MCEN 4151
Flow Visualization
Team First Report

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1   Introduction

The purpose of this image was to capture the interesting fluid phenomena that is created when a liquid is excited using low frequencies. Vivid colors were chosen to really bring out this phenomena in the most artistic way possible. While this is a neat looking effect, having the right aesthetics is key in creating a powerful and visually pleasing image. Originally a slow motion video was planned but after snapping a few pictures, the static capture of this phenomena was so impressive the final media form was changed. Collaborated with Michael Lloyd, Joey Hall, and Schuyler Vandersluis to create apparatus and capture images.

2   Flow Apparatus

To excite a fluid enough to create the excitation of normal modes in the fluid, a powerful diaphragm capable of moving at different frequencies was needed. The team chose to use an old 8" woofer out of a speaker to accomplish the long excursion waves required to produce this phenomena. Using this woofer with a 100 watt amplifier was perfect to produce the tones needed. A mobile phone tone generator application was used to experiment with different frequencies in order to find one that created the coolest effect in the liquid. The physical phenomena seen in this image is known as cymatics which was derived from the modal vibration phenomena. In this phenomena, a standing wave is excited to the point where all components of the system are affected sinusoidally. In this image, the nodes of this standing wave are clearly represented by the peaks in the fluid waves.

3   Visualization Technique

Creating a fluid with the right viscosity posed a few issues at first. Milk was mixed with food coloring but this fluid combination wasn't viscous enough and creating the large standing waves was not possible. A mixture of milk, white latex paint, and food coloring created the perfect fluid to be excited with our woofer. Initially, the speaker was turned on at low frequency around 40 Hz and then the food coloring was mixed in drop by drop in hope of capturing the mixing process due to the waves of the fluid. Multiple experiments

containing different mixtures of milk, paint, and colors were completed and photographed to capture as many images as possible.

4   Photographic Technique

A Canon Rebel XS was used with an 18-55mm lens to capture this fluid phenomena. Since the woofer was approximately 8" in diameter, close shots were necessary in order to avoid capturing unwanted backgrounds in the image. To achieve this, a focal length of 55mm was chosen with this lens and the camera was positioned very close (a few inches) to the dynamic fluid, . This experiment took place outside to harness the powerful light of the sun and to create interesting shadows from the nodes of the standing fluid waves. Since the fluid was rapidly oscillating, an exposure time of 1/400 sec was chosen with an F-stop of f/14 and ISO of 200. The camera was set to shoot continuously to capture different points in time of this dynamic wave. The only post processing was a slight change in the brightness and contrast completed in Photoshop and shown in Figure 1. The original untouched image is shown in Figure 2.
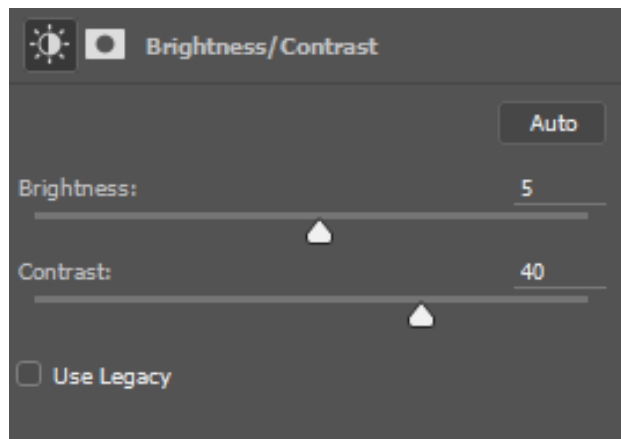

Figure 1: Contrast and brightness modifications made in Photoshop

Figure 2: Original untouched image

5 Conclusion

Capturing the interesting and beautiful phenomena of cymatics was achieved by creating this image. Using the right mixture of milk and paint created a fluid that could be excited using a woofer capable of producing low frequencies. Once excited, the fluid exhibited normal modes of the standing wave used to excite it. These are clearly illustrated in this image and appear as "droplets" on some nodes. The blue food coloring gives this image an interesting aesthetic appeal while the sun created excellent lighting that casted interesting shadows around the nodes. A larger woofer containing larger voice coils could enhance this phenomena by providing more linear excursion resulting in larger wavelengths in the fluid nodes.