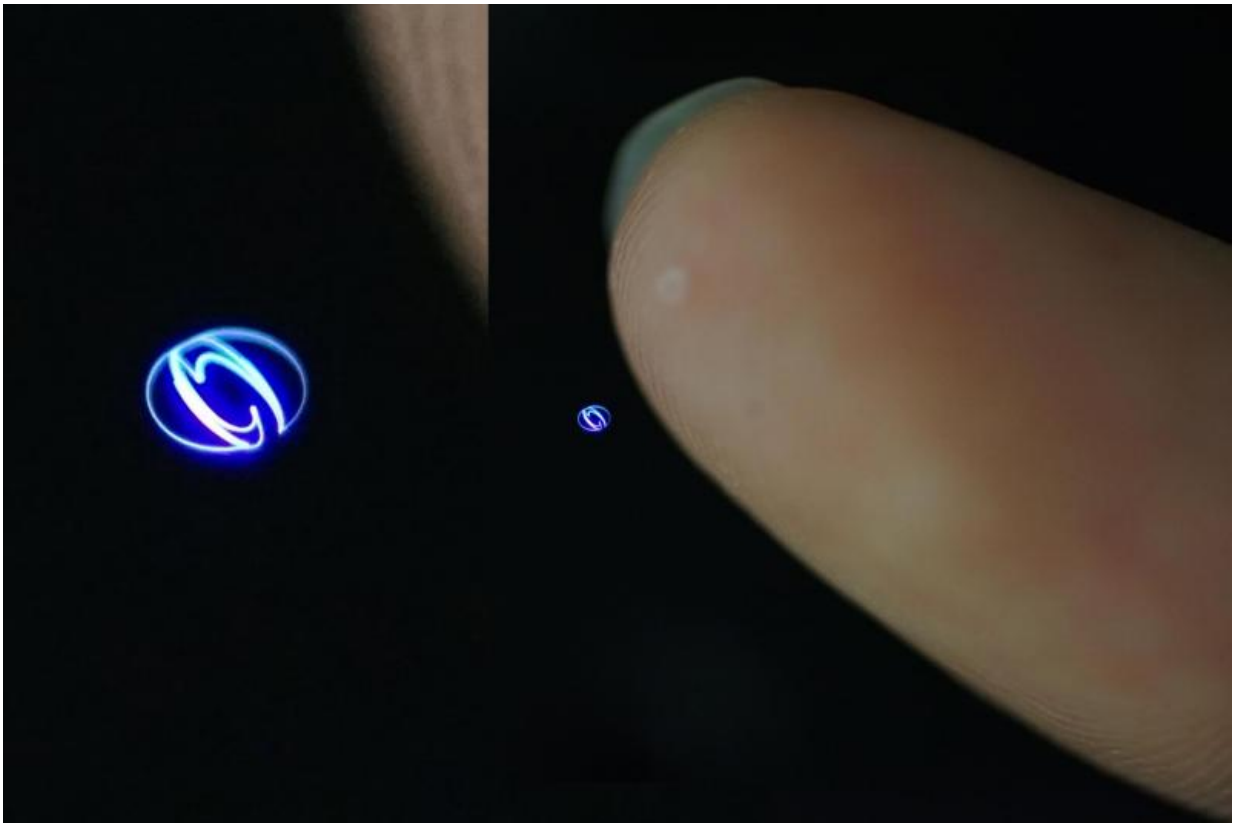
Images in the air: Researchers turn to femtosecond lasers

June 30 2015, by Nancy Owano



Say the word "display" and one easily anticipates an image on a screen or on a table surface or within a next-gen box enclosure. Last year, Aerial Burton went another route reminding everyone that something else is

possible. The group demonstrated an aerial 3D display that projects text and images into mid-air.

"The big difference is that this is a screenless display," said Akira Asano, director, Aerial Burton, in a DigInfo TV video at the time.

What was the application area of interest? They were thinking in times of emergencies. The system could be of help with urgently needed communications in the event of a disaster, letting people know where to evacuate or get food and emergency supplies.

The technology which they explored is plasma emission, said Asano. According to the DigInfo TV video, "The images are constructed by firing a 1kHz infrared pulse laser into a 3D scanner, which reflects and focuses the pulses of the laser to specific points in the air. The molecules at that point are ionized, and the energy is released as photons."

Asano said they wanted to make it transportable by car, "so users can convert any suitable vehicle into a 3D display transporter, and take the display to where it's needed." As well as prioritizing transportability, said DigInfo TV, "Aerial Burton plans to market the display overseas, to increase recognition of this technology."

This month, Evan Ackerman in *IEEE Spectrum* made note of Aerial Burton's work in the context of further news about display images in mid-air. This time, he said, Japanese researchers have worked to create, as their paper posted on the arXiv server describes, "Fairy Lights in Femtoseconds: Aerial and Volumetric Graphics Rendered by Focused Femtosecond Laser Combined with Computational Holographic Fields."

