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Superpositioning High Power Lasers for Mid-Air Image Formations

Auston Viotto
aviotto@unomaha.edu

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Superpositioning High Power Lasers for Mid-Air Image Formations

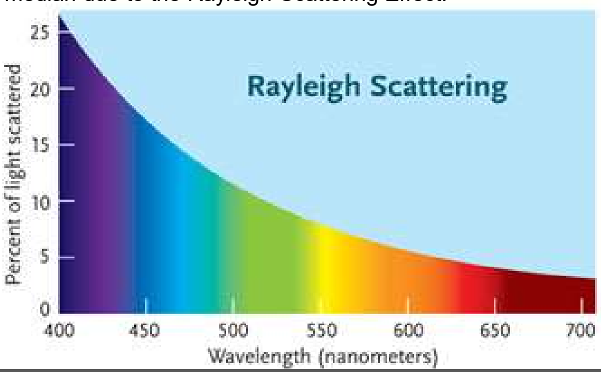
Auston Viotto | University of Nebraska Omaha

Problem

Create 3-dimensional images – holograms – in air without the need for special glasses or reflections off of surfaces.

Hypothesis

A voxel can be created in the air at a point of superimposed/ culminated light from an expanded energy density without a median due to the Rayleigh Scattering Effect.



Objectives

1. Superimpose two laser beams to create a single point of light caused by the Rayleigh effect.
2. Superimpose multiple points to create a 3-dimensional object in the shape of the points.

Variables / Research

Rayleigh Scattering

- Light scattering caused from the oscillating electric field vibrating N_2 and O_2.
- Intensity = $\frac{1}{\lambda^4}$

Energy Density

- Laser energy over a larger area will be less noticeable.
- Shirking the area to a point increases the visibility of the beam creating the voxel.

Latent Image

- Scanning the voxel through the air fast enough to create an image we can see.

Materials

Materials	Quantity
Axicon Lens, AR coating, 20̊ angle	2
Air-Spaced Doublet, AR coating, 50 mm	1
Bi-Concave Lens, AR coated, -75 mm	1
100mW 473nm DPSS TTL Laser	1
Linear Motorized Stage, 3 mm/s	1
Beam Capturer	1

Procedure

Figure 1. Preliminary procedure:

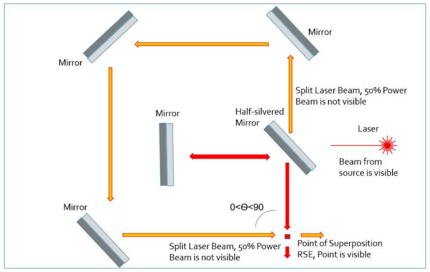
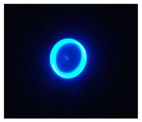


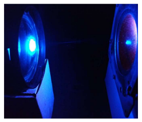
Figure 2. Primary procedure:

Step 1



Space axicon lenses apart to maximum radius for doublet aperture.

Step 2

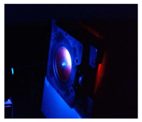


Air-Space Doublet focuses the parallel rays to one point in space, increasing the energy density.

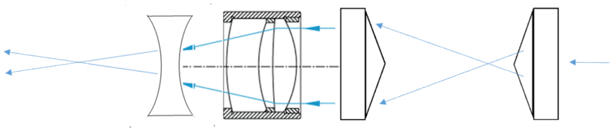
Step 3

Timing the laser pulsing, and optic-mechanical stages to move the voxel.

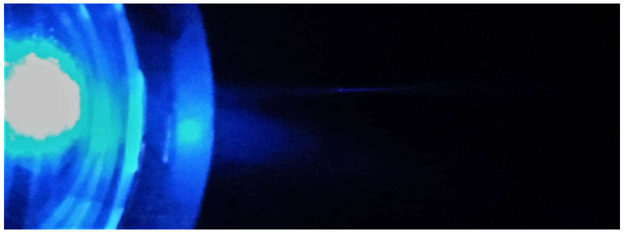
Step 4



Exiting light rays enter a large beam capturer.



Results



Directly superimposing two laser beams could not produce a viable, noticeable voxel. Angles larger than close to parallel mathematically only increased brightness of the voxel by 7% (See Figure 1).

The energy density of the laser beam is expanded over an area profile making the light less noticeable as it travels through the air. The energy density is compressed into a 21μm diameter allowing the non-visible light to condense and become more visible creating a cylindrical volumetric pixel. The pixel is not very sharp and could only be used for larger images where clarity is less of a concern (See Figure 2).

Conclusion

Further research will include creating a sharper, brighter voxel by increasing the diameter of the lenses and increasing the power output of the laser. Also, different beam steering mechanisms to create images larger and faster will be explored.

Aims to benefit medical teams before critical surgery, military and emergency services' use of topographical maps, and NASA researchers in zero gravity environments by allowing these teams to create 3-D representations of their plans that are more effective than 2-D maps and diagrams.

Acknowledgements

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