

Aerotech Harmonic Cancellation

The Aerotech Harmonic Cancellation algorithm, part of the Dynamic Controls Toolbox, dramatically reduces positioning errors on systems with periodic disturbances.

Aerotech's Harmonic Cancellation algorithm dramatically reduces positioning errors on systems with periodic trajectory commands or disturbances. This feature, part of the **Dynamic Controls Toolbox**, provides an easy-to-use command set and graphical user interface to enable the algorithm and to extract the highest possible performance from your investment in a precision motion control system.

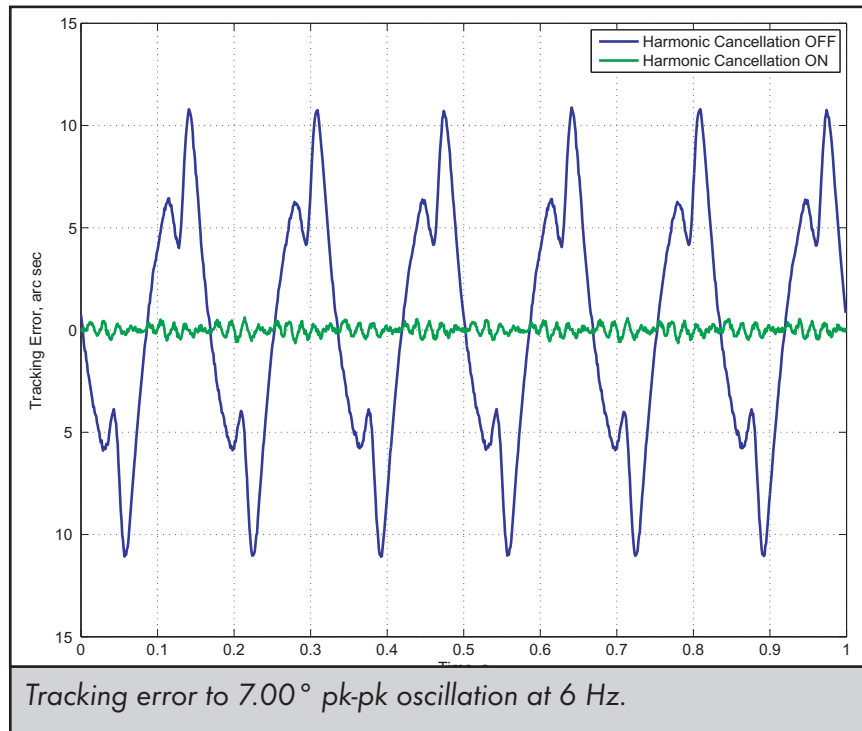
Periodic inputs are common in sensor-testing applications, where accelerometers, gyroscopes, geophones, and other inertial measurement units are shaken with a known profile in order to calibrate their response. The harmonic cancellation algorithm can be used to either reduce the unwanted higher-harmonics in single frequency commands (lower the total harmonic distortion of the input signal), or to better track more complex arbitrary waveforms.

Figure 1 shows the effectiveness on a simple 6 Hz, 7 degree, peak-to-peak position command. The tracking error includes a component at the fundamental frequency as is predicted by a linear analysis, but also includes higher-order harmonics due to inevitable nonlinearities in the stage mechanics and power amplifiers. Enabling the harmonic cancellation algorithm reduces the root-mean-square tracking error 25X down to 0.24 arc-second. Multi-axis profiles can be followed with no frequency-dependent phase shift between them, again reducing the pre- and post-processing required to extract an accurate calibration.

Multi-axis systems are often challenging because a periodic or rotational motion on one axis leads to unwanted error motions on the other axes. Machine tools (where either the tool or the work piece may be spinning), tracking and surveillance systems, spin stands for data storage, and semiconductor wafer processing all exhibit this problem to some degree. The harmonic cancellation algorithm can adapt to these disturbances that are periodic on the position of another axis, even if the speed of that axis, and thus time-based frequency, changes.

The harmonic cancellation algorithm operates much like the traditional "Integral" term in a PID controller, but applies to

sinusoidal inputs rather than constant ones. The output of a standard integrator adjusts to eliminate steady-state error to constant disturbances, and the outputs of the harmonic cancellation filters adjust to eliminate periodic errors to periodic inputs. As the disturbance or commands change, the control effort changes appropriately. For positioning systems undergoing periodic motion or seeing periodic disturbance inputs, the Aerotech Harmonic Cancellation algorithm offers a purpose-designed solution for just these applications.



For more information, please contact an Aerotech Application Engineer at 412-963-7470, or visit our website at www.aerotech.com.



WORLD HEADQUARTERS: Aerotech, Inc., United States • Phone: +1-412-963-7470 • Email: sales@erotech.com
Aerotech, Ltd., United Kingdom • Phone: +44-118-9409400 • Email: sales@erotech.co.uk
Aerotech GmbH, Germany • Phone: +49-911-9679370 • Email: sales@erotechgmbh.de
Aerotech KK, Japan • Phone: +81-47-489-1741 • Email: sales@erotechkk.co.jp
Aerotech China • Phone: +852-3793-3488 • Email: saleschina@erotech.com

www.aerotech.com