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MITSUBISHI ELECTRIC ANNOUNCES SEAMLESS DOME DISPLAY SYSTEM WITH MULTIPLE PROJECTORS.

TOKYO—February 15, 2005—Mitsubishi Electric Corporation (President and CEO: Tamotsu Nomakuchi) announced the development of its seamless dome display system with multiple projectors. The system overlaps images projected by off-the-shelf projectors seamlessly. It also displays a high-resolution image without distortion onto a hemisphere screen. Computer graphics (CG) contents for flat screens are available for the dome screen without modification. It offers an immersive visual experience to the audience by covering wider view of them.

The seamless dome display system with multiple projectors was jointly developed with Mitsubishi Precision Co., Ltd. (Headquarters: Minato-ku Tokyo, President and CEO: Takehiko Tatsuko).

Background and Abstract

Dome screens are used as large display system for clients in entertainment and advertising fields, who require impressive and realistic visuals, because they cover wider audience view compared to flat screens.

However, the use of an off-the-shelf projector for dome screens gives only poor quality low-resolution images at one hand, and the use of dedicated projectors for dome screens requires specially adapted CG contents, not circulating popularly, on the other hand. Thus the combination of (off-the-shelf) projectors, to provide high resolution images seamlessly, has been utilized, but this method yet has a difficulty in adjusting location of images each other and undistort them on the screen, with such operations as to set up projectors by time-consuming manual adjustment or automatic adjustment by using an exclusive camera and devices dedicated to the purpose.

Mitsubishi Electric Corporation has invented a new calibration technique based on the shape of the dome screen to undistort images and adjust positions between the screen and the projectors. The technique realizes a large display system which projects undistorted high-resolution hemispheric images with multiple projectors. In addition to the calibration method, Mitsubishi has applied its own methods of deforming and

overlapping images and distributing PC's tasks for rendering, which it has already developed for flat screens, and then it has attained the seamless dome display system with multiple projectors, which displays 3D CG contents on the hemisphere screen in real-time.

Main Features

1. Automatic calibration between the projectors and the screen

   We have developed a new calibration method between the projectors and the screen with a pair of cameras. Our method needs just widely prevalent web cameras which have 640×480 pixels resolution.

2. Capability of displaying general 3D CG contents for flat screen

   Our system has a capability of displaying OpenGL® based 3D CG contents made for flat screen without modification. To display the contents on the curved screen, it undistorts contents' images in real-time while projecting the contents.

   *OpenGL®: An industry standard for 3D CG contents.

   OpenGL® is a trademark of Silicon Graphics, Inc.

3. High-resolution visualization in real-time with distributed rendering method.

   The system is scalable. You can add projectors as many as you want to get more high-resolution image. As the system assigns one PC for one projector and has Mitsubishi's distributed rendering method, frame rate does not become slower regardless of the number of projectors.

Results & Specifications

1. Accurate and fast calibration

   The calibration method with a pair of web cameras adjusts projected images each other by less than 1-pixel error in the center of the screen and by less than 3-pixel error at the rim of the screen. It takes about one hour to adjust 6-projectors' images.

2. Real and impressive visualization in real-time

   Our system visualizes a various kind of common 3D CG contents more real and strongly compared to flat screens. Audience can experience immersive CG world, which they have never experience with flat screens, as if they were in the virtual CG world.

