The hologram and telepresence

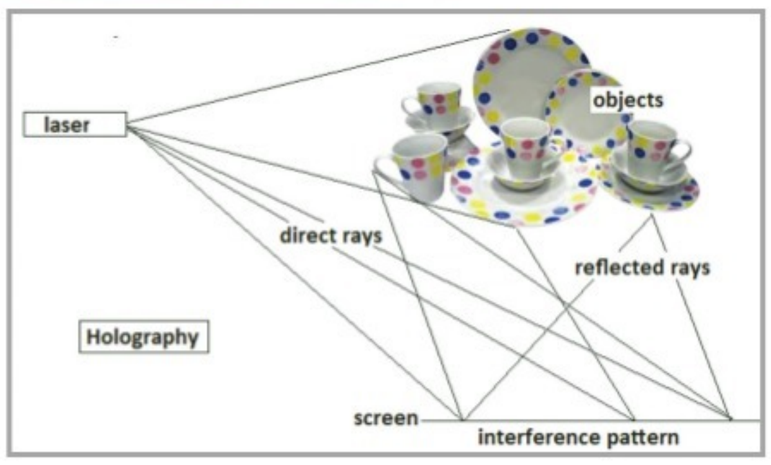
The split-second hologram would take us to places that 3D reality displays are trying to reach

S ANANTHANARAYANAN

The representation of the lion at the Make in India show at the Hannover Messe in 2015 was a spectacular display using augmented reality technology. This and allied methods have changed the character of teleconferencing, advertising and entertainment. They use computer generated audio and video effects that recreate the environment of distant places. They also relay images of the reactions of participants so that they can respond to each other as if they were face to face.

The reality they create, however, when it is on a screen, is not real 3D, except that views from all angles are readily available and the images are of high quality. Objects can thus be rotated and the viewer can speed behind corners, but the screen looks the same, from whichever angle it is seen. The imaging that creates real 3D, where each eye, without the use of special glasses, sees a distinct image, and the mind can perceive depth, has been possible only with the hologram, which works with the help of lasers.

The trouble with holo-graphy, however, is that holograms are static pictures and take time to create. Therefore it is not useful for important applications, like transmitting images for medical or surgical operations, which need to show moving pictures.



Professor Nasser Peyghambarian and his group in the University of Arizona had published in the journal, *Nature*, a method of creating holograms every two seconds. This may have been the first step in speeding up the process to enable real 3D and moving representation.

Ritesh Agarwal and others at the University of Pennsylvania now report in *Nano Letters*, the journal of the American Chemical Society, a medium that switches between three hologram images on being stretched. This could help design new displays and speed up display or transmission.

An improved method of display, currently in use, is virtual reality, where the user wears a head-set to experience real depth and intense "immersion" in the target locale. The device has goggles that present separate images to each eye and the images could be real-life or computer-processed animation.

The image has depth, like a real-life view, but is still not true 3D, as one cannot move around to get a view from a different angle. Virtual reality has found success for personal entertainment but not for practical use as it does not allow users to communicate, or to participate in the action they are viewing.

Another development is augmented reality, which is not real 3D, but different views of real objects, or computer creations, which are projected on transparent screens. With special optical and sound effects, and the images being rapidly refreshed by computers, the impression is created of the viewer being surrounded by objects, movement, buildings or a landscape.

This was the technique used to create the illusion of a lion from India walking among the audience, and then morphing into a mechanical assembly of machine parts, at the opening ceremony of Hanover Messe. The same class of techniques also allowed Prime Minister Narendra Modi, to present himself during his election campaign, apparently in person, before dozens of far-flung audiences at the same time.

In the field of engineering too, 3D software takes a set of engineering drawings and creates 2D images of the finished product, building, bridge, tower, et al. The software then allows the image to be rotated and turned around, to provide multiple views.

The viewer can also zoom in to any specific part, for a closer look, and so on. The software even allows the user to make changes in the 3D view, so that corresponding changes are carried out in all the related 2D drawings, for use by engineers.

True 3D, or an image that looks like a real set of objects with depth, so that one object moves before or behind another, when a viewer moves her head, however, is created only with the help of the hologram.

The hologram works by capturing not the image of an object, as received at a sensor or set of sensors, but by capturing the wave front of light waves that emerge from the object. If the same wave front is then created again, there is no way any sensor, like a pair of eyes, can tell that what they see is not the real object itself.

Recording the wave front, however, is easier said than done, because the light that falls on things is a mixture of light waves that are in all stages of wave motion and there is no single wave front to capture. This problem can be overcome by illuminating the scene to be captured with laser light.

While the waves of the laser are synchronised, or "in step", there is still the problem of capturing a wave front. This is overcome by bringing in two sets of light waves, those that come directly from the source laser and the waves reflected from the objects, to fall on a light-sensitive screen.

