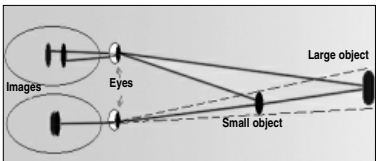
Calling long distance

Working together, video-conferencing and holograms can shrink distances with 3D clarity, writes s ananthanarayanan

TELECONFERENCING never made it big because flat pictures of other people do not look "life-like" and the system cannot produce the "eye contact" of a face-to-face meeting. There are ways to display pictures in 3D that are more lifelike, but these typically need two views of a scene to be seen at the same time, which is only possible by beaming a separate image for each eye and involves polarised light and special spectacles. The hologram is a remarkable way of creating a 3D image that one can actually "walk around", but this has needed special arrangements and time to produce and could not be used for communication of moving pictures!

Nasser Peyghambarian and colleagues at the University of Arizona at Tucson and the Nitto Denko Technical Corporation at California report in the journal *Nature* that they may have broken through with a system to create reasonably good hologram pictures, over a distance, every two seconds, that can combine 3D clarity and also a sense of movement.



Both eyes see the two objects as the same size. One eye sees them in line, the other eye sees them as separated. The brain puts the two images together and works out the sense of depth.

Three dimensions

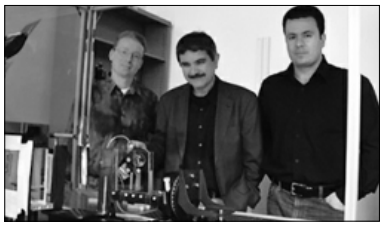
The way we see, with the sense of depth and clearly making apart things that are nearby and those that are far off, is thanks to our eyes. With only one eye, we would never have depth perception. Objects further away would look smaller, no doubt, but we would have no way of knowing whether these were further away or, in fact, at the same distance, but smaller. With both eyes, which are placed a few inches apart, each sees a slightly different image of the same scene, and the relative change in positions is affected by the distance of things from the viewer. All animals soon learn to process this difference in what each eye sees into a 3D picture of the objects in view. Even common birds that have eyes on either side of the head (for their own reasons of security and wide angle of view) need to view a tidbit with each eye by turning the head to get a fix on its position before feeding.

The lack of 3D view, at least in teleconferencing, was first addressed in *tele-immersion* through a combination of stereoscopic projection and rapid projection. The stereoscopic (that is 3D) picture was created by using a series of pairs of cameras, each pair being placed apart, like a pair of eyes, and the images beamed separately for view in eyepieces set within a viewing helmet. Other methods used in 3D movies, for instance, involve polarising the light from each of the cameras along a different axis and providing the viewer with spectacle lenses to admit only the relevant image for each eye.

And for creating the quick response, of the listener to the speaker, the best communication technology was brought in to transfer the images as fast as possible. In fact, convincing images could not be created with only one pair of cameras and a whole array, 64 cameras in one arrangement, had to be used. The total data to be transmitted also grew and the concept could not develop because of limited bandwidth, apart from the cumbersome helmet and other gear involved.

Hologram

The advent of lasers has provided us with a simple method of creating stationary images in three dimensions. The hologram uses the principle that there is a single system of light waves that come off an object and this whole system is the same, whether it is seen by one eye or the other. The two eyes see different things because the same light wave strikes each eye at a different time and place, or at a different stage of its own wave motion. Thus, along any plane in the path of the waves, the waves from a stationary object, as well as the original beam, would all strike at each spot and add or negate each other at the spot, depending on their stages of wave motion. The net effect would be to create an interference pattern that would capture the relative phase of each light wave at each point on the plane.



Pierre Blanche, Nasser Peyghambarian and Savas Tay of the University of Arizona.

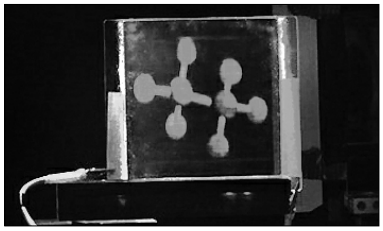


Image of the updateable holographic display showing a 3D model of an ethane molecule.

