A Three-Dimensional Interactive Simulated-Globe System Application in Education

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Abstract

This study proposes an innovative three-dimensional (3D) Interactive Simulated-Globe System application. The instrument includes: a data processing unit, a wireless control unit, an image capturing unit, a laser emission unit as well as 3D hemispheric body imaging. The 3D hemispheric body imaging is designed to display the output image from a data processing unit. The Laser emission unit is for emitting a laser spot on the output image. Based on the spherical coordinates of the laser spot, detected by a data processing unit through an image capture unit, the spherical coordinates, with a plane coordinates converter operation, can provide spherical coordinates to convert into plane coordinates for the data processing unit. Utilizing the coordinates location, of the laser spot through image acquisition, calibration and internal coordinates with external coordinate converter operation can be guided the cursor, output by the data processing unit on 3D hemispheric body to launch synchronous movement with laser spot. To combine wireless control technology can perform synchronous driven, control and interactive with the software image on 3D hemispheric body. This work allows general planet software such as Google Earth (Mar, Moon), used in a variety of panel displays or projection turn into the 3D hemispheric body, and then through the laser spot emitted by the laser emission unit and wireless control unit, allows the laser spot in synchronization to control the cursor and software on the 3D hemispheric body imaging for a variety of interactive, and then perform the effect of 3D interactive globe system in any classroom or astronomical Museum for formal and Social education.

Keywords-three-dimensional; interactive; spherical coordinates; internal coordinates; external coordinate

I. INTRODUCTION

The various sizes of earth or planet instrument models have been widely used in traditional classroom and astronomical museums; they have become an integral part of teaching aids for formal or informal education teaching field. [1-3] In recent years, related inventions have attempted to use projection to project earth or other planets software images as digital teaching auxiliary aids. [4-6] However, the way to project earth or other planets software image on the screen is not much difference to use traditional earth or planet instrument for the teacher in the teaching and can not to fully demonstrate the advantages of digitization teaching aids in this way. Therefore, we propose a kind of earth or planet instrument, which can take advantage of simple technology and classroom existing equipment. This instrument is employed to project the earth or other planets images as three-dimensional sphere surfaces. By forming 3D earth or plants images, and utilizing the interactive technology of this work, the operator can use a simply handheld wireless control device to interact and synchronize control the cursor and function then perform the effect of an 3D interactive globe system.

II. RELATED WORK

Existing applications of laser guidance technology, U.S. Patent No. 6,275,214 [7], use a variety of different light sources for projection to projection curtain via the camera receives images. Through image processing and computer software program calculated the light projected onto the screen spot position of the projection screen to convert the signal to control a computer mouse cursor moves. The existing the whiteboard also uses the image capture element to achieve method (internal coordinates based on the coordinates of the image input is converted to the coordinates of the external programs and methods), in U.S. Patent No. 4,507,557 [8]. At present, the 3D image projection method synchronizes the projector in a different direction and position on the respective image in a 3D sphere. The corresponding image project on a spherical surface according to each specific projector to multiple projectors, each represents a specific image region of the sphere to generate a complete surface projection mapping imaging such as U.S. Patent No.0,256,302 [9]. Other method as 3D internal back projection methods, this method is to use the projector image, projected to an inner surface of the 3D projection surface. The formation of the 3D projection surface outside observer can see the imaging. Application examples are celestial bodies such as the earth, the planets and the anatomical organs in detail, such as the U.S. Patent No. 8,066,378 [10]. A 3D convex surface of the

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display system is the system's display surface having a 3D convex shape. Projector system sucked image output to the internal display surface of the display surface, the image due to the convex shape of the display so that the viewer can see the 3D stereo images. For details is on U.S. Patent No. 7,352,340 [11]. The 3D internal projection system is to use optical scanning or projection, projected on a large 3D objects on the inner surface, so that when viewed by an external stereoscopic imaging effect, such as the U.S. Patent No. 0,027,622 [12].

