Cavitation Video

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Team Second

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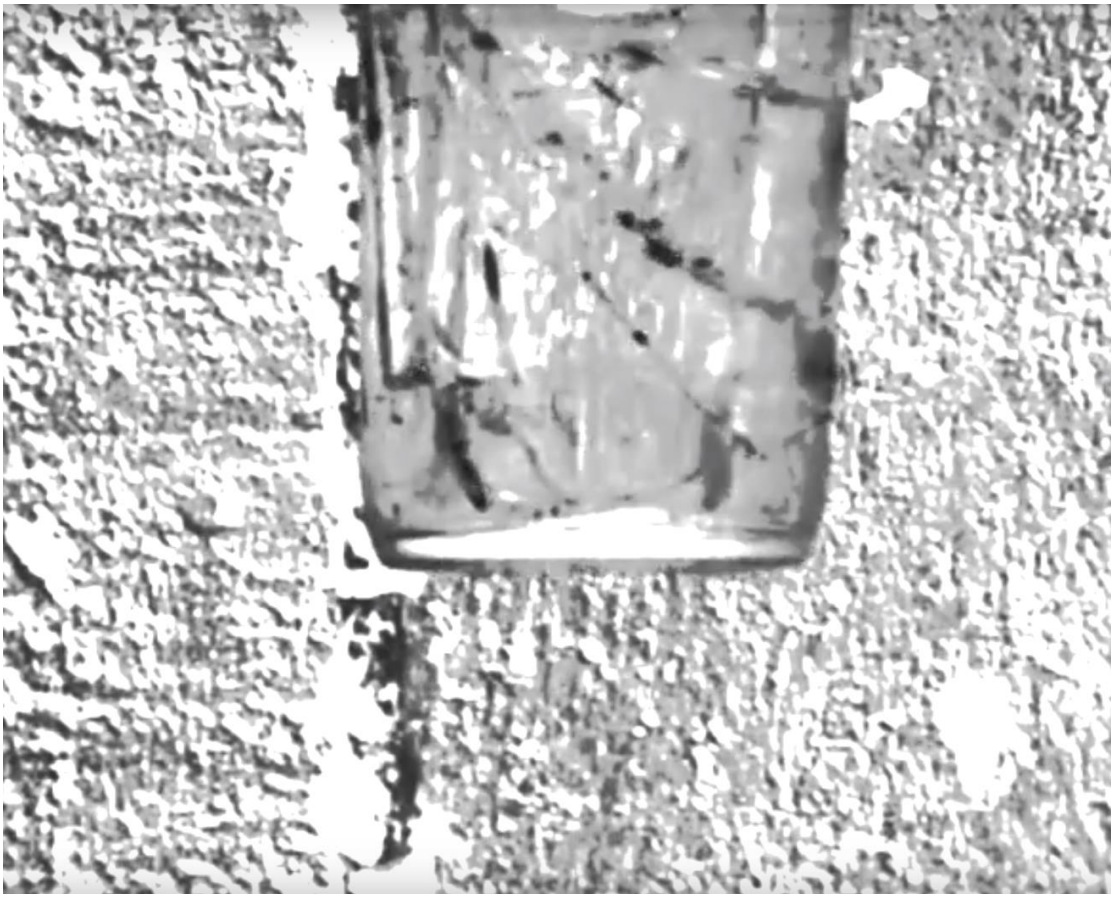

Figure 1: Screenshot of bottle cracking from cavitation

Team #07: Ross Cooper, Dylan Crane, Matthew Finney & Anna Lynton

Background

For the Team Second project, our team wanted to capture cavitation. Our goal for this project was to take a slow-motion video of cavitation occurring within a bottle. Working with Ross Cooper, Dylan Crane, and Anna Lynton was a great opportunity to collaborate because everyone was excited for the project and our project was a success.

