

## Research on Virtual Interactive Sand Table for Showing of Energy Conservation Data

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**Abstract**—With the rapid development of interaction technology, the digital sand table has gradually replaced the traditional sand table. In such fields as the real estate exhibition, the city planning exhibition, the tourist attractions showcase, the military training, the water conservancy and hydropower, and the topic galleries, due to its three-dimensional, interactive, diversified, and immersive showing effect, the digital sand table has got impressive effects and won viewers' extensive favors. In 2010 Shanghai Expo, Chinese government wanted to show world its determination and the effect it had achieved in energy conservation. So the authors proposed and created the virtual interactive digital sand table project 'The New Energy and Environmental Monitoring Platform in New Energy Pavilion. Based on interaction technology of Laser identification, display technology of projection fusion splicing, the artwork made use of virtual reality technology and information visualization design method in order to show vividly and visually the use of new energy and energy-saving and emission reduction measures taken in the Six Pavilions along the Central Axis, which is one of the central areas of 2010 Shanghai World Expo. In addition, the digital sand table was connected to the central database of 2010 Shanghai Expo and the sensors in the pavilions and the axis so that it can receive and visualize the energy-saving and emission reduction data of them at real time. During the exhibition duration of a half year, the project got good feedbacks from all areas of society. Shortly after viewing the virtual interactive sand table, Shanghai Bao Shan District government asked the authors to create a similar but larger digital sand table to show its district planning of Dachang Town.

**Keywords**- virtual sand table; 2010 Expo; protection fusion splicing technology; green laser identification interactive technology; virtual reality technology

### I. INTRODUCTION

In 2010, the World Expo with the theme of "Better City, Better Life" was held in Shanghai, China. In order to show the development results of new energy utilization in China, reflect the inseparable relationship between the application of new energy and the environment, and advocate low carbon life to the world, World Expo Organizing Committee has established the New Energy Pavillion, and it is required to record new energy development and application in the Shanghai World Expo Park with the real-time data. Therefore, the new energy and environmental monitoring system located in the central region of the museum shows

the use of an area of new energy and energy-saving and emission reduction measures taken by the Chinese government in the World Expo with multimedia technology and means, which embodies the determination and action of national government to implement carbon emission reduction, and the implementation effectiveness of relevant departments and units. At the same time, in other display modules, through the latest multimedia interactive technology and the technique of augmenting reality, it instills environmental awareness of energy saving and emission reduction to the audiences in the novel and joyful atmosphere.

### II. PROJECT BACKGROUND AND DEMANDS

In the New Energy Pavilion of World Expo 2010, as the focus of the display modules, new energy and environment monitoring system is required to achieve the following points in function:

The first function is the non-contact human-robot interaction by using the laser pen;

The Second is the data real-time transmission of energy-saving and emission reduction of Shanghai Expo six pavilions along the central axis;

Thirdly, the virtual digital sand table needs to be connected to the data signal sent back by the sensor from the other exhibition hall of the World Expo;

Fourthly, the virtual digital sand table can be synchronized with the weather condition during the Expo;

Last but not least, the software can automatically loop without human intervention.

### III. KEY TECHNOLOGIES USED BY THE PROJECT

The key technologies used by this project include the following: protection fusion splicing technology, green laser identification interactive technology, virtual reality technology. The topology graph is designed as follows:

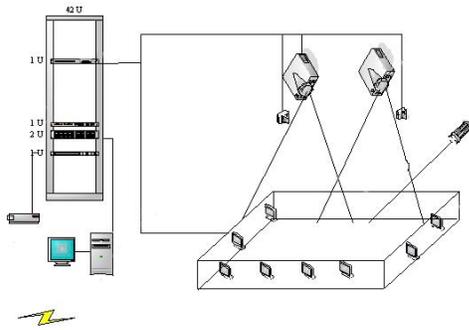


Figure 1. The topology graph of the virtual digital sand table system in the New Energy Pavilion

### A. Projection fusion splicing technology

**Seamless splicing:** Seamless splicing is a special, higher-requirement projection display applications, from the aspect of splicing effect, the development of seamless splicing technology has gone through three stages so far: the hard edge splicing, overlapping splicing and soft edge fusion splicing. In view of the project cost limitation, the project uses the method of overlapping many sets of low grade commercial projectors together. Each projector is driven by a different computer, or the different graphics channels in the same computer. In this project, technology principles of projection splicing fusion are generally as follows:

#### 1) Overlapping

The first step in the process is to make the two image overlapped, the pixel in the overlapping area will be conducted the fusion processing in the entire overlapping area, that is to say, the two images will be faded to black. The general method is applicable to any number of images, also applicable to those images which may not be arranged in rectangular way. The projector used in this project is XGA (1024 × 768), the pixel in the overlapping area is 256. The final width of the image is  $2 \times 1024 - 256 = 1792$  pixels, and the height is 768 pixels.

