

# WEB VIEWERS FOR EDUCATIONAL VR CONTENTS

Yoshihiro Okada<sup>1</sup> and Kanami Oki<sup>2</sup>

<sup>1</sup>*Innovation Center for Educational Resources (ICER), Kyushu University Library, Kyushu University*

<sup>2</sup>*Department of Physics, Faculty of Science, Kyushu University  
Motooka 744, Nishi-ku, Fukuoka, 819-0395, Japan*

## ABSTRACT

This paper introduces web viewers for educational VR contents. Recently, many types of VR goggles have been released as commercial products and many entertainment applications for them have been created. However, educational VR contents have been created so far are not so many because the creation of VR contents is time consuming task. We need to create many educational VR contents to enhance educational efficiency using VR technology. On the other hand, many types of scanning devices have been researched and developed, e.g., Lidar cameras, 360VR cameras and so on. Using these scanning devices, we can obtain 3D data like Point Cloud Data (PCD), 3D model data, 360VR images/videos. To use these 3D data as educational VR contents, we need viewer applications for them. In this paper, the authors propose such viewer applications as web services. The proposed web viewers also have functionality to upload 3D data from users' web-browser to the web-server on that the web viewers are stored. Therefore, it becomes possible for users like teachers to provide other users like students with educational VR contents as web contents. In addition, as the proposed web viewers support VR goggles, they provide students with immersive environments.

## KEYWORDS

Web Viewers, 3D Models, 360VR, Point Cloud Data, VR, Educational Materials

## 1. INTRODUCTION

This paper treats activities of ICER (Innovation Center for Educational Resources), Kyushu University, Japan. The missions of ICER are to provide educational materials using the latest ICT and to support teachers for creating such educational materials. In this paper, we introduce web viewers for educational VR contents that were developed as the activities of ICER. Recently, many types of VR goggles have been released as commercial products and many entertainment applications for them have been created. However, there have been few educational VR contents so far because the creation of VR contents needs much time and human resources. In the near future, our center ICER has to create many educational VR contents to enhance educational efficiency using VR technology. On the other hand, many types of scanning devices have been researched and developed so far, e.g., Lidar cameras, 360VR cameras and so on. ICER has these scanning devices. Using these scanning devices, we can obtain 3D data like Point Cloud Data (PCD), 3D model data, 360VR images/videos. To use such 3D data as educational VR contents, we need viewer applications for them. Then, we propose such viewer applications as web services in this paper. The proposed web viewers also have functionality to upload 3D data from users' browser to the web servers that the web viewers are stored. By this functionality, it becomes possible for users like teachers to provide users like students with educational VR contents as web contents. As the proposed web viewers support VR goggles, they can provide students with immersive environments.

The remainder of this paper is organized as follows: In next section 2, we describe related work. Section 3 introduces scanning devices that ICER possesses, and Section 4 introduces web viewers for each 3D model data, Point Cloud Data (PCD) and 360VR images/videos, respectively and explains how users like teachers prepare educational VR contents of these data. Finally, we conclude the paper in Section 5.

## 2. RELATED WORK

Usually, we need to use any toolkit systems for creating interactive 3D applications like educational materials. As a research system of our laboratory, there is IntelligentBox (Okada and Tanaka, 1995) that is a development system for interactive 3D graphics desktop applications. There have been many applications including educational materials (Okada and Ogata, 2017, Kosuki et al, 2012, Nomi et al, 2021, 2022) practically developed using IntelligentBox so far. Although there are web-based 3D graphics applications developed using the web-version of IntelligentBox (Okada, 2013), those cannot support VR goggles such as Meta Quest 2. We need to use other toolkit systems for educational VR contents. Unity is one of the most popular game engines in the world (<https://unity.com/>). We have developed a couple of serious games for educations using Unity (Sugimura, et al, 2014). Although Unity is very powerful, it requires programming knowledge and skills of its operations. So, Unity is not easy for common end-users like teachers to use it. Our proposed web viewers of PCD, 3D model data and 360VR images/videos are developed using Three.js, one of the popular WebGL-based 3D graphics JavaScript library systems (<https://threejs.org/>). We have developed several web-based 3D educational materials using our development frameworks (Okada. et al, 2016, 2016, 2017, Ma. et al, 2018, Hirayama. et al, 2019, Yamamura. et al, 2020) based on Three.js.

