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Methodology of infrared camera lag measurement

David Alain
DRDC – Valcartier Research Centre

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IMPORTANT INFORMATIVE STATEMENTS

Abstract

In this Reference Document, a methodology was described to perform latency measurement of infrared cameras.

Résumé

Dans ce document de référence, une méthodologie a été décrite pour effectuer la mesure de la latence des caméras infrarouges.

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1 Background

In all digital cameras, time lags, or camera latency, can occur between signal-in and signal-out due to signal conversation and processing. It is also noted that frame rate of a camera may add an average lag to the total latency.

In visible spectrum, a simple approach for measuring lag is to have a reference time imaged by the camera under test. The reference time could be an analog clock or a digital chronograph. The video output of the tested camera is fed to a monitor to display the captured reference time, which consists of combination of lags generated by the tested camera and monitor. A second visible camera would be used to take snapshots of both the live reference time and the displayed reference time generated by the tested camera simultaneously. The difference between the two reference times shown in the same snap shot is the combined lag of the tested camera and monitor. Finally, the lag of the monitor alone is measured with the use of a video signal input lag tester (e.g., from Leo Bodnar). The lag of the tested camera could then be determined.

However, for infrared cameras (middle wave and long wave infrared), which are sensitive to heat or thermal contrast, neither readable times of a clock nor those of a digital chronograph could be properly obtained from imagery. A different technical approach is then required.

This Reference Document presents a methodology for latency measurement of most infrared cameras (middle wave and long wave).

2 Methodology

2.1 Items

The technical approach requires the following items:

- a black body or a warm source with an active surface area of about 12" by 12";
- an optical chopper with controller (e.g., Stanford Research Systems, Model SR540);
- a video signal input lag tester from Leo Bodnar;
- a monitor;
- a visible camera for taking snap shots; and
- the tested infrared camera.

2.2 Procedures

First, the monitor lag was measured with the video signal input lag tester.

Second, the optical chopper disk, consisting of several periodic windows, was modified with masking tape so that only one unique disk position could be seen in both the visible and the thermal spectra. With this set-up, the two opened windows along the same radius on the disk could be located and seen in the visible spectrum at only one position (or angle).

Third, the chopper was positioned in front of the black body (or a warm source).

Forth, the tested infrared camera was positioned in front of the chopper to capture live video of the black body infrared signal modulated with the chopper.

Fifth, a second visible camera was used to capture snapshots of the rotating chopper and its infrared images displayed on the monitor. One should position this visible camera so that it could clearly capture the live view in visible and the lag view of infrared image displayed on the monitor.

Sixth, the chopper rotational speed was first set at low frequency (e.g., 5 Hz). The frequency is then increased gradually. Snapshots are taken with the visible camera and inspected in the process. At low frequency, positions of the two opened window appear the same in live visible and lag infrared. As frequency increases, their positions will begin to separate, as illustrated in Figure 1. To calculate the infrared camera latency, the chopper frequency is adjusted so that the separation of the two opened window positions is about half of a rotation.

Additional explanation (Step three to five): Typically, there are two groups of periodic windows distributed on two concentric circles on the chopper disk. The chopper controller is used to set the frequency of the open-and-close events, at a fix position, on the chopper disk. In the current configuration, all except one window, on the concentric circle with the smaller radius, were covered with tape. In this way, the two opened windows along the same radius on the disk could be located and seen in visible at only one angle. With the help of a black body generating an elevated thermal background in front of the chopper disk, images of modulated thermal signal and the same position of the two-opened window on the disk could be captured by an infrared camera.

2.3 Interpretation

In the set-up, a monitor by Viewsonic (N2230W-2M, 21") was used. According to the lag tester, the display lag is 26 ms. A 35-Hz frequency was selected to obtain a half-rotation lag of the two opened windows. Knowing there are six windows on each concentric circle on the chopper disk, this means that the disk was actually turning at 35 Hz / 6 or 5.8 Hz or at a speed of 172 ms per rotation. As a result, for half of the rotation, 86 ms is the total lag between the tested infrared camera and monitor. Therefore, the lag of the tested infrared camera is 86 ms minus 26 ms or is equal to 60 ms.

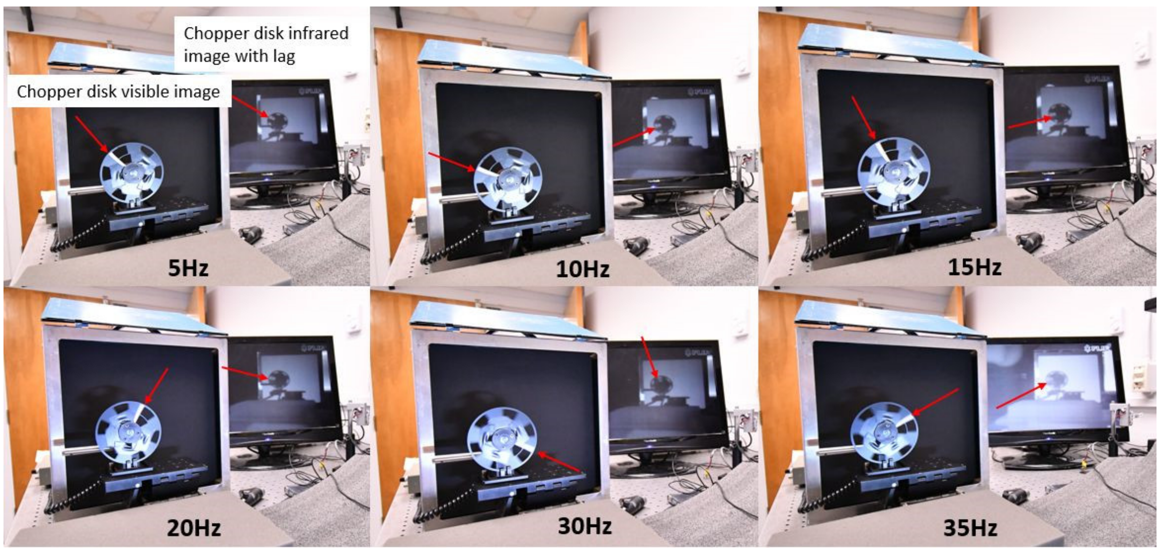

Figure 1: *Sequence of images showing marked positions of two opened window of the chopper disk (red arrows) in visible image without lag and in infrared image with lag at different modulation frequency (5 to 35 Hz).*

3 Conclusions

A methodology was described for latency measurement applicable to most infrared cameras. An example of latency calculation was presented with typical values.

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