Team Second

Ross Cooper

Mathew Finney
Anna Lynton
Dylan Crane

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1 Introduction

For the second team photo we decided to use a high speed camera to view cavitation as a soda bottle was impacted by a mallet. We did a few attempts to create a variety of different shots that displayed the affect in detail. The video this report was done on displays very little information about the time leading up to the cavitation action, but shows details about the flow afterwards once the glass has broken. It also includes snapshots in which multiple free floating water droplets collide.

2 Experimental Setup

This experimental set up was relatively simple. To use the high speed camera we had to make sure there was plenty of light so we decided to opt for an outdoor setting in direct sunlight. We set up against a concrete wall to provide a textured background that would contrast the smooth falling water. We held the bottle in a single hand and tapped the top with a large rubber mallet to provide the effect. On the other side of things we had the high speed camera set up on a tripod about 7 ft away from the soda bottle we ere filming. The camera was plugged directly into a wall outlet as well as a laptop computer to record the footage.

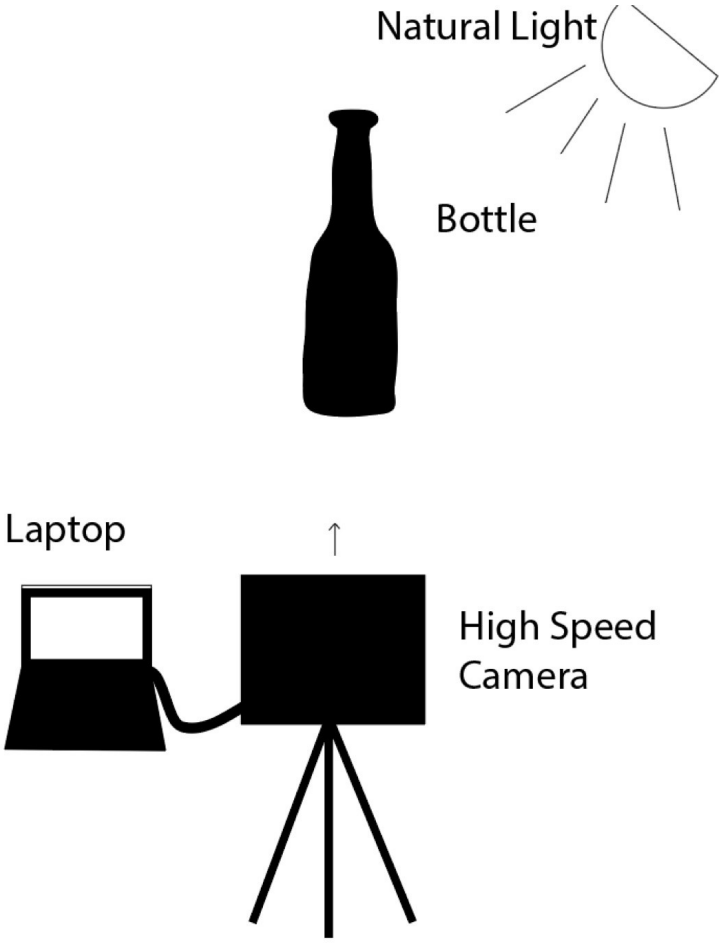

Figure 1: Experimental set up diagram

3 Fluid Physics

The most interesting fluid physics behind this experiment is based on cavitation. Cavitation is the formation of vapor cavities within a liquid. This can happen for many different reasons, but one of the main causes is from forces acting upon the liquid. When a liquid is no longer under high pressure, it can vaporize much quicker.

In the case of the soda bottle, the sudden acceleration downward of the bottle forces creates a lack of the initial gravitational pressure on the bottom of the bottle.[1] In this area of low pressure, usually lower than atmospheric pressure, you see cavitation. This bubble that forms is water vapor.

Once this bubble forms, it will soon implode on itself. This is because the glass bottle stops accelerating and the force of gravity is once again on the water. This implosion creates a shock wave which in this case is strong enough to shatter the glass bottle. Cavitation is a marvelous effect that creates the beautiful images we see.

4 Visualization Techniques

The visualization techniques used in this set up were pretty straightforward. We did not alter the water in any way and did very little to change how the flow looked. In this video the outside sunlight reflecting on the water flow was enough to see exactly what was happening during the experiment.

5 Photography Techniques

This video was taken with a phantom C210, which is a lower range high speed camera created by Vision Research. We used a 50mm lens on this camera, and kept the aperture as large as possible to allow as much light in as we could. The footage was shot at 2,540 fps to capture a resolution of 512x512 pixels. When using this camera, the higher the frame rate the smaller the possible resolution. This lead to a compromise between a high resolution video and one that would give better time resolution. We chose this frame rate to get the needed detail without sacrificing the beautiful quality.

6 Comments

This was a very fun video to take. The way a small droplet of water moves through the air is pretty mesmerizing, and it makes for a wonderful video.

References

[1] Brennen, Christopher. "Cavitation and Bubble Dynamics" (PDF). Oxford University Press. p. 21. Retrieved 27 February 2015.