PRECISE VISUAL SPEED ESTIMATION FROM BROADLY TUNED V1-LIKE SPATIO-TEMPORAL FILTERS. John A. Perrone*. Dept. of Psychology, University of Waikato, Hamilton, New Zealand.

In spatio-temporal frequency (STF) space, a moving edge has a spectral signature with energy concentrated along a narrow line that is oriented relative to the spatial and temporal frequency (TF) axes (Watson & Ahumada, 1983). Changes in the edge speed produce a change in the orientation of this spectral line. We would therefore expect that a motion filter designed to respond selectively to a particular edge speed (spectral orientation) would be narrowly tuned in STF space and have an orientation to match that of the