Holograms in daily life

A resource-hungry technology could be trimmed and brought within reach

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Instantly representing distant things in true-life, in three dimensions, has been an elusive dream. The technology itself has been there, but the resources needed for implementation are prohibitive.

Takashi Nishitsuji, Takashi Kakue, David Blinder, Tomoyoshi Shimobaba and Tomoyoshi Ito, from Tokyo Metropolitan and Chiba Universities, Japan, and Vrije Universiteit in Brussels, write in the journal, *Scientific Reports*, of developments in the building and transmission of holographic images, which could enable shapes and images to be created and conveyed over distances in a practical way.

Images that are captured in drawing, or in photography, are essentially two dimensional. What they record are the shape and colours of an object, as projected on a plane surface -- a canvas, camera screen, or the retina of the eye. There is an impression of depth as distant parts of a familiar object are shown smaller than nearer parts.

Meaningful appreciation of depth, however, needs two such images, from points that are separated by a distance, like the images on the retinas of a pair of eyes. Images recorded from different points and projected, one to each eye could thus create a life-like image. We may recollect the 3D images in the *Viewmaster* device. But the images are static, and one cannot move one's head and "see around" the objects being shown.

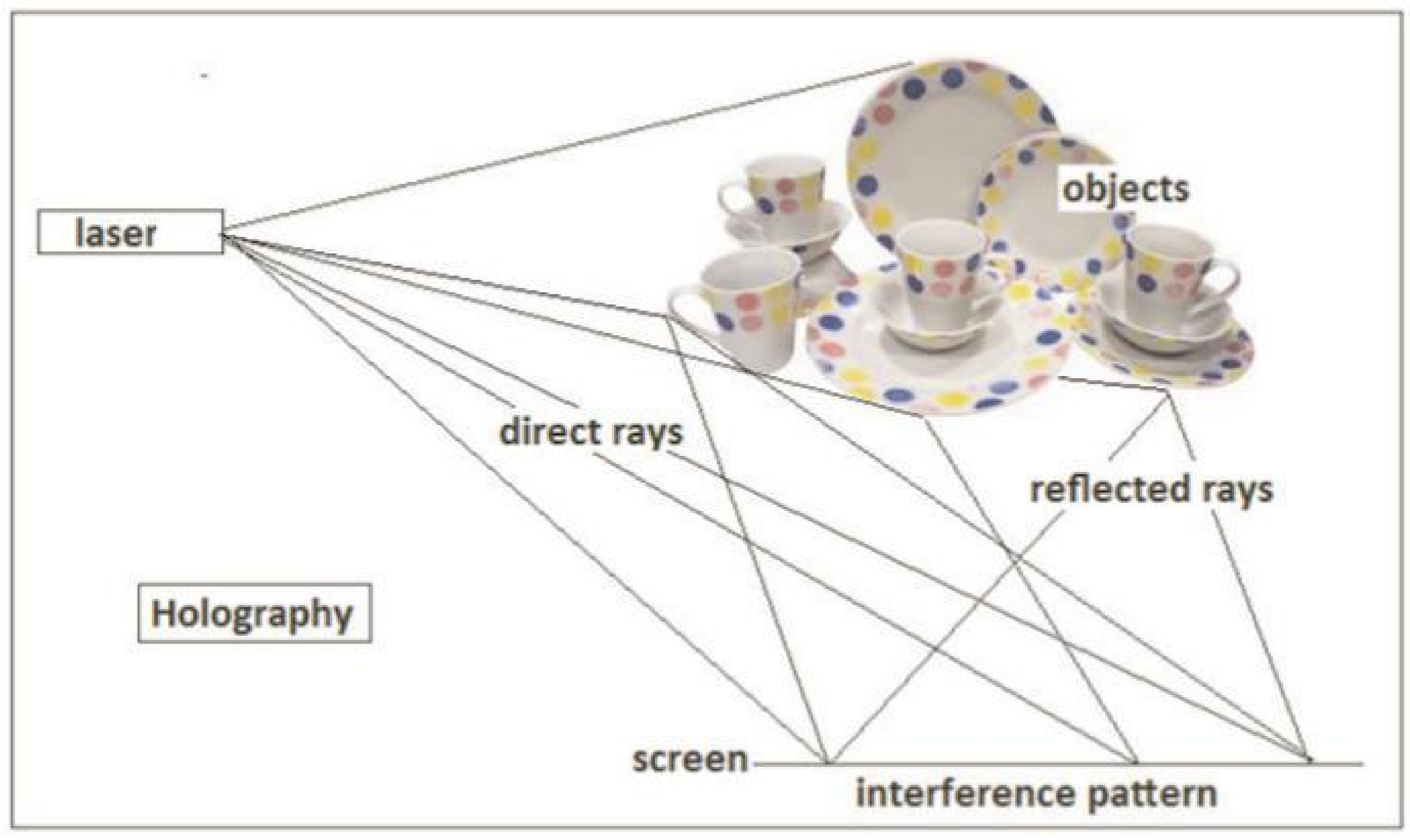
The hologram, however, makes this possible. The hologram is not the recording of the image of an object, as received at a sensor or set of sensors, but is created by capturing the wave-front, or the pattern of light waves that emerge from the object. If the same wave-front is created again, it appears to sensors, like a pair of eyes, that what they see is the real object. In normal imaging, however, it is not the wave-front that is captured; it is an image of the object focused on a screen. The hologram, in contrast, does not focus the image, it arises from two sets of light waves, those that come directly from the source laser and the waves reflected from the objects, and capture the interaction.