There is thus the interaction of two wave fronts that arrive at the screen. At each different point on the screen, the two wave fronts would either add, to get stronger, or cancel, to get weaker. The screen is hence covered with a pattern of dark and bright portions, like a bar code, and this distribution captures the relationship of the illuminating light and the light that has been reflected by the objects illuminated.

Now, if this screen, with the pattern of dark and bright parts, is again illuminated by a beam from the same laser, the wave front that emerges would have the same intensity distribution as the wave front which was originally spread across the screen. A person who looks at the screen would thus see the same, original wave front and would see the same objects as before. As the pattern on the screen, and hence the wave front, does not depend on where the viewer is located, any viewer would see the original objects as if they were physically there.

The problem, however, is that it takes time to print the pattern, which is the hologram, on the screen and it is a static pattern. To show motion, we need to create a hologram every sixteenth of a second, and then to run through the holograms at the same rate, so that the eyes see continuous motion.

Nasser and Ritesh

The breakthrough reported by the team at Arizona was to record holograms using different coloured lasers on the same polymer sheet, and to do it within two seconds. Creating a hologram every two seconds would not be fast enough to smoothly record a scene that is in motion, but it may be the start of a process by which the time taken is reduced.

The succession of holograms could then be transmitted, to allow a distant viewer to experience the action as if she were personally there. This may lead to applications in telemedicine, advertising, prototyping, updatable 3D maps and entertainment, the Arizona authors say.

The Pennsylvania group created a hologram of geometric shapes using nanoparticles in a flexible sheet. A sheet whose components and thickness have the same physical dimensions as the wavelength of light can mould and shape a wave front that falls upon it.

The group created a surface with gold nano-rods embedded in synthetic sheet, so that the optical properties of the layout of particles could be changed by stretching the sheet. A computer-generated hologram of a pentagon, which was created on the sheet, could then change to a square, and then to a triangle, when the sheet was stretched.

The discovery suggests the possibility of holograms that could be manipulated and the electronic transmission of 3D information for display using a re-configurable hologram.

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A nightmare in ice

It is human irresponsibility that is causing both climate change that is melting the permafrost, and growth of the 'super bug'

HAJRAH MUMTAZ

These days, I find myself hooked on a TV show called *The Hundred*, which contemplates a distant future where most of mankind has been wiped out by nuclear war. But then, the post-apocalypse genre is after all among the most fascinating. Humanity loves to contemplate its own destruction, particularly whilst ensconced in the comforts of modernity.

The nuclear disaster scenario is only one of many such threads in the post-apocalypse genre. One of them is medical disaster. Many of us were left scarred by *I am Legend*, for example, where a virus has wiped out most of humanity while turning those left into mutated nocturnal vampire-zombies.

While shivering deliciously at the predicament of the last man in New York, many of us would have found ourselves thinking, "Could it actually happen?"

Nuclear disaster is certainly a clear and present danger, but the stuff about a medical crisis … there's no chance that something will start turning people into flesh-eating zombies, right? Maybe. But as for a virus of some sort, a mutated bacteria or bug, confidence proves difficult to summon up. There are several examples where pandemics have produced a natural, wide-scale cull of humanity.

The Black Death killed anywhere between 75 to 200 million people in Eurasia. Other diseases that have caused death on a large scale include smallpox, cholera and tuberculosis.

Now, however, medical science appears to have everything well sorted. Several diseases have been wiped out, such as smallpox — deemed responsible for the somewhere between 300 and 500 million deaths during the 20th century — which was declared eradicated in 2011.

The risk of exposure to others has been hugely shrunk on the global level, such as polio. And modern treatments and vaccinations mean that in general terms, the world currently has perhaps the healthiest population than ever before, all seven billion-plus of it.

But planet Earth has a way of evening the score with humanity whose activities have such profoundly adverse consequences. In recent years, researchers have started to worry about the possibility of ancient viruses and bacteria springing back to life as climate change melts permafrost soils. As cited in a recent article on BBC Earth, the evidence is mounting.

Last August, in a remote corner of the Siberian tundra in the Arctic Circle, a 12-year-old boy died and about 20 people were hospitalised because of anthrax. Research suggests that some 75 years ago, a reindeer infected with anthrax died and its carcass became trapped in the permafrost.

Eventually a heatwave came in the summer of 2016 that thawed the permafrost and exposed the reindeer corpse, releasing anthrax into water and soil. Scientists have discovered intact the Spanish flu virus dating back to 1918 in corpses buried in mass graves in Alaska's tundra. Smallpox and bubonic plague are highly likely to be buried in Siberia.

Without climate change, superficial permafrost layers about 50cm deep melt every summer. But now, in the Arctic Circle, temperatures are rising about three times faster than in the rest of the world.

Global warming is gradually exposing older layers of permafrost, raising the frightening possibility of diseases from hundreds and even thousands of years ago being resurrected — diseases that haven't been seen for so long that mankind would have no natural immunity to them, nor the benefits of research. Permafrost is an excellent preserver of microbes and viruses, because it is cold and dark and there is no oxygen. Bacteria, meanwhile, can remain alive for up to a million years.