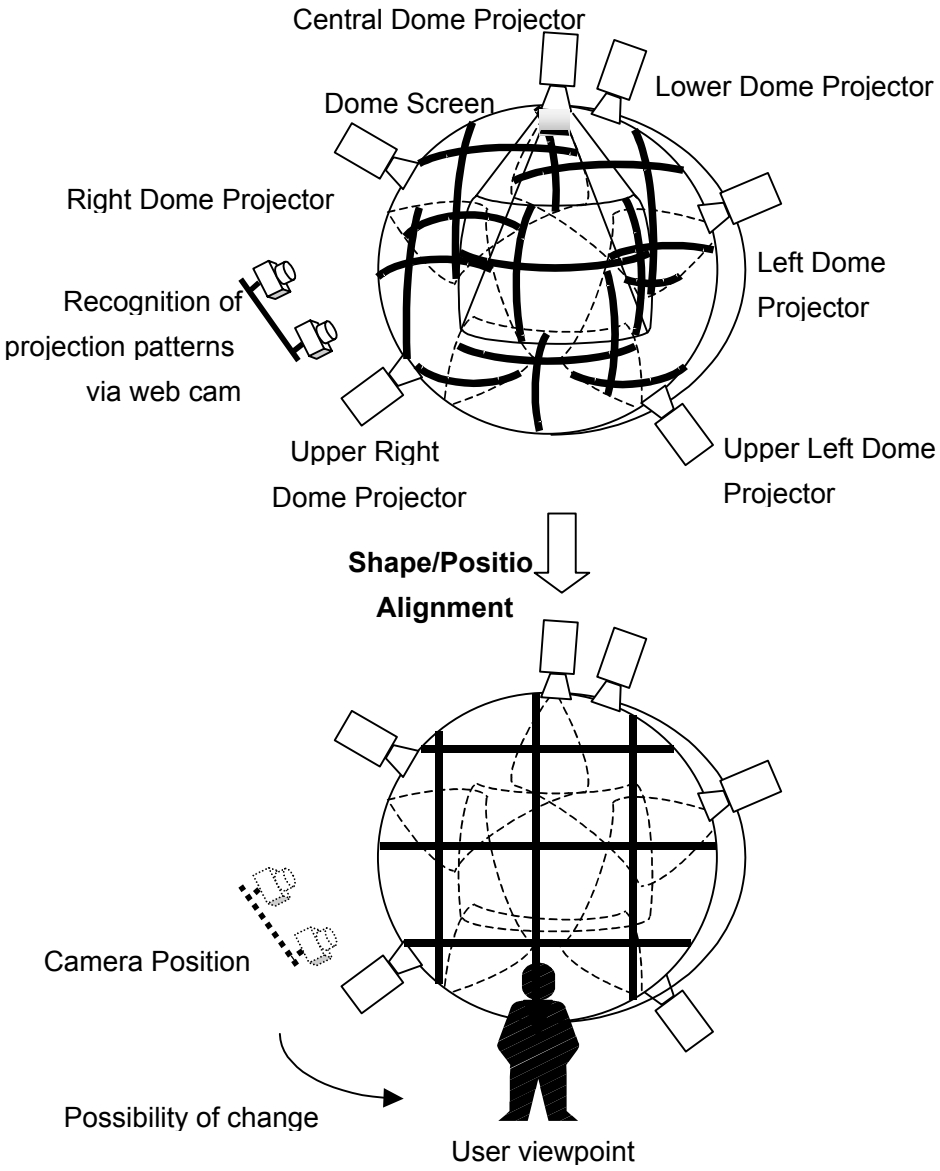
Future Developments

Mitsubishi Precision Co., Ltd. will release a seamless dome display system with multiple projectors as its own simulators' display system. Mitsubishi Electric Corporation is planning to offer the system to the amusement market and the advertising market, where the system rides on the strength of realistic visualization, as parts of a large display system and attraction facilities.

Mitsubishi Electric Corporation also intends to develop items such as transportable display system, displaying live-action contents and applying these techniques to other curve-shaped screens.

Automatic Location Coordination

So that the multiple projectors can smoothly connect and create one unified image, it is necessary to detect areas where the projected image overlaps and is creating a high quality image and then conduct location coordination. In addition, we must also find the amount of distortion caused by projecting a flat screen image on a rounded surface and simultaneously correct for it. One problem is that if the amount of image distortion is moved to the user the image corrected for image distortion will also change. The way this problem has often been solved in the past was to use the technique of coordinating the image by using an image recorded from placing a camera in the position of a supposed user to find the amount of image distortion. This technique it was necessary to have a human subject place a camera at the users view point and use a high-resolution camera to clearly adjust the image.

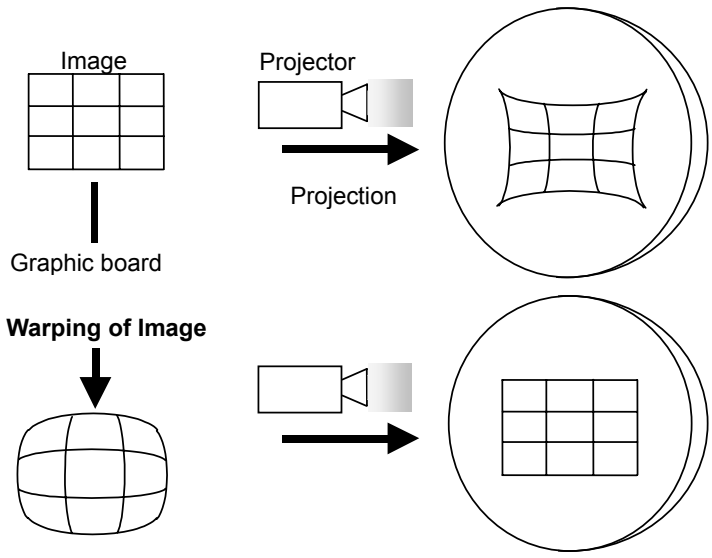


Using our new method, it is now possible to adjust the image position between the projectors by using two 640X480 pixels off the shelf web cameras. Specifically, from the results by camera to find the relationship of the two cameras and image projected on the dome from the projector the image can adjust to a three-dimensional curved surface. Next calculate the position and distortion from each image projected on the dome screen from the set user position and its three dimensional style. Because the system operates in multiple forms to find position and amount of distortion adjustment, the set location of the camera does not limit the viewpoint of the user, allowing flexible position coordination.

