Optical Three-Dimensional Imaging Device Using the Integral Photography Technique

Patent No.6,301,416 (U.S.), Japanese Patent Application No. HE110-288,407

This invention relates to an optical three-dimensional imaging device that optically transmits stereoscopic images using the integral photography (IP) technique. The IP technique is one type of three-dimensional imaging method; it incorporates micro lenses similar to the compound eye of an insect. This application involves an improvement to the fundamental invention, patent family US 6,137,937, which was introduced in the spring 2002 issue of Broadcast Technology.

US 6,137,937, as presented in that past issue of Broadcast Technology, employs multiple, equal-length, optical fibers (graded index optical fibers) that act as a lens due to their heterogeneous gradient indices, such as their radial-squared property. The disclosed autostereoscopic image apparatus is capable of imaging, transmitting, and displaying stereoscopic images, through a structure in which the length for the grated index optical fiber is equal to an integer multiple of one period of the optical path, to create an identical two-dimensional array at both edges of the optical fiber assembly (hereinafter referred to as the "optical fiber group"). According to the previous application, an autostereoscopic image can be transmitted without having to convert the light into an electrical signal or increase the optical transmission line scale.

However, this previous application (US 6,137,937) had a problem, in that its reproduced stereoscopic image could only be constructed behind the edge surface of the optical fibers (i.e. in the optical fiber group), as shown in Figure 1, making it incapable of creating a stereoscopic image as an aerial image in front of the optical fibers. The capability to present a reproduced stereoscopic image as an aerial image at the frontal surface of the optical fibers is extremely crucial to its practical implementation.

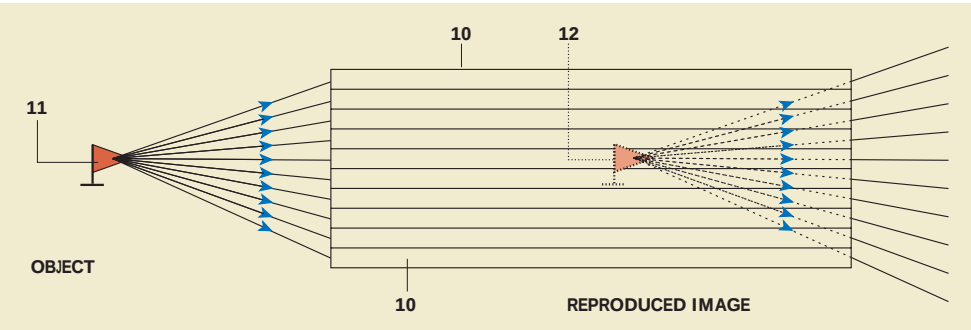

Figure 1

Consequently, improvements are being made to this recent invention to make possible aerial image presentation outside the optical fiber edge surface, by determining the length of the optical fibers for the optical fiber groups at odd-number multiples of the half period of the optical path, and then by serially aligning the optical fibers groups in pairs or even-numbered sets at these intervals. The intervals are set so that the image (first image) formed by the first optical fiber group is located in front of the incident end face of the second optical fiber group. It can obtain a reproduced aerial image generated by the first optical fiber group of the same size as that of the original object. The aerial image, however, appears with its convex and concave states reversed, due to the fact that the image is seen from the antipode of the object. To solve this problem, this device again sets optical fiber groups at the particular intervals, serially in pairs or even-numbered sets, to cause the inverted convex-concave relationship in the stereoscopic image caused by the optical fibers to reoccur. Therefore, the obtained three-dimensional image is displayed as an aerial image located outside the end faces of the optical fibers. Possible applications of this invention include endoscopes and bore scopes that can present three-dimensional images.

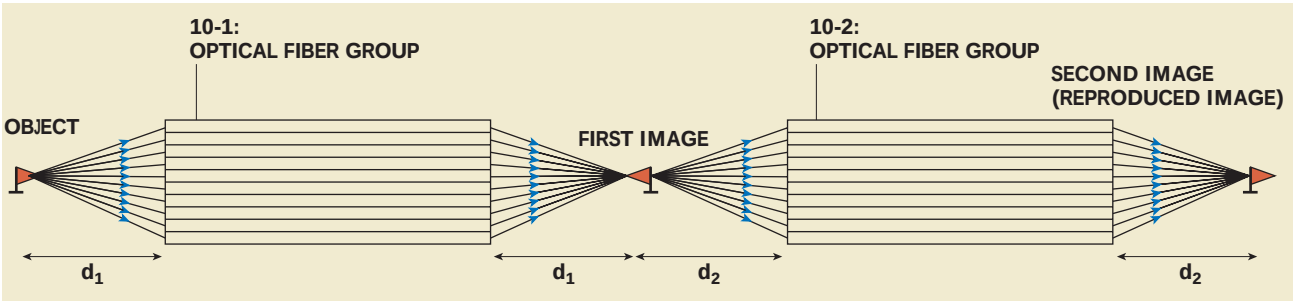

Figure 2