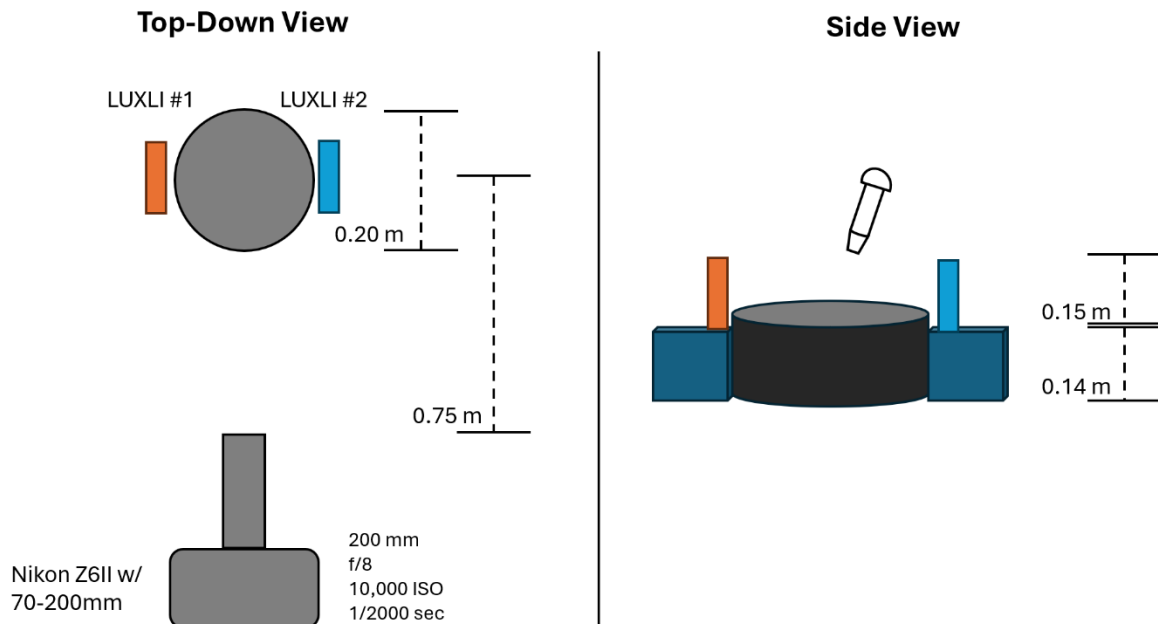


Water Polo:

The intended purpose of the image was to create a dual-colored, high-speed photograph of a single water droplet interacting with a water surface in a cooking pot. The dropper used as part of the apparatus proved to drop a few droplets at a time, rather than a single. This led to the idea of capturing the interaction of multiple droplets interacting with the free surface at the same time. The final image shows the chaotic and unpredictable result of these interactions. The dark background of the pot and environment led to a narrow depth of field. The limited illumination, combined with the fast shutter speed and selected aperture, required an ISO setting of 10,000. The resulting image contained visible noise. The final selected image captures a recognizable shape: the main body of water resembles the torso of a water polo player, with an extended section suggesting a raised arm reaching out for an airborne ball. The resemblance emerged from the splash geometry rather than a deliberately shaped object. The image was produced independently.

The apparatus consisted of a cooking pot approximately 8 inches (0.20 m) in diameter, filled with water to a depth of 5.5 inches (0.14 m). A large kitchen dropper was held approximately 6 inches (0.15 m) above the water surface and used to release individual drops. The water was not allowed to settle completely between releases. Consequently, each new drop encountered surface waves and raised surface layer heights from the preceding impacts. The selected photograph captures the interaction between a newly arriving drop and the disturbed water produced by the previous drop.



Schematic of Apparatus Setup

The flow was driven by a sequence of closely spaced impacts. An initial drop displaced the receiving water, generating a surface depression and outward disturbances. The subsequent recovery of a drop impact cavity can produce an upward moving structure known as Worthington Jet [1]. In this experiment, the next drop arrived before the water had returned to rest, allowing it to interact with liquid already moving from the previous impact. This interaction produced the unusually tall, irregular splash selected for the photograph. The exact timing and geometry cannot be reconstructed from the final image alone, but the experiment is different than a single drop striking an undisturbed pool.