If this pattern were recorded as a series of dark and white bands and similar light were shone on this pattern, a viewer would not be able to say whether he/she was seeing the interference pattern or the original object itself! This kind of thinking does not work with ordinary light because in ordinary light the waves are all out of step and jumbled, but it certainly does with laser light, which consists of ordered wave trains. The pattern, which comes about with lasers, is the *hologram*, which is able to create images that cannot be distinguished from reality. (See box.) Holograms can even be generated using ordinary pictures from different angles, combined into an interference pattern using computers. But the problem is that the interference patterns, however produced, need to be recorded, say, on photographic media before the 3D image can be viewed. As the process of recording takes time, it is not practical to transmit and employ a series of images from one place to another with the frequency that could convey any sense of movement. It is here that the development by the Arizona group has achieved a breakthrough.

Novel material

Screens made of inorganic crystals have been developed in the past to work as "refreshable holographic displays". This method suffers from a starting disadvantage that the crystals need to be "grown", which is a laborious process. This same group of researchers had earlier reported progress using organic polymers, which are more easily erected. But the images had limitations and could be refreshed only once in four minutes.

But the system now reported is a display based on material that can be refreshed every two seconds. The material is built into holographic units known as *bogels*, to combine *hologram* and *pixels*, and there are 120 hogels in a four-inch by four-inch display. The system is that the "tele-presence" is created using 16 separate cameras that take pictures every second. The 16 images are processed into hogel data in a host computer and can be transmitted over computer networks to the hologram display. The hogels are refreshed in sequence from one side of the display, while the image is viewed by incident light shone from the other side. The writing and reading thus go on together and the viewer sees the 3D image continuously.

What the Arizona and California group has done is to demonstrate materials and a procedure for nearly real time 3D display, which would have several applications. If scaled to a life-size, two-way transceiver, it would create actual communication between people separated by physical distance. More relevant are uses in medicine and surgery. In brain surgery, for instance, surgeons from around the world could observe the procedure in three dimensions and participate.

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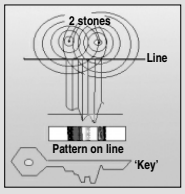
Separate Hologram

INCIDENT light and light from an object can be likened to ripples caused by two stones dropped in a pond. The ripples interfere when they meet and would "add or annihilate". There would thus be a pattern of "high and low" along any line drawn across the wave train. Now if this pattern along the line were converted into a "key", with teeth where there were "downs" and gaps where there were "ups", then the key could reproduce the pattern from which it was made.

If "waves" were recreated like this, by pushing the key into the water, then the "expanding pattern" would be just like it was in the original case because the pattern along the line preserves the history.



Constants and variables

Hereditary distinction in bacteria is expressed in mutations and recombinations, says tapan kumar maitra

THE variations micro-organisms undergo can be classified under two broad categories: a) non-hereditary (modification-type) due to the dissimilar developmental conditions of individuals of one and the same genotype, and b) hereditary, caused by mutations and genetic recombinations of the genes.

Intraspecies non-hereditary variation: This kind of variation is found quite frequently. It occurs under various comparatively mild effects of the environment on microbes, due to which the ensuing changes are not fixed in a hereditary sense. For example, strains of coli-bacilli, which grow on agar with sodium ricinoleate, form long filaments. Upon the addition of calcium chloride these cells become quite short. A deficiency of calcium in the medium provokes an increase in spore production and a slimy growth in anthrax bacilli. Inorganic iron has a great influence on the formation of toxins. A decrease in oxygen lowers the degree of pigmentation and increases the number of smooth colonies in tubercle bacilli. The addition of lithium to the nutrient medium induces growth of microbes in the shape of curious branched giant forms, spheres and finest filaments. Glycerin and alanine induce pleomorphism in cholera vibrios.

