A FINGER MOTION TRACKING DISPLAY SYSTEM FOR JAPANESE SIGN LANGUAGE DEMONSTRATIONS

Makoto J. Hirayama† Akira Asada† Ritsuko Kikusawa††
†Osaka Institute of Technology ††National Museum of Ethnology

ABSTRACT

A finger motion tracking display system is developed for Japanese sign language demonstrations. The system uses a finger tracking device by infrared stereo cameras (LEAP Motion Controller). This device and its software detect finger shapes and positions in real time. In a current demonstration system, animation pictures are displayed depending on user's finger gestures as Japanese sign language, although the number of words is few. The system can also be used for a user interface of interactive museum exhibitions without touching.

Keywords: digital museum, motion sensor device, finger tracking, sign language, museum exhibition

1. INTRODUCTION

During COVID-19 Crisis, touch panel screens, push buttons, or any kinds of physically touching user interfaces have been avoided for prevention of infections.

In most museums, touch screen display contents are out of order. In some museums, disposable gloves are used to touch a display screen for interactive contents, such as in Fig. 1. The figure is compiled for an explanation purpose, from pictures at National Crafts Museum in Kanazawa[1]. This content can rotate the pottery used for tea ceremony in any angles on screen by dragging it by fingers.

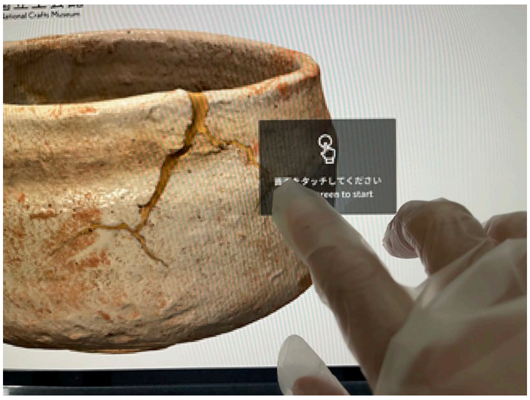

Fig. 1: Disposable gloves to touch display screen for interactive contents.

In some other museums, non-contact user interfaces are used. Use of non-contact user interface devices is suitable in the current situations. For example, in one exhibition at National Ethnology Museum, a page flipping user interface without touching fingers[2] was used as shown in Fig. 2.

Fig. 2: A page flipping user interface without touching[2].

Although there are some candidates to realize simple non-contact switches, more complex inputs are sometimes required for some interactive applications.

To realize a flexible user interface for display screen-based contents, a finger motion tracking display system is developed, mainly for Japanese sign language demonstration contents in a museum exhibition.

2. PROPOSED METHOD

As a user interface of screen-based display contents, use of a finger motion tracking device is proposed for museum exhibitions, to enable variety of complex inputs by gestures and sign language behavior. Users can input gesture like commands by moving fingers in front of display screen without touching any physical devices. Furthermore, if finger shape and motion recognition could be done with high accuracy in future, sign language inputs can be done to increase accessibility to native signers.
As a finger motion tracking device, LEAP Motion Controller[3] is used for the current implementation of the system. LEAP Motion Controller is a commercial product released by Ultraleap Inc. Two infrared cameras are placed inside the device to detect fingers. It is connected to PC via USB. It can be used from programming environment such as C# in Visual Studio. Supplied SDK of LEAP Motion Controller is specialized to recognize fingers shapes so that programmers can add hand gesture like user input interfaces for original applications easily. Detecting area coverage is 140 degrees horizontal and 120 degrees vertical and 10cm to 60cm far from the device. In these detecting areas, fingers shapes and positions of left and right hands can be detected. Fig. 3 shows the LEAP Motion Controller device.

Fig. 3: LEAP Motion Controller.

3. IMPLEMENTATION

3.1. Programming Environment

Implementations of prototype systems are done as application programs of Windows 10 on a notebook PC. Unity[4] is used as a development platform of interactive graphics contents. The version of Unity is 2019 (64bit). Leap Development Kit 4.1.0+52211_win and UnityModules_LM_4.6.0 was used to use LEAP Motion Controller from Unity. C# is used as programming language.

3.2. Recognitions of Hands and Fingers

A target application of the current system is a museum exhibition that explains Japanese sign language to whom does not know sign language. Examples of Japanese syntax are shown as interactive contents like a game. Thus, some simple finger shapes of Japanese sign language are recognized.
Frame class of SDK holds a current frame captured by two infrared cameras and recognition results of hands and fingers configurations. Fig. 4 shows objects within a frame used in the current application.
Count is the number of hands in a current frame. Palm direction is also stored. In Fingers, information of 5 fingers is stored. Bending or stretching of each finger is stored in IsExtended.