The resulting structure reflects the combined effects of inertia, gravity, surface tension, and viscosity. The incoming drop transfer momentum to the moving water, while the shape and velocity of the existing surface affects how the momentum was redirected. Gravity pulls the elevated water downwards; surface tension influences the contraction and breakup of the rebound jets and detached drops from either the jet itself or falling from the dropper have differing shapes and speeds depending on impact conditions and timing. [2]. The additional interaction between successive impacts further contributes to the complicated structure. The resulting shape resembles a water polo player, with a raised extension suggesting an arm and detached droplet suggesting a ball. The appearance demonstrates an unsteady splash but does not by itself establish turbulent flow. The incoming drop's speed can be estimated by using the 6-inch release height. If the drop detached approximately from rest and neglecting air resistance, $g = 9.81 \text{ m/s}^2$ and $h = 0.1524 \text{ m}$ (6 inches),

$$U = \sqrt{2gh} = \sqrt{2 \times 9.81 \times 0.1524} \approx 1.7 \frac{\text{m}}{\text{s}}$$

The unrounded height conversion is in the calculation, while the result is reported to two significant figures to reflect the approximate measurement. This estimate describes the drop's speed at the undisturbed water-surface elevation. If it contacted a raised splash before reaching the specified height, its fall distance would have been shorter. The relative collision speed depends on the motion of both the incoming drop and existing structure; it cannot be determined from release height alone. If the dropper actively propelled the water, the initial release velocity would also need to be included. The incoming drop diameter was not measured directly, so a representative diameter of 2.0 mm (D) was assumed for the calculations. This diameter was among the water-drop sizes used in laboratory impact experiments by Zhou et al. [4]. The water density ρ is assumed to be 1000 kg/m^3 , dynamic viscosity $\mu = 0.001 \text{ Pa}\cdot\text{s}$, and surface tension $\sigma = 0.073 \frac{\text{N}}{\text{m}}$. [3].

$$Re = \frac{\rho \times U \times D}{\mu} = \frac{1000 \times 1.7 \times 0.002}{0.001} \approx 3400$$

$$We = \frac{(\rho \times U^2 \times D)}{\sigma} = \frac{1000 \times 1.7^2 \times 0.002}{0.073} \approx 79$$

The Reynolds number compares inertia with viscous effects, while the Weber number compares inertia with surface tension. Values substantially greater than one indicate that inertia is strong relative to the corresponding resisting effect the chosen scale. The quantities help characterize the impact, but neither establishes turbulence nor identifies the exact splash by itself. The exposure duration was $t_e = \frac{1}{2000} = 0.0005\text{s}$. The estimated movement during the exposure $L = U \times t_e = 1.7 \frac{\text{m}}{\text{s}} \times 0.0005 \text{ s} = 0.85 \text{ mm}$. The visualization relied on the colored illumination of the water. An orange LUXLI LED panel was positioned to the left of the pot, and a blue LUXLI RGB panel was positioned to the right, as shown in the schematic of the apparatus above. The lights were approximately 4 inches (0.1 m) from the impact region, with lights in the room being turned off. Reflection and refraction at the curved surfaces produced contrasting highlights that outlined the splash and detached droplets. Tap water was used for the experiment with no other additives.

The photograph was captured using a Nikon Z6II digital mirrorless camera with a VR 70-200 mm f/2.8 lens at a focal length of 200mm. The exposure settings were ISO 10,000, an aperture of f/8, and a shutter speed of 1/2000 s. The short exposure helped capture the rapidly changing splash, while the ISO compensated for the limited light available at the selected shutter and aperture. High-speed continuous shooting was used to capture successive frames and increase the likelihood of capturing an interesting interaction between the drops. The camera was mounted on a BENRO tripod and focus was set manually. The approximate distance from the subject to the lens was 30 inches (0.75 m), and the final cropped field of view measured was approximately 1 in by 0.8 inches (0.025 x 0.02 m). The original RAW image was processed in Adobe Lightroom Classic. The original image measured 6048 x 4024 pixels, and the final cropped image measured 1934 x 1547 pixels. The crop concentrated attention on the splash and droplets surrounding it. Exposure increased by 1.34 stops, shadows were raised by 68, whites by 15, and blacks by 17. Contrast was reduced by 7 and clarity by 26. Orange saturation and luminance were increased by 12 and 15, while blue luminance was reduced by 40. Red-primary calibration adjustments also contributed to the final color of the image. Sharpening was set to 51, and a denoising technique was used along with simple spot treatment to remove artifacts.



Image Before Processing



Post – Processed Image

The final image connects a brief fluid event with a recognizable human gesture. I particularly liked the diagonal extension of the splash and the placement of the detached droplets, which together suggest a player reaching towards a ball. The blue and orange highlights strengthen this impression by lighting up and defining different portions of the water's surface. The photograph shows surface deformation and droplet separation clearly, although it does not reveal the underwater motion or the full sequence that produced the shape. Some airborne droplets are soft, and the pot rim distracts from the main subject. In a future attempt, I would use a fixed dropper position and more consistent release timing to compare successive impacts. A sequence of images would help determine how the figure formed, and stronger illumination could contribute to a lower ISO or higher f-stop. The image fulfills the artistic goal of creating a recognizable form within rapidly changing fluid interactions but leaves room for a more controlled investigation of the underlying flow.

References:

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