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The construction of remote communication system between haptic-devices

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***Abstract*:** Recent years, advances in medical technology are remarkable. With the development, many lives being difficult to save are saved and burden reduction to patients is realized. Further growth will be expected in future. As there are a few cases which need the latest medical technologies, it is difficult for doctors to acquire experience to cope with such cases. But the human life must be respected, so they are not permitted to practice the operations for a real patient. At present, they must learn by experiences such as lectures, reference books, the teach wares of past successful examples and the operation practices with experienced professors.
This research purpose is construction of the operation simulation system which allows learners to experience the medical specialist's manipulation of a knife and a scissor in operation and makes it possible to reproduce the real operation.

Keywords: PHANTOM**,** Haptic-feedback device, Communication, Skype

I. INTRODUCTION

Recent years, advances in medical technology are remarkable. With the development, many lives being difficult to save are saved and burden reduction to patients is realized. Further growth will be expected in the future.

On the other hand, the quantities of learning required to doctors and young trainees increase to cope with medical technique which progress every day. From this aspect, their burdens grow bigger and bigger. This phenomenon is thought as one of the factors that candidates for doctors decrease.

As there are a few cases which need the latest medical technologies, it is difficult for doctors to acquire experience to cope with such cases. But the human life must be respected, so they are not permitted to practice the operations for a real patient. At present, they must learn by experiences such as lectures, reference books, the teach wares of past successful examples and the operation practices with experienced professors.

In these methods, the true experience is limited and the technical acquisition takes time. So the construction of the operation simulation system with reality is hurried to solve this problem.

So, this research purpose is construction of the operation simulation system which allows learners to experience the medical specialist's manipulation of a knife and a scissor in operation and makes it possible to reproduce the real operation.

II. SYSTEM STRUCTURE

Fig.1 shows the system structure in this research. The operator uses PHANTOM, and manipulates the operation on the virtual space. (PHANTOM is haptic-feedback device.) The computer is connected with this PHANTOM in a special line.

Next, we prepare a similar another device. It is necessary to transmit data between two spots to enable the operation training in the remote place. OpenGL was used for drawing of the operation of PHANTOM. Microsoft Visual C++ is used for the display and operation by a virtual space. As the system configuration, it is the above.

We develop this communication system, go over about the efficiency of the communication, and make a suggestion.

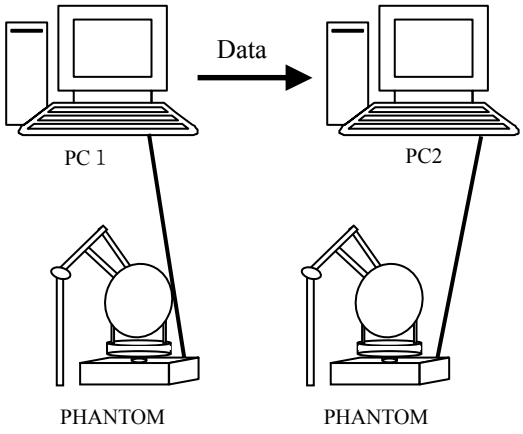

Fig.1 System structure

1. PHANTOM

PHANTOM is a three dimensional haptic feedback device. The user uses it, and sense of force interaction of high accuracy can be realized. PHANTOM can not only visual information, but also re-create realistic the sense of touch that is one of senses to which expressions are abundant most in three dimensional object and dynamic interaction.

Another feature, it loads the positional sensor of at least three degree of freedom.

In addition, it loads the force feedback mechanism of at least three degree of freedom by torque control that used direct current motor. The update rate is also very high, and it is possible to process it by about 1000Hz. So it can re-create a more detail, more exact model. Fig.2 shows actual PHANTOM.

Fig.2 PHANTOM Premium 1.5

2. Skype communication

Skype is Internet communication service. It uses technology of PSP. As for Skype merit, a telephone steady in a low-speed line and firewall is possible. And, security is secured because data is encrypted. The other party's online can be easily distinguished. All in all, it is used telephone service and messenger. It applied it to the data communication in this research.

3. Open GL

Open GL is programming interface for 3D graphics. It is possible to operate at the very high speed, and to draw in 3D highly accurate image.

III. DATA COMMUNICATION

Fig.3 shows the application that we develop. OpenGL is used at the left of application for drawing of PHANTOM point that the user operates.

As a method of operation

1. Selection of other party user's ID
2. Selection of sender side or receiver side
3. Selection of UDP communication or TCP communication

The communication can begin by completing this procedure. The communication is confirmed; when the user starts the transmission of data, they can check the data-coordinates of present PHANTOM point, force to hang to PHANTOM, image compressibility and image update time.

