Three-dimensional Image Optical System

This invention relates to a three-dimensional image optical system that generates (presents) a three-dimensional optical image, specifically to an afocal three-dimensional image optical system to which an integral photography (IP) technology is applied.

For one of the schemes for three-dimensional television that allows the three-dimensional vision from any of arbitrary viewing points, an IP three-dimensional camera device that uses a micro lens array apparatus or a pinhole array apparatus has been known. As one of applications of this IP three-dimensional system, a technology has been known wherein a radially graded refractive index rod lens (called a “radial GRIN lens”, hereinafter) which has a particular optical length.

FIG. 1 shows a principal side view of an afocal optical element used for the three-dimensional image optical system.

The afocal properties of the afocal optical element regarding the present invention is not only constructed by the two convex lenses commonly seen in the conventional technologies but two cylindrical lenses, a pair of a convex lens and the concave lens and two radial GRIN lenses.

The three-dimensional image optical system 1 regarding the present invention comprises an elementary image optical subsystem 3 which is composed of plural afocal optical elements 2 which are aligned in a planar array. The afocal optical element 2 is composed of the first optical component and the second optical component, both of which are aligned on a common optical axis. The focal distances of the first and the second optical components can be same or different. However, the first and the second optical components have a common focal point on the common optical axis. For the optical characteristics of this elementary image optical subsystem 3, the first optical component plane and the second optical component plane at the location of the first optical component and the second optical component are defined. They are the symmetrical planes for the convex lenses 12a and 12b. Another set of optical characteristics is a hypothetic incidence plane 2a and a hypothetic emission plane 2b. For the system of two convex lenses, the hypothetic incidence plane 2a and the hypothetic emission plane 2b are defined by the forward focal points of the first optical components and the back focal points of the second optical components, respectively. The common focal point is located between the first optical component and the second optical component on the optical axis. For the system of the afocal optical element wherein a convex lens and a concave lens are used, the hypothetic emission plane 2b is located between the convex lens and the concave lens. The common focal point locates in the reverse side of the subject from the concave lens.

FIG. 1 is a schematic that shows a side view of an afocal optical element and an elementary image optical subsystem used for the three-dimensional image optical system according to the present invention.

The three-dimensional image optical system can reproduce the three-dimensional optical image which has the reverse convex and concave relation with the subjective image along the optical axis since the optical system reproduces the three-dimensional optical image of the subject by IP three-dimensional system, the longitudinal magnification is largely changed, the depth of the image is emphasized or shrunk in depth by decreasing the depth magnification.

As shown in FIG. 2 the three-dimensional image optical system 1 composed of the two elementary image optical subsystems 3 and the subject which is a precious exhibit are put beyond the window glass 7 that segregates them from the visitors. The emission plane of the second elementary image optical subsystem 3 faces the visitors and the intermediate three-dimensional image Qe is reproduced beyond the window glass 7 and the three-dimensional image Qr is reproduced in the limit zone into which the visitors are kept off by a low fence 8. Each of the elementary image optical subsystems 3 has an array on which afocal optical elements 2 are arranged and the optical gobo element 4 are formed around the afocal optical elements 2.

The three-dimensional image optical system can reproduce the three-dimensional optical image in a remote distance from the actual subject, therefore it is possible for the viewers to recognize the position of the precious exhibit is close even it is exhibited further from the viewers.

FIG. 2 is a schematic that shows a perspective view of an exhibit shown by using the three-dimensional image optical system.