Web-based multiplex image synthesis for digital signage

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***Abstract*—This article contributes to the shared implementation techniques of multiplex image synthesis algorithm using a WebGL based game engine named PlayCanvas. The multiplex imagery technology can show multiple different images on a single screen simultaneously. This technology was developed using two different approaches: one is ExPixel, and the other is ExField. ExPixel is a multiplex imaging technology that can generate multiple images on a 3D flat panel simultaneously. ExField is Augmented Glassless Synthesis technology that can show up to nine highly detailed images on a single screen at once.**

Keywords—Multiplex image sybthesis; PlayCanvas; WebGL; ExPixel; ExField; fragment shader;

I. MOTIVATION

In recent years, the applications for game engines such as Unity and Unreal Engine have gotten richer and wider. For example, interactive digital signage is one such field that has been using the above two engines to create real time graphics application. These contents are implemented into the executable file however, and their implementation varies depending on the platform. On the other hand, cloud implementation is also being developed in various fields. In this research, we are developing a new digital signage which runs on browsers with high performance graphics utilizing WebGL based game engine.

II. PREVIOUS RESEARCH

Scritter [1] is a projector based multiplex imaging system which uses two DMD projectors with linear or circular polarization. It displays two images simultaneously but requires two polarized glasses to see the pictures separately. Without glasses the viewers see a doubled image with their naked eyes on screen. ScritterH is the next iteration of Scritter. It hides an image for naked eyes using image canceling algorithms. These images synthesis were implemented onto an executable of XNA application working with GPU as pixel shader. Multiplex hidden imagery technology was also realized on flat panel with ExPixel technology [2]. It displays one image for the naked eye and another displayed on a 3D passive flat panel display. Viewers can choose which image to view by putting on or off the circular polarizing filter. The Grassless Augmented synthesis technology is known as ExField [3]. It can show one image for an angle and another image for a different angle so audiences see difference images from difference angles.

III. THEORY

This section describes the ExPixel and ExField technology used in this research. It also describes PlayCanvas used in the implementation of Web-based game engine.

A. *ExPixel*

ExPixel is a multiplex hidden imagery technology that displays different pictures on a single screen when viewed by different polarized lenses. One can see the images separately by synthesized pixels video display shaders with polarized lenses. There are two images in this research named A and B. What a bright, A ', a dark B B ', A '-B ' as C ,C display even-numbered columns, B ' can be implemented by writing to odd-numbered columns display. In addition, bright equation (1), dark equation (2), A '-B ' equation (3) of the algorithm shown below.

$$a' = a \times (1 - a_{min}) + a_{min} \quad (1)$$

$$b' = b \times a_{min} \quad (2)$$

$$c = (a'^{\gamma} - b'^{\gamma})^{\frac{1}{\gamma}} \quad (3)$$

B. *ExField*

ExField is a multiplex hidden imaging system that shows different contents depending on the angle it is being viewed from. No installation of multiple video devices is required to achieve this result. By layering the lenticular lens in Normal display multiple images and then synthesized by a shader and

shows a video that can be implemented. This implementation mainly uses two parameters. One is in the process of turning the angle and needs to create an uneven lenticular lens overlay and set the lenses at an angle. The second is processing according to the width of the surface of the lens.

To achieve this result the width of the side of the display pixel width needs to be varied and changes to the angles of the lens parameter adjustment process from the angle of the slope and width of the lenticular lens surface.

ExField needs concave lens to be shown diagonally, and the angle affects the parameter adjustment. Implementation of ExField has two required parameters. One is the angle parameter, and the other is the pixel value parameter. Calculated from the angle parameter 1 to equation (4), pixel processing algorithm to equation (5).

$$T = \frac{\left(\frac{x}{3} - \frac{y}{\tan(\theta)} + \frac{0}{\cos(90-\theta)} \times 100\right) fmod \times \frac{0}{\cos(90-\theta)}}{\frac{0}{\cos(90-\theta)}} \quad (4)$$

$$P_{(x,y)} = \begin{cases} C(1)_{(x,y)} & (0 \le T \le \frac{1}{n}) \\ C(2)_{(x,y)} & (\frac{1}{n} \le T \le \frac{2}{n}) \\ \vdots & \\ C(n-1)_{(x,y)} & (\frac{n-2}{n} \le T \le \frac{n-1}{n}) \\ C(n)_{(x,y)} & (otherwise) \end{cases} \quad (5)$$

C. PlayCanvas

PlayCanvas is a game engine developed using Web-based graphics processing with real-time shader [4]. Contents created by PlayCanvas are available and performs excellently.

When developing contents using JavaScript and GLSL, OpenGL Shading Language is the GLSL. Loading images via JavaScript and create them in a GLSL shader processing.

The system can process suitable for display of 1920 x 1080 and available plain as a 3D model, in this case the camera distance to 13.03. Figure 1 shows editor of the PlayCanvas.