There are many commercial services for creating interactive web contents using 360VR camera images. The service of RICOH (<https://www.theta360.biz/>) does support 360VR images but not 360VR videos nor PCD. The service of Matterport (<https://matterport.com/>) does support 360VR images and PCD but not 360VR videos. Our proposed web viewers are supposed to be released as open web services. Then, it is thought that the number of educational VR contents will grow quickly, and as a result, the education using VR technology will be promoted.

## 3. SCANNING DEVICES AND THEIR SOFTWARE

In this section, we introduce three types of scanning devices, i.e., Artec Leo for 3D model data, Leica BLK 360 for Point Cloud Data (PCD) and Insta360 for 360VR images/videos as shown in Figure 1.



Figure 1. Image of sensing devices of Artec Leo(left), Leica BLK360(middle) and Insta360 Pro(right)

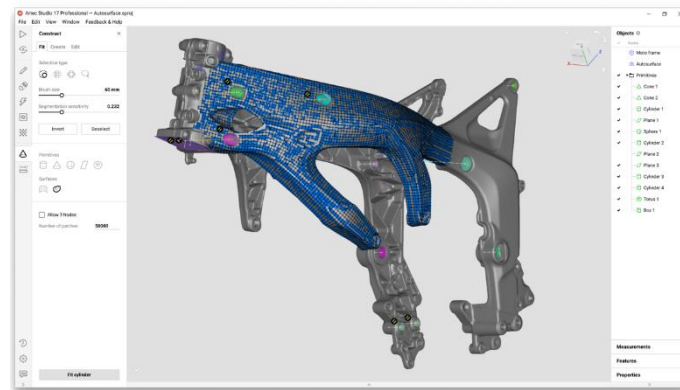


Figure 2. Screen image of Artec Studio

### 3.1 Scanning Device for 3D Model Data and its Software

As a scanning device for 3D model data, we use Artec Leo as shown in the left part of Figure 1. Artec Leo makes 3D scanning easy because it is the wireless and fully standalone professional 3D scanner consisting of the new NVIDIA Jetson TX2 processor onboard, 5" HD built-in display and battery. It has the ultimate all-in-one 3D scanning function of fast, accurate, and high-quality data capture. You can find the full specifications from <https://www.artec3d.com/portable-3d-scanners/artec-leo>. Once we obtain 3D points data by scanning any real-world objects, we use Artec Studio that is a dedicated software handling scanned 3D points data to generate 3D model data (<https://www.artec3d.com/3d-software/artec-studio>) shown in Figure 2.

### 3.2 Scanning Device for Point Cloud Data (PCD) and its Software

As a scanning device for Point Cloud Data(PCD), we use Leica BLK 360 shown in the middle part of Figure 1. The BLK360 captures the world with full-color panoramic images overlaid on a high accuracy point cloud easily by the single button. Also, it is easy to handle the BLK360 because of its light weight and compact size. By using an iPad and the cyclone field, a dedicated software installed in the iPad, anyone can capture the world around him/her with high resolution 3D panoramic images. Using the software, the BLK360 streams image and point cloud data to the iPad in real time. You can find the more details of the BLK360 from <https://leica-geosystems.com/en-in/products/laser-scanners/scanners/blk360>. Once we obtain PCD by scanning any real-world rooms or buildings, we use Cyclone REGISTER 360 (BLK Edition), a dedicated software that processes scanned PCD to generate merged PCD (<https://leica-geosystems.com/en-gb/products/laser-scanners/software/leica-cyclone/leica-cyclone-register-360>) shown in Figure 3.

