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HoloVizio, the holographic 3D display of the future

At this year's radiology convention's technical exhibition in Szeged, visitors could marvel a real world sensation, a display of the third dimension, the display which works on the basis of holography.

On a 32 inch monitor, similar to the television monitor, vein conjunctions, ribs, a skull cut horizontally at the crown, and other anatomic formulas appeared one after the other. By standing opposite the monitor it became clear what the sensation was, the formulas appeared floating in the air, rising in front of the monitor's flat screen, giving a real spatial experience. Stepping aside and looking behind the image, more and more details appeared to the viewer.

We asked the inventor, Tibor Balogh, a Dennis Gabor-prize winner engineer and owner of the Holografika company about his invention.

The interview was prepared by Dr. Éva Németh.

What were the antecedents of you developing a real three dimensional display?

To display something as if it was really there was an old dream. Looking at the hologram everyone asks, is the object really there? We would almost love to touch it. It is the concurrence of reality and imagination. Today's displays are flat and everyone has got used to them. When we are looking at the TV screen, we know that we are seeing an artificial picture, no matter how much we improve the resolution, the colour and the quality of the picture, the image still appears artificial, meanwhile, if I look out the window we can see the real world. The difference between the two is the missing depth.

Did anyone else work on spatial display before, or it's only your idea?

I was already interested in holography at the University. Every book of the topic ended with a pessimistic view to the future. Due to the complex technology and huge amount of information needed, which to produce and process seemed unrealistic, to realize holographic TV and cinema was impossible, said the authors of the time. Dennis Gabor's hologram is not suitable to display movement, it's like a spatial photograph. The difference between a hologram and a 3D display is precisely like the difference between a photograph and a monitor. So a lot of people played with the idea, it was like a dream and what was impossible to achieve according to others always interested me.

How did you get to the basic idea?

The essence of the idea is that I use the "working" of the window as the model.

The birth of this simple but elegant idea was a heuristic experience, in this regard it is similar to the classic inventions.
But the realization needed determined teamwork. We had to alter several parts of the system until it got to it's present form, as it worked differently in practice than on paper.

It is an unusual way of wording it, how does the window really "work"?

When we look out the window from our room we can see a three dimensional image. Let's look at the window's one point in a way that we cover the whole glass with black cardboard, which has a tiny, spot-like hole on it. From this single point light beams of different colour and intensity leave the glass of the window to various directions. If I could create a light-emitting surface which emits light of different colour and intensity to various directions from its each and every point, then I truly displayed reality. If I could even control it than I solved the problem.

In principle, the screen of our device is a hologram. Each and every one of its point works like the window model. These points are the pixels, of the 3D display we call them volume pixels, in other words, voxels. Inside the device we produce light beams with complex light modulation technique, in a special geometric arrangements. With appropriate control it is achievable that the light beams can propagate in such direction as if they were leaving from a point behind the hologram screen or they were crossing in a point in front of the screen. From these beams the hologram screen composes a continuous image. The result is a real 3D view that can be walked around in any direction up to 50 degrees. We can even look behind the objects without glasses or any other aid.

Three-dimensional cinema is already well-known, although for the spatial experience we do have to wear glasses. What is the difference in principle?

So called stereoscopic solutions tried to imitate the 3D spectacle. Special glasses separate the information belonging to each eye. Therefore we only have twice as much information, the pictures which are seen by the right and left eyes. A real 3D picture contains a hundred times more information. This is the reason why, with the stereoscopic system some of the details, which we want to look at closer by moving our heads around, hide from us. In the case of the holographic display the image continuously changes, we see different things from various directions, just like in reality.

What steps helped to get the present state?

The basic patent was announced in 1992. I proved the principle on laboratory models. I managed to display a small, few-pixel picture, a light spot floating in front or behind the

hologram plate, depending on the control. It really needed a lot of imagination for anyone to see what was such a big invention. I got to this stage from my own resources, then I have managed to win the support of the OMFB, by receiving an interest-free loan.

