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Research paper

Real-Time Shading Image Implementation Technology for Physical Viod Display

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Abstract

Background/Objectives: The purpose of this study is control technology to reflect user's appearance and movement in the void display in real time.

Methods/Statistical analysis: In this paper, we have developed real-time shading image data acquisition based on RGB-D sensor and real-time interaction image control structure for realizing 0-255 Depth image of physical void display. We also study integrated interlocking control solution for integrated interlocking of hardware and software.

Findings: Conventional flip displays show data in 0,1 image representation. On the other hand, the void display we are studying acquires real-time data based on RGB-D and shows the data in depth 0-255 image representation.

Improvements/Applications: In the void display, the image representation of 0.1 was extended to the depth 0-255 representation.

Keywords*: Flip Display, Shading image, physical display, RGB-D sensor, Real-Time Interaction Image Control*

1. Introduction

Recently, not a flat screen display, the kinetic display, which combines kinetic art that moves in a three-dimensional manner, has been widely used in art works, advertisements, performances, and architectural fields to secure a market. There is a big visual difference between stopping and moving. The kinetic display is physically moving in a three-dimensional structure, maximizing the visual immersion feeling, and has differentiation from the conventional display, thereby expanding the market worldwide.

At present, as technology advances, kinetic art that combines technology and art has developed and further developed into a genre called physical display or kinetic display, moving to the media field. Kinetic display is a kind of application of kinetic art reflecting the mechatronics technology which is a fusion of machine and electron[1].Display technologies derived from kinetic displays can be classified into pin-type using flip-style displays and actuators and wire-type displays [Figure 1]. Usually, this type of display is composed of modules and each module is composed of pixels to realize various images through the display.

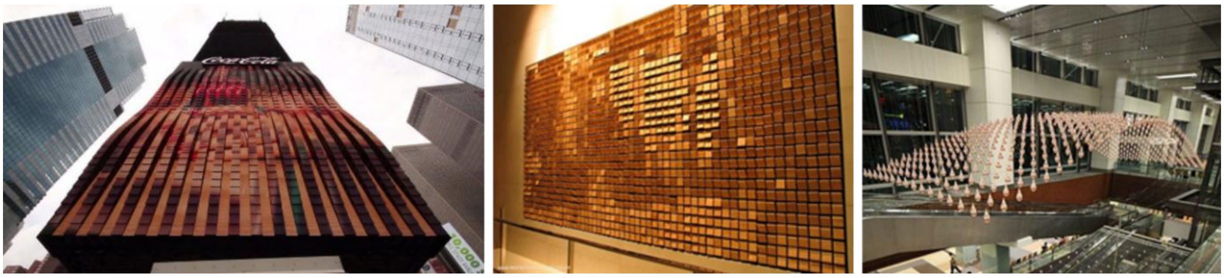

Figure 1: Pin type, flip type, and wire type surfaces

The void display that we study in this paper is developed in the flip dot display and the module consists of pixels. The flip-dot display is a suitable implementation method to represent text or to implement a simple shape by using a pixel on one side of a flip disk and a white pixel on the other side and moving the image back and forth by a magnetic field. The flip display is a form that would not be suitable for expressing fine gradation effects. In order to realize a natural image movement and a detailed image, it is necessary to develop a void display capable of implementing gray scale, not a flip method using plus angle and minus angle of the surface itself.

Physical void display development research is divided into hardware and software development in two main areas. The void display implements a shading image by being shaded by the angle of the void disk. Then, in order to realize this, an image control technology for converting the original image into grayscale is required. In this paper, we propose a real time interactive image content creation technology for multivariable physical void display and a solution using hardware and software integrated interlocking control technology.