Capture Setup

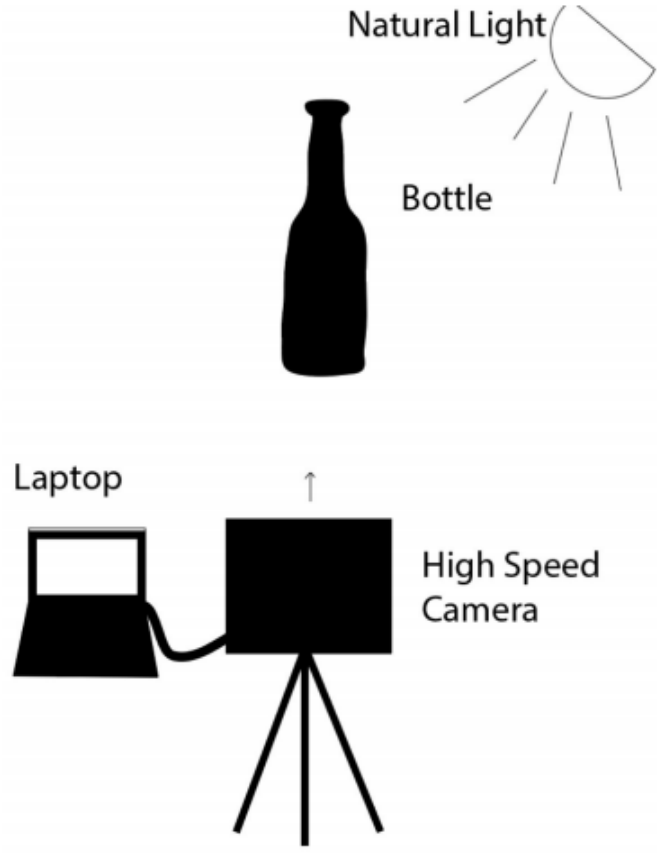

Figure 2: Capture setup

Figure 2 shows the setup used to capture the video. We used a high speed camera at a distance of 7 feet away to capture the slow motion video. The camera was plugged into an outlet and connected to the computer to record the clip. We conducted the experiment outside to use direct sunlight as our light source. We held the bottle in one hand and tapped the top of the bottle with a rubber mallet in order to spread the force as evenly as possible to get a clean break. Additionally, we decided that a textured background would add textural contrast to the water falling smoothly.

Flow Physics

The flow phenomenon we were aiming to capture was cavitation. Cavitation occurs when forces act on a liquid, forming bubbles in low pressure areas. In our experiment, we struck a soda bottle, causing immediate downward acceleration. This resulted in the glass bottle moving down faster than the water, forming a low pressure region at the bottom of the bottle.[1] The bubbles soon implode creating a shockwave that breaks the bottle. This process occurs in a couple of seconds so a high speed camera gave us the ability to clearly capture this phenomenon.

Visualization Technique

We did not add color or anything in the water as a visualization aid. Utilizing the sunlight outside gave us the ability to clearly see the phenomenon.

Photographic Technique

We captured the video with a Phantom C210, made by Vision Research. The recorded footage was shot at 2,540 frames per second at a resolution of 512 pixels by 512 pixels. We used a 50 mm lens and maximized the amount of light captured by making the aperture as large as possible. Since the frame rate was high, the resolution was low, which is a property of the camera. We had to decide between the tradeoffs of high speed and high resolution. We decided that a frame rate of 2,540 fps optimized the flow detail without losing too much resolution. I edited this video in Final Cut Pro. I chose to put a greyscale over the video and inverting it so that the flow would have the maximum contrast, bringing out the detail. Additionally, I further slowed down the video to highlight the bubble formation. Lastly, I overlaid a royalty free track to make the video more dramatic.

Results

I am happy with the video we produced because it clearly illustrates the phenomenon of cavitation. My favorite part is the visualization of the bubble formation. Next time I would like to capture cavitation with a different background to removing some of the distracting elements. Additionally, a better high-speed camera could increase the resolution of the video without sacrificing the frame rate, generating a higher quality video.

References

[1] Institute of Physics. (n.d.). What is Cavitation? Retrieved November 13, 2018, from http://www.physics.org/article-questions.asp?id=134