International Publication No. WO2007/116639A1

Imaging Optics and Display Device

Invented by : ***MAEKAWA Satoshi***

Example of actual image projected by micro-mirror arrays

Overview of the technology

The invention is a mirror array consisting of numerous two-sided corner reflectors, each made up of two mirrors arranged perpendicular to each other. Each mirror in the prototype measures just 100 micrometers; some 60,000 mirrors are neatly packed into an area measuring 5 cm × 5 cm. This micro-mirror array is a "magical mirror" that makes a three-dimensional object placed below appear to float just above. As a collection of simple tiny mirrors, this micro-mirror array requires no power supply or light source.

Figure 1 shows the structure of the micro-mirror array. It features numerous square holes neatly arranged in lattice form. Mirrors are positioned on two adjacent surfaces of the four inner sides of each square hole. All of the mirrors are aligned in the same direction, and the remaining two sides are non-mirror surfaces to prevent internal reflections (see Fig. 2). When you look at the object placed below the micro-mirror array from an oblique angle in the direction perpendicular to the micro-mirrors, the object appears to float in the air (see Fig. 3). Images of three-dimensional objects are inverted as if mirrored.

The extreme simplicity of the structure of this device suggests manufacturing the array would be easy. This is not the case; the tiny mirrors must be precisely formed and

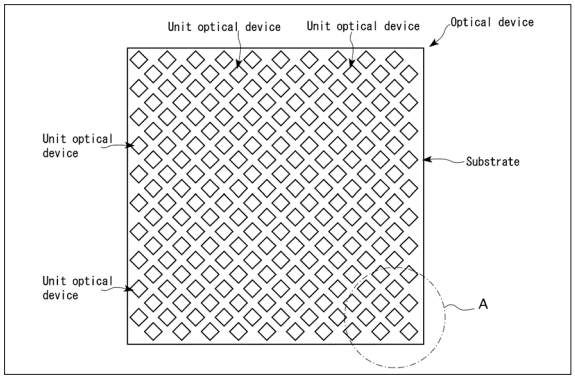

Fig.1 Top view of micro-mirror array

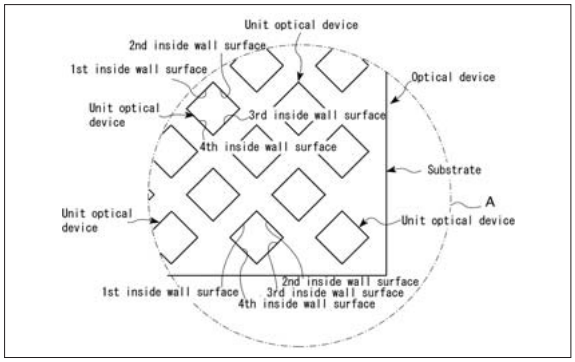

Fig.2 Top view of micro-mirror array (partial enlarged view)

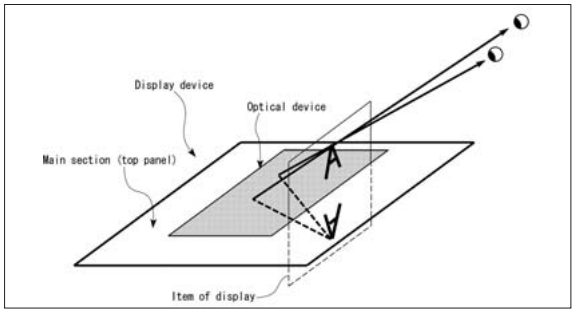

Fig.3 View of three-dimensional image produced by the micro-mirror array Prototype status

arranged to produce clear, undistorted images. The manufacture of this mirror device entails nano-engineering.

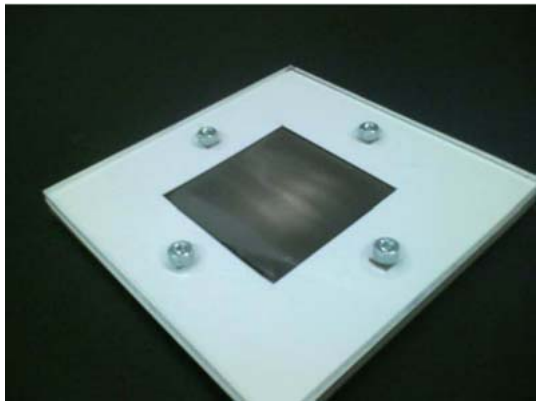

Photo 1 Prototype micro-mirror array (dark square section at the center)

Prototype status

We have created a working prototype (see Photo 1) measuring 5 cm × 5 cm. Seeing is believing; I recommend you see the actual device for yourself. The device is about the size of a mobile phone's display panel, but displays a floating image. Images of both three-dimensional objects and two-dimensional display devices like LCDs appear to float in the air.

Examples of applications

The first application of the invention conceived by the author was attractions in amusement parks (see Fig. 4). The device can make ghosts and monsters appear suddenly in front of children walking or traveling in a ride in darkness. Children on rides would enjoy the thrill of running right into the ghosts or monsters — although this experience may be too overwhelming for small children. One practical application of this technology would involve three-dimensional sense simulations. When combined with a haptic device, the invention can display images in the air in an empty room, allowing several people to share a displayed image and perform collaborative tasks as part of a practical training program. The invention can be also used in various other applications, including mobile phones and toys.

Fig.4 Example of use in amusement park (haunted house attraction)

Commercial availability

A product nearly identical to the prototype described here is already available from Nihon Denkei Co., Ltd. This product is offered mainly as a sample for use in planning and designing future applications.

Future topics

Before micro-mirror arrays can enter wide use, three issues need to be addressed: mass production, cost reduction, and development of larger products. Produced using high-precision processing techniques, the prototype provides distortion-free images. But with current processing methods, making micro-mirror arrays is too expensive to allow use in toys and similar products. The most pressing need is to develop processing technologies capable of solving the three preceding issues, and I am seeking to establish new manufacturing methods to achieve those objectives. While the

structure of the invention is quite simple, precision processing is difficult. There are several nano-technology research teams at NICT. If an effective collaboration system can be established within NICT, I believe we will see widespread use of micro-mirror arrays in the not-so-distant future.

(Article written by SAWADA Fumitake, Expert, Intellectual Property Management Group, Research Promotion Department)

Patents Obtained by NICT may be used for a fee.
Please contact NICT Intellectual Property Management Group
for information on patent licensing and technical data.