III. PROPOSED THEOREM

This research main technology is divided into two parts. The first part is laser guide technology to control cursor. For controlling the cursor directional control function, it needs to install a laser emitter source and utilizes an optical camera with special light filter lens receiver to detect the laser source on the screen. After some image process and the spherical coordinates with plane coordinates converter operation, the movement of image can be transformed by a cursor command to guide the cursor directional control function. The second part is to install a wireless control electron circuit in our system. By linking the wireless control technology, it can direct execute each kind of interactive control function completely.

A. Image acquisition

The 3D hemispheric body imaging is to display the output image from data processing unit as shown in Figure 1. Laser emission unit is for emitting laser spot imaging on hemispheric body and the spherical coordinates of laser spot was detected by a data processing unit through the image capture unit. The key point of image acquisition technology in this study is the red visible light filter when an optics camera is used. This kind of special light filter lens may filter the Blue and Green visible light on the 3D hemispheric body imaging effectively, and causes optics photography function effective to trace the laser emitter spot on the three-dimensional imaging hemispheric body. The wherefores is red visible light filter lens make whole image and background turn into full red view. And it is because the wavelength of red laser spot is higher than any visible red color. When using this spot tracking can provide spherical coordinates of laser spot precisely.

B. The spherical coordinates with plane coordinates converter operation

Laser emission unit is for emitting laser spot imaging on hemispheric body. Based on the spherical coordinates of laser spot, detected by a data processing unit through the

image capture unit and the spherical coordinates with plane coordinates converter operation can make spherical coordinates convert into plane coordinates for the data processing unit. By the coordinates location of the laser spot through image acquisition, calibration and internal coordinates with external coordinate converter operation can be guided the cursor, output by the data processing unit on 3D hemispheric body imaging to launch synchronous movement with laser spot as shown in Figure 2. The formula of spherical coordinates convert into plane coordinates as follow:

$$r = \sqrt{x^2 + y^2 + z^2}$$

$$\theta = \arctan\left(\frac{\sqrt{x^2+y^2}}{z}\right) = \arccos\left(\frac{z}{\sqrt{x^2+y^2+z^2}}\right)$$

$$\phi = \arctan\left(\frac{y}{x}\right)$$

On the contrary, formula of plane coordinates convert into spherical coordinates as follow:

$$x = r\sin\theta\cos\phi$$
$$y = r\sin\theta\sin\phi$$
$$z = r\cos\theta$$

C. Wireless control technology

By wireless control technology, this work can perform control and interactive with the software image on 3D hemispheric body imaging. We have succeeded to develop a useful technique for the classroom and museum, and have obtained the solution of the man-machine interface for its interactive operations. A three-dimensional interactive globe system was proposed in this study. This invention makes general planet software, used in a variety of panel displays or projection turn into the 3D hemispheric body imaging. Through the laser spot emitted by the laser emission unit and wireless control unit, allows the laser spot to synchronize control the cursor and software on the 3D hemispheric body imaging for a variety of interactive. Then perform the effect of 3D interactive globe system in education.

IV. IMPLEMENTATION

A. System installation

Figure 3 shows the schematic diagram of 3D interactive simulated-globe system. In this figure, the system contains information processing unit, image capture Unit, a three-dimensional imaging hemispheric body, laser emitting unit and wireless control unit. The 3D hemispheric body imaging is to display the output image from data processing unit. The operator held a laser emission unit for emitting

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laser spot on imaging hemispheric body in front of hemispheric. The laser spot position was detected by a data processing unit through the image capture unit. By program operation can drive the control cursor on 3D hemispheric body imaging to execute simultaneous movement with laser spot. Wireless control unit is a device, installed a wireless control electron circuit inside. Each button has unique command function for remote control information processing unit then can perform control command function. By simple technology and classroom existing equipment, this system shows an effect solution for interactive of three-dimensional interactive globe system.

B. Calibration

The data processing unit by the image capture unit to detect five laser spots on the 3D hemispheric body imaging in sequence at initial. Based on the five laser spot localization method by internal plant coordinates with external spherical coordinates conversion program operator can calibrate the coordinate of control cursor on the imaging hemispheric body at the outset. Every point for calibration takes approximately a few seconds for each. That is followed by a defined sequence for completing five points calibration. When each point is captured by the camera the tracking process can be started, the cursor tracking is set up completely. By this five laser spot localization method, the control cursor on the imaging sphere can launch synchronous movement with laser spot precisely.