Real Time Distortion Adjustment

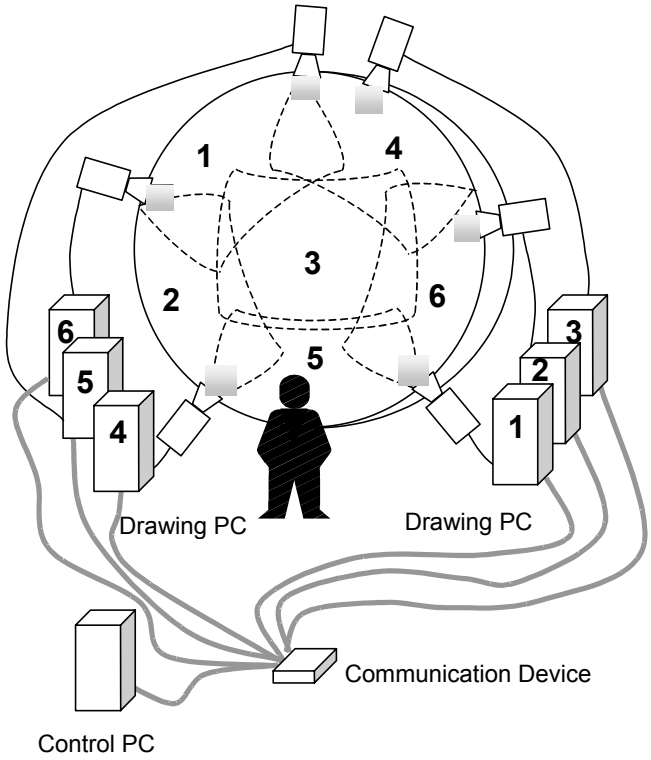
Projectors currently on the market have been designed with projecting on flat screens in mind. For this reason, projecting an unadjusted image onto a dome screen will cause straight lines to curve, and create distortions. To project an image correctly on a dome screen, it is necessary to correct these distortions before projecting computer graphic images.

To cope, we use this product's graphics board to make changes at the pixel level to realize a high quality graphics display showing distortion corrections at high quality. We are now able to make this change in real time. In previous systems, it was necessary to prepare adjustments of three dimensional computer graphic content in advance. With the system we developed it is possible to adjust three dimensional content program distortions on the fly by simply running the system. We have thus created a system with a high general-purpose nature, which can use normal three dimensional computer graphic content.



Distributed Rendering Technology

This system does its distributed rendering (drawing of computer graphics) on multiple PC's. Generally speaking, when one computer does all rendering for a giant dome screen, the image breaks down and is grainy. However, with our system, each computer does rendering of only a section of the entire giant image, and we are now able to produce a high-resolution three-dimensional computer graphic image. Even with the increase in computers there is no slowdown in communication speed. We have realized a scalable system capable of high quality images on even an extremely large screen



In the above image is an example of 6 computers constructing an image on a giant dome screen. They are connected through a communication device, which is wired to the control PC. Each PC controls rendering for a certain area of the dome screen which then projects a unified image. The overlapping areas are smoothed over by lowering brilliance realizing a uniform rendering. When starting up the off the shelf three-dimensional computer graphic control computer, the six rendering PC's start rendering on the dome screen. The giant rendered three-dimensional computer graphics gives a feeling of three dimensions near the center of the dome, enveloping the viewer senses in an imaginary atmosphere

About Mitsubishi Electric

With over 80 years of experience in providing reliable, high-quality products to both corporate clients and general consumers all over the world, Mitsubishi Electric Corporation (TSE:6503) is a recognized world leader in the manufacture, marketing and sales of electrical and electronic equipment used in information processing and communications, space development and satellite communications, consumer electronics, industrial technology, energy, transportation and building equipment. The company recorded consolidated group sales of 3,309 billion yen (US$ 31.2billion*) in the fiscal year ended March 31, 2004. For more information visit http://global.mitsubishielectric.com

*At an exchange rate of 106 yen to the US dollar, the rate given by the Tokyo Foreign Exchange Market on March 31, 2004.