

DubFlow

I. INTRODUCTION AND BACKGROUND

The goal of this project was to capture the observable effect that music can have on a liquid. More specifically, how the vibrations from a subwoofer of a speaker could potentially move and displace a fluid. Inspiration for this project was derived from an idea that was hatched whilst listening to music and doing homework. Special thanks to Zach Ritenour for letting me use his camera and to Jake Thames for keeping the fluid container stationary on the subwoofer.

II. PROCEDURES

The apparatus consisted of a Logitech Z333 speaker, a Sony a6400 camera, tripod, Whole Milk, and McCormick Red Food Coloring. For the speaker, the subwoofer was turned onto its side with the vent facing upwards, as shown in **Figure 1**. I then tested to determine the best container material to hold the liquid. I also went through my dubstep playlist to find the hardest (most bass heavy) drops to see which ones would have the most vibration coming through the subwoofer.



Figure 1. Logitech Z333 Speaker Subwoofer (left) and turned on it's side (right)

After some trial and error, the water inside a tupperware container had the most movement. I tried to use a glass bowl but the music had zero effect on the water. This was likely due to the fact that the overall weight of the glass bowl was much higher than the tupperware and as a result the vibrations were not strong enough to have any kind of impact on the fluid. In addition, the tupperware was so light that the music would cause it to move. This was something I would have to account for when taking the photos later, which led to the recruitment of my roommate to hold it in place. I also settled on the second drop in one of my favorite songs, Odyssey by Barely Alive, since it essentially had a rapid machine gun like bass that would ensure the most displacement of the fluid once placed on the subwoofer. The next part of the process was making this picture worthy, which led me to switch to using milk so I would have a white backdrop. I also decided to drop red colored food dye into the milk to see how it dispersed as a result of the vibrations in the fluid. The setup required a top down look at the tupperware so I borrowed my friend's camera and tripod and angled it to face down at the ground, which is demonstrated in **Figure 2**.



Figure 2. Sony a6400 angled downwards using tripod

I then took cardboard and cut out a circle the size of the tupperware and placed white printer paper over the cardboard. The white border along with the white milk would create a good backdrop that blocked out the black subwoofer and tan carpet below, as shown in **Figure 3**. The resulting apparatus allowed for an effective capture of the effects that were observed during the capture of the image. For each trial, my roommate held the tupperware, I started the music just before the musical drop, I then dropped the red dye in, the musical drop started, and I would take as many pictures as possible while the dye dispersed into the milk. The final image was taken during the third trial. The pictures from trial one revealed that the speaker was on a downslope, causing the dye to move to one side of the milk. For trial

two, I leveled the subwoofer with a piece of cardboard, but did not get any good captures with the camera. Finally, on trial three I turned up the volume and focused on taking pictures as soon as the dye was dropped. The resulting images were super fascinating and visually pleasing.



Figure 3. Cardboard with printer paper placed on top of tupperware filled with milk

III. RESULTS AND ANALYSIS

From a fluid mechanics perspective, sound waves travel faster through liquids than they do with air. The final volume of the music was at $\sim 85\text{dB}$. Placing the tupperware directly on the subwoofer ensured that the liquid was feeling the full force of the 85dB , since sound dissipates as radius from the source increases. The speed of the vibrations coupled with the fact that fluids are negligibly compressible leads to the intriguing shapes that were captured on camera. Additionally, the shapes are also dictated by the bass characteristic. Electronic music producers have the ability to manipulate sound waves of their own design. The differing Sine, Saw, Square, etc. waves lead to unique vibration characteristics. The **Appendix** has multiple examples of the different shapes that the milk had across the drop in the Barely Alive song.

The McCormick Red Food Coloring was used to show both the displacement of the dye from the vibrations and also contrast the white milk to make the images more visually appealing. The dye helped to make the shape of the milk pop more as it dispersed, especially in the final image. For the lighting, these pictures were done indoors inside my bedroom. I had to account for shadows that were cast by the tripod by moving the apparatus to be directly below one of the ceiling lights. This helped reduce the shadows but some were still present in the photo from the tripod legs. If I were to re-do this entire process, I would

likely try and provide more lighting around the apparatus to ensure there are no lighting issues. The original unedited photo and the final image can be seen in **Figure 4**.

