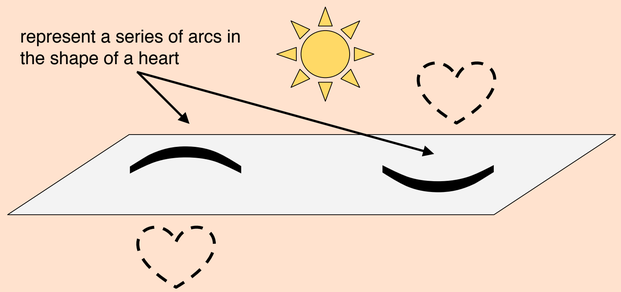
Optimizing 3D Scratch Holograms

Alice Zhao[1], Adam Norton[2]
Palo Alto High School[1], Google Inc. Optics[2]

Introduction

Scratch holograms scatter light in order to form raised images.[1] As noted by their name, scratch holograms are made by creating abrasions on the surface of a dark colored flat surface.[3] These abrasions are a series of arcs.[1] This project utilizes a laser engraver. If arcs are convex relative to the light source then the hologram appears floating below the plane. Similarly, if arcs are concave, the hologram appears to be floating above.[2]



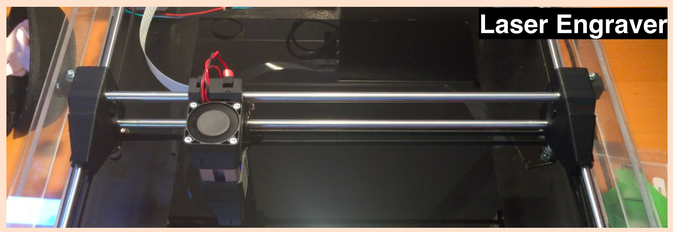
Goal & Significance

Main focus

In order expedite the process of making a white-light hologram, a laser engraver will be engraving vectorizing pre-selected images. The laser is more powerful and precise than a traditional sharp object used to make scratches. The goal is to create the **most ideal arc** by adjusting the parameters of the laser engraver.

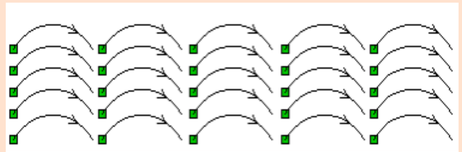
Why it matters

Traditionally, scratch holograms are made by scratching arcs on a shiny surface by hand.[4] The scratches are overlaid a few dozen times to get the 3D effect.[5] The current process is slow, tedious, and not automated.



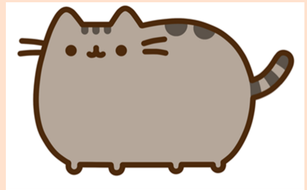
Stage 1: Optimizing the Arc

1. Create a matrix of arcs that reflects the matrix of varying laser powers and laser speeds on dark acrylic.
2. Measure the viewing angle of each arc with a pointed light source and a protractor and record it in degrees in the matrix.
3. Measure the width of the arc using a microscope and Stage Micrometer. Record results in millimeters in the matrix.



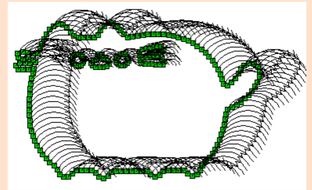
Stage 2: Making the Hologram

1. Using Adobe Illustrator, convert a chosen image into its vector components.
2. Import the vectors (.dxf or .dwg) onto the software of the laser engraver.
3. Choose the appropriate arc radius and make an arc length of 120°.
   a. In order to get different levels of the hologram, vary the radius of the arc. Shorter radii will yield holograms that appear above the plane.
4. Copy the arcs onto the vector, ensuring that the arcs are not too dense or sparse.
5. Delete the original vector.
6. Create the same toolpath, which specifies the power and speed of the laser cutter (3.2 Watts and 400 mm/sec was found to be ideal), for all of the arcs
7. Wear safety goggles as your arcs are engraved on dark acrylic
8. View holograms under a pointed light source; tilt the acrylic to see multiple views



Original image

Vectorized

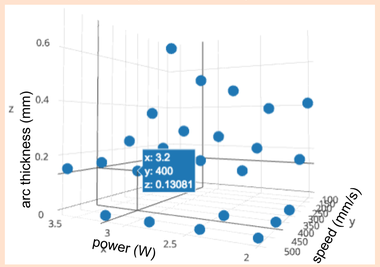


Toolpath overlaid

Data Analysis

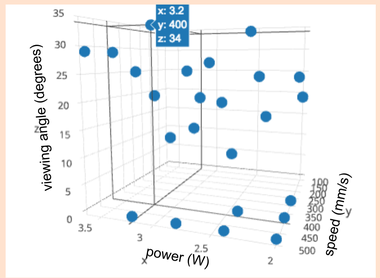
The Effect of Exposure to the Laser (Speed, Power) on Arc Thickness (millimeters)

		Power (Watts)				
		2	2.4	2.8	3.2	3.6
Speed (mm/min)	100	0.40894	0.38735	0.47879	0.53975	0.72517
	200	0.16764	0.20828	0.25527	0.27813	0.36576
	300	0	0.13208	0.16256	0.20828	0.23495
	400	0	0	0.08763	**0.13081**	0.15494
	500	0	0	0	0	0.14986



The Effect of Exposure to the Laser (Speed, Power) on Viewing Angle (degrees)

		Power (Watts)				
		2	2.4	2.8	3.2	3.6
Speed (mm/min)	100	19	14	4	18	7
	200	24	24	18	25	19
	300	0	33	27	32	25
	400	0	0	15	**34**	29
	500	0	0	0	0	29



Results

Speed of the laser engraver: 400 mm/s
Power of the laser engraver: 3.2 Watts (max 4 Watts)

These parameters minimize the arc thickness (0.13081 mm) and maximize the viewing angle (34°) without compromising each other to create the most ideal arc.

Acknowledgements

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Works Cited

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