Waves of Light

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MCEN 4151 Flow Visualization

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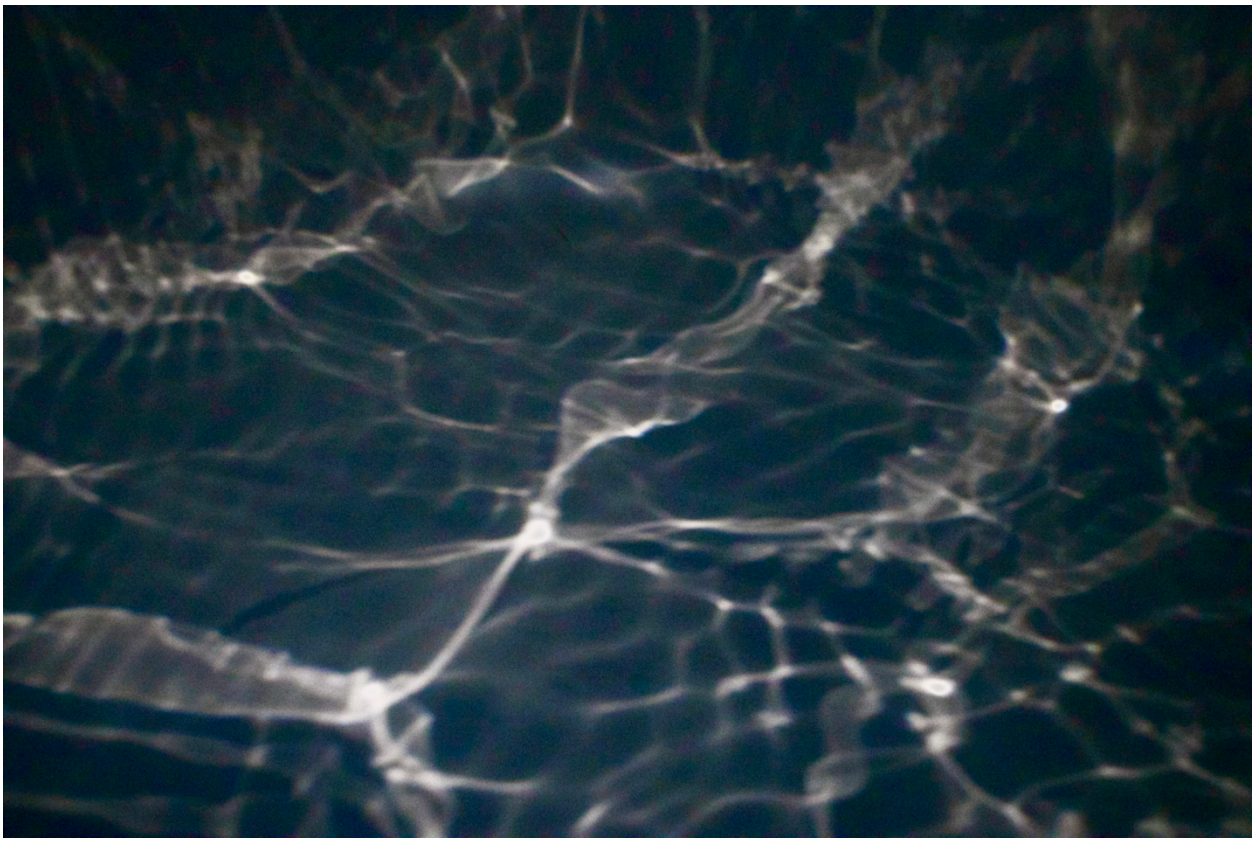

Figure 1: The caustics caused by light being shown through a clear bucket of water while the water is being agitated.

Introduction

This image was taken for the second team project in the Flow Visualization course. The intent of it was to visualize how light reflects through the surface of water as waves move across the surface. It was my original intent to try and capture waves from a single source bouncing off a wall and interfering, but it was difficult to time the photo and was not as visually appealing as the final image. I would also like to thank Cooper Lay and Sam Nicastro for their help setting up the experiment.

Procedure

For this photo, light was shown from a phone light above a plastic tub that was approximately 2.5 by one foot. A phone light was used because the effect was more drastic with a smaller light source. From there the caustics were projected onto a white surface as seen in Figure 2. “Caustics may be defined as the envelope of light rays that have been reflected or refracted from a curved surface and projected onto a surface where they can be visualized.” [1]

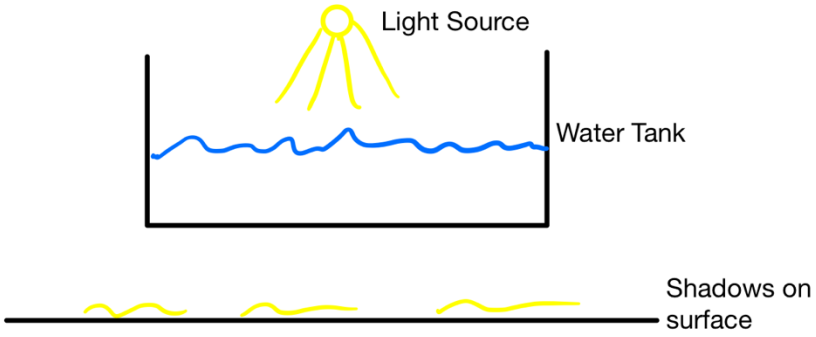

Figure 2: A sketch of what the setup looked like.