The range of modification-type variation is limited by a genotype-determined reaction norm, ie the aggregate of phenotypes, which are created on the basis of a definite genotype. The traits formed, as the result of modification may, be relatively stable or labile. In some cases traits induced by factors of the external environment may be maintained by several and even many generations. Long-term modification of morphological, physiological, and immunobiological properties is encountered in many species of living organisms which occur in different levels of organisation. Modification does not disturb the normal equilibrium between the physiological processes of the organism or the correlation between the organism and the environment.

Adaptive processes to short-term fluctuating deviations from the normal conditions of the habitat are particularly marked in micro-organisms. Such deviations may be cyclic, occurring with the seasonal changes in the climate, or purely accidental. These lead to suppression or activation of gene controlled processes which could not take place under the previous environmental conditions. The genetic apparatus does not undergo changes in these cases.

Under the influence of unfavourable conditions of life some species of bacteria undergo profound changes with the formation of peculiar small colonies (L-colonies) with a dark dense centre and a loose edge. These altered micro-organisms are known as L-forms of bacteria. They occur, for example, under the effect of penicillin, immune serum, phage, chemicals, irradiation and other unfavourable factors.

Intraspecies hereditary variation: Hereditary variation in bacteria results from changes in the genetic structures. Contrary to plants and animals, bacteria are predominantly haploid organisms; they contain one genome and combine within themselves the functions of the gamete and the individual. The viruses also belong to typical haploid living systems.

The unit of heredity is the gene, an area of DNA in which the sequence of the amino acids in the polypeptide chain is coded and which controls a particular property of the individual. S Benzer named the region in a genome, which accomplishes only a single function the cistron.

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Will we ever find the cure?

In time, hopefully science will find a way to defend our species against Aids and avenge the loss of the millions killed by this scourge, says rhishav n choudhury

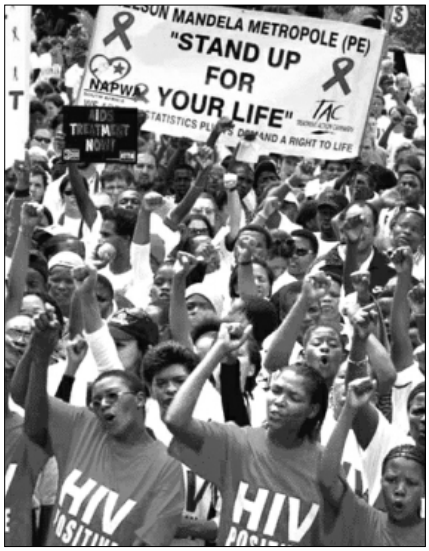
We hope to have such a vaccine ready for testing in approximately two years. ~ Margaret Heckler, US secretary of health and human services, speaking on a possible vaccine to cure Aids back in 1984.

IT'S been 30 years since Acquired Immunodeficiency Syndrome was first diagnosed among homosexuals in California and New York and over 25 years since the Human Immunodeficiency Virus was discovered to be its causal agent. Thirty-three million people around the globe are living with Aids and every day roughly 6,000 die, while another 6,800 join the ranks. In India, an estimated 2.5 million are affected and yet we remain unsure about of when medical science will be able to prevent and find a cure.

HIV is a retrovirus which, in simple terms, can rapidly reproduce itself inside the cells of the host (in this case, humans) that it infects, with the reproduced viruses then commandeering additional cells in an exponential cycle. The virus achieves this by first using a protein called the *envelope* to bind onto CD4 and CCR5 proteins on the cell surface. It then fuses with the cell and empties its contents into the cell's cytoplasm.

This allows the viral enzyme, reverse transcriptase, to copy the virus's RNA genome into double-stranded DNA, a process that often creates errors leading to mutations and generating diversity in the virus copies. Another viral enzyme, *integrase*, then inserts the viral DNA into the host DNA. The host cell then transcribes the viral genes back into RNA that travels to the cytoplasm, where ribosomes produce the encoded proteins. The viral RNA and proteins then move into the cell membrane where they form budding virus particles. Finally, the HIV enzyme protease modifies the viral protein chains, enabling the particles to mature into a form that is ready to infect a new cell.

