Utilization of Ultra Sonics for Making a Hologram Tangible

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ABSTRACT: In this present day technological era, technology plays a crucial role than art and artists. Holography on the other side gained its roots in the industry representing an era of three dimensional (3D) entertainments. For example, movies like 'Avatar', 'The Iron Man' and 'The Minority Report' used HOLOGRAPHY extensively which made the viewers to have a very good visual experience. Although Holograms used in those films were graphically designed in the computer (CGI) ,we can generate a Hologram by our usual HOLOGRAM MAKING METHODS. But till now, there is no evidence that Holograms are tangible .We can only see the Hologram but cannot touch and feel it. This paper presents an analytical approach towards Tangible Holography by Utilizing U.S (ULTRA SONIC) WAVES, giving rise to a new form of live entertainment in real time applications.

Keywords: Hologram , Ultra Sonic Waves , Interference, Diffraction , Wave Function .

I. INTRODUCTION TO HOLOGRAPHY

The technique which is widely gaining grounds nowadays is 'Holography'. It is a technique which enables 'three dimensional' image viewing. For this purpose it uses a laser, interference, diffraction, light intensity recording and suitable illumination of the recording. This technique was invented by '**Dennis Gabor'**, Nobel laureate in Physics. The principle of holography is about capturing and reproducing the light field. The light field is at each point is determined by an amplitude and phase. In comparison with 'classical photography' the reproduced image looks flat because the light field is integrated over some time and the adequate optical intensity is captured on a photographic material and when this is illuminated by a light source the captured intensity is replayed into all directions. On contrary the technique used in holography is it records the phase and amplitude of the light field. When hologram is illuminated by a proper light source the exact phase and amplitude gets reconstructed and the original light field gets recreated. Hence for observer the entire light field is visible and the three dimensional sensation is achieved.

Fig: *Holographic Projection Of Steve Jobs*

II. HISTORY OF HOLOGRAPHY

The Hungarian-British physicist **"Dennis Gabor"** (in Hungarian: *Gábor Dénes*), was awarded the Nobel Prize in Physics in 1971 "for his invention and development of the holographic method". His work, done in the late 1940s, built on pioneering work in the field of X-ray microscopy by other scientists including Mieczysław Wolfke in1920 and WL Bragg in 1939. The discovery was an unexpected result of research into improving electron microscopes at the British Thomson-Houston Company in Rugby, England, and the company filed a patent in December 1947 (patent GB685286). The technique as originally invented is still used in electron microscopy, where it is known as electron holography, but optical holography did not really advance until the development of the laser in 1960. The word *holography* comes from the Greek

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words ὅλος (*hólos*; "whole") and γραφή (*grafē*;"writing" or "drawing").

The development of the laser enabled the first practical optical holograms that recorded 3D objects to be made in 1962 by Yuri Denisyuk in the Soviet Union and by Emmett Leith and Juris Upatnieks at the University of Michigan, USA.

Early holograms used silver halide (Ag-X) photographic emulsions as the recording medium. They were not very efficient as the grating produced absorbed much of the incident light. Various methods of converting the variation in transmission to a variation in refractive index (known as "bleaching") were developed which enabled much more efficient holograms to be produced.

III. HOLOGRAM PROJECTION USING HOLOLENS :

Microsoft has a vision for the future, and it involves terms and technology straight out of science fiction. Microsoft's HoloLens, which the company unveiled at its Redmond, Wash., headquarters on Wednesday, is a sleek, futuristic headset with transparent lenses. You can see the world around you, but suddenly that world is transformed -- with 3D objects floating in midair, virtual screens on the wall and your living room covered in virtual characters running among.

Microsoft's HoloLens is not actually producing 3D images that everyone can see , Instead of everyone walking into a room made to reproduce 3D images, Microsoft's goggles show images only the wearer can see. Everyone else will just think you're wearing goofy-looking glasses. The company is not trying to transport you to a different world, but rather bring the wonders of a computer directly to the one you're living in. Microsoft is overlaying images and objects onto our living rooms.

As a HoloLens wearer, you'll still see the real world in front of you. You can walk around and talk to others without worrying about bumping into walls.The goggles will track your movements, watch your gaze and transform what you see by blasting light at your eyes (it doesn't hurt). Because the device tracks where you are, you can use hand gestures -- right now it's only a midair click by raising and lowering your finger -- to interact with the 3D images.

IV. ULTRASONIC WAVES (US WAVES)

In order to know the wave nature of Ultra Sounds, first we have to know some basic properties of a wave . They are ..

