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TOUCHABLE 3D HOLOGRAM TECHNOLOGY

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ABSTRACT-Mid air displays which project floating images in free space have been seen in SF movies for several decades. Recently, they are attracting a lot of attention as promising technologies in the field of digital signage and home TV, and many types of holographic displays are proposed and developed. You can see a virtual object as if it is really hovering in front of you. But that amazing experience is broken down the moment you reach for it, because you feel no sensation on your hand. A holographic display which provides floating images from an LCD by utilizing a concave mirror. The projected images float at 30 cm away from the display surface. A user can get near to the image and try to touch it. Of course, his fingers pass through it with no tactile sensation.

Index terms- holographic displays, concave mirror.

1. INTRODUCTION

Since the last writing (2002), many changes and improvements have been made during the past few years. Holography is now offered in both sessions of PHYS 128A/B, allowing more students to perform the lab. The optics table has been divided into two partitions which allows a specific set-up to remain intact. There is enough equipment to permit two simultaneous labs to run without daily tear-down and set-up. The lab now has two electromechanical shutters. All the lower division accessories have been replaced with professional accessories. We stress using the table's mounting capabilities. All the accessories mount to the table. Magnetic mounts have been eliminated (except for the shutter assembly). Each lab group has their own equipment drawer outfitted with all the accessories needed to perform the lab. This includes both hardware and optical components. The processing of the film has also changed. Standard developing techniques and chemicals are used.

Our objective is adding tactile feedback to the hovering image in 3D free space. One of the biggest issues is how to provide tactile sensation. Although tactile sensation needs contact with objects by nature, the existence of a stimulator in the work space depresses the appearance of holographic images. Therefore some kind of remote controllable tactile sensation is needed. That is achieved by our original tactile display [Iwamoto et al. 2008]. The following paper explains the technologies employed for a "Touchable Holography."

The rapid developments in Information Communication Technology (ICT) have made tremendous changes in the many fields of life. Therefore, educational institutions have been quick to take advantage of technological services via integrating ICT into education, which in turn has produced new models of education such as e-learning, distance learning and blended learning. These models

have changed the face of learning as well as playing an essential role in the in-crease of the student population and also providing a good opportunity to learn at any time and/or place.

Recently, technological developments are playing an important role in improving the educational process. For example, we see many educational institutions using sophisticated technological tools such as touch screens, new software and others. However, before using any new tool in education, it must be evaluated to test its ability and effectiveness.

This paper is set in the context of ICT usage in the learning environment. Its key focus is on the level of effectiveness of 3DHT as a new tool which could support teaching and learning in educational institutions. For that, the paper will be directed at achieving the following objectives as well as answering the research paper questions.

2. RELATED WORKS

HOLOGRAPHIC DISPLAY

We use "Holo [Provision 2009]," a holographic display which provides floating images from an LCD by utilizing a concave mirror. The projected images float at 30 cm away from the display surface. A user can get near to the image and try to touch it.

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TACTILE DISPLAY

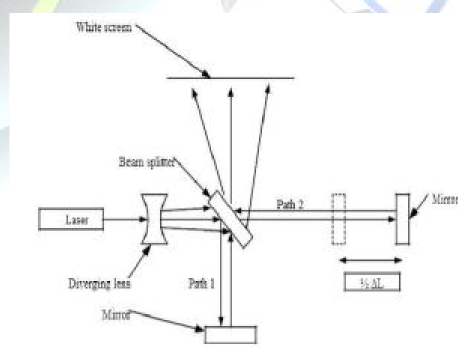
"Airborne Ultrasound Tactile Display [Iwamoto et al. 2008]" is a tactile display which provides tactile sensation onto the user's hand. It utilizes the nonlinear phenomenon of ultrasound; acoustic radia-tion pressure. When an object interrupts the propagation of ultra-sound, a pressure field is exerted on the surface of the object. The acoustic radiation pressure P [Pa] is written as

OUTLINE

In traditional photography, objects are transformed into a two-dimensional image onto the surface of a film or CCD via a lens. This image is a latent image. It becomes visible after processing (developing). The finished product (photograph) has some noticeable limitations. One, it lacks depth of field, that is you cannot "see" behind the subject. Secondly, if the photo is torn into shreds, you do not have a complete photo. Holography, on the other hand does not utilize a lens to form a latent image. It relies on the principle of interference to produce an image. The interference pattern is captured by the film and processed. The hologram is then illuminated with laser light (transmission) or white light (reflection). A holographic image is then observed. To produce an interference pattern, a single (coherent) source is split and then recombined. Any path differences are manifested as dark and light rings or patterns. This basic requirement is also a characteristic of holograms. A laser beam is split or caused to be divided. One beam is sent directly to the photographic plate or film. This is the reference beam. The other beam illuminates an object. The scattered light is then sent to the film. This is the object beam. There, the constructive and destructive interference patterns are captured. These patterns are not visible to the naked eye. However you may notice "bull's-eye" patterns or lines on holograms. These are interference patterns usually produced by the optical system and/or by dust on the surfaces of optical components. This is called "noise." After processing, laser light or white light is directed on or through the hologram depending on which type is being viewed. The reflected or transmitted light is scattered by the interference patterns into your eye. At this point, the eye-brain system interprets the light rays and reconstructs the image of the original object. It is able to do this because all the space-time information has been captured by the interference patterns on the hologram. Hence, the eye-brain mechanism cannot distinguish any difference between the light scattering off the original object and the light being redirected (via the diffraction pattern) by the hologram. In either case the "image" is the same.