Normally, the first line of immune defence, or non-specific immune system, is made up of cells patrolling the body for invaders that destroy virus-infected cells on the spot. However, HIV replication is so intensive that this system is usually crippled by the initial onslaught of the replicating virus. The second line of immune defence includes innate immune cells, known as antigen-presenting cells, their role being to capture some of the viral proteins to show them to more specialised immune system components to elicit a response. Among these specialised components are T cells that have two important types; helper and killer cells. The helper T cells play an extremely important role in alerting the immune system to initiate an attack against a foreign particle. Usually, the antigen-presenting cells then use the Major Histocompatibility Complex molecules to deliver the foreign proteins or antigens to the helper and killer cells, which then use their receptors to recognise the antigen-MHC complexes. The description of the intruder received by the killer T cells,



along with a chemical signal transmitted to them by the helper cells, cause them to proliferate and begin a seek-and-destroy mission. The killer T cell response then destroys most virus-infected cells.

Immune cells also produce antibodies that neutralise the virus by attaching themselves to the virus. In the case of HIV, however, the response is usually too little too late and by the time they have any effect, a lifelong chronic infection has already been established.

One of the reasons behind the inefficiency of the immune system against HIV is that from the start the ailment targets helper T cells, replicating inside them and destroying them in the process, which implies a massive neutralisation of one of the most important regulators of immune response. In particular, HIV targets memory helper T cells that serve as the immune system's memory of past exposures to pathogens. This leads to a severe depletion in memory helper cells, causing the entire immune system's command-and-control centre to be crippled to the extent that it never fully recovers. Another reason is that the virus gets better at evading the killer T cells because of the errors in the viruses' DNA formation that result in mutations in the viral copies. The diversity in the viruses enables them to display viral proteins on infected cells that are increasingly unrecognisable to immune cells. The mutations also prevent the antibodies produced by the immune system from recognising many of the viral particles in the host cells.

So how do we destroy and eradicate this ever-changing fiend? Ideal vaccines for Aids would prime the body's immune defences to prevent HIV from infecting cells or at least prevent the virus from reproducing to high levels in the critical early stages of infection. To do this, vaccines would attempt to stimulate the same immune responses provoked by natural infection to create a memory of the virus. The problem in this solution is that HIV's immense ability to mutate usually evades this approach because the immune memory is not broad enough. The potential vaccine will need to be able to generate antibodies and killer T cells that are able to recognise HIV particles that are vastly different. There have been numerous attempts to create such a vaccine, so far without success.

Although the creation of a suitable vaccine has evaded us, what we do have at present to combat Aids is a cocktail drug therapy. More than 25 drugs have been approved to date; used in the right combinations this can suppress the replication and prevent spread of the virus to new cells, often keeping blood levels so low that the virus seems to have been eradicated. The only problem is that once drug treatment stops, the virus rapidly reappears from its hiding places or reservoirs. So how does the virus hide? Most of the HIV in the blood comes from the earlier mentioned T memory cells, which display parts of HIV on the surface and usually die from the infection of the virus or from an immune attack targeted at the displayed parts. However, some manage to survive and enter a dormant state in which then tend to sit quiet for long periods of time while harbouring the HIV genome in their DNA and enabling them to make new copies of the virus if reactivated. Besides lying in wait in dormant memory T cells, HIV may reproduce at a low rate in certain other cells. Macrophages and dendritic cells are two of the predominant immune cells that inherently seem to ward off immune defences and anti- HIV drugs. Some HIV-infected cells in a few parts of the body may even be shielded from the immune system and certain drugs. For example, HIV in cellular and anatomical structures, like the central nervous system and the genital tract, does not reach the blood readily when a patient is aggressively treated with drugs, but might generate a vigorous infection when treatment stops.

These are some of the problems slowing creation of suitable prophylactics, and allowing this deadly virus to survive. However, HIV vaccine researchers haven't given up and are gearing up for a renewed fight despite numerous failures. In time, hopefully science will find a way to defend our species against this destructive disease and avenge the loss of the millions killed by this scourge.

The writer is a freelance contributor