A. INTERFERENCE

It is the superposition of two or more waves. We describe the wave function as …

$$\psi(\vec{r}) = A(\vec{r})e^{i\phi(\vec{r})}$$

where $A\overrightarrow{(r)}$ is the amplitude and $\phi\,\overrightarrow{(r)}$ is the phase. Now its intensity can be defined as square of absolute value of wave function which is ….

$$I(\vec{r}) = |\,\psi(\vec{r})|^2$$

where $I(\vec{r}\,)$ is intensity of the wave. Since wave equation is linear differential equation it can be defined as ….

$$I(\vec{r}) = |\,\psi_1(\vec{r}) + \psi_2(\vec{r})|^2 = I_1 + I_2 + 2\sqrt{I_1 I_2}cos\{\phi\}$$

Here I_1 and I_2 are individual intensities and the phase difference between them is $\phi = \phi_1 - \phi_2$. We add the

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interference term $2\sqrt{I_1 I_2}\cos\phi$ which can positive (constructive interference) or negative (destructive interference).

B. DIFFRACTION

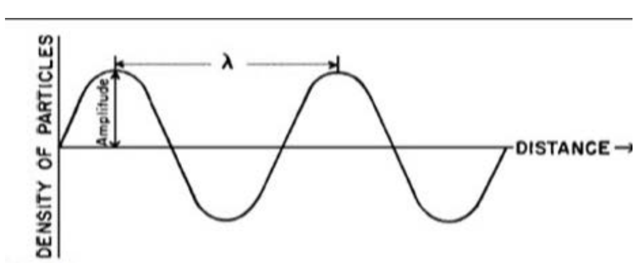
It is the phenomena where bending of light rays happen when a wave encounters an obstacle. According to **Huygens-Fresnel principle** for a secondary wave every point of wave front can be considered as a point source. The point source at other place is considered as coherent superposition of secondary waves .

ULTRA SONIC WAVES:-

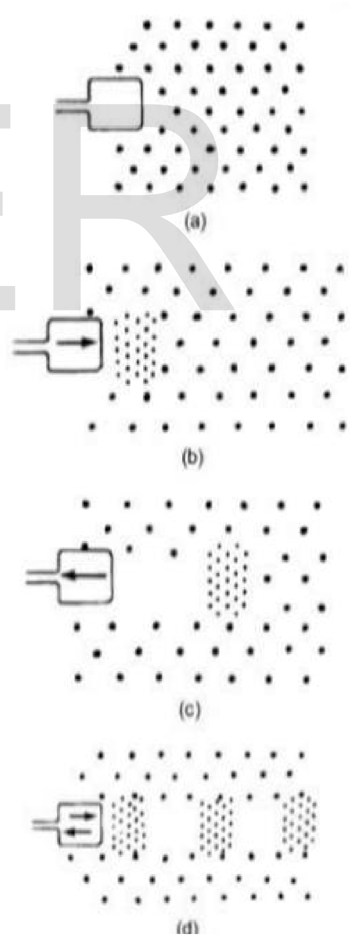
Ultrasound is a mechanical disturbance that moves as a pressure wave through a medium. When the medium is a patient, the wavelike disturbance is the basis for use of ultrasound as a diagnostic tool. Appreciation of the characteristics of ultrasound waves and their behaviour in various media is essential in understanding the use of diagnostic ultrasound in the field of Holography.

PROPAGATION OF US WAVES:-

During the propagation of an ultrasonic wave, the molecules of the medium vibrate over very short distances in a direction parallel to the longitudinal wave. It is this vibration, during which momentum is transferred among molecules, that causes the wave to move through the medium.



A zone of compression and an adjacent zone of rarefaction constitute one cycle of an ultrasound wave. A wave cycle can be represented as a graph of local pressure (particle density) in the medium versus distance in the direction of the ultrasound wave. The distance covered by one cycle is the wavelength of the ultrasound wave. The number of cycles per unit time (cps, or just sec^{-1}) introduced into the medium each second is referred to as the *frequency of the wave*, expressed in units of hertz, kilohertz, or megahertz where 1 Hz equals 1 cps. The maximum height of the wave cycle is the amplitude of the ultrasound wave. The product of the frequency (ν) and the wavelength (λ) is the velocity o f the wave; that is, $c = \nu\lambda$.



a.) Uniform Distribution of molecules in a medium

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b.) Movement of piston towards right produces a zone of compression

c.) Withdrawal of piston to the left produces a zone of rarefraction

d.) Alternate movement of the piston to the right and left establishes a longitudinal wave in the Medium

