Team First 2016

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Flow Visualization

Professor Jean Hertzberg

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Introduction:

For the first team image team six decided to see the interesting flows that can be created by placing water on a subwoofer. For my personal take on the image I attempted to get the feeling of an alien planet in the image. For this project I worked with and would like to acknowledge my teammates Michael Waterhouse and Hunter Miller for help with the images and apparatus set up.

The Apparatus:

For our project we used Klipsech 200w speaker/subwoofer to generate fluid flow on the port of the subwoofer. The type of fluid we used was water with red food coloring dye mixed in. We tipped the subwoofer on its back so that the port was in the vertical direction. We first covered the speaker with white printer paper to have a nice white background since the speakers were black. Then we laid down a layer of saran wrap so the fluid would not absorb into the white printer paper. We also had a white printer paper as a background to grab images from multiple angles. We tried to use a small spotlight that was placed about a foot above the subwoofer but in some images the saran wrap emitted rainbow colored reflections that were distracting. So in order to prevent that we had to play around with different sources and angles of lighting. Here trial and error was the easiest way to figure out what lighting worked best.

(Apparatus description and Figure 1 courtesy of Michael Waterhouse)

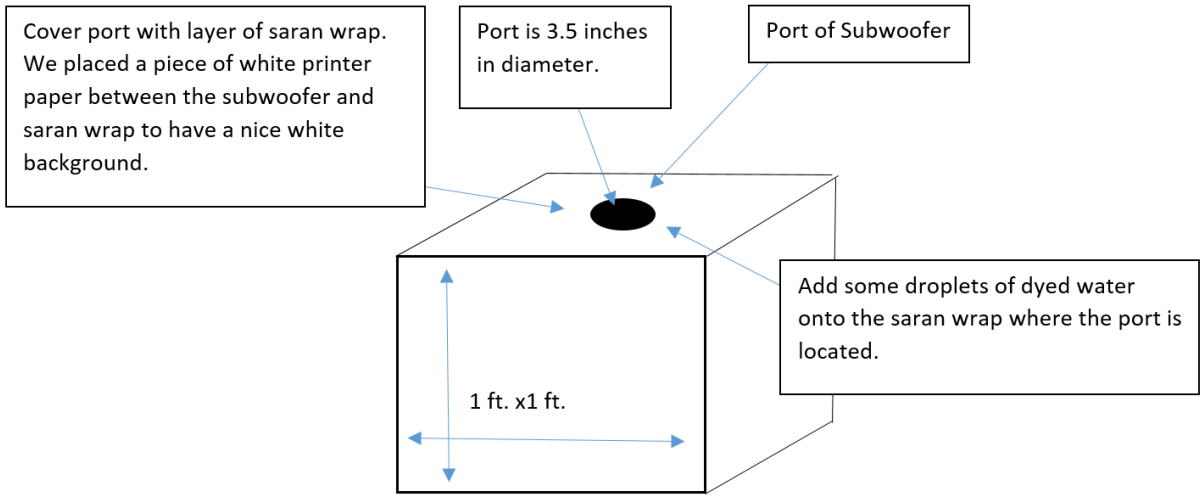

Figure 1: Speaker setup

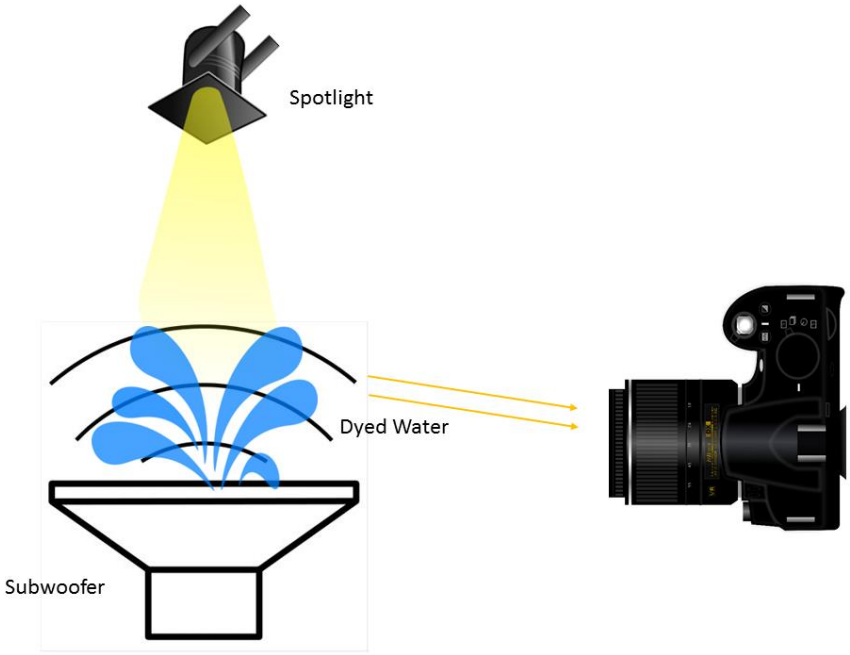

Figure 2: Lighting and camera arrangement

Visualization Technique:

To visualize the flow on the speaker colored water was placed on the saran wrap and the speaker was turned on. The colored water was able to show the wave flow, especially the constructive interference that resulted in jets. To calculate the constructive interference we estimated the speed of the water at ~1.5 m/s horizontally on the speaker surface, at the 70 Hz the subwoofer was operating at this results in a wavelength of 2.14 cm. Using the nodal points (constructive interference) equation of PD = m * wavelength, where m is any half number (0.5, 1.5, etc), we can see that the distance between constructive interference droplets is 2.14 cm * 0.5 or 1.07 cm apart. This matches our observed droplet distance of ~1 cm. At the speed of ~1.5 m/s horizontally the flow moved 0.003 m during the capture of the image.

Photographic Technique:

The photo was obtained using a Canon EOS Rebel T5 with an 18mm-55mm lens. Light was obtained via a spotlight placed about one foot about the subwoofer. However the light levels were still a bit low so ISO was set to 2500 which resulted in some graininess, which ended up allowing the desired alien planet effect to be achieved. The rest of the camera settings can be seen in the below table.

Camera	Canon EOS Rebel T5
Lens	18mm - 55m
Original Image Size	5184 x 3456
Final Image Size	4972 x 2761
Field of View	~6" by ~4"
Focal Length	39mm
Aperture	f/5
Shutter Speed	1/500
ISO	2500
Exposure Bias	0 step

The image was edited pretty heavily in order to give the feeling of ooze on an alien planet using GIMP. This resulted in the loss of some focus and increasing the effects of some ISO noise already present in the image, however I think the lesser focus and increased graininess of the image helps to add to the effect of making the image appear as though it is on an alien planet with some sort of live ooze erupting from the surface.

Figure 3: Unedited Image

Image Intentions:

I think this image manages to give the feel of an alien planet, especially with the saran wrap adding some terrain like texture. However, moving forward I would like to try some other things like using ooblek to get a better feeling of ooze, brighter lighter for faster shutter speeds and better focus with lower ISO. Also, some different base surfaces to see their effect of the flow phenomenon and if it would add more terrain like texture to the image.