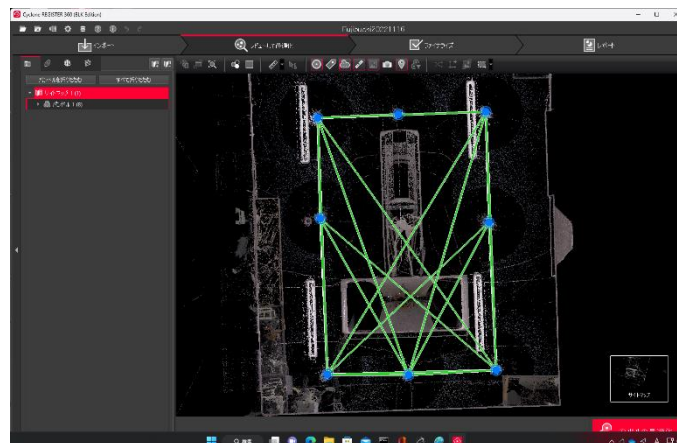


Figure 3. Screen image of Cyclone REGISTER 360

### 3.3 Sensing Device for 360VR Images/Videos and its Software

As a sensing device for 360VR images/videos, we use Insta360 Pro as shown in the right part of Figure 1. It was created by designing from the ground up with creators in mind. Its compact, spherical frame is custom-milled from aluminum alloy and surrounded with six 200° lenses. A detachable base and easy-to-grip contours make it a versatile on-set companion. You can find more detail specification of Insta360 Pro from [https://www.insta360.com/product/insta360-pro/#pro\\_specs](https://www.insta360.com/product/insta360-pro/#pro_specs). Once we obtain fish-eye images/videos by scanning any real-world rooms or buildings, we can use Insta360 STITCHER, a dedicated software to generate 360VR images/videos by stitching the scanned fish-eye images/videos (<https://leica-geosystems.com/en-gb/products/laser-scanners/software/leica-cyclone/leica-cyclone-register-360>) shown in Figure 4.

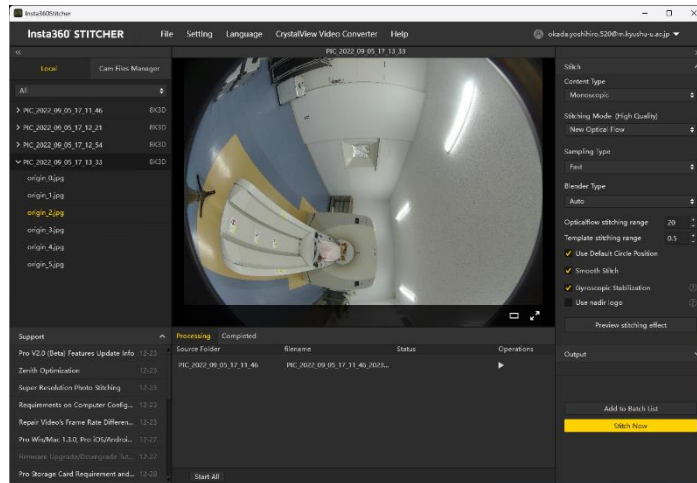


Figure 4. Screen image of Insta360 STITCHER

## 4. WEB VIEWERS

In this section, we introduce three web viewers for 3D model data, PCD, and 360VR images/videos and explain their functional details to show how users can use them.

