Name(s)

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Project Number

J1031

Project Title

A 3D Autostereoscopic Quasi-Static Volumetric Display

Abstract

Objectives

My objective is to create a 3D Display that does not require glasses and can transition between images or states (albeit slowly). A 2D screen can be thought of as an array of square pixels. For a 3D screen to be constructed, each of the pixels should be a volumetric pixel (voxel). These voxels have to either be invisible (off state) or colored (on state) to create a 3D pattern or image.

Methods

Materials:Peristaltic Pump, Solenoid Valve (10), H-Bridge Circuit, Arduino board, Breadboard, Transistors (10), Acrylic Voxels (8), Tubing (Acrylic, Silicone, Airline), Wesson Vegetable Oil, Colored Water, Beakers

Methods/Procedure:
1.Choice of Materials for Voxel & Liquid: When two materials have the same index of refraction (like Veg. Oil and Pyrex: 1.47), one is invisible when placed in the other. This is the genesis of the 3D Display s off state. After many tests, it was found that acrylic and Wesson Vegetable Oil were the most practical choices.
2.Choice of Tubing/Pump/Valves: A pump with various tubings was used to transport the fluids. Valves were used to direct the fluid to the correct voxel.
3.Voxel Design: After many iterations, a large acrylic voxel with an independent air-release tube was used.
4.Motor & Valve Control: Since the Arduino could not provide enough power to the motor and valves, a transistor and diode circuit was constructed for the valves and an H-Bridge circuit for the motor.
5.Arduino Software Design: Arduino code and a GUI controlled all the components.

Results

I successfully constructed an eight-voxel set-up which has an off and on state. By transferring oil or colored water to each voxel, the state can change. The total time to change the state is 2m:30s (1m:30s for removing fluids and 1m to add) per voxel. All voxels work consistently. Note that after each state change, there was a small residue left over that could not be taken out simply because the tube does not extend to the edge of the voxel.

Conclusions

The display worked! Since this display contained only eight voxels, it could not display any meaningful images. However, this project serves as a proof of concept that can be expanded in the future to include a larger number of voxels, a faster voxel change time, more colors, and smaller voxels. If a larger display were constructed, real 3D images such as 3D MRI scans or airplane positions can be accurately displayed.

Summary Statement

I designed a glasses-free 3D display which can slowly transition between images.

Help Received

My dad helped me with drilling holes in the voxel and with soldering and debugging the electronics. My mom helped me with the Arduino GUI.