The tub was being constantly agitated during the capture of the photo to create waves and cause them colide into each other creating various amplitudes. Water has a refractive index of 1.33 [2] that causes light to change direction when it passes through the water-air boundary at an angle. Because the waves have a continuous curvature, they create lenses that concentrate the light that can then be visualized.

It is difficult to understand the speed of the waves looking at the motion blur because you can’t tell the difference between what is motion blur and what is the natural deflection of the light.

This photo was taken on a Canon ESO 77D with a 55mm lens. The focal length was set to 30, f-stop to 4.5, ISO to 6400, and the shutter speed to 1/400 to maximize the light hitting the sensor while not having too much motion blur. The only light used to in the scene was the phone light shining through the tub. A brighter light that still has a small source point would have been preferred. The photo remained uncropped at 4000 x 6000 pixels. The brightness and contrast

were boosted during editing and the tint was shifted to make the photo cooler as you can see when comparing to the original image in Figure 3.

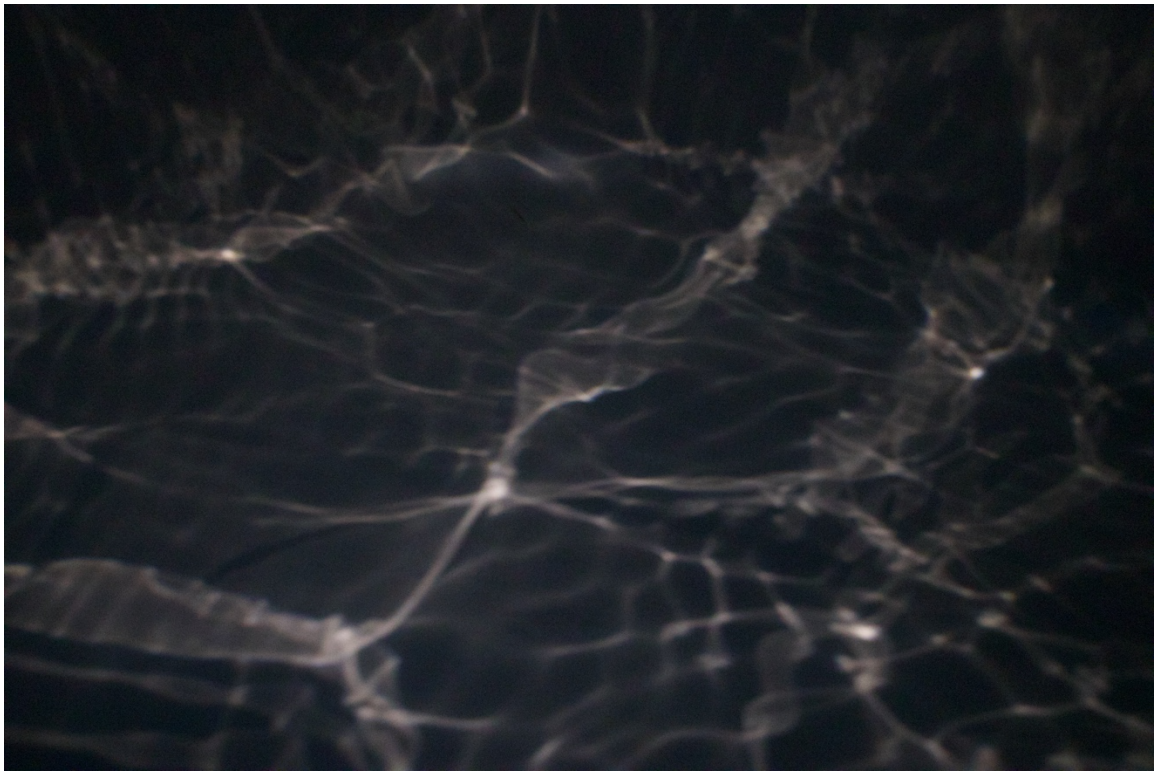

Figure 3: The original, unedited photo.

Discussion

I think it is interesting how you can see where the waves are interacting and where the highest amplitude waves are occurring. I wish I could have had a brighter light to use, but I really like that you can see the bright spot where two big waves overlap. In the future I would like to play around with the height of the tub above the ground to see if I can focus the light, as well as adding an object in the tub to redirect the flow.

Work Cited

[1] Beven, K. (2019, January 3). *On the physics of caustic light in water*. On Landscape. https://www.onlandscape.co.uk/2019/01/physics-of-caustic-light-in-water/

[2] Polyanskiy, M. (2017). *Refractive index of H2O, D2O (Water, heavy water, ice) - Hale*. Refractiveindex.info. https://refractiveindex.info/?shelf=main&book=H2O&page=Hale