*Table***:** ***Frequency Classification of US Waves***

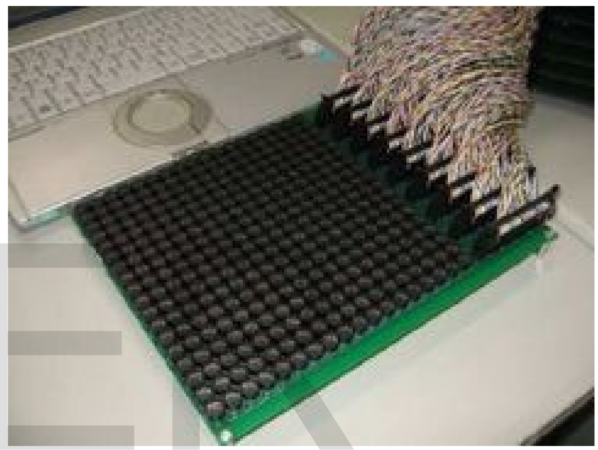
Frequency (Hz)	Classification
20 – 20,000	Audible Sound
20,000 – 2,000,000	Ultra Sound
2,000,000- 3,000,000	Diagnostic Of US Waves

.TANGIBLE HOLOGRAPHY:-

Mid-air displays which project floating images in free space have been seen in Science Fiction 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. My 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 the original tactile display .

WORKING:

TACTILE DISPLAY:-



"Airborne Ultrasound Tactile Display" is a tactile display which provides tactile sensation onto the user's hand. It utilizes the nonlinear phenomenon of ultrasound, acoustic radiation pressure.

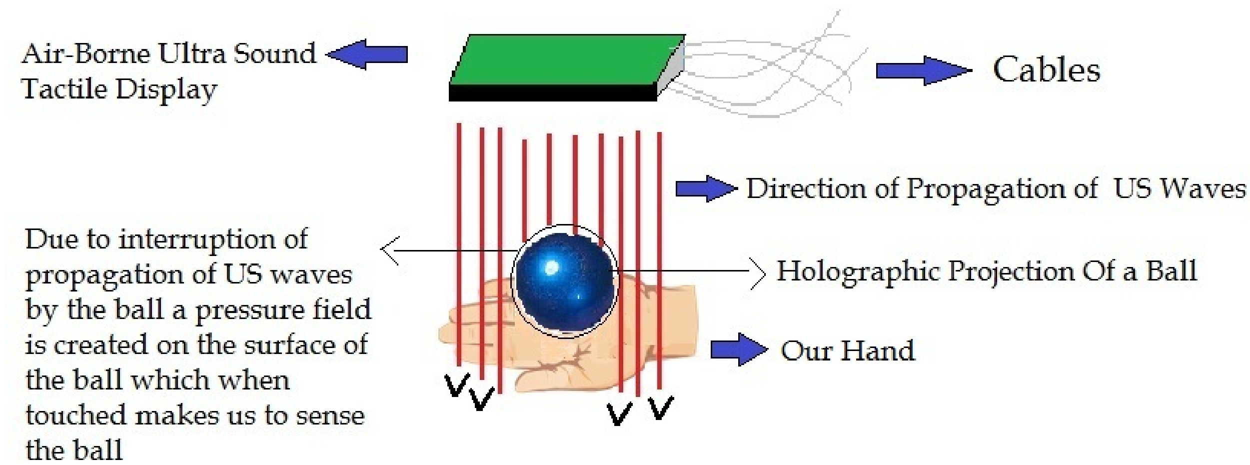


*Fig: **Pictorial Representation Of Working Of Tactile Display for Tangible Holography***

When an object interrupts the propagation of ultrasound, a pressure field is exerted on the surface of the object. The acoustic radiation pressure P [Pa] is written as ....

$$P = \alpha E \quad \text{--------} (1)$$

where E [J/m3] is the energy density of ultrasound and α is a constant ranging from 1 to 2 depending on the reflection coefficient at the object surface. The acoustic radiation pressure acts in the same direction of the ultrasound propagation. That is, roughly saying, the ultrasound “pushes” the object.

Eq.(1) suggests that the spatial distribution of the pressure can be controlled by using wave field synthesis. When the tactile display radiates the ultrasound, the users can feel tactile sensation on their bare hands in free space with no direct contact.

Normally it consists of 324 ultrasound transducers and the resonant frequency is 40 kHz. The phase delays and amplitudes of all the transducers are controlled individually to generate one focal point and move it three-dimensionally. The total output force within the focal region is 1μN. The diameter of the focal point is 20 mm. This produces sufficient vibrations up to 1 kHz.

APPLICATIONS:

The developed system can render various virtual objects because not only visual but also tactile sensation is refreshable based on digital data.

It is useful in various applications like –

- **VIDEO GAMES**
- **3-D COMPUTER AIDED DESIGNS**
- **MOTION CAPTURE TECHNOLOGY**
- **SECURITY CHECKING CODES**
- **EFFECTIVE DISPLAY BOARDS**
- **FILM MAKING**
- **EFFECTIVE MRI SCANNING**

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[12] Concept was conceived by me after watching epic science fiction movies like AVATAR, IRONMAN, MINORITY REPORT etc .....