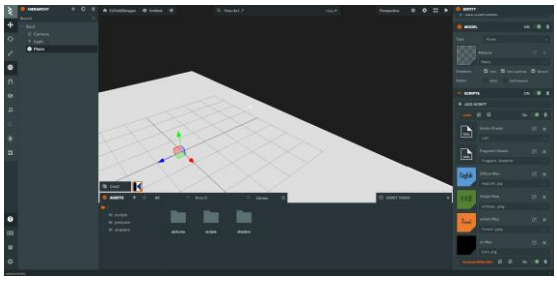

Figure 1 : PlayCanvas editor

IV. Development and Implementation

In this study, we have tested Unity and “PlayCanvas” as the engine for multiplexing invisible video technology with easy handling for contents developer. We had already developed ExPixel shader and ExField shader on Unity and it can perform UHD (4K) resolution. This study, implements multiplex hidden image synthesis and Grassless multiplex image synthesis by WebGL instead of a stand-alone application. Conventional multiplexing mechanism performed on pixel shaders on GPU with two images. Through this trial, we had success in combining two images in a fragment shader using PlayCanvas. It performs real-time multiplexing two still images in HD (1920x1080) resolution.

A. ExPixel viewer

ExPixel viewer combines images in JavaScript and GLSL on PlayCanvas. Figure 2 is a combined image which shows the differences in images in no time when one is equipped with polarized glasses. Image that says "English" when wearing polarized glasses and the audience can see image which is written “nihongo” when wearing polarized glasses.

Figure 2 : ExPixel image by PlayCanvas

B. ExField viewer

ExField viewer combines images in JavaScript and GLSL on PlayCanvas. Figure 3 shows the combined images, and we can utilize keyboard inputs to adjust the parameter of individual images. This image was taken without lenticular lens.

Figure 3 : ExField image without lenticular lens

Figure 4 shows three images with lenticular lens. These images are designed to be shown to the naked eye. Furthermore these pictures all look differently depending on the angle they are being viewed from. For example, the word “French” is shown when viewed from up front, “English” is shown when viewed from the right, and finally the word “Nihongo” is shown when viewed from the left.

Figure 4 ： ExField images with lenticular lens

Figure 5 image shows figure which look on the top of display.

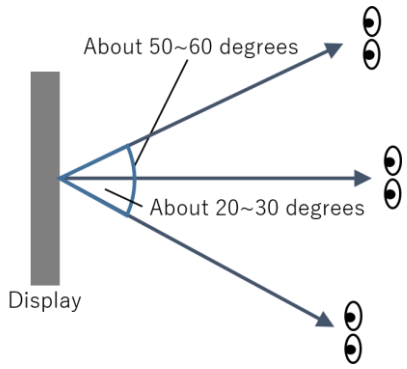

Figure 5 look on the top of the display

C. *ExField for Alioscopy*

As a first prototype, ExField was realized as a combination of 4K display (IODATA M4K282X) and a lenticular lens (lens pitch=20 lines/inch), in this report, we had also tried to apply our web based engine with a commercialized autostreo 3D display Alioscopy 3DHD-24. And its results as follows. Results when using this display ExField as follows.

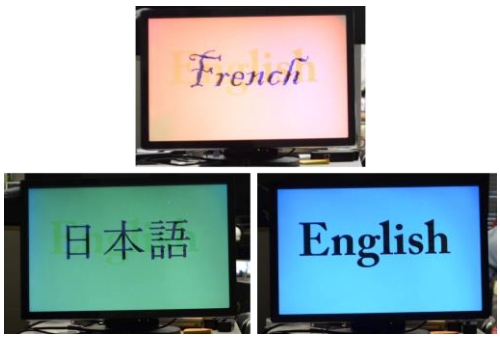

Figure 6 ExField images with Alioscopy lens

These photos the result of combining ExField with Alioscopy display. Just like figure 4, the word “French” is shown when viewed from up front, “English” is shown when viewed from the right, and finally the word “Nihongo” is shown when viewed from the left.

Despite of the effects being the same they are fundamentally different than figure 4.

Figure 7 image shows figure which look on the top of Alioscopy display.

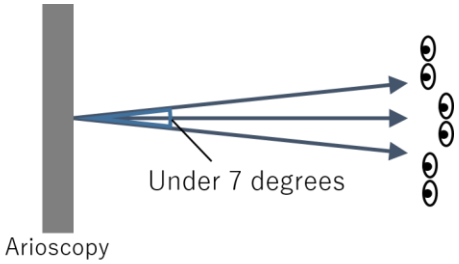

Figure 7 look on the top of Alioscopy display

V. Conclusion

This study researches web-based multiplex image synthesis. We have integrated PlayCanvas into both ExPixel and ExField, and we have confirmed that multiple images can be outputted at the same time. By turning both ExPixel and ExField into web-based platforms, it lays down the groundwork that will eventually enable the multiplex of URL based images. Improved usability for web based to perform on multiple displays and signage in the city requires each executable file does not implement. In the future, we will be able to build a scalable content environment if we make up the differences of each device, such as 4Kdisplay, 8Kdisplay, smartphone on the server side.

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