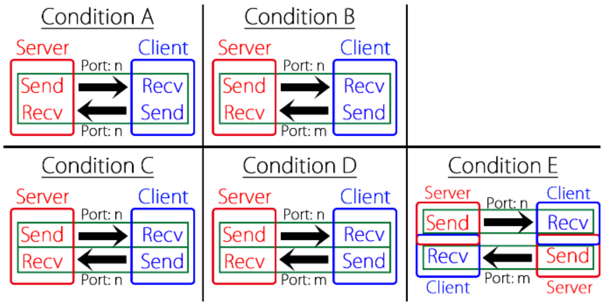

Fig.4 Communication Conditions

2.4 Communication Experiment Results

According to the logs of the experiment, we found that there was a delay of approximately 0.3[sec] (Fig.3 left). Therefore, it is considered that the servo ratio between server and client will be approximately 3[Hz]. The ratio is not enough speed to carry out the remote haptics communication properly. Accordingly, it is necessary to consider a plan improve the communication speed. We measured the communication speed under various conditions and obtained the results as shown in Table 1. As a result, we found that the condition of separated port number and separated threads for sending/receiving process is the fastest of all.

Table.1 Relationship between communication conditions and servo ratio

Condition	Communication Ratio
A	3[Hz]
B	5[Hz]
C	5[Hz]
D	50[Hz]
E	100[Hz]

3. VIRTUAL CALLIGRAPHY

3.1. Virtual Calligraphy System

We focused on “Calligraphy” as an application example of haptic representation in a remote place.

Many people think that they would like to learn Japanese from the future. In particular, those who want to come to Japan. Among others, reading and writing of Kanji is definitely necessary. In this research, we focused on writing "Kanji". In general, if a student writes it in the correct stroke order, writing that is more accurate could be realized. The application aims to the user to learn the correct stroke order of kanji by using remote haptic environment.

Virtual calligraphy system was developed by modifying the server client program described in previous. This content currently we can present 10 simple basic Kanji.

When the cursor approaches the starting point of the stroke of a letter, the attractive force is presented to the user. Additionally, reaction force occurs so that it does not come off the line. Repeat this operation to learn the correct stroke order. (see Fig. 3)

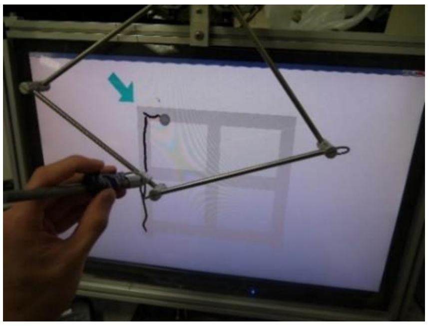

Fig.5 Virtual Calligraphy System

3.2. Stroke Order Experiment

We examined whether 20 subjects (ages 18-22, Japanese people) can use our system and write in the correct stroke order. Trajectories of the user’s movement were recorded in order to analyze the required time to trace characters and their stroke order. We also asked the subject that how did he/she perceive haptic sensation from the system and how did he/she able to learn the correct stroke order of Japanese letters.

3.3 Stroke Order Experiment Results

90% of people were able to write according to the correct stroke order, but the remaining 10% of people were in the wrong order. "Did not perceive the arrow showing the next stroke", "Did not feel the presented reaction force" was the reason.

4. FUTURE WORK

It is necessary to investigate the causing of network delay in detail. In addition, we would like to experiment with various conditions and explore the method of improvement.

Moreover, we need to do more experiment to examine the haptic effect of this virtual calligraphy system. We will investigate between various conditions of with/without haptic sensation for learning Kanji stroke.

5. REFERENCES

[1] Diment, L.E., Ruthenbeck, G.S., Dharmawardana, N., Carney, A.S., Woods, C.M., Ooi, E.H., Reynolds, K.J.: “Comparing surgical experience with performance on a sinus surgery simulator”, *ANZ Journal of Surgery*, Vol.86, Issue 12, pp.990-995 (2016)
[2] Minogue, J. , Borland, D. , Russo, M. , Chen, S.T.: “Tracing the development of a haptically-enhanced simulation for teaching phase change”, *CHI PLAY 2016 - Proceedings of the Annual Symposium on Computer-Human Interaction in Play Companion*, pp.13-219 (2016)
[3] Mazzoni, A., Bryan-Kinns, N., “Moody: Haptic sensations to enhance mood in film music”: *DIS 2016 Companion - Proceedings of the 2016 ACM Conference on Designing Interactive Systems: Fuse*, pp.21-24(2016)
[4] Sithu, M., Ishibashi, Y. , Huang, P., Fukushima, N.: ”QoE assessment of operability and fairness for soft objects in networked real-time game with haptic sense”, *21st Asia-Pacific Conference on Communications*, pp.570-574 (2015)