#### 2) Fusion

Blending is each pixel at the overlapping area in one image at is multiplied by a value, so that when it is added to the corresponding pixel on another image, the pixel can be expected.

#### 3) Geometric correction of the playback screen

The program also built in the curved surface correction system, when the projector projects the images to cylindrical arc curtain wall, the image will be geometrically distorted because of the curved projection wall, which affects multi-screen splicing and viewing, especially when many sets of projections project the all-around cylindrical screen, the broadcast system with curved surface correction system is indispensable particularly;

The curved surface correction of this program adopts advanced Bessel equation grid correction system, which is easy to adjust a variety of geometric distortions, its interface is as figure 2.

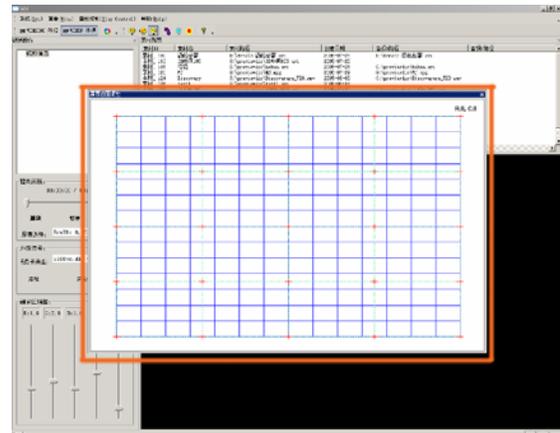


Figure 2. Geometric correction interface

This program uses the signal processing and video and audio playback devices designed for the seamless large screen display used in the projector, adopts the advanced PC cluster structure with the characteristics of clear structure, easy to operate, easy to maintain and easy to upgrade, and it has an excellent price-performance ratio, so it has a wide range of use in the field of seamless large-screen display, digital television broadcasting and other fields of exhibition, multimedia presentations, the monitoring center.

The core technology of the equipment is based on Microsoft direct graphics processing module. It uses software to realize the edge blending and curved surface correction of the image, which can meet the needs of ultra-large-format digital images and special-shaped curtain wall projecting and overcome the common image synchronization and centralized operation problems of the cluster system, and provide reliable equipment for the implementation of such programs. This system mainly processes giant screen playback of digital images, and is compatible with analog or digital signal processing, after adding signal module, the system provides direct broadcast support for simulation of AV and analog VGA signal, and it can effectively realize the AV and VGA signals demonstration on the big screen.

### B. Green laser interaction and key points of pattern recognition techniques

Binarization processing method and dynamic threshold processing algorithm of the image processing algorithms are used in the software design to preprocess the image acquisition, and recognize the projection screen algorithm and image edge fast scanning algorithm. And we compare and use the edge algorithm and edge tracking algorithm to calculate the projection screen. While using this system, first of all, adjust the camera to the projection screen with hand, set up the screen coordinate system. The software goes into the laser mouse work state in the mode of operation of background, identifies the location of the laser pointer.

### C. Software Production

#### 1) Development of virtual reality software

3D VIA Virtools is a set of integrated software, which can integrate the popular file formats, such as 3D model, 2D graphics or sound effects. Virtools is a set of real-time 3D environment virtual reality editing software with rich interactive behavior module, it can produce 3D products with many different functions, such as the Internet, computer games, multimedia, architectural design, interactive television, educational training, simulation and products display.

Virtools can produce virtual environment with immersion. It generates a variety of sensory information to the participants, gives participants a feeling of being personally on the scene. It is a virtual reality human-computer interaction system.

Virtools can produce USES 3 D products with many different functions, such as the Internet, computer games, multimedia, architectural design, interactive TV, educational training, simulation and product display, etc.



Figure 3. Effect after the completion of 3D modeling in Virtools

The production team of this program establishes the venues model of a shaft six museums in the World Expo in 3 Dmax, limited by the production time and available data, the other venues models of the World Expo are replaced by the white mode. Then the model is integrated into the 3DVIA Virtools for lighting and set the camera motion path, and conduct the interactive production. To ensure when the audience selects a venue, namely simulates the flight touring process, giving the audience sense of immersion and sense of the scene, at the same time, making the venue of new energy use and carbon emissions data displayed to the audience through the human-computer interaction interface with visual information and real-time way.

