Haptic Analysis of Virtual Gratings using Triangle Waves

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Background

Spatial Domain

Frequency Domain

Time Domain

Frequency Domain

Time Domain

Frequency Domain
Background: Fourier Decomposition

\[ S(x) = \sin(2\pi fsp x) \]

\[ T(x) = \frac{8}{\pi^2} \left[ \sin(2\pi fsp x) - \frac{1}{9}\sin(3 \cdot 2\pi fsp x) + \frac{1}{25}\sin(5 \cdot 2\pi fsp x) \right] \]

- A triangle wave has many more frequency components (actually, \( \infty \)) than a sine wave
- ...But the fundamental frequency component is slightly smaller by a factor of \( \frac{8}{\pi^2} \)
Experimental Setup

Two Experiments:

- Determine detection threshold for Sine Wave and Triangle Wave Grating

- Determine amplitude of Triangle Wave at which it can be barely differentiated from a Sine Wave of same frequency

Mini Stick

Haptic Interface Research Laboratory, Purdue University
Experiment #1: Detection Experiment

- 1 Up - 3 Down Adaptive Experiment
- Forced Choice
- 3 Interval - 2 Alternatives

Obtain threshold values for different amplitudes and frequencies
The Bolanowski Curve

- Obtain two detection threshold curves
- One for Sine wave and one for Triangle Waves

H. Z. Tan, "Overview of the Human Somatosensory System"

- Obtain ratio of two curves
Expected Results

At high frequencies, the ratio should be $8/\pi^2$

Why $8/\pi^2$?

$|\text{Fo sin}| / |\text{Fo tri}| = 8/\pi^2$

Steven Cholewiak and Hong Z. Tan, "Frequency Analysis of the Detectability of Virtual Haptic Gratings"
Experiment #2: Discrimination of Sine Vs Triangle Waves

- 1 Up - 3 Down Adaptive Experiment
- Forced Choice
- 1 Interval - 2 Alternatives
Expected Results

• At amplitudes at which the fundamentals are below the detection threshold, the discrimination of sine and triangle wave might be provided by the 3rd harmonic.

Note: Results are dependent on the results for Experiment #1
Questions?

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