### 4.1 Web Viewer for 3D Model Data

After generating 3D model data, users can upload using a data upload web service for them onto a target web server. Figure 5 shows the screen images of the data upload web service for 3D model data. The texts are Japanese and English. In the left part of Figure 5, there are three file selection inputs, the upper box is for a 3D model file of .obj format, the middle is for a material file and the lower is for a parts names file of the 3D model. Once you choose 3D model file and two subsidiary files in the three boxes and push the send button, the files will be uploaded onto the web server. If the file upload is completed successfully, the message including two URLs (WebGL Ver. and WebXR Ver.) will appear in the browser as shown in the right part of Figure 5. This case, a brain model was uploaded on the server. Furthermore, if you click on the upper URL(WebGL Ver.), the uploaded brain model will appear in the browser as shown in the left part of Figure 6. In the middle part of the browser, there is the menu to specify a manipulation type such as rotate, translate and zoom. You can rotate, translate and zoom the brain model by the mouse drag operation. If you move the mouse cursor on any part of the brain, its corresponding name appears those names are defined in the parts names file. Then, students can learn the details of a brain interactively. If you click on the lower URL (WebXR Ver.), the uploaded brain model will appear in the browser as shown in the right part of Figure 6. You can see 'ENTER VR' button in the right lower part of the browser. By clicking on the button, the web viewer will become VR mode as shown in Figure 7. This means that the user can look the brain model using a VR goggle like Meta Quest 2.

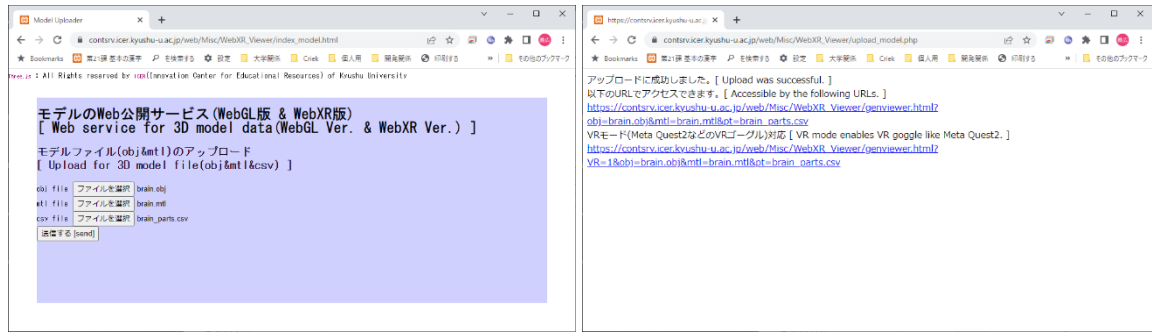


Figure 5. Screen images of the 3D model data uploader before and after uploading the data files (left and right)

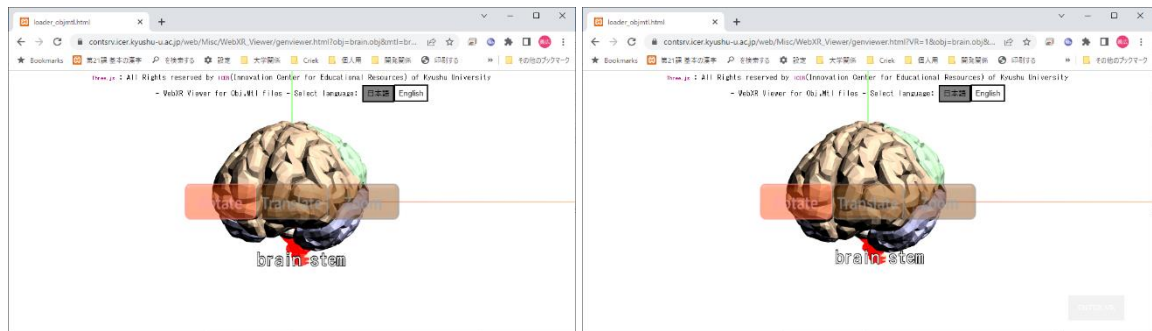


Figure 6. Screen images of web viewer for 3D model data of WebGL mode (left) and WebXR mode (right)