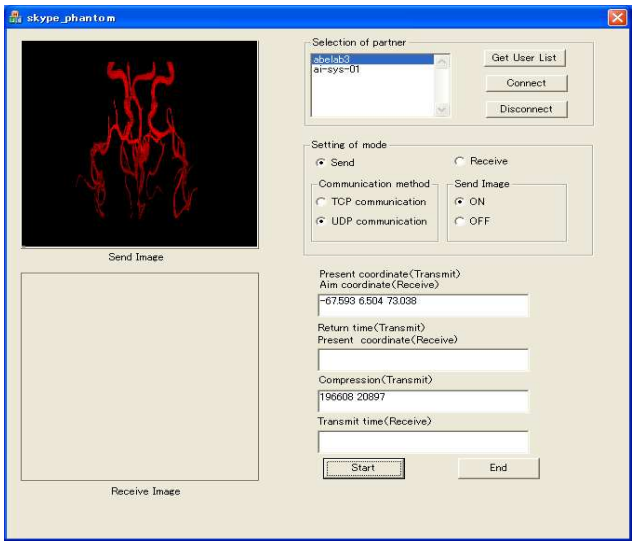

Fig.3. Operation screen

IV. DATA COMMUNICATION

The communicated data is PHANTOM's coordinate data, force data and image data in the research. The communication environment is in LAN in the laboratory.

1. PHANTOM coordinate data

The coordinate data is the numerical data in each direction of x, y and z to be able to treat PHANTOM. We compare the data update time of the UDP communication with that of TCP communication by Skype communication.

As a result, the data up data time of the UDP communication is shorter than that of TCP communication. As this factor, UDP communication is doesn't confirm the arrival of data on the receiver side, and the sender side keeps sending data one after another. When the data come off and the lack of one, the data is sent again to transmit data surely in the TCP communication. So it takes time to communicate.

2. Image data

The volume of image data is very large compared with that of coordinate data and the time needed to send image data is also long. This makes a use feel unnatural because images are not synchronized with the haptic sensation. Consequently, the compressed image data must be sent and then restored at the destination.

Fig4 shows this idea.

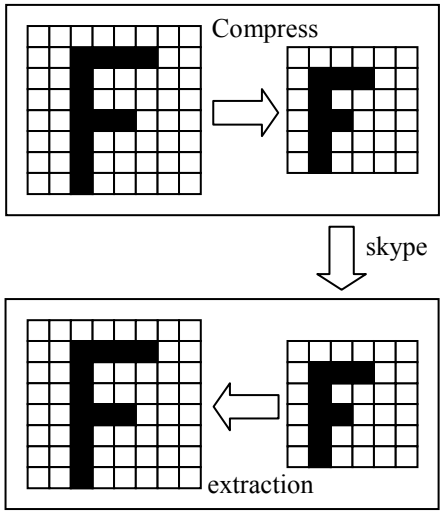

Fig.4. Idea of image compression

For 4 types of image data as shown in Table 1, the update rate of each image at destination are examined, and the influence which the compression rate gives the update rate are also measured, as shown in the same table.

When the compression rate is 100%, the update rate increases along with the decrease of resolution, and the update rate for the images of 100×100 is almost same as that for the 50×50 image.

When the compression rate is 80%, the same trend is observed as that of 100% compression. The update rates of all images except for the 500X500 image are almost same.

When the compression rate is 50%, the same update rates are obtained for both 100×100 and 50×50 images but the rates decrease for 500×500 and 300×300 images. It seems that when an image is too large, the time taken in compressing the image is more than that taken in transmitting it.

Table1 Result of image data communication ms

		Compressibility		
		100%	80%	50%
Resolution	500×500	47	32	200
	300×300	31	16	100
	100×100	16	15	16
	50×50	15	15	15

It is difficult to improve the efficiency of image data transmission with method mentioned above. To reduce the

time required, it seems effective to reduce the size of th e image to be sent but too small image is useless.

Another solution is to use more efficient computer co nsisting of 4 CPU; after dividing an image into 4 region s and by allocating each region to each CPU using APL provided with OpenMP, the efficient compression of an image is attained. Unfortunately, the computational efficie ncy is not quadruple but twice of the original one becaus e it takes time to divide the original image into 4 region s.

In a medical application with use of haptic device, it is considered that a visual point is not changed often but the tissue added operation with medical tools such as a scalpel or clamp is locally deformed. This implies that the image observed from a view point will not change globally. Consequently, the region except for the deformed portion remains intact; the difference between successive two images can be exploited. Of cause, a deformed part varies along with the movement of a medical tool, difference between successive two deformed regions. The detailed method is now under construction.

V. CONCLUSION

In this research, we develop communication system using the haptic-feedback device PHANTOM and Skype communication.

We develop a virtual space on the computer, and the user operates PHANTOM while watching the virtual space. This virtual space is developed by OpenGL and Microsoft Visual C++. The communication data is the coordinate data and the image data.

At a result, because coordinate data is the numerical data, the early communication was comparatively possible. But, the capacity of the image data is larger, and it takes time to communicate. We develop the data compression method and improve the performance of the computer, and try the efficiency improvement of the transmission rate. So, we were able to obtain the result of corresponding.

Problems to be solved include followings:

A method to calculate collision detection between a medical tool and tissue

A method to simulate deformation process along with calculating haptic reactive force

How to make both image and reaction force synchronized at the destination to give a remote trainee the high reality of medical operation.

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