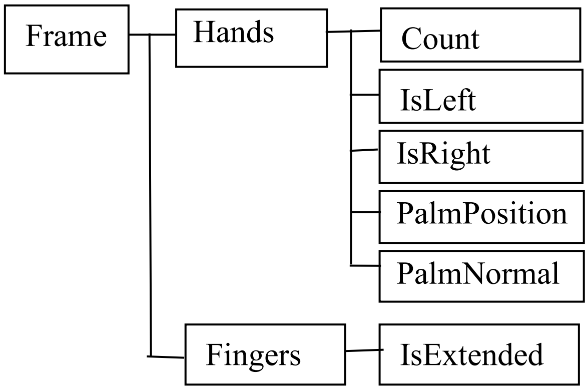

Fig. 4: Leap Motion Controller Objects used in the current application.

4. CONTENTS OF SIGN LANGUGUAGE DEMONSTRATION

4.1. Demonstration System and Contents

A prototype of museum exhibition that explains Japanese sign language to whom does not know sign language is developed. The main purpose is to demonstrate that sign language is language which have individual syntax different from spoken language.
The system consists of a display screen, a finger motion tracking device (LEAP Motion Controller), and a personal computer. A notebook PC version is shown in Fig. 5. The device is placed vertically on upper edge of the screen. In real exhibitions, a large display is hanging on a wall vertically, and the device is put on the wall below the display, facing front of a person who watch the contents. Or, it may be placed on a table in front of the large display, facing up. In this case, person's hands are tracked from the bottom.
When the contents is started, an initial screen is displayed, and it is waiting for user. When a user come and he/she moves his/her hands in front of the display, it recognizes them as sign language words, then a

character animation is displayed on screen depending on hands and fingers shapes.

Fig. 5: LEAP Motion Controller device placed on a notebook computer display.

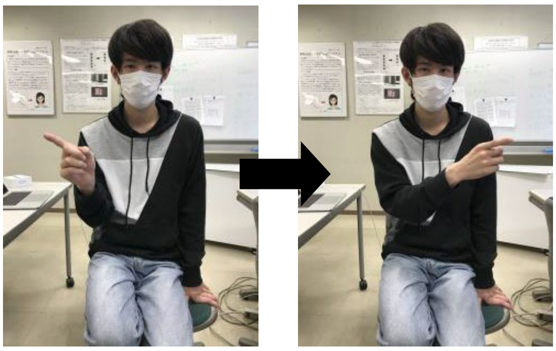

Fig. 7: "from/to" by an index finger movement.

In the current prototype, only 4 words are recognized, which are "boy," "girl," "like," and "to/from." Fig. 6 shows the example Japanese sign language word sequence of /boy/, /girl/, /to/, /like/, which means "A boy likes a girl." "Boy" and "girl" are noun, "like" is verb, and "to/from" is a word which express a direction by moving an index finger from an object to another (Fig. 7). Recognized sentences are either "A boy likes a girl." or "A girl likes a boy."

When a user does such movement in Fig. 6 in front of the screen, the system displays characters of a boy and a girl (Fig. 8), and a heart mark is flying from the boy to the girl. Fig. 9 shows an example of character animation. This is a very limited and simple sign language recognition system used only for an introduction purpose, although it cannot be used in real situations. However, even if it is very limited, contents with user interactions are more impressive than one-way explanations.

Fig. 8: Character animation by hands and fingers recognition.

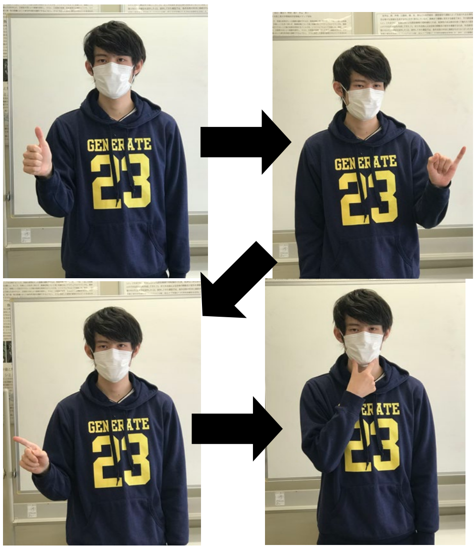

Fig. 6: A sign language sentence, "A boy likes a girl."

4.2. Feasibility Evaluations

With 10 students, recognition rates of 3 sign language words, "boy, " "girl," and a direction of "from/to" were tested. "Boy" (stretching thumb and bending other 4 fingers) were recognized at accuracy of 88%, "girl" (stretching little finger and bending other fingers and thumb) 94%, "from/to" motion 72%. Flipping motions of "from/to" were sometimes framed out and overlapped by other fingers and palm, then recognition rate is low. In verb "like," thumb and index finger were often invisible by chin and framed out often so that the recognition was very low less than 50%, thus improvements and position changes were needed.

In conclusion, the prototype is not feasible as real exhibition contents, so far.