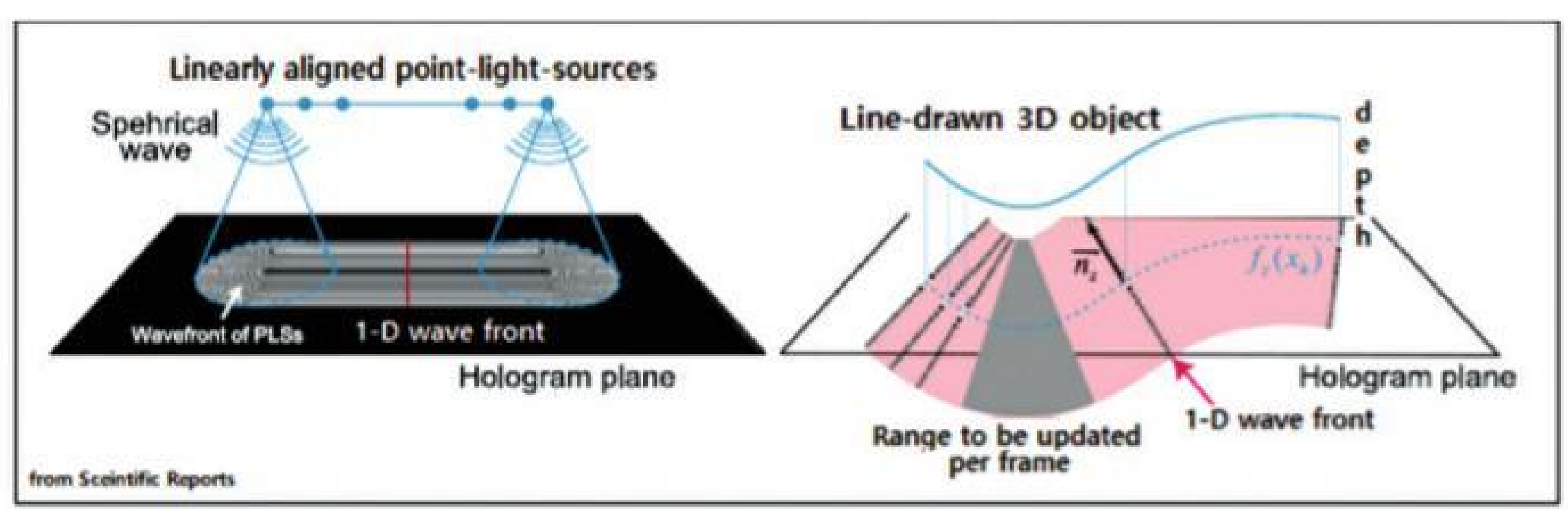
Waves from the two sources fall on every point on the hologram plate. And at each point, the waves either add, to get stronger, or cancel, to get weaker. The screen is hence covered with a pattern of dark and bright portions, like a bar-code, and this distribution captures the relationship of the illuminating 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 originally played upon the screen. A person who looks at the screen would thus see the same, original wave-front, and perceive 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, views from different parts of the screen would show different images, as if the original objects were physically there.