2. The Shading that Appears on the Flip Type Display

The flip display is not an LED-type electroluminescent display, but a digilog type display that is a fusion of analog and digital. Unlike displaying an image on a flat surface, the flip display is characterized in that it implements the image by plus angle and minus angle of the surface itself. The image on the left side of [Figure 2] is the electric signboard installed at the airport, and the numbers and letters are changed using the flip disk, and the image on the right is the work 'Cloud' of the media artist group Troika. More than 5000 black and silver flip points are constantly moving, changing the shape of the 'Cloud'. This form is based on the technique of expressing binary images in which the object is grouped into one of two values, such as black or white according to the color contrast of the front and back sides of the flip [2] [3]. Flip displays are seen as a suitable technique for displaying text or for implementing simplified shapes. As mentioned above, the flip display is implemented as the contrast of the colors on the front and back, making it impossible to change the image gradation or natural movement. Therefore, in order to make the image to be displayed naturally, it should be developed in a form that can control the brightness, not the binarized image.

Figure 2: One of the Solari boards in the Qantas F SYD lounge. Image: Cynthia Drescher, Troika 'Cloud'

In the basic flip display mode, it is possible to realize a display form that expresses the brightness difference by applying the change of contrast according to the lighting and angle control of the and the flip disk and the control of the shading image control in real time [Figure 3].

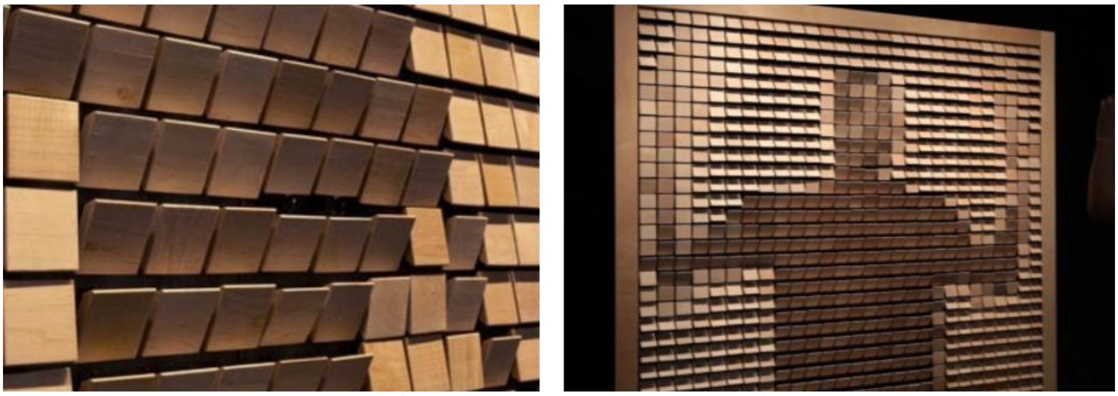

Figure 3: Brightness Difference according to Angle Adjustment of Flip Display Type

3. Real-Time Interactive Image Control Technology

3.1. Real-Time Image Data Representation Based on RGB-D

The real-time image control technology is an image control technology for reflecting user's external shape and motion in the void display in real time. In this study, we first acquire RGB image information and transmit the image data to the void display by applying shading technology to the acquired image information.

Today we are witnessing the birth of a new generation of sensing technologies capable of providing high quality synchronized videos of both color and depth, the RGB-D (Kinect-style) camera [4]. In this study, object recognition was performed using a Kinect sensor. For RGB-D object recognition, information on RGB data and depth data should be provided [5] Kinect consists of an RGB camera and a depth sensor. These sensors are applied to a Color View photographed by a general RGB camera and a Depth View representing depth information of the photographed image to recognize the user's position and motion. Through this, Skeleton View information representing the user's skeleton is recognized [6]. After obtaining the RGB image information of the object received from Kinect, the obtained data is

applied to the shading technique. The gray image is divided by the intensity of black from 0 to 255,which represents the pixel

value at 256 intensities. [7] Conversion from an RGB image to a grayimage results in the loss of chromaand only brightness.
The formula for changing from RGB image to gray image is as follows.

$$Gray = (299 \times R + 587 \times G + 114 \times B) \div 1000$$

$$R = G = D = Gray$$

R. G. B reflects the difference in brightness [8].

The image data of 15 frames per second received from the Kinect Sensor is converted into gray image data, the original image data is represented as shading data, and the gray image data is corrected based on the center value [Figure 4]. The acquired image data is transferred to the void display.