C. Interactive control

To combine laser guide technology and wireless control technology, this work can fully demonstrate the advantages of digitization 3D interactive simulated-globe teaching aids in this study. For example: the operator can rotate the earth or the planet, drag, draw, click, move, zoom in and zoom out any icon or function to directly interactive with 3D simulated-globe as show in Figure 4. Whenever to control the laser spot, stopped at the desired tap objects imaging on 3D simulated-globe then continuously pressing left mouse button function key on handheld device and we can perform a drag function in this system as we want. If we want to rotate this 3D simulated-globe, we only have to control the laser spot in any position on the globe and to press left mouse button function key on handheld device and quick move to left or right then release the button at the same time. The 3D simulated-globe will continuous rotate following by our movement speed and direction until the laser spot on globe and to press left mouse button function key again to stop it.

As we want to select any objects or icons on the 3D simulated-globe, the laser spot pointed objects or icons and click left mouse button function key on handheld device and the objects or icons will be selected. The zoom function in our system is to point the laser spot on the desired imaging objects and click left mouse button function key on handheld device to select an objects. Then subsequently press the zoom in or zoom out function button on handheld device issued the command to control zoom the desired imaging objects on 3D simulated-globe. Based on zoom function in this study, the pointed object by the laser spot on globe will be enlarged or reduced as we want. Such as when forward mouse wheel or key in PgUp is making a selected object to enlarge. On the contrary, backward mouse wheel or key in PgDn is making the selected objects to shrink. With drag and click function as mention above, we also can use drawing software to draw any sign, mark, emblem, label and symbol on the 3D simulated-globe.

The operation of the present study described as follow: First step, the data processing unit output the image on hemispheric body by a projector as shown in Figure 4. Subsequently, an operator held a device, integrated by the laser emitting unit and the wireless control unit. After, the operator points to the laser spot on an imaging hemispheric body. Then, the coordinate position of laser spot on the imaging hemispheric body was detected through the image capture unit. At the same time, data processing unit executed the internal coordinates with external coordinate converter operation and calibration. By laser-guided control program and the five points calibration program, enables the control cursor on the imaging hemispheric body can be synchronized movement with laser spot. With conjunction laser emission and wireless control units, the laser spot can synchronous drive the 3D simulated-globe by control cursor movement and issued a variety of computer command function. Finally, this work complete and achieve an efficient and economical interactive simulated- globe system.

V. CONCLUSIONS

This work can take advantage of simple technology and classroom existing equipment to employ project the earth or other planets software the images in three-dimensional sphere surface, thereby forming a three-dimensional earth or plants images. By use the interactive technology of this work could make general planet software, used in a variety of panel displays on the projection turn into the three-dimensional imaging sphere. Through the laser spot emitted by the laser emission unit and wireless control unit, allows the laser spot synchronization to control the cursor and software on the three-dimensional imaging sphere for a variety of interactive, and then perform the effect of three-dimensional interactive globe system in any classroom or astronomical museum for formal and social education. We have succeeded to develop a useful technique for the classroom and museum, and have obtained the solution of the man-machine interface for its interactive operations.

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[8] Non-contact X, Y digitizer using two dynamic ram imagers,U.S. Patent No. 4,507,557.

[9] Three-Dimensional(3D) image projection, U.S. Patent No. 0,256,302.

[10] Three-Dimensional internal back-projection system and method for using the same, U.S. Patent No. 8,066,378.

[11] Display system having a three-dimensional convex display surface ,U.S. Patent No. 7,352,340.

