Signal Processing Methods of Thermoreflectance Imaging

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Motivation

ices rapidly get smaller and more complicated, rmance becomes increasingly complex.

processing technique:

at very high frequencies while the signal is beating frequency

te at low frequencies can be viewed in a higher se"

rmoreflectance Theory

system is based on thermoreflectance. When l, the amount of reflected light changes oximation:

$$\left(\frac{1}{R}\frac{\partial R}{\partial T}\right)^{-1}\frac{\Delta R}{R} = \kappa^{-1}\frac{\Delta R}{R}$$

stant is known, the change in temperature easuring the reflectance with a camera.

w Imaging Algorithm

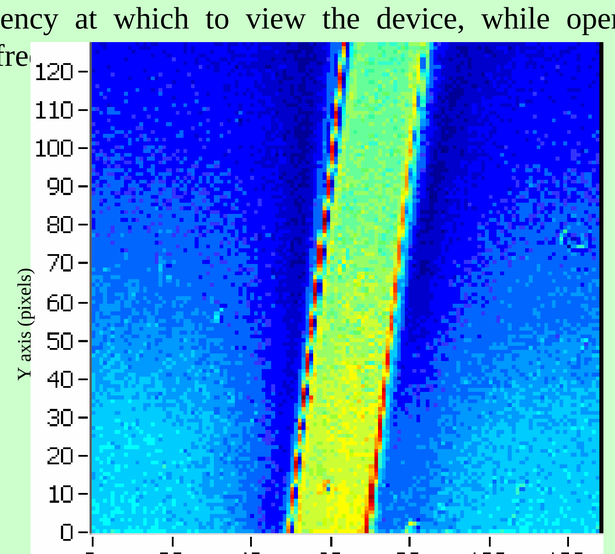
reate a program that implemented a new signal d as the "stroboscope[1]."

fferson Modifications made by Chris Wegemer

ct way to control and view heterodyned signals.

Downsampling Imaging

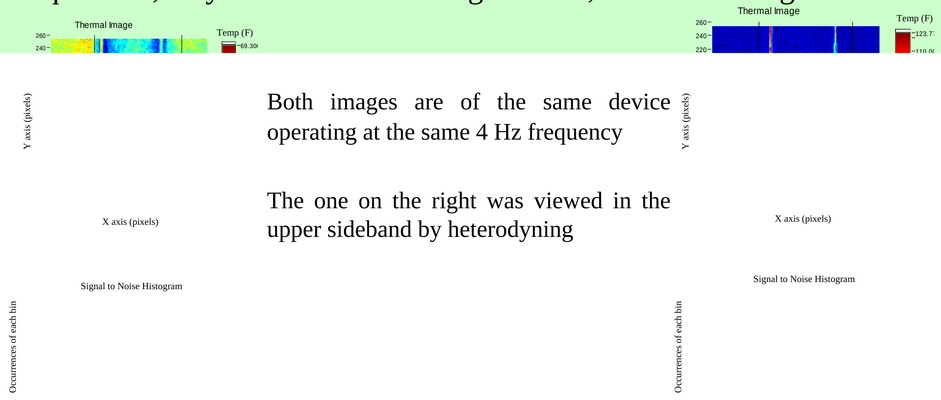
Many devices need to be tested at high frequencies, well beyond the camera's upper limit of 170 Hz. Using heterodyning, one can choose the camera frequency at which to view the device, while operating it at virtually any fre



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

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.



Both images are of the same device operating at the same 4 Hz frequency

The one on the right was viewed in the upper sideband by heterodyning

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.

Heterodyne Signal Processing Focuses on Improving Image Quality

The basis of heterodyning is to mix a signal with a reference signal to produce a beat signal. The beat signal contains the amplitude and phase information of the original signal, but at a lower frequency. Using a lock-in amplifier, the beat signal can be extracted and displayed.

1. Comparing the image quality between the upper and lower sidebands

Work Referenced

1. Grauby, S., Forget, B.C., Hole, S., Fournier, D. High resolution photothermal imaging of high frequency phenomena using a visible charge coupled device camera associated with a multichannel lock-in scheme, Rev of Scientific Instruments, Volume 70, number 9.