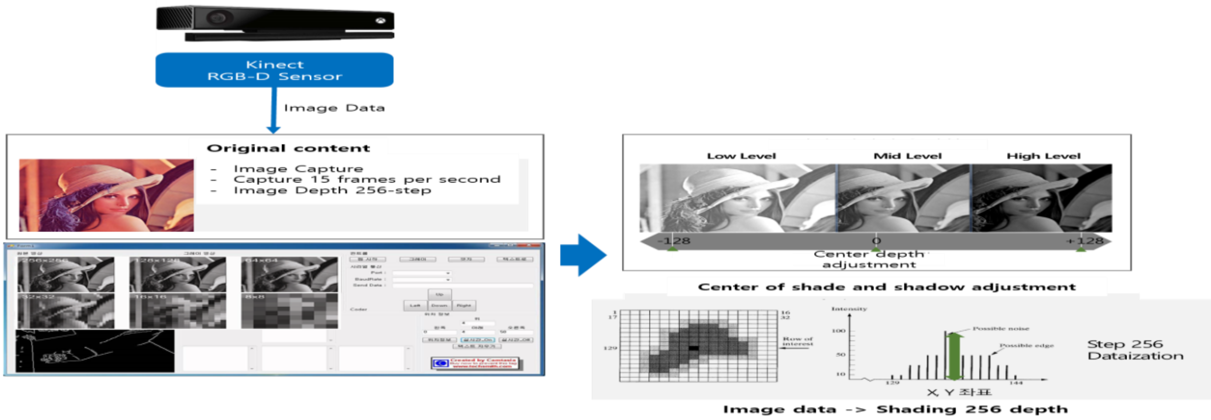

Figure 4: Video data shading technology

3.2. Real-Time Interaction Image Control Structure

The real-time interactive image suggestion solution is shown in [Figure 5]. The RGB-D based sensor that implements the 3D depth image receives the real-time interaction image data and converts the input image data into shading and binarization data according to the change of brightness in 256 steps. In the middle of [Figure 5], we can see that it is necessary to build a data-set-based RESTfull API optimized for void displayer. Therefore, the Data-set is defined according to the predetermined rules to utilize the image data that was shaded in the order of the reference time, Y axis, X axis, display coordinate data, and image coordinate data in the void display. Then, a defined Data-set is converted into a database, and a RESTful API is constructed to transmit data to the physical display through a predetermined communication protocol (HTTP) [9]. Finally, in order to harmonize the mapping data between image data and physical display, it is necessary to apply the distortion image restoration and matching technology using Distance Ratios. When some images are distorted due to camera blur or subject blur, we restore distorted image data using distance ratios formula through geometry transformation and then calibrate.

