Freeze Frame of Oscillatory Fluid Flow

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Flow Visualization

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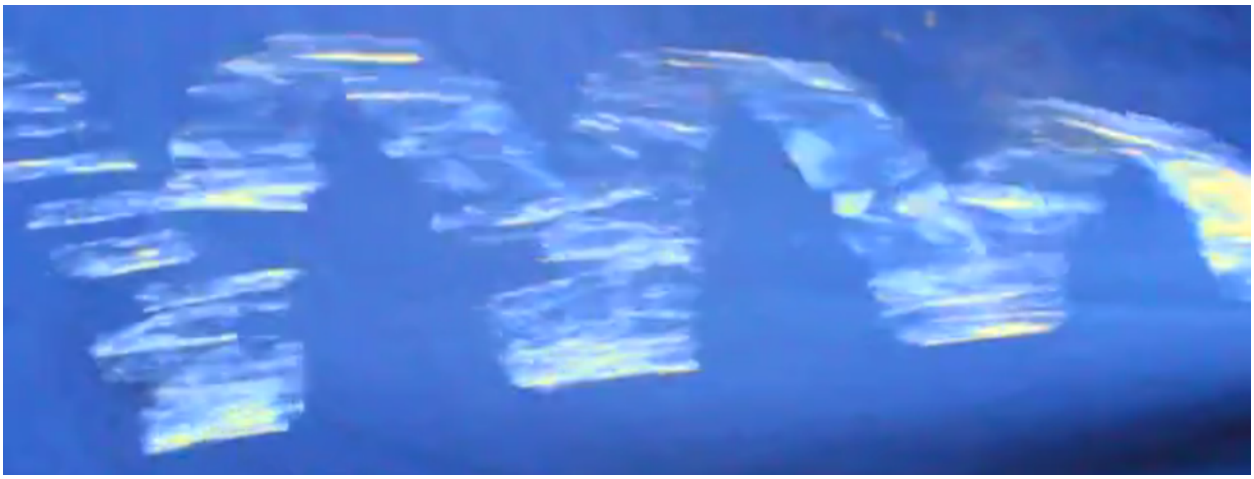
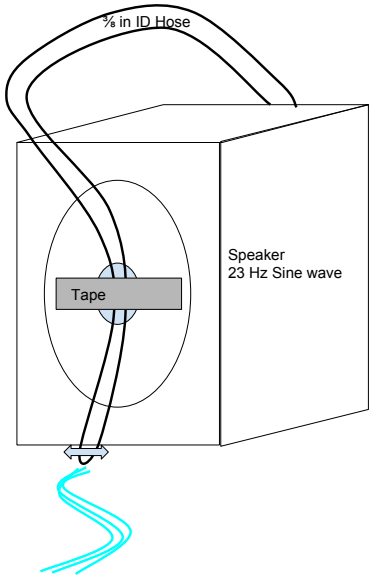


This is the first group project done by John Zeldes, Rachael Grosskrueger, and Brock Derby. The purpose of this video is to show a freeze frame of oscillatory fluid flow. It shows how a fluid falling in the form of a sine wave of different frequencies can appear to freeze in time by filming at similar frequencies to the fluid flow. This experiment was inspired by "Amazing Water and Sound Experiment #2" filmed by "Brusspup" and shows this phenomenon captured using higher camera shutter speeds.

This particular fluid flow was created by taping a hose directly to a subwoofer oscillating at 23 Hz. Water poured out of a tube which ended roughly 1 inch below the speakers base. By playing a 23 Hz sine wave through the speaker, the water exiting the tube was also oscillated at 23 Hz. In order to make the sine wave appear to flow backwards it was filmed at 24 frames per second, 1 Hz faster than the speaker. The speaker was set up as shown below.



The Flow exiting tube was disrupted by the 23 Hz vibrations from the speaker causing the water to fall as a sine wave. This falling sine wave is very difficult to see with the naked eye, however, a camera filming at a similar frequency can cause the water wave to appear stopped, or move backwards or forwards. For this video, a 23 Hz sound wave was place through the speaker while the camera filmed at 24 fps, making the sine wave appear to move backwards, towards the water source.

The visualization technique used was freeze frame, similar to a strobe light effect. This was utilized by setting the camera to near the frequency of the fluid flow 23 Hz and 24 fps. This means the camera captured the wave in a similar position every time. The materials to do this include a 10 inch subwoofer and amplifier, garden hose, water source, and sound wave function generator, and a 3/8 inch ID clear tube supplied by Rachael Grosskrueger. The video shown was taken outside at around 4 pm to allow for afternoon daylight with the camera facing away from the sun with a black sheet backdrop.

This shot was taken with a Cannon T3i, with an approximate field of view around 4 ft X 3 ft. The focal point was roughly 4 feet away from the camera and was manually focused. The shot was taken in RAW form at 24 fps with the ISO and shutter speed set to automatic. Since, the shutter speed and ISO were on an automatic setting which I was unable to change, I believe they varied slightly throughout the film. Although I was unable to find the actual shutter speed and ISO values, it is clear that the camera did not have a high enough shutter speed and ISO to properly capture fast moving water. Finally, the image was trimmed cropped and color enhanced using I Movie to increase

the image saturation revealing a slight rainbow and increasing the movies temperature to a warmer hue.

This image ultimately freezes a sine wave of water being sprayed from a tube at 23 Hz. The fluid physics would have been far more visible if the camera shutter speed was adjustable in video mode. This would have significantly decreased motion blur allowing more specific fluid physics to be seen. The motion blur caused by a slow shutter speed was my main dilemma with this experiment as the motion blur hid most of the more interesting aspects of the fluid flow. I would have liked to use a camera which had the ability to adjust the shutter speed and ISO in video mode to reduce the motion blur and achieve a shot with a resemblance to the video made by Brusspup which is liked below.

References

1. https://www.youtube.com/channel/UCeQEKFH31vvD-InkTGSvCrA .
Amazing Water and Sound Experiment #2 [Youtube broadcast]. (2013, March 11). In Brusspup Illusions and Science. Brusspup.