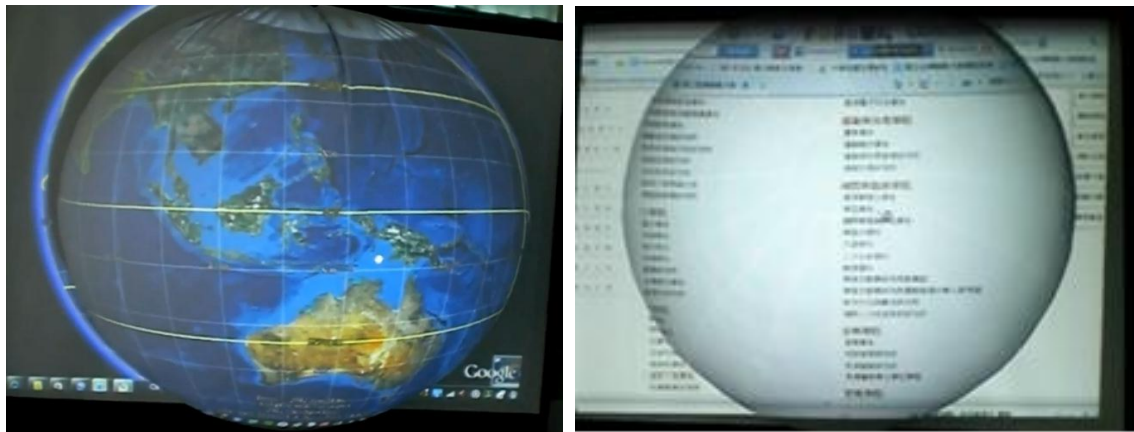[12] Three-dimensional internal projection system, U.S. Patent No.: 0,027,622.

Figure 1. The 3D hemispheric body imaging is to display the output image from data processing unit
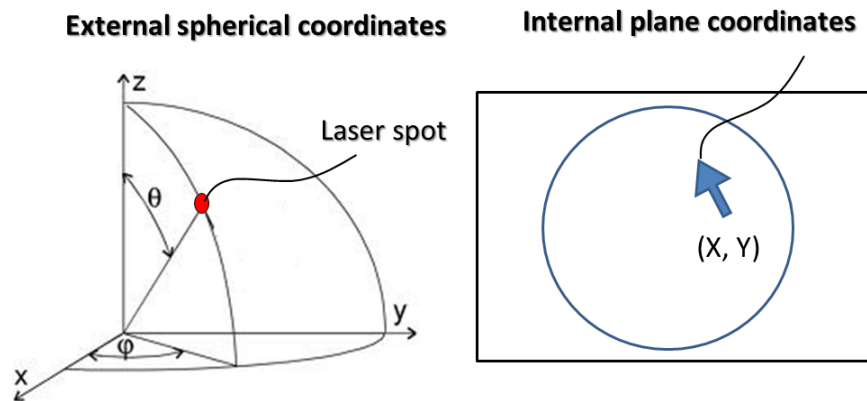

