

Team First Report

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Flow Visualization MCEN 4151

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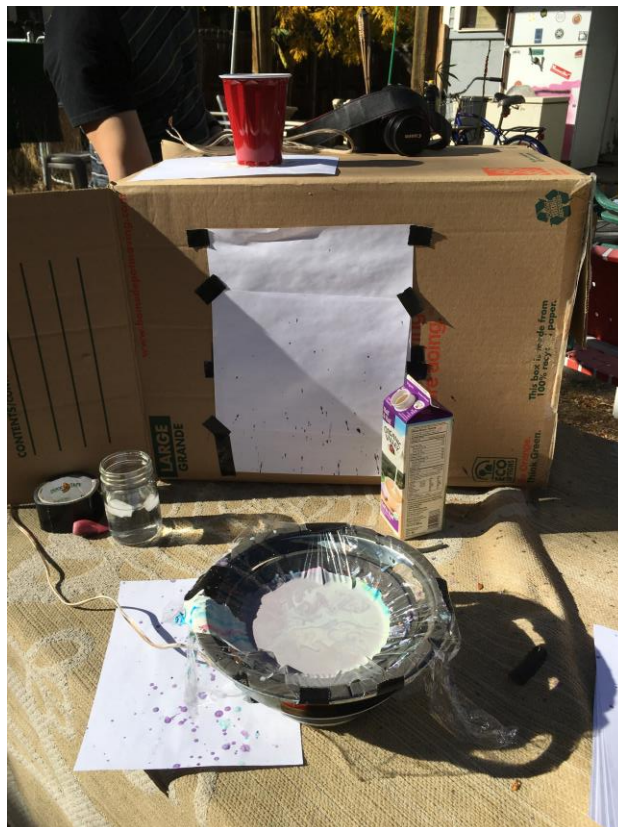


I. Introduction

This photograph embodies a delightful fluid flow produced by exciting a liquid with low frequency soundwaves. The intent of the image was to display an extremely interesting flow pattern caused by the interaction of sound waves with a liquid. Vivid color dyes were added to the liquid to beautify the image and highlight the interesting aspects of the phenomena. We initially hoped to capture this flow with a slow-motion video but ended up discovering that our still photos were able to display the phenomena just as impressively. I would like to thank my teammates, Michael Lloyd, Ryan Daniel, and Schuyler Vandersluis for their hard work and generous help in creating this image.

II. Flow Apparatus

In regard to the flow apparatus, we used an outdoor lighting scene with natural sun-light coming from the left of the camera/photographer at around 2:30 PM. We used a couple pieces of white paper taped together on a box for the background (although my photograph didn't need a background) and held the camera directly above the fluid about .2m away. The fluid rested upon an old 8" woofer which we connected to a 100-watt amplifier. We then proceeded to play various frequencies through the woofer using a mobile phone tone generator app in order to find a frequency which produced the most interesting flow pattern. This specific flow pattern describes cymatics which is a vibrational wave phenomena. At certain levels of excitement, standing waves are produced as all components of the system are affected sinusoidally. The picture below shows the whole setup for the photograph.



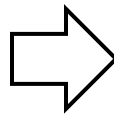


III. Visualization Technique

In order to create the flow phenomenon in the picture, we first needed a fluid that had a good viscosity. We ended up using a mixture of white latex paint and milk with added dye for coloring; this allowed for a fluid (paint is non-newtonian essentially) that was perfectly viscous to create the waves we wanted. These Faraday waves are a standard wave pattern that is changes based off the frequency of sound that we played through the woofer. The visualization of sound and vibration in the image is beautiful as the waves crash and cavities collapse and create jets in the void. The Worthington jets then break into droplets due to Plateau-Rayleigh instability. This image was created using a sound of around 40Hz and we slowly added food dye hoping that it would mix according to the vibration patterns.

IV. Photographic Technique

We used a Canon EOS DIGITAL REBEL XS with a 18-55mm lens to photograph this flow pattern. We shot the image about .2m away from the fluid and used a focal length of 33mm in order to truly focus on the fluid and remove any unneeded background. The fluid was moving quite quickly so we used an exposure time of 1/250 sec and an F-stop of f/14 with an ISO of 200. We needed to take quick shots so the camera was set to shoot continuously in order to get a picture with the desired wave formation. Both the edited and original photos are 3888x2592 pixels. The photo was edited using Adobe Photoshop Express through which I was able to mess around with the contrast and clarity to make the image more colorful and crisp. Below is a side by side of the original and edited versions.



Original

Edited

V. Conclusion

This beautiful phenomenon was a literal splash to experiment with and try to capture. Using an old woofer and the perfect mixture of milk and paint colored by dye, we were able to create an amazing flow pattern characterized by cymatics. Standing waves and Worthington jets with droplets at some of the peaks are clearly displayed in this photo. The yellow, blue, green, and red dyes give the photo much more vibrancy and the sunlight produces great shadows which highlight the vertical aspect of the waves. In hindsight, one would be able to produce much larger waves/wavelengths though the use of a larger woofer with bigger voice coils.