KRON TECHNOLOGIES
HIGH-SPEED IMAGING

CHRONOS CAMERA APPLICATION NOTE

How to Double the Frame-rate of a Pair of Chronos Cameras

Highlights:

This application document describes how you can set and trigger a pair of Chronos high-speed cameras to increase the frame-rate by two fold. Recording at double the frame-rate of a single high-speed camera can be useful if you want to obtain more detail from a particular event while keeping a larger viewing area. A short test is performed to describe how this can be achieved.

Test Setup

Two Chronos 1.4 high-speed cameras, one monochrome and one color, are positioned as displayed in Figure 1. A droplet is dispensed by a syringe located 0.85 m from the surface of a steel plate that the droplets impact.

The diameter of the droplets is D = 4.4 mm. The velocity of the droplet approaching the plate is 3.7 m/s. The cameras record the droplet as it approaches the plate and spreads on it. The trigger switch is used to trigger the function generator. Then the latter sends out signals from its channels 1 and 2 to camera 1 and 2, respectively.

Camera 1 is a 1.4 Chronos monochrome camera and camera 2 is a 1.4 Chronos color camera. Both cameras have a 50 mm Rokinon lens attached, f#1.7. The resolution of camera 1 and 2 is 40.6 and 39.9 µm/ pixel, respectively.

The cameras are set to record 5,000 frames maximum. When the number of cycles ends the recording and the footage recorded can be reviewed and saved.

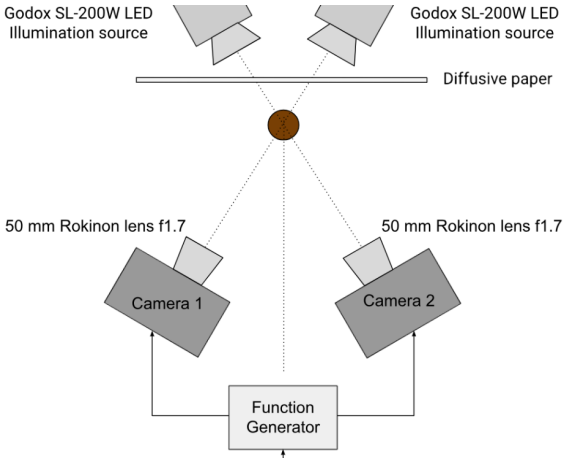

Figure 1
Schematic representation of the setup used to double the recording frame-rate

Time Delay Validation

The signals from the function generator and both cameras were recorded in an oscilloscope, RIGOL MSO5074, to verify the time delay between them. Figure 3 presents the signals recorded, signal 1 and 2 are the oscilloscope's channels 1 and 2, respectively. Channel 3 corresponds to the output signal from camera 1 and channel 4 is the output signal from camera 2. In the image the time delay of 500s between the function generator's channels 1 and channel 2 is annotated.

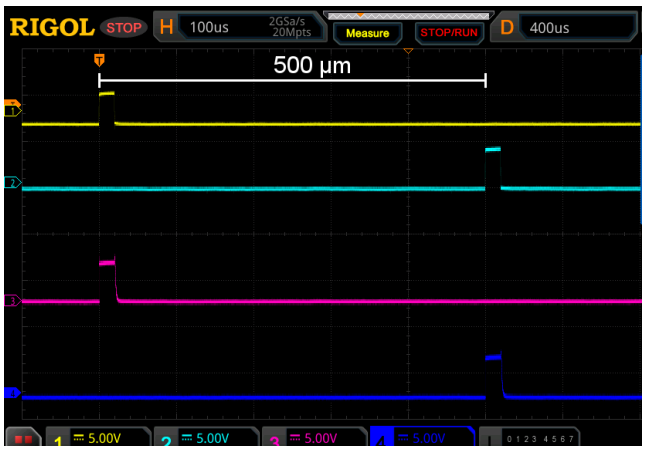

Figure 2
Oscilloscope screen

The function generator's signal from channel 1 and 2 correspond to the yellow and light blues traces. Camera 1 and 2 signals are represented by the pink and dark blues traces, respectively.

Next, we want to check the time delay between channel 1 and camera 1, and channel 2 and camera 2. Figure 3 portrays the time delay between the function generator's output signals and the cameras. The left side is the delay of 440 ns from the time the function generator's signal, from channel 1, is sent and the time when camera 1 is recording. The right side depicts the delay between the function generator's signal, channel 2 and camera 2, 240 ns.

Figure 3
Schematic representation of the setup used to double the recording frame-rate

The goal of this exercise is to increase the frame-rate from 1,000 fps to 2,000 fps. The interframe decreases from 1 ms to 500 µs. We can take the time delay as the upper limit of the temporal uncertainty, Δt. Thus we have Δt = 0.440 µs / 500 µs = 0.00088 or 0.09%. This is really a small temporal error, it does not affect the visualization of the event to be recorded.