Then there are two other chilling realities.

First, there is the growing anti-vaccination movement in some parts of the world, leading to pockets of epidemics of diseases such as chicken pox that are entirely preventable. The reluctance of people to have their children vaccinated is based mostly on misinformation, plus the benefits of herd immunity — in a population free of polio, for example, the chance of encountering the virus is very slim.

But the high rate of modern travel and transport means that viruses and microbes are exchanged across the continents, and herd immunities are being compromised, to the extent that the Obama administration was considering formulating legislation forcing parents to have their children vaccinated.

Secondly, the "super bug" now seems a reality, and in 2015, the World Health Organization warned that antibiotic resistance had globally reached such levels that we are looking at "the end of modern medicine as we know it" — humanity is hurtling towards a "post-antibiotic era in which common infections will once again kill". The situation has not improved significantly over the last year and a half.

If such nightmares do come to pass, the very slim silver lining for the cynical is this — humanity will have its own blood on its hands, since it is human irresponsibility that is causing both climate change that is melting the permafrost, and growth of the "super bug".

Dawn/ann

PLUS POINTS

Power of a poem

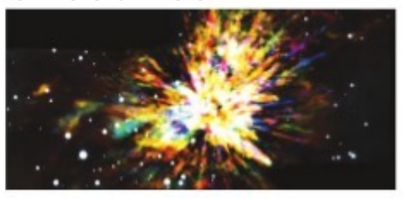
The world's first air cleansing poem, which has removed more than two tonnes of pollution from the environment, is being auctioned off for charity to help in the battle against lung disease. The poem by award-winning writer Simon Armitage, professor of poetry at the University of Sheffield's school of English, has been transformed into 12 limited edition artworks that were being auctioned to raise funds for the British Lung Foundation yesterday.

Printed on a specially-treated material developed by Sheffield scientists, the poem, *In Praise of Air*, is capable of purifying its surroundings through catalytic oxidation. The team behind the project believe its catalytic technology could help urban areas tackle high levels of pollution.

Since being developed in 2014, the poem has removed more than two tonnes of nitrogen oxide from the environment whilst being on display on the wall of the University's Alfred Denny building. Now, 12 sections of the poem have been stretched onto frames and signed by Armitage for auction at a special celebration event. The team also hope the poem and its air-cleansing technology can be replicated on billboards and artwork in towns and cities across the world to help tackle pollution.

Professor Jo Gavins, who leads the project from the University of Sheffield's school of English, said, "The nitrogen oxides that *In Praise of Air* helped to remove from the atmosphere during its time on the wall of the Alfred Denny building are a major cause of lung diseases and we hope to have raised public awareness of their damaging impact through our cross-disciplinary collaboration."

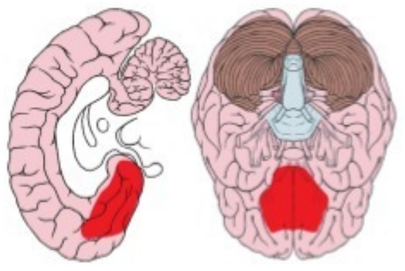
500-year-old encounter



The birth of a star can be a violent and explosive event. Around 500 years ago, a pair of young stars had a close encounter that blasted them apart. This event has been recorded by astronomers using the Atacama Large Millimetre/ submillimetre Array (Alma), a gigantic array of radio telescopes situated in the famous high-altitude Chilean desert. Shortly after starting to form some 100,000 years ago in a bustling "star factory" about 1,500 light-years from earth, several protostars gradually drew closer due to gravity. Two of them collided, triggering a powerful eruption that launched other protostars and hundreds of giant streamers of dust and gas into space at speeds greater than 150 km per second. This event is relatively short-lived, taking centuries to play out, but releasing as much energy as the sun does over 10 million years. The Alma image, in colours indicating the relative speeds of the particles, is combined with a near-infrared image from another telescope, which shows shock waves produced by the explosion.

The straits times/ann

Brain & religion



Location of the ventromedial prefrontal cortex

Suffering a brain injury can make people more religious, scientists have found. Researchers from Northwestern University in Illinois, US, found patients who had a brain trauma were less willing to accept new ideas and became more extreme in their religious beliefs.

The study, published in the journal *Neuropsychologia*, found that lesions in a part of the brain called the ventromedial prefrontal cortex were linked to higher levels of religious fundamentalism. The team used brain scans to assess the extent of the damage to the participants' ventromedial prefrontal cortex and then measured the strength of their religious beliefs using a commonly-used survey.

While highlighting the significance of their findings, however, the scientists also warned there are a number of other factors that determine the force of a person's religious convictions, including personality traits and their social environment.

Ben Kentish/The independent