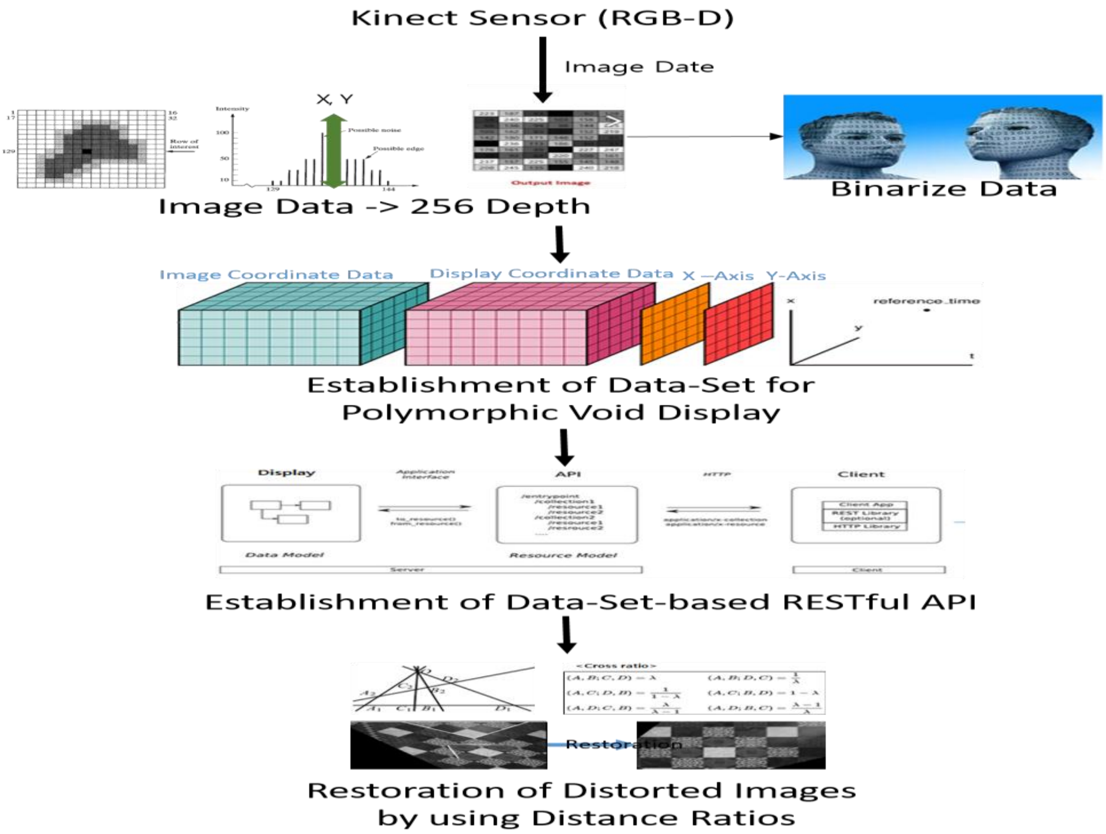

Figure 5: Real-Time Interaction Image Control Technology Flow [10]

4. Development of Integrated Control Solution

In order to transmit the shading image data to the void display through the kinetic sensor, it is necessary to configure the hardware and software integrated operation for the integrated operation control of the void display [Figure 6]. Build communication module for interlocking with physical display control module. And next, communication protocol is set, it can play a role of interlocking with the control module and the integrated operation control server.

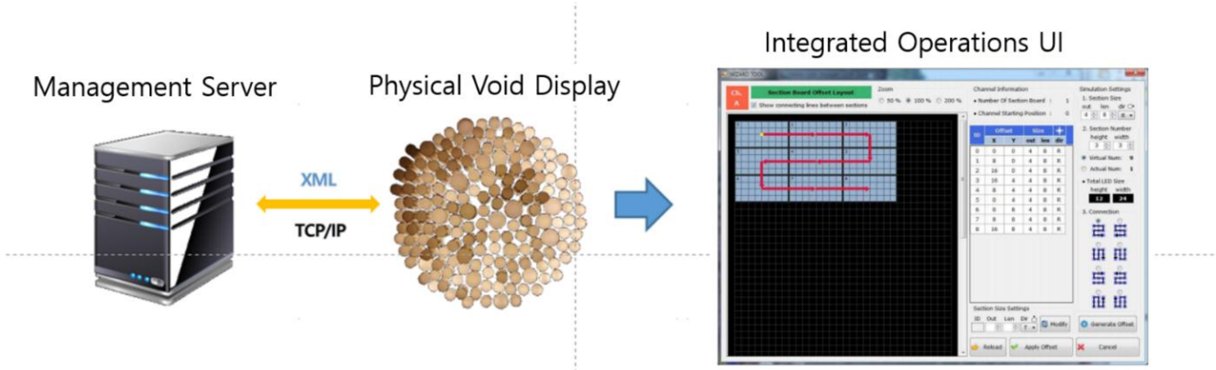

Figure 6: Shape data address mapping UI

This is UI screen composed of address mapping control function by displaying numerical value of void display shape data as [Figure 6] for integrated user interface control to send image data according to physical display type. The shape data address mapping UI allocates an address to each line board according to the configuration information and distributes data.

