Team 2

Flow Visualization

MCEN 4151

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Introduction

Using the same teams from our first group assignment, we were instructed to further explore the complexity of fluid flow. The purpose of this second group assignment was to challenge the students to develop a more difficult fluid phenomena now that the ice had been broken from the first group image. For our image, my team and I decided to explore how the shearing forces of a tennis racket impact a bowl of Jell-O. This concept was extremely difficult to implement and timing was of the utmost importance. After many test trials and diminishing Jell-O reserves my team and I reached the unfortunate conclusion that this idea was far too difficult to implement with the equipment at hand. Plan B, was dropping an M&M from down on to the Jell-O and capturing the impact crater propagate throughout the Jell-O.

Methodology

This image was captured at night in a kitchen under normal fluorescent lighting. Cherry flavored Jell-O was molded into 4-5 inch disk shape using a standard Tupperware container. The Jell-O was then placed on a paper towel on a nearby kitchen counter. Using one candy from the package of Halloween themed M&M's, one team member dropped the candy, while the other captured the image (see figure 1). This method allowed for multiple repeated trials without depleting any additional resources. After a handful of test shots, my team and I finally honed in on the timing and camera settings.

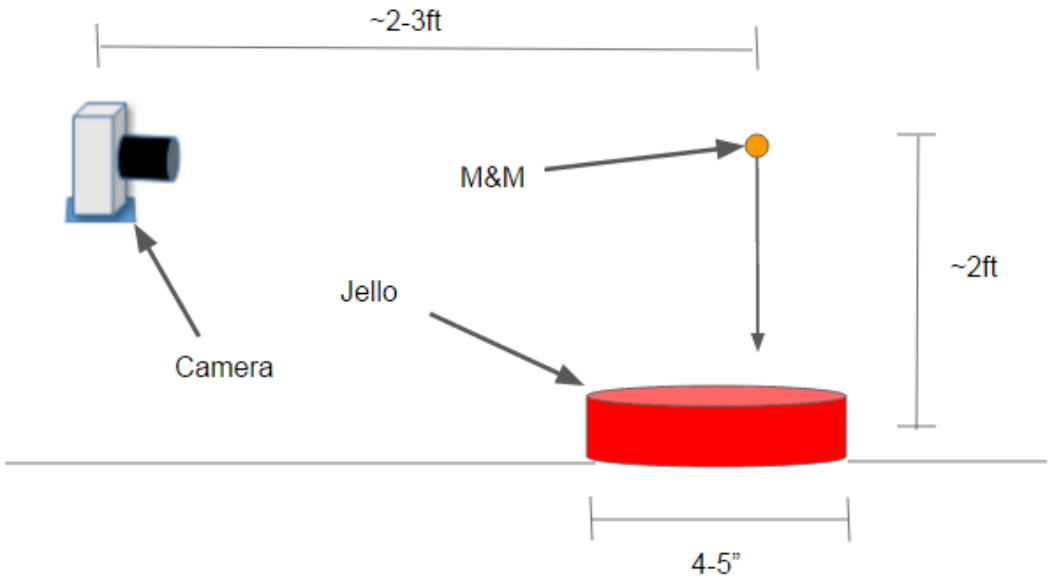

Figure 1: Schematic of setup (not to scale)

Analysis

My final image is simply just a cropped image of the original (figure 2). The wave propagated throughout the Jell-O quite fast, less than a second, so I chose this particular image because of it seems to be right after impact.

After doing some research, it was determined that this “wave” is a shockwave that propagates throughout the medium (Jell-O) due to the displacement created by the M&M [1]. One of the telltale features of the impact crater in this image raised rim surrounding the right side of the M&M. You may notice that the M&M was not dropped directly in the center, it was dropped slightly to the left. This was unintentional. This is why the rim is only appears visible on the right side of the image. The remainder of the rim has already passed through the top side of the Jell-O disk on the left hand side and is likely passing through the surrounding edge. The speed of the propagating wave depends on the density of the medium it’s passing through [2]. In the less dense the medium, the wave speed is the greatest [2]. Since the Jell-O is mostly water the speed of the shockwave will likely be similar to its speed in water.

Technique

For this shot we use my teammates Canon EOS Digital Rebel XSi. We used the autofocus feature to focus on the Jell-O then we adjusted the shutter speed to avoid motion blur. Luckily the multiple overhead fluorescent lights provided plenty of light to properly light the Jell-O. We chose to shoot with an ISO-1600, F-stop 5.6, 1/200 sec shutter speed, and a 55mm focal length.

Figure 2: Original (left) and Final (right)

I did not do very much post processing. I did crop the original image down from 4272 x 2848 to 2009 x 1445 pixels. I did try inverting the colors but I felt that it made it difficult to see the propagating wave, so I decided to leave it as is.

Conclusion

In the end, I was actually pretty disappointed on how this image turned out. I had high hopes for our first idea and got very discouraged when it did not work out. My resulting image is somewhat interesting and illustrates neat phenomena but I was anticipating better results. If I were to try this experiment again I would use a larger piece of Jell-O and make an effort to drop the M&M close to the center in order to get a nice impact crater. I do also believe that is experiment would look interesting using a slow motion camera.

References

[1] “Shockwaves” The Physics Hypertextbook Web. 11/21/15 http://physics.info/shock/

[2] “Characteristics of a Transmitted Pulse” A Less Dense to a More Dense Medium Web. 11/22/15 http://www.physicsclassroom.com/mmedia/waves/ltm.cfm