They came up with a method for rendering aerial and volumetric graphics using femtosecond lasers. Ackerman wrote about their latest development, first explaining what Aerial Burton had accomplished. The

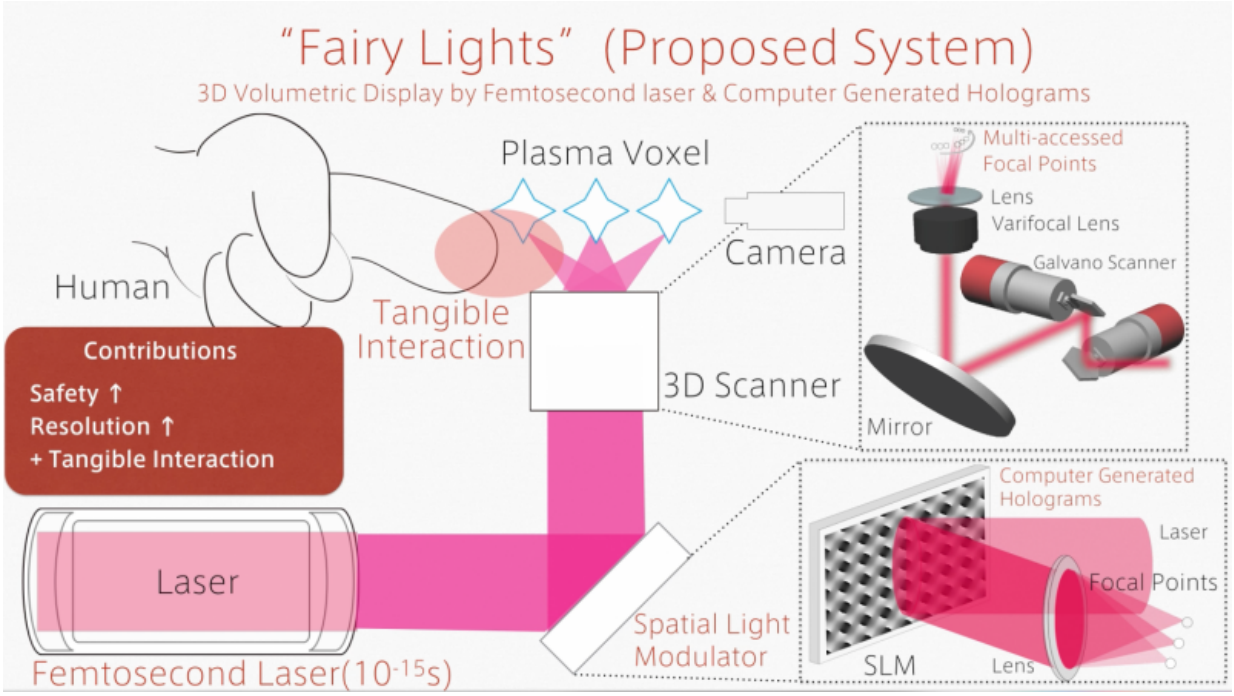
method involves "a laser that scans through a volume of air very quickly, firing tens or hundreds of thousands of times per second to create a sequence of short-lived (nanosecond-scale) voxels that create the effect of a moving image." Ackerman noted that a nanosecond-scale plasma burst contains "a significant amount of energy; you don't want to go walking through one of these displays, because it will burn you."

The researchers behind the recent "Fairy Lights" have a system that uses femtosecond lasers and the result is a plasma display that's safer to touch.

IEEE Spectrum said, "Each one of those dots (voxels) is being generated by a laser that's pulsing in just a few tens of femtoseconds. A femotosecond is one millionth of one billionth of one second."

The researchers are from the University of Tsukuba, Utsunomiya University, Nagoya Institute of Technology, and University of Tokyo. Yoichi Ochiai, one of the authors, who is an assistant professor at the University of Tsukuba, is principal investigator of the Digital Nature Group and is CEO of Pixie Dust Technologies.

The authors said, "we use femtosecond lasers with pulse durations of 30-100 fs, and 269 fs. This leads to safer plasma generation than nanosecond lasers, which can be incorporated into our daily lives. The design space and possible scenarios of the plasma-based 3D display are discussed. In addition, we use an optical device, called the spatial light modulator (SLM), to modify the phase of light rays and produce various spatial distributions of light based on interference."



The authors also said, "Our system has the unique characteristic that the plasma is touchable. It was found that the contact between plasma and a finger causes a brighter light. This effect can be used as a cue of the contact. "

John Biggs in *TechCrunch* said there is still considerable energy in the lights touching them to create "a physical sensation akin to haptic feedback. This means you can actually 'feel' light as it floats in front of you, creating some pretty unique user interface systems."

Dave Gershgorn in *Popular Science* also talked about their work: He said they "fired their femtosecond laser through a spatial light modulator, which continues the beam through a series of lenses, a mirror and a Galvano scanner, which positions a mirror to precisely direct the laser

beams. A camera underneath the hologram captures user interaction, allowing the dots to respond to being 'touched.'"

Gershgorn said, "The key to making these holograms safe is the shorter duration of the laser's bursts. In tests, if the lasers fired in more than two second bursts, they burnt the leather researchers used to simulate skin. But, if they transmitted at 50 milliseconds to 1 second bursts instead, the leather was unscathed."

What now? Ackerman commented, "To become useful as the consumer product of our dreams, the display is going to need to scale up. The researchers suggest that it's certainly possible to do this with different optical devices."

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