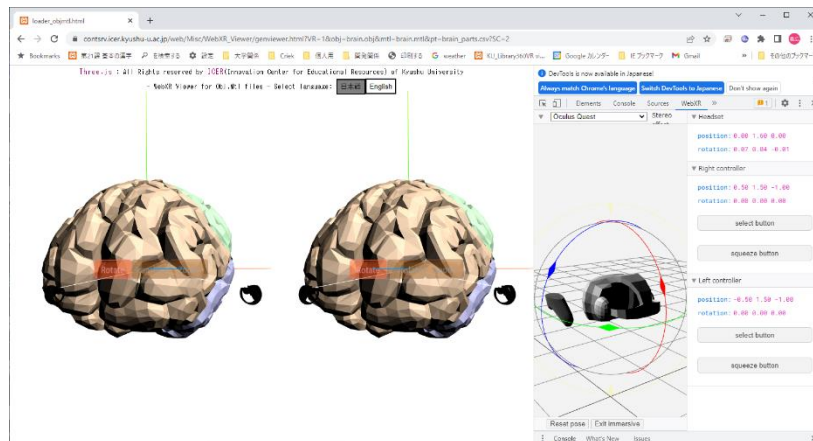


Figure 7. Screen image of web viewer for 3D model data of WebXR mode (stereo view)

## 4.2 Web Viewer for Point Cloud Data(PCD)

After generating merged PCD, users can upload using a data upload web service for them onto a target web server. Figure 8 shows the screen images of the data upload web service for PCD. The texts are Japanese and English. There is one file selection input box in the left part of Figure 8. Once you choose PCD file in the input box and push the send button, the PCD file will be uploaded onto the web server. If the file upload is completed successfully, the message including two URLs (WebGL Ver. and WebXR Ver.) will appear in the browser as shown in the right part of Figure 8. In this case, PCD of the CT training room was uploaded. Furthermore, if you click on the upper URL(WebGL Ver.), the uploaded PCD will appear in the browser as shown in the left part of Figure 9. You can change your eye position and direction in the room by the mouse drag operation.



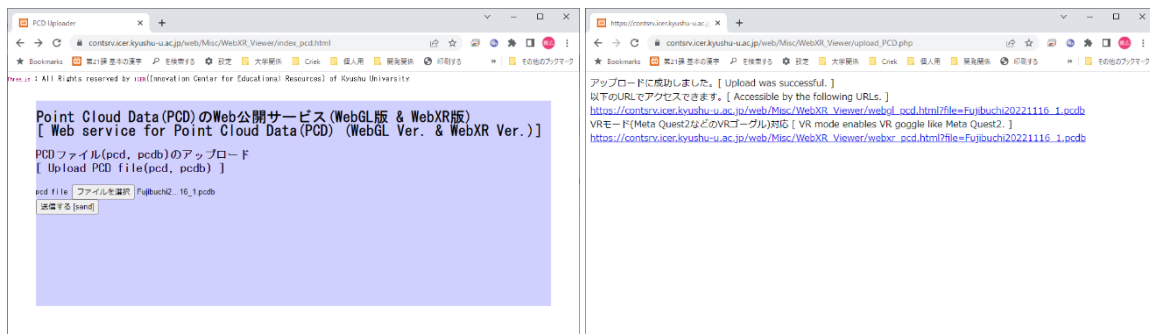


Figure 8. Screen images of PCD uploader before and after uploading the data file (left and right)

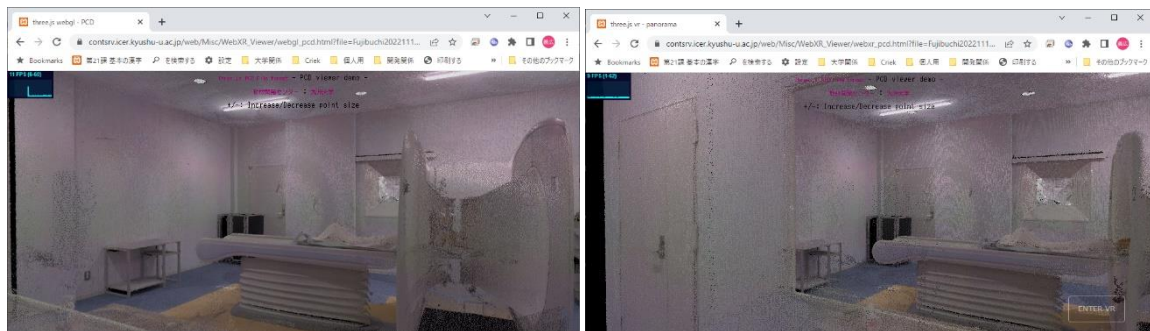


Figure 9. Screen images of web viewer for PCD of WebGL mode (left) and WebXR mode (right)