Figure 4 portrays images taken from camera 1, upper row, and those recorded by camera 2, lower row. The interframe time in each sequence is 1 ms. The images were post-processed to match their intensity. In the first frame, upper row, the droplet is not in the image. Then, due to the time delay between the cameras, the first frame of the lower row portrays the lower part of the droplet in it. The vertical position of the droplet in the two sequences is different due to the time delay between the two cameras. In the last frame of the upper row the droplet is about to make contact with the plate. In the lower row, last frame, the droplet already impacted the plate.

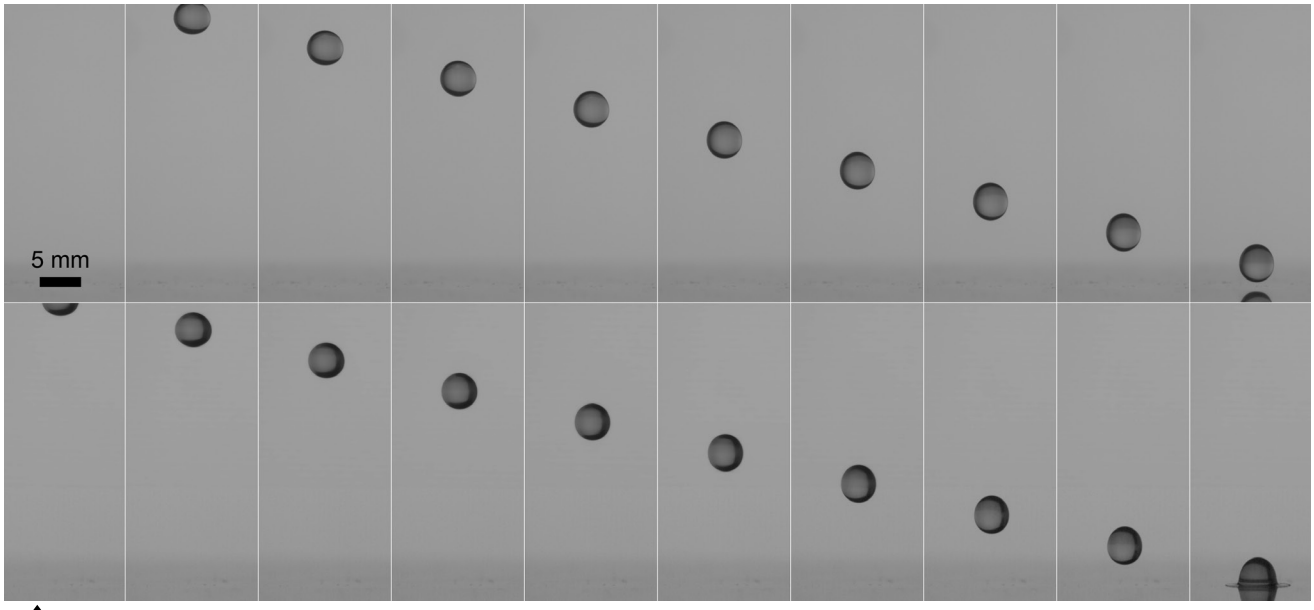

Figure 4
Upper row. Images from camera 1. Lower row. Images from camera 2. In both sequences the interframe time is 1.0 ms

The images can be combined into a single sequence. This is shown in figure 5. In it, the interframe time is 0.5 ms, 2,000 fps. One can see the droplet motion in more detail.

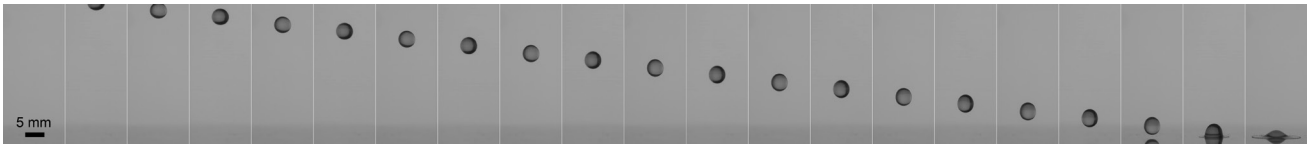

Figure 5
Images from both cameras combined. The interframe time is 0.5 ms

Final Comment

This application document shows it is possible to double the frame-rate using two Chronos cameras. This can be a useful option in applications that require more detail of a particular event or the user wants to have a higher frame-rate while keeping the full frame. The procedure to setup the cameras configuration and renaming the files recorded by the camera can be seen **here.**