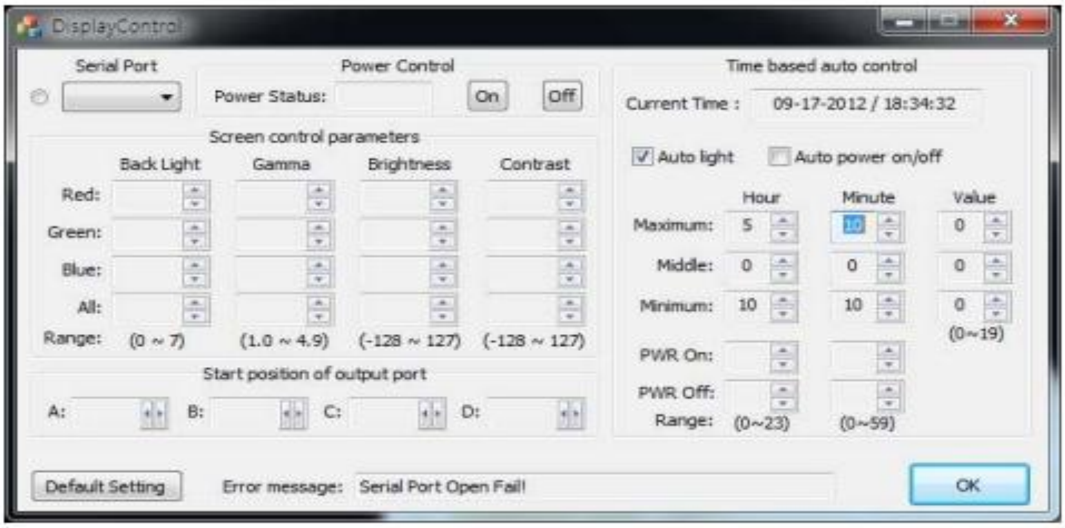

Figure 7: Date adjustment UI

[Figure 7] adjusts the shading data from 0 to 255 steps received from the video image on the data adjustment UI screen according to the address.

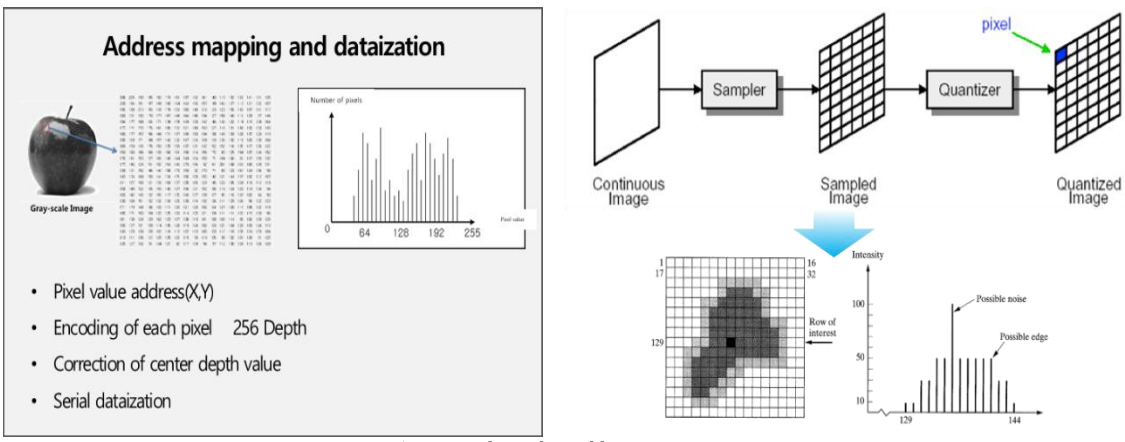

Figure 8: Shape data address mapping UI

MCU address mapping and data conversion schemes are required for data control to send image data according to physical display type. Development of image coordinate by main control board, development of coordinate pixel coding and serial transmission unit [Figure 8].

5. Conclusion

This study aims to derive the basic data of the integrated control platform study of physical void display in the future. This is a control technology study to reflect the user's appearance and movement in the void display in real-time. Conventional flip display implements a binary image, which shows image data of 0 and 1, enabling simple image implementation. And the physical void display can display the RGB image data value as gray image data of 0 ~ 255 depth step, and can be extended to 0-255 depth step representation. We developed the UI that controls the void display, and developed it to enable the integrated control of the void display. This paper is a study of real-time image control and integrated control solution for physical void display implementation. In the future, additional research is needed to realize a more precise shape through performance analysis with the various sizes of void displays.

Acknowledgment

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