Signal Processing Methods of Thermoreflectance Imaging

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Motivation

Devices rapidly get smaller and more complicated, and performance becomes increasingly complex.

A processing technique: heterodyning, allows viewing of signals at very high frequencies while the signal is beating frequency and at low frequencies can be viewed in a higher frequency.

Thermoreflectance Theory

The system is based on thermoreflectance. When the temperature of a device is known, the change in temperature can be measured by a camera.

The amount of reflected light changes due to changes in temperature.

\[
\frac{1}{R} \frac{\partial R}{\partial T} \Delta R \approx k \Delta T
\]

Upsampling Imaging

Nearly all electronic devices have inherent “pink noise” that decreases with an increase in frequency. By heterodyning devices that operate at low frequencies, they can be viewed at higher ones, thus decreasing noise.

By processing the images into the above histograms, the signal to noise ratio of each method can be easily compared. The sharper the peak, the less noisy the signal. By comparing these two, it is clear that the image on the right acquired from the upper sideband is much clearer.

Downsampling Imaging

Many devices need to be tested at high frequencies, well beyond the camera’s upper limit of 170 Hz. Using heterodyning, one can choose the camera frequency at which to view the device, while operating it at virtually any frequency.

Various devices are tested using different frequencies and compared.

The camera produces images that are compared to determine the best method for viewing high frequency phenomena.

Thermal image of a resistor operating at 10000 Hz, viewed in the lower sideband of 20 Hz.

References