Nor is it necessary that holograms be made from actual objects and laser light. The interference can be simulated and the pattern on the hologram can be generated by software. Computer generated holograms -- CGH -- or electro - holography, has become "a very promising technology," the *Scientific Reports* paper says. As the pattern recorded, or generated, arises from interference of light waves, we can imagine that the pattern on the hologram would be fine, with dimensions comparable to the wavelength of light. The quantity of data in the CGH is hence very large and the computers to generate a hologram need extensive resources.

And with all this, what is created is a static pattern. To show motion, we need to create a hologram every sixteenth of a second, so that the eyes see continuous motion. Even if this were made feasible, there is a problem when the data needs to be transmitted. This would be needed in practical applications of the hologram, like transmitting a surgical operation, for review in real time. Or a display of navigation data as 3D pictures, to a motorist.





from Scientific Reports

There have hence been several approaches to compress the computation load and data in CGH, says the team writing in *Scientific Reports*. One method is to consider the light from the object to come from a series of point light sources, which reduces the extent of data to consider. This is combined with data handling approaches, like maintaining a library of precalculated results, from which the programme could pick up the required values, in place of carrying out computation.

Other methods are to approximate and simplify the computation or to recognise aspects of the image that would be the same for both eyes, or to embed some of the computation processes into the hardware. Despite all that, however, sophisticated computing facilities are required to achieve practical computing speeds, the paper says.

Usually, the point light sources, PLS, that simulate the object, generate two-dimensional wave-fronts, or surfaces, which the computational utilities superimpose, to arrive at the CGH. In the current work, what is considered are the PLS which are along a line, at the same depth. The result of this method, which the authors call the "Computer Graphics - - line method", is a one-dimensional wave-front. Superimposition of one-dimensional wave-fronts is computationally far simpler than doing it with 2D wave-fronts.

The three-dimensional image to be projected is hence built up of multiple 2D images, which consist of outlines. Although not with details, the basic depth relationships are maintained. The dimension of depth can hence be added to figures like symbols and letters, which would make it suitable for "car navigation systems and remote work support systems," the paper says.

The method has limitations, one being that "full" 3D is not possible, as continuous lines in the direction of depth are not possible. But it is a method that permits interactive 3D projection, and has the great merit that it can run on an ordinary, consumer computer.

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PLUS POINTS

Hallucinating painters

Prehistoric cave painters in Europe were hallucinating deep underground due to a lack of oxygen while making their art, researchers have claimed.

The evocative paintings created in the pitch-black baffled academics as they were often far away from the cave's entrance and in difficult to access parts of the tunnel.

But a ground-breaking new study by Israeli researchers has shown that the intrepid Palaeolithic artists sought out the most remote parts of the dark because it induced oxygen deprivation in their brains, a process known as hypoxia.

To be able to see in the darkness they had to light torches, which would lessen the amount of oxygen in the depths of the cave, possibly causing them to hallucinate or have euphoric out-of-body experiences while creating paintings that are dotted around remote spaces in Europe.

The paper was published by Yafit Kedar and Ran Barkai of Tel Aviv University in *Time and Mind: The Journal of Archaeology, Consciousness and Culture,* and further suggests that the cave spaces may have been viewed by the artists with reverence and seen as sacred.

The authors write, "We discuss the significance of caves in indigenous world views and contend that entering these deep, dark environments was a conscious choice, motivated by an understanding of the transformative nature of an underground, oxygen-depleted space."