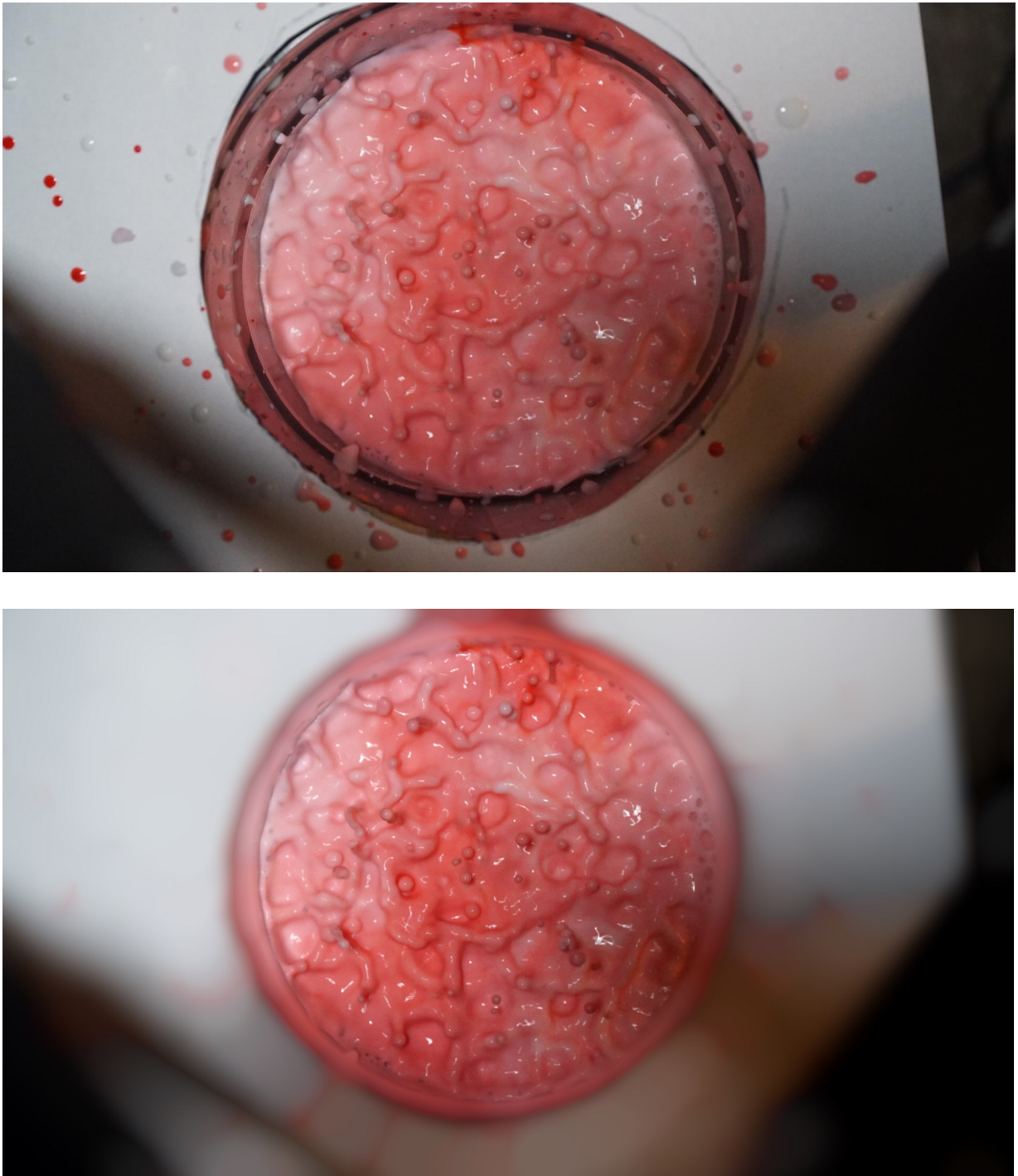


Figure 4. Unedited final image (top) vs. final submission (bottom)

Due to my limited experience with digital cameras I did not change any of the settings on the camera when taking the photos. The only aspect that was changed was the zoom, which required some playing around with in order to get the camera in focus. The distance from the tupperware was ~26

inches. Dimensions for the photo were 1920x1080 with a focal length of 65mm. Most post processing was done using Pixlr, where touch ups were done to blend the edges of the paper and the tupperware while removing stray pen marks from the stencil. While there was a very cool splatter pattern on the paper, I decided to use a bokeh effect to hone in on the circle of milk since the shadows from the tripod detracted from the photo. This image almost looks like a brain or even a group of stick figures linking arms. From my perspective, the image reveals the intricate shapes that milk can take when vibrating in particular ways.

IV. CONCLUSION

I am very happy with the final image and believe it demonstrates fluid physics through sound--which is something people normally do not consider when it comes to forces acting on a fluid. I feel I accomplished my goals and was able to bring my idea to life. If I were to do this over again I would take a video instead, strictly because I think the process from start to finish would be super cool to watch. Capturing a specific instance like I did was fulfilling but I think a video would have been even more intriguing. I also would work on improving the lighting around the apparatus. If I were to further this idea I would try out different fluids and see how I could manipulate their interactions in interesting ways. Overall, Image/Vid 1 was a rewarding project and was visual proof that my favorite music genre can create fluid related art as well.

APPENDIX

Other visually interesting images:

