Effective Acuity for Low-Pass Filtering of Real World Images

Amy A. Kalia, Gordon E. Legge, and Christopher S. Kallie

Department of Psychology, University of Minnesota Twin-Cities, Minneapolis, MN

Images of Eye Charts
- Original images: high-resolution photographs of two Lighthouse Distance Acuity charts
  - standard viewing distance of 4 meters
  - resolution of 80 pixels per degree
- Filtering: Gaussian and 4th-order Butterworth filters
  - six bandwidths: 1.33-35 cycles per degree (defined as the frequency at 50% of maximum amplitude)
- We tested more than one filter type to see how the sharpness of the filter rolloff affected acuity measurements.

Procedure
- Participants: 5 normally-sighted subjects
- Task: Subjects read the two standard eye charts, one for each blur filter
  - Chart images were read from a near viewing distance where unfiltered 20/20 letters were easily recognizable.
  - Testing was from most to least blurry to minimize learning effects.
- Measurement: the number of lines read and letters missed for each filtering condition
  - Acuity was computed as the smallest resolvable letter size in degrees.

Results
- For bandwidths greater than 0.07 deg/cy (i.e. less than 15 cy/deg) there was a linear relationship between filter bandwidth and the smallest resolvable letter size.
- The smallest resolvable letter size for a 1 deg/cy bandwidth was approximately:
  - 1.1 degrees for the Butterworth filter (Snellen acuity of 20/264 or 1.1 cy/letter)
  - 0.63 degree for the Gaussian filter (Snellen acuity of 20/151 or 0.63 cy/letter)

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Contact:
Amy Kalia
akalia@mit.edu

Conclusions
- We found a linear relationship between the bandwidth of two blur filters (expressed as degrees/cy) and acuity (expressed as the smallest resolvable letter size in degrees).
- This function provides a first step in approximating the information available in real world images viewed with reduced acuity.