The researchers believe heading into the depths was a conscious choice and an "ontological arena" that allowed the early humans to "maintain their connectedness with the cosmos."

Kedar told *Haaretz* that the cave-men artists may have thought that they were communicating with another being. She said, "The idea is they went in (to the bowels of caves) because they believed something was there, that there were entities beyond the wall."

Kedar had the idea for the paper after visiting rock-sites in Europe and wondering why cavemen ventured more than a kilometre inside the tunnel and into cramped spaces to create art.

The independent

Preventing pesticide poisoning

Upon penetrating into an organism, pesticides spread rapidly, becoming selectively accumulated in separate parts or organs of a body

TAPAN KUMAR MAITRA

The pesticides used for protecting plants are biologically active substances and act not only on their targets but are also a potential hazard for Nature and the health of humans.

Pesticides are characterised by a different toxicity to humans and warm-blooded animals. Their action manifests not only directly during the period of application but may also be chronic. Some of them, accumulating on objects of the environment, gradually concentrate in the food and fodder, become a real hazard to beneficial animals and humans, and may lead to serious alterations in ecosystems, biocoenoses and landscapes.

That is why the chemicals used in agriculture must be studied from a general sanitary standpoint, with a view to their behaviour in the environment and to all the sources from which they may enter a human organism. The main task in ensuring safety in pesticide application is the finding of effective measures and means for the sanitary protection of the environment, especially atmospheric air, food products of a vegetable and animal origin, sources of water supply, and the soil from contamination with chemicals in amounts dangerous for the health of people.

Humans and animals may be poisoned either by the pesticides themselves or by the products of their metabolism. Poisoning by pesticides may be occupational or encountered in everyday life. Occupational poisoning occurs among workers busy in preparing the working formulations of pesticides, treating orchards or fields, or occupied in the treatment of seeds. Poisoning sometimes occurs upon the accidental spraying of pesticides when the apparatus was being prepared. Cases are known of poisoning when drinking water, eating, or smoking during work with toxicants.

Cases have been noted of intoxication when caring for plants (weeding, trimming, etc) soon after the application of pesticides. In most cases, the cause of occupational poisoning was performing the work without the appropriate individual means of protection.

The poisoning by pesticides of persons having no direct relation to work with them is referred to as non-occupational poisoning. A major cause of such poisoning is the careless storage of pesticides. A great hazard to health is the use of containers freed of toxicants to store food products. Poisoning often occurs upon the unskilful use of pesticides to control synanthropic insects.

It is important not only to preserve beneficial animals, but also eliminate a possible source of supplying pesticides into human organisms with products of an animal origin. The poisoning of animals and accumulation of residual amounts of toxicants in their organisms occur because of the improper use of chemical means of protecting cattle from insects, when the animals feed on plants containing pesticide residues or on treated grain, when water from contaminated sources is used, when fodder is given to them in containers emptied of toxic chemicals, or upon the accidental contact of animals with such chemicals.

A danger of poisoning birds and fish appears when persistent pesticides are used and the rules for the application, storage and transportation of toxicants are violated, when contact of the birds and fish with a poison scattered or washed into water basins is possible. The systematic use of pesticides having cumulative properties leads to their concentration in the organisms serving as food for birds and fish.

Upon penetrating into an organism, pesticides rapidly spread, becoming selectively accumulated in separate parts or organs of a body. Some of them are bound by proteins or other components of the cells, while others are metabolised and excreted from the organism. Organophosphorus compounds, carbamic acid derivatives (carbaryl), and aromatic nitrocompounds (DNOG) are detected in various tissues of an organism already in a few minutes after ingestion.

The maximum concentrations of those pesticides in the internal tissues is noted in one-and-a-half to six hours after entry. When ingested one time in a dose of LD50, they are completely excreted from the organism in 24 to 96 hours. Organochlorine compounds accumulate more slowly, and their maximum concentration is observed in 25 days or more after entry. In large amounts, pesticides accumulate in the liver, kidneys and heart. Most of them in small amounts penetrate the brain.

