MCEN 4151: Flow Visualization

Section 001

Image-Video 03

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The Image-Video 03 assignment gave us an opportunity to create an improved image or video after getting feedback and suggestions from our previous two Image-Video assignment. The intention behind the assignment was for us to create another fluids phenomenon and capture it using camera, adjusting any necessary setting in order to procure a high-quality image. From viewing previous images/videos on the internet and in the class, I found that injecting food coloring into a vase of water created really cool flow patterns as the food coloring traveled within the water. Due to this, I decided to create a video where I used a syringe and injected three different colored dye into a vase of water.

The basic fluid phenomenon that was captured in this picture was the transition of turbulent flow from the initial injection to laminar flow as the dye settles and mixes with the water. The reason for the initial turbulent flow is a result of the high force produced on the syringe. This force causes the dye to enter the water at a high velocity which cause a very distinct turbulent stream as it entered the water. Along with the initial injection, the video shows the dye creating these vortex rings due to the dye doing work on the surrounding water. These vortexes get bigger and more distinct as time passes due to the dye doing more work over that time span. In order to calculate the Reynolds number some assumptions needed to be made. The first assumption was that the syringe was pushed at about $0.1\,\frac{m}{s}$. In order to accurately represent the velocity coming out of the small syringe, the initial velocity of $0.1\,\frac{m}{s}$ was scaled by a factor of about 0.20 which resulted in the velocity to be about $0.5\,\frac{m}{s}$. Using the equation for Reynolds number shown below, the Reynolds number for the initial injection of dye was calculated to be 2490.

$$Re = \frac{UD}{v} = \frac{(0.5\frac{m}{s})(0.005m)}{1.004 \times 10^{-6}\frac{m^2}{s}} = 2490.04$$

Since the calculated Reynolds number of 2490 is greater than 2100, this indicates that the flow coming out of the syringe and going into the water is turbulent.

I had difficulty making this video since I was doing everything by myself but the set up was pretty simple and it is shown later on in the report. I used three different colored dye (yellow, red, and green), bought from King Soopers, to inject into the water. In order to get the image of the initial injection of the dyes, I decided to position the camera about 5 inches away from the vase at a 30° angle. With this angle I was able to capture the moment the dye hit the water as well as when the dye settled and mixed with the rest of the water. I took this video in the evening, so I did not have the opportunity to use natural lighting. I instead had to work with what I had which was the kitchen light. In order to have a clear background, I placed a white cardboard, supported by a speaker, right behind the vase. As for how fast I injected the dye into the water, I just injected as I normally would. I am not really sure how to measure that which is the reason I assumed the velocity in the calculation for the Reynolds number above. The overall setup of the camera and vase is shown below in *Figure 1*.

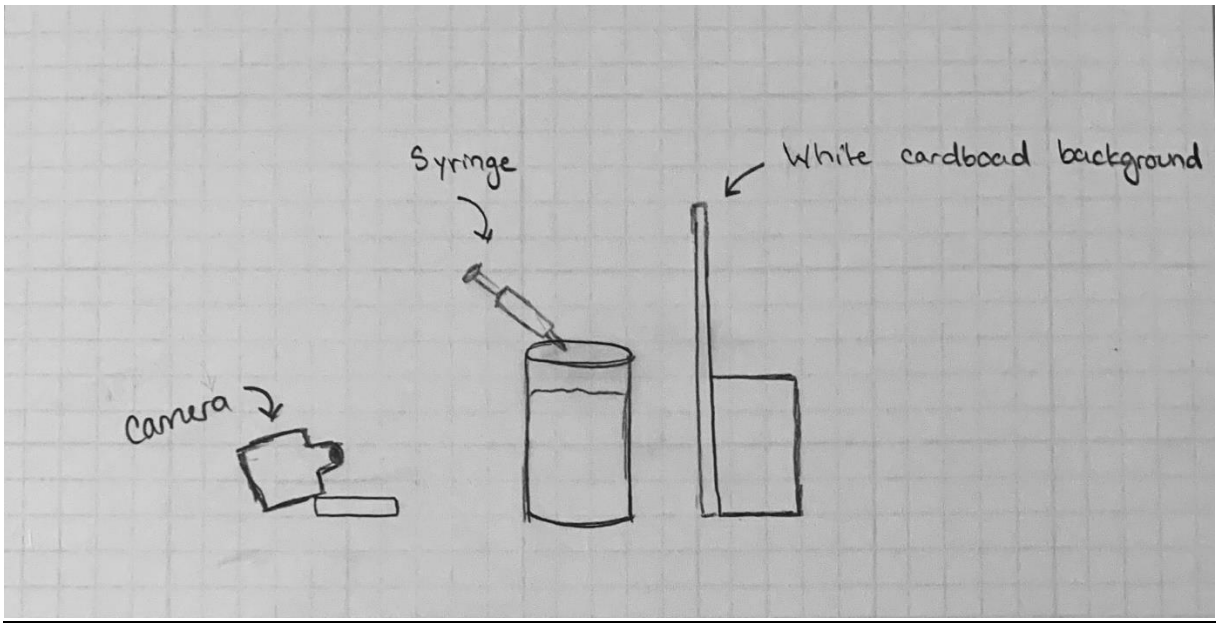

Figure. 1 Diagram showing the setup of the camera & the vase where the food coloring was injected.

The photograph was taken on a Canon EOS Rebel T6 camera. The camera lens was set up at a 30° angle and was at a distance of about 5 inches. The settings were set as: focal length of 55mm, exposure time of 1/250sec, an ISO of 800, and f-stop of f/16. The video had a frame width of 1920 and a frame height of 1080. For the image processing, I ended up using MiniTool Movie Maker to adjust my video. This was my first time making a video and editing it so I was mostly exploring what adjustments I could have done with what MiniTool provided me. Because of this, I did not make much changes to the original video. Within MiniTool I applied a filter that altered the colors of each individual coloring dye and the background. The yellow dye became a light orange, the red became a dark vibrant orange, and the green became black. Since I was using my kitchen lighting, the yellowish light tint became white. This was intended because it gave a good contrast with the rest of the colors. The only other adjustments I made was slowed the video down so that the views could see the different flows for each of the dye.

Overall I liked how my final video came out. The filter that I applied make it look Halloween themed which was really cool. I also really liked the transition that the dye had from turbulent to laminar within the vase. A suggestion that I received form my classmates was that I should try to work around having such a noticeible reflection on the vase. A way that I would improve this in the future would be to add a dark sheet over the camer so that there will be no noticioble refelction in the final video. Another thing was that the video was blurry and a way to fix this is to adjust the focus manually instead of having it as autofocus. Other than that, I would like to improve in my video editting skills for future video submissions. All in all, I feel that the video fulfilled my intend of showing the flow transition of colored dye in water.