After the first results I tried to get in touch with large manufacturing companies. It was a milestone when Sony indicated their interest in the invention. As a result, in 1996 we signed a joint development contract to produce a laser display. Sony was mainly interested in developing large projectors based on laser technology. The results of the joint research were also shared. Some of the patents became the properties of Sony and some are jointly owned by Sony and Holografika, therefore we continued to develop the colour 3D display.

Instead of the laser, we started to implement the use of the white light, consequently we had to redesign the whole system.
The new prototype was completed by the end of 2001 and was available to see by the general public at the Millenaris exhibition which was opened at that time. This device is entirely different, the parts are simpler, can be assembled in a lego-like manner, if you like, thus even mass production could be possible. Today, beside others, we cooperate with the Technical University Budapest, Atomic Physics Department, where they do a lot of optical research as well.

What areas of utilization of this method can you see in the future?

Obviously, the future belongs to the 3D display. Only in this direction it is worth to continue. If displays would have improved in such pace as information technology, we would already have wall-sized, spatial displays. Instead, we are still sitting in front of devices with cathode-ray tubes, an outdated technology. 3D data is available in many fields, but we reject large part of it as the display of this data happens in two dimensions. Architecture, auto and aeroplane design and simulation, molecule design, flight navigation and virtual reality games are such areas.
Medical application is the development's promising opportunity in the fields of radiological diagnostics and intervention. With today's modern medical imaging methods, like the 3D ultrasound, CT the MRI and some others, we can create so called 3D images. As a result of perspective, light and shadow effects these images give graphic displays of anatomic structures, but in reality these are only two dimensional, flat images. There are other similar experiments around the world, however they all have the same problem, none of them is able to realize the natural view. Following the logic of the stereoscopic systems, they created systems which instead of 2 pictures showed 8-10. As you move in front of the series of flat images, the view from some positions can give a spatial experience. However, it is not so comfortable to the user, and can be even tiring watching it for a longer period of time.

Compared to these systems, the real time holographic display can bring revolutionary changes, as it doesn't have limitations in time nor in space. More people can consult by looking at the same image. At the same time they can sense the spatial interrelations and

all that information quantity as natural reality, what previously could only be displayed on 60-80 flat images. It is also an advantage that you don't have to learn the assessment of the spectacle, because the method uses the natural viewing function we have already learnt as babies.

This year's radiology conference in Szeged was a world-first occasion, when the opportunities of the medical applications were introduced. Since when are you working on such research and who are your partners in the medical field?

One and a half years ago we contacted Dr. Zoltán Harkányi, the leader of the Heim Pál Children's Hospital's ultrasound and CT laboratory. We asked for his assistance in working out which clinical fields could utilize the holographic display.
We started working together by Dr. Harkányi and his colleagues providing us with 3D data, so we could try them in practice. For this work we got support through a grant, recieved from the Education Ministry's Information Research Support Fundation. We created a consortium with the participation of the Heim Pál Children's Hospital and the Technical University, with a long term goal of developing a three dimensional medical platform. Firstly, we created spatial displays based on data from real clinical examinations, then we studied how the new methodology can help the diagnostic work. Based on our work with Heim Pál Children's Hospital, the Hungarian branch of General Electric Medical Systems also joined the technical development. We showed the result of our joint work at the conference in Szeged. At the booth of GE – perhaps not too immodest to say – the system, which is called HoloVízió created a huge interest.
It is essential to mention Dr. István Szikora, colleague of the National Neurosurgery Academic Institute, from whom we also received significant professional help.

What could be the short and long term future in the field of medical application?

Several clinical applications are conceivable. Such as vein examination, done by different methodologies – the 3D angiography, the 3D CT and MR angiography – tumor diagnostics, brain surgery, fetal diagnostics and traumatology.
Also different radiology interventions and radiation planning which is all controlled by the imaging devices, in other words, every diagnostic and theraputic operation, where the best possible localization of the change is essential. It could all seem futuristic, however real time holography as a demonstration tool could play an important role for example in education or in planning of operations as well. On the virtual model you could remove organs, formulas and if you want to know what is underneath them you can look at them without even leaving a scratch on the patient.

Looking at technology, the "future's operating theatre", distance consultation, education and remote surgery are not only dreams.
The true to reality 3D displaying will serve as the foundation to all these great opportunities.