FILM

The film we will be using is an all-purpose film for reflection and transmission holograms. The type is PFG-01. It is a fine-grained red sensitive holographic film designed for transmission or reflection hologram recording. Average grain size is
40 nm, resolving power more than 3000 lines/mm, spectral sensitivity range 600-680 nm (including 633 nm, 647 nm), and emulsion thickness 7-8 um. To identify the emulsion side, lightly moisten your lips and place the film between your open lips. Compress your lips onto the film. Do not drag film through your lips. Now open your lips. What do you experience? Have you found the emulsion side? Photographic film is a sheet of plastic (polyester, celluloid (nitrocellulose) or cellulose acetate) coated with an emulsion containing light-sensitive silver halide salts (bonded by gelatin) with variable crystal sizes that determine the sensitivity and resolution of the film. Sometimes the substrate is a glass plate. When the emulsion is subjected to sufficient exposure to light (or other forms of electromagnetic radiation such as X-rays), it forms a latent (invisible) image. Chemical processes can then be applied to the film to create a visible image, in a process called film developing. In black-and-white photographic film there is usually one layer of silver salts. When the exposed grains are developed, the silver salts are converted to metallic silver, which block light and appear as the black part of the film negative.



3. VIEWING A REFLECTION HOLOGRAM

Locate the box of reflection holograms in the lab. Select one and hold it in such a manner as to have the room light reflect off the surface. Reorient the film until you view an image. Now turn on the slide projector.

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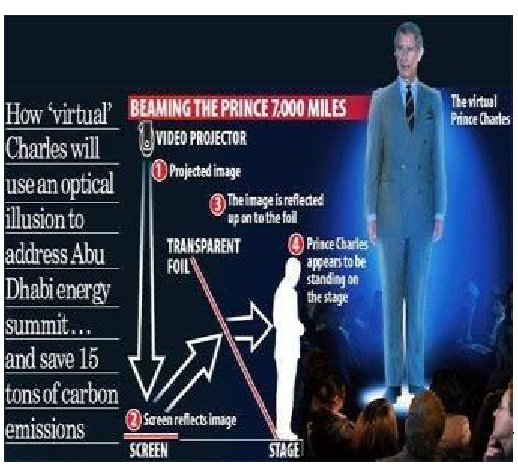
4. CREATING A REFLECTION HOLOGRAM

Reflection holograms have a few rare subtleties. First they are very inefficient. Second, they can be viewed with white light. Let's take a closer look at the film .

5. THE IMPORTANCE OF 3DHT ON SOCIETY

The importance of 3DHT on the society lies in the interdependence of human relations. For in- stance, the Pentagon wants to create computerized hologram- like moms and dads that can talk with the kids when their parents are deployed far from home. Navy commander Russell Shilling, the experimental psychologist overseeing the program, said "a child may get a response from say-ing 'I love you,' or 'I miss you' or 'Good night`... the goal: reassuring little ones whose parent has suddenly disappeared" (Thompson, 2009).

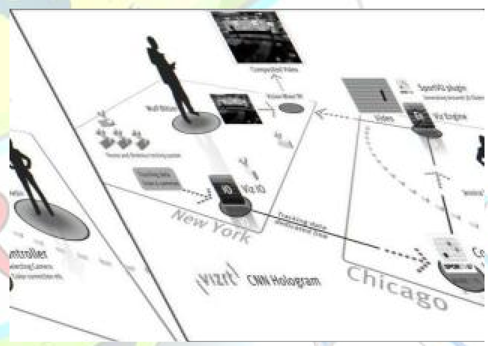
Another example on this issue is the virtual assistant. For instance, the virtual holographic assistant can help you to prepare a meal in the kitchen, or stand beside you and talk about different topics. Although this may sound like pure fiction, there is reason to believe that it could become reality in just a few years' time.. Prince Charles confirmed this fact in a green energy conference in Abu Dhabi, as shown in Figure2. He was keen to prove his green credentials by noting that if he had chosen to appear in person, his long-haul flight would have emitted around 15 tons of carbon dioxide, the greenhouse gas which is causing global warming. Hence, he appeared as a hologram to congratu-late Abu Dhabi for its plans to harness the power of natural resources to create a new zero carbon city called "Masdar". As the 3DHT, Prince Charles left the audience with the words: "I am now going to vanish into thin air, leaving not a carbon footprint behind!" (Jacob, 2008, p.2).



6. 3D HOLOGRAM TECHNOLOGY (3DHT)

The word, hologram is composed of the Greek terms, "holos" for "whole view"; and gram meaning "written". A hologram is a three-dimensional record of the positive interference of laser light waves. A technical term for holography is wave front reconstruction (Universal-Hologram, 2009). Dennis Gabor, the Hungarian physicist working on advancement research for electron micro - scopes, discovered the basic technology of holography in 1947. However, the technique was not fully utilized until the 1960s, when laser technology was perfected.

3D Holographic Technology (3DHT) created in 1962 by scientists in both the United States and the Soviet Union. However, 3DHT has advanced notably since the 1980s owing to low-cost solid-state lasers that became easily accessible for consumers in devices such as DVD players (Chavis, 2009).



The way 3DHT operates is by creating the illusion of three-dimensional imagery. A light source is projected onto the surface of an object and scattered. A second light illuminates the object to create interference between both sources. Essentially, the two light sources interact with each other and cause diffraction, which appears as a 3D image.

Through the enormous development of technology, many scientists began to make greater use of 3DHT. Indeed, scientists managed transfer of individuals from one place to another without the need to travel. This sounds like something from a science fiction movie or T.V show. But this phenomenon has already taken place in American elections in 2008, when Jessica Yellin, in Chicago, was `beamed up` into Wolf Blitzer's studio in New York with a very realistic display (Fig-ure1).

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