#### 2) Development of laser identification system Microsoft Visual Studio

Cameras are used to intake the laser spot into the computer, and then identify the coordinate position of the laser beam by the computer, control the cursor movement according to the coordinate position in the corresponding position. The invention uses the MS Visual Studio. Net tools for software development, image recognition and processing technology, and invents the image corners fast scanning algorithm to improve the operating speed. It is cleverly designed and it can well realize the function of laser pointer cursor controlling remote operation computer, which has very high practical value in the large area of interactive programs.



Figure 4. The project field

### IV. VISUAL DESIGN OF THE USER INTERACTION INTERFACE

This project is supposed to face the audience all over the world, whose content is the measures taken by the Chinese government and effectiveness in the new energy use and energy conservation and emission reduction. To effectively transfer the content, the interface visually fundamental key is positioned at the bright tone full of sunshine and hope. The main tone is blue sky and green land, indicating the concept of environmental protection. The golden sun penetrates through the clouds and shines on the ground, endowing the picture with warm and bright color. What man-machine interactive interface design mainly takes into account is how to clearly, effectively and vividly transfer abstract real-time data to the audience in the way of information visualization. According to the requirements, the data content displayed by each exhibition hall is divided into three aspects, i.e. low-carbon technology, low-carbon efficiency and energy conservation data. In addition, indoor environmental data are required to be displayed in real time. Through the researches and attempts, in the end, the rotary rolling plate and the scroll bar are used to vividly display the changing real-time data; in the meantime, different colors are used to indicate different exhibition contents for distinguishing each other. Design artwork for real-time information interface is shown as figure 5.

## V. CONCLUSION

The project initiates the largest virtual digital sand table of laser interactive real-time data in China. It adopts the seamless edge blending technology, green laser image recognition, 3D simulation and other high and new technologies, to realize the physical sand table basic functions of dynamic demonstration and real-time update; meanwhile, it establishes an abundant effect of human-computer interactive interface, to vividly display the World Expo's new energy use, innovation and breakthrough.

The virtual digital sand table is a real-time browsing 3D electronic sand table which is made according to the users' needs. It can simulate the flight and visit process, and display the geographic coordinates and height information.

Among them, the content of virtual digital sand table includes: vector thematic maps, grid satellite image and digital elevation model, which are combined to form an electronic sand table of 3D virtual reality, according to the needs, marking text information such as place names, street and road names and so on; it can adjust the height and angle for browsing in 3D environment; it can add 3D facilities, such as buildings, roads, trees, characters and son on; it can randomly inquire the information of attributes, photographs and videos in detail.

Compared with the existing electronic sand table, the digital virtual sand table has, in addition to the effect of possessed by the electronic sand table, more 3D demonstration effect for the planning and landscape. It restores the original meaning of the sand table, and need not a physical sand table any more. Compared with the traditional sand table model, the digital virtual sand table can realize the functions the physical sand table cannot do. For example, scaling display for the local region.

In addition, in the same sand table demonstration area, it can realize the function of multiple sand tables. Therefore, it has more wide application field, having the characteristics of reality, 3D, rapidness, briefness and convenience, accuracy and dynamic, to achieve more abundant demonstration effect.

The applications of digital sand table include urban planning, real estate demonstration, venue display, interior

design, virtual sample houses, interactive advertising, 3D product display, industrial control simulation, equipment management, virtual production line, recovery of historical sites, virtual roam and tour guide, road and bridge planning and design, urban traffic simulation, railway system simulation, virtual battlefield, etc.

In April 2011, the interactive virtual sand table work received Shanghai Baoshan District government's favor and attention. Therefore, it derives a new project work: Virtual Interactive Sand Table of Planning for Dachang Town of Baoshan District, Shanghai. The work is shown in the following figure:



Figure 5. Virtual Interactive Sand Table of Planning for Dachang Town of Baoshan District, Shanghai

The whole block 3D map of Dachang Town of Baoshan District shown on the following screen can realize the interactive virtual tour through the laser pen. Through pressing the button in the lower left, 3D map's zoom in, zoom out and right-left movement can be realized. All key buildings in the 3D map have labels, clicking it through the laser pen can trigger the animation on the vertical screen, to show the building's 360-degree rotating model and related specific graphic information.

## REFERENCES

- [1] <http://baike.baidu.com/view/5203663.htm>