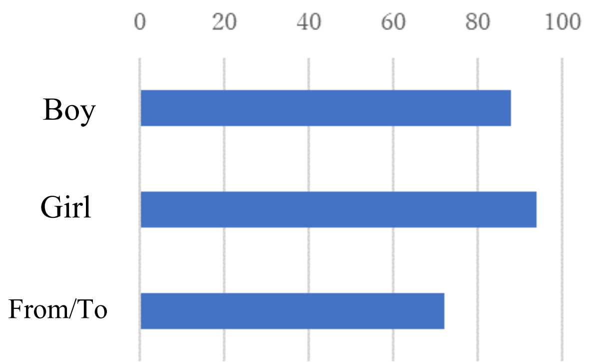

Fig. 9: Recognition experiment results.

4.3. Future improvements

Currently, several enhancements are planned toward feasible exhibition contents.

At first, placements of the motion tracking device will be reconsidered. In the evaluation experiment, hands were often out of range when a user moved his/her hands for sign language. Also, the word "like" could not be recognized by hiding hands by chin. The tracking area of the device is depth between 10cm to 60cm preferred, up to 80cm maximum, and 140×120° typical field of view (Fig. 10). The best position of the tracking device will be found by repetitive trials.

In our initial developments in several years ago, we used Xbox Kinect and Kinect v2 (Microsoft)[5] as body motion capture devices. By Kinect, wider areas could be captured but details of hands and fingers could not be captured. Kinect was obsoleted by the maker in few years ago. Thus, we switched the device to LEAP Motion Controller, for detailed finger tracking. Currently, Kinect is reborn as Azure Kinect DK[6]for enterprise market. We may think about Azure Kinect DK or other depth cameras, in future, depending on application contents.

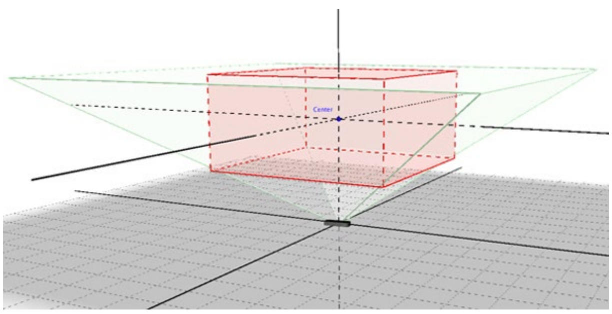

Fig. 10: Recognition zone of hand gestuers (LEAP Motion Controller).

From Ultraleap Inc., another device similar to LEAP Motion Controller is released as "Stereo IR 170."[7] (Fig. 11). It has wider field of view. The tracking area of the device is depth between 10cm to 75cm preferred, up to 1m maximum, and 170×170° typical field of view. Currently, it is evaluated and tested in our lab.

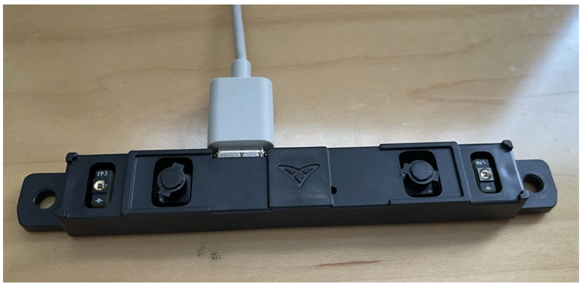

Fig. 11: Stereo IR 170.

Second, contents will be improved. More variations and attractive features will be added. Also, stable, maintenance free, completed standalone software with easy user interfaces will be made for museum exhibition purpose.

5. SUMMARY

A finger motion tracking display system is proposed, and a prototype was implemented. A prototype demonstration content for Japanese sign language experiences was implemented and tested. So far, the accuracy is low and infeasible to real exhibition, but currently and in near future, several enhancements are being applied. User input interfaces without touching are necessary and important for interactive museum exhibitions, in the current COVID-19 situations.

6. REFERENCES

[1] National Crafts Museum, The First of the National Crafts Museum's Grand Opening Exhibitions: Japanese Crafts — Materials, Techniques and Regionalities, Kanazawa, Ishikawa, Japan, 2020.
[2] Takuji Suzuki, Non-contact page flipping device "Sawarazumekuri" - development and application on museum exhibition, SIG on Digital Museum and Humanities, 1, pp. 34-39, 2021 (In Japanese).
[3] Ultraleap Inc., Leap Motion, http://ultraleap.com, 2021.
[4] Unity, Unity, https://unity.com/developer-tools, 2021.
[5] Microsoft, Kinect for Windows SDK 2.0, https://developer.microsoft.com/en-us/windows/kinect/, 2021.
[6] Microsoft, Azure Kinect DK, https://azure.microsoft.com/en-us/services/kinect-dk, 2021.
[7] Ultraleap Inc., Leap Motion - Stereo IR 170 Evaluation Kit, http://ultraleap.com, 2021.