Figure2. Internal coordinates with external coordinate converter operation
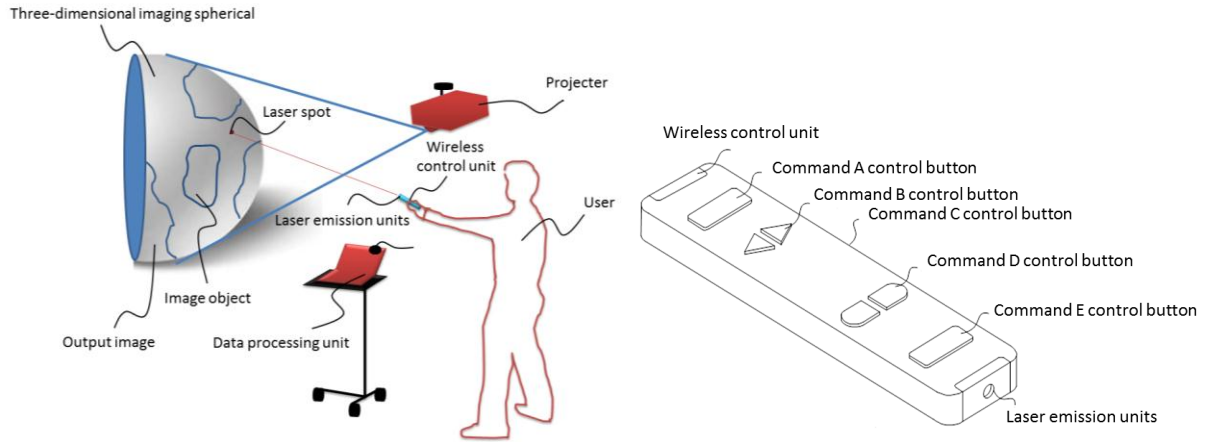
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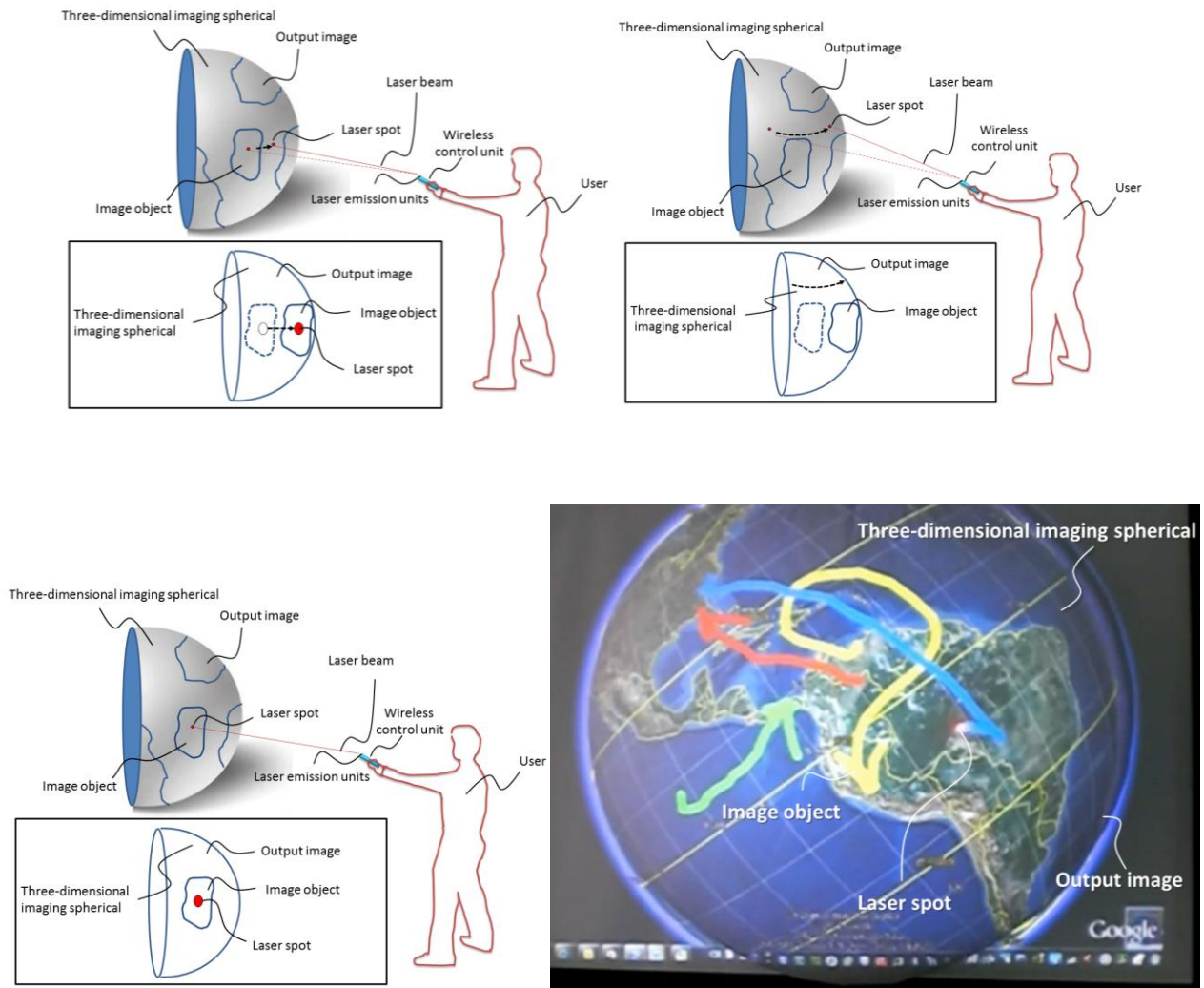Figure 3. The schematic diagram of 3D interactive simulated-globe system

Figure 4. The operator can rotate the earth or the planet, drag, draw , click, move, zoom in and zoom out any icon or function to directly interactive with 3D simulated-globe

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