The deposition of pesticides in some tissues is possible. For example, organochlorine compounds accumulate in fatty tissue. Some pesticides may accumulate in the skin and then enter the blood. At the places of their accumulation, pesticides undergo metabolism with subsequent deactivation or activation. Processes of metabolism occur most actively in the liver, kidneys, and in the intestinal tissues.

Metabolism is often the basic process lowering the concentration of a pesticide in organs. For instance, the concentration of heptachlor in the liver and fatty tissue mainly diminishes owing to its decomposition to epoxide and other metabolites. Poisons are excreted from an organism via the kidneys, gastrointestinal tract, lungs, skin, or mammary glands.

The mechanism of the toxic action of pesticides is determined by the absorption, transportation, metabolism, and influence thereof on the general metabolism in an organism. The initial causes of the toxic action of pesticides vary. Some pesticides cause a change in the cellular structures (for example, of the mitochondria), violating the conjugation of vitally important processes such as oxidation and phosphorylation of a substance.

Pesticides characterised by structural similarity to natural compounds of the organism join the conventional metabolism, as a result of which the functions of the metabolites synthesised with their participation are disrupted. For instance, the structural similarity of triazine derivatives to pyrimidine bases allows them to participate in metabolism as antimetabolites of pyrimidine bases, which leads to the synthesis of improperly built proteins. For this reason, the harmful action of triazine manifests itself when the new proteins begin to function.

The ability of pesticides to react with active groups of enzymes leads to inactivation of the latter and causes violation of the exchange reactions in which they participate. The result is the accumulation of intermediate products of metabolism causing poisoning of the organism. Most organophosphorus pesticides are inhibitors of the cholinesterase activity of enzymes.

Just as diverse as the nature of pesticide action on the organisms of warm blooded animals is the manifestation of this action. Pesticides cause acute, subacute, or chronic poisoning, affecting impor-tant organs and systems of an organism, disrupting exchange processes, and aggravating the course of previous diseases.

Pesticides may have a local action, destroying a tissue directly in the zone of contact of an organism with the poison. It may be irritative, anesthetising, or necrotising. The mucous membranes and lung tissue are especially sensitive to pesticides. Upon entering the blood, they are carried to different organs and tissues and affect the indices of an organism's vital activity. Under the influence of many pesticides, the gene responsible for the synthesis of haemoglobin is activated, changes occur in the morphological composition of the blood and the functional properties of the leucocytes, and shifts are noted in the content of the blood's erythrocytes.

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New Covid-19 test

A new Covid-19 rapid test that can detect variants of the virus has been developed in Singapore. It produces results within 30 minutes and can be used directly on patient samples. It is also about 10 times more accurate than rapid antigen tests currently in use in the country.

The variant nucleotide guard test is the first rapid test in Singapore to make use of a gene-editing tool known as CRISPR or clustered regularly interspaced short palindromic repeats.

Developed by scientists from Nanyang Technological University, the VaNGuard test uses a reaction mix containing a specific enzyme that acts like a pair of "molecular scissors".

The enzyme targets specific segments of the genetic material of Sars-CoV-2 -- the virus responsible for Covid-19 -- and snips them off the rest of its viral genome. Successfully snipping off the segments is how the enzyme identifies the presence of the virus.

To ensure that variants are not missed, two short genetic sequences -- known as guide RNAs -- are used to recognise sequences that are extremely similar between the variants but also unique to the virus. Associate professor Tan Meng How, who led the study, said, "Should these binding regions mutate, a new test can be redesigned in under a week."

CRISPR technology is traditionally used in scientific research to alter DNA sequences, giving it the potential to cure -- and not just treat -- any disease caused by DNA differences. Currently, rapid antigen tests that detect proteins called antigens on the surface of the virus are used in Singapore. Should a mutation affect the viral antigen, some tests may be ineffective.

Redesigning a rapid antigen test takes longer because it relies on antibodies and the redesigning of an antibody requires more time, Tan said.

The straits times/ann