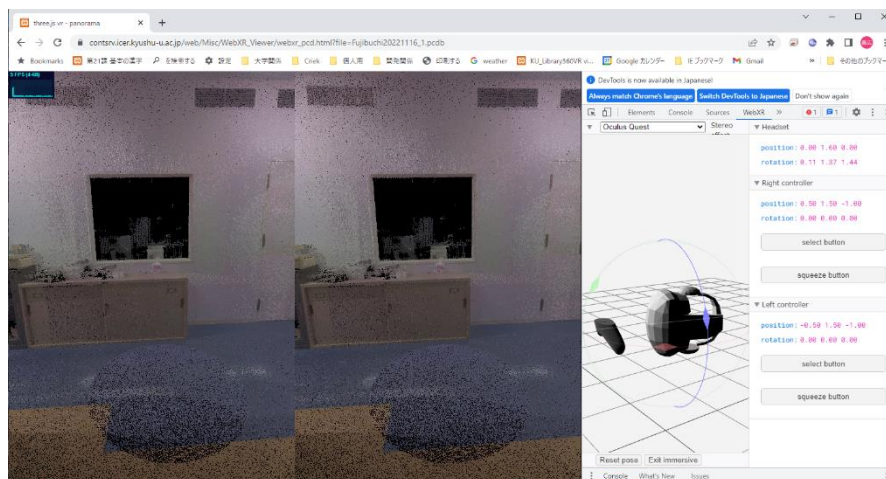


Figure 10. Screen image of web viewer for PCD of WebXR mode (stereo view)

If you click on the lower URL (WebXR Ver.) of the browser of the right part of Figure 8., the uploaded PCD will appear in the browser as shown in the right part of Figure 9. You can see 'ENTER VR' button in the right bottom of the browser. By clicking on the button, the web viewer will become VR mode as shown in Figure 10. This means that the user can see the CT training room using a VR goggle.

### 4.3 Web Viewer for 360VR Images/Videos

After generating 360VR images/videos, users can upload using a file upload web service for them onto a target web server. Figure 11 shows the screen images of the file upload web service for 360VR image/videos. The texts are Japanese and English. There are two file selection input boxes, the upper box is for 360VR images and the lower is for 360VR videos as shown in the left part of Figure 11. Once you choose 360VR image file in the upper box and push the send button, the file will be uploaded onto the web server. If the file upload is

completed successfully, the message including two URLs (WebGL Ver. and WebXR Ver.) will appear in the browser as shown in the right part of Figure 11.

In this case, 360VR image of the CT training room was uploaded onto the server. Furthermore, if you click on the upper URL (WebGL Ver.), the uploaded 360VR image will appear in the browser as shown in the left part of Figure 12. You can change your eye position and direction in the room by the mouse drag operation. If you click on the lower URL (WebXR Ver.) of the browser of the right part of Figure 11, the uploaded 360VR image will appear in the browser as shown in the right part of Figure 12. You can see 'ENTER VR' button in the right bottom of the browser. By clicking on the button, the web viewer will become VR mode as shown in Figure 13. This means that the user can see the CT training room using a VR goggle. Furthermore, once you choose 360VR video file in the lower box in the browser of the left part of Figure 11 and push the send button, the file will be uploaded onto the web server. If the file upload is completed successfully, the message including two URLs (WebGL Ver. and WebXR Ver.) will appear in the browser similarly to the right part of Figure 11. Then, you can watch 360VR video of the CT training room in both WebGL mode and WebXR mode similarly to Figure 12 and Figure 13. Medical students learn how the CT therapy device works.

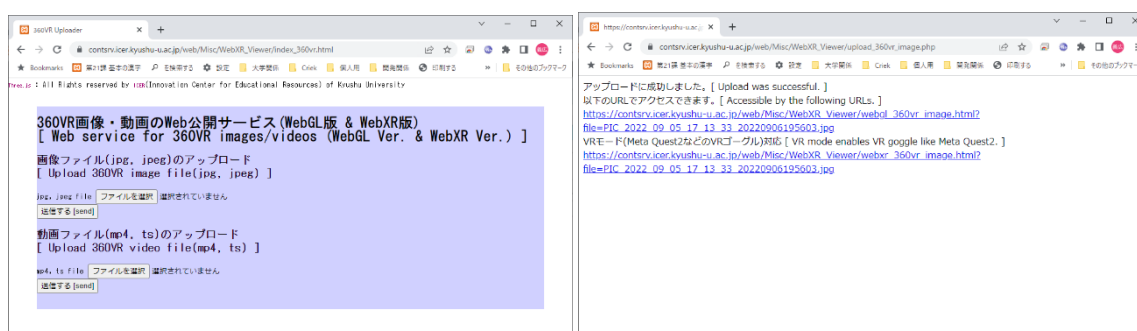


Figure 11. Screen images of the 360VR image/video uploader before and after uploading the files (left and right)

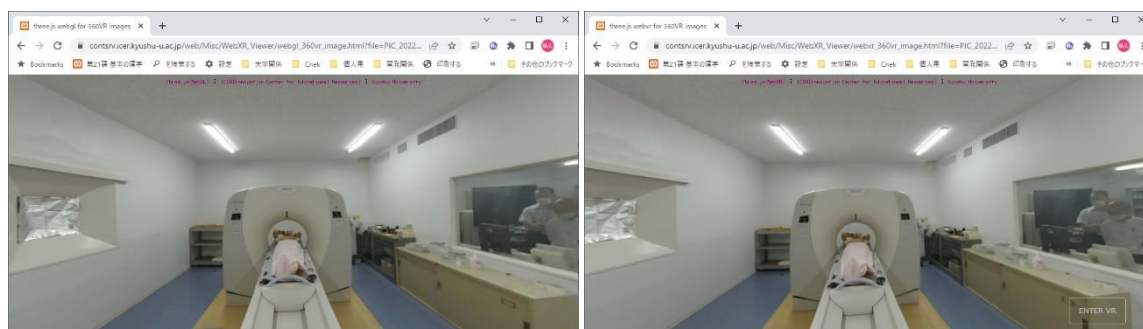


Figure 12. Screen images of web viewer for 360VR images of WebGL mode(left) and WebXR mode (right)

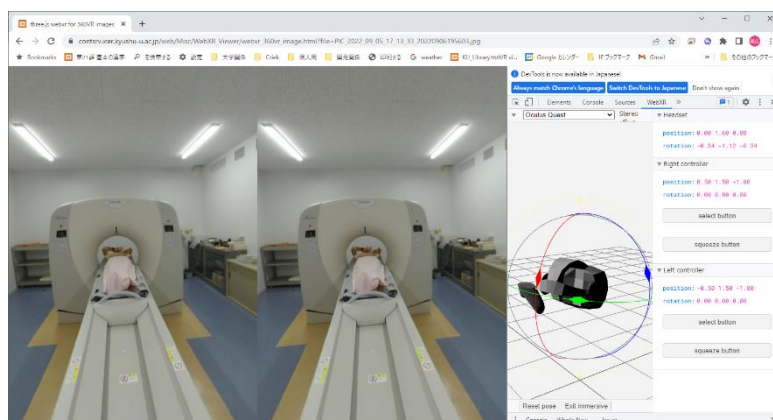


Figure 13. Screen image of web viewer for 360VR images of WebXR mode (stereo view)

## 5. CONCLUSIONS

Recently, many types of scanning devices have been researched and developed, e.g., Lidar cameras, 360VR cameras and so on. Using these scanning devices, we can obtain 3D data like Point Cloud Data (PCD), 3D model data, 360VR images/videos more easily rather than ever. To use these 3D data as educational VR contents, we need viewer applications for them. In this paper, we proposed such viewer applications as web services. The proposed web viewers also have functionality to upload 3D data from users' web-browser to the web-server on that the web viewers are stored. Therefore, it becomes possible for users like teachers to provide other users like students with educational VR contents as web contents easily. In addition, as the proposed web viewers support VR goggles, teachers can provide students with immersive environments that are regarded to have higher educational efficiency.

## ACKNOWLEDGEMENT

This research was partially supported by JSPS KAKENHI Grant Number JP22H03705.

Also, we appreciate Prof. Toshioh Fujibuchi, Graduate School of Medicine of Kyushu University, for his help to obtain 360VR images/videos and PCD of the CT training room.

## REFERENCES

- Hirayama, D. et al, 2019. Web-Based Interactive 3D Educational Material Development Framework and Its Authoring Functionalities, Proc. of the 22nd International Conference on Network-Based Information Systems (NBIS-2019), ISBN 978-3-030-29028-3, pp. 258-269.
- Kosuki, Y. and Okada, Y. 2012. 3D visual component based development system for medical training systems supporting haptic devices and their collaborative environments. Proc. of 6th International Conference on Complex, Intelligent, and Software Intensive Systems, CISIS 2012, pp. 687-692, <https://doi.org/10.1109/CISIS.2012.131>
- Ma, C. et al, 2018. E-Learning Material Development Framework Supporting VR/AR Based on Linked Data for IoT Security Education, Proc. of 6th International Conference on Emerging Internet, Data & Web Technologies (EIDWT 2018), ISBN: 978-3-319-75928-9, pp. 479-491.
- Nomi, M. and Okada, Y. 2021. Improvement of Dental Treatment Training System Using a Haptic Device. Proc. of the 15th International Conference on Broad-Band and Wireless Computing, Communication and Applications, BWCCA 2020, pp. 143-153, Lecture Notes in Networks and Systems; Vol. 159 LNNS.
- Nomi, M. and Okada, Y. 2022. Dental Treatment Training System Using Haptic Device and Its User Evaluations. Proc. of the 16th International Conference on Complex, Intelligent and Software Intensive Systems CISIS-2022, pp. 569-580, Lecture Notes in Networks and Systems; Vol. 497 LNNS.
- Okada, Y. 2013. Web Version of IntelligentBox (WebIB) and Its Integration with Webble World, Vol. 372 of the series, Communications in Computer and Information Science, Springer, pp. 11-20.
- Okada, Y. and Tanaka, Y. 1995. IntelligentBox: a constructive visual software development system for interactive 3D graphic applications, Proc. of Computer Animation '95, IEEE CS Press, pp. 114-125.
- Okada, Y. et al, 2016. Interactive Educational Contents Development Framework Based on Linked Open Data Technology, 9th annual International Conference of Education, Research and Innovation, pp. 5066-5075.
- Okada, Y. et al, 2016. Framework for Development of Web-based Interactive 3D Educational Contents, 10th International Technology, Education and Development Conference, pp. 2656-2663.
- Okada, Y. et al, 2017. Interactive Educational Contents Development Framework and Its Extension for Web-based VR/AR Applications, Proc. of the GameOn 2017, Eurosis, ISBN: 978-90-77381-99-1, pp. 75-79.
- Okada, Y., Ogata, T. et al, 2017, Component-based approach for prototyping of Tai Chi-based physical therapy game and its performance evaluations. Computers in Entertainment, 14(1), <https://doi.org/10.1145/2735383>
- Sugimura, R., et al, 2014. Mobile Game for Learning Bacteriology, Proc. of IADIS 10th Int. Conf. on Mobile Learning 2014, pp.285-289.
- Yamamura, H. et al, 2020. A Development Framework for RP-type Serious Games in a 3D Virtual Environment, VENOVA 2020 in Proc. of the 14th International Conference on Complex, Intelligent, and Software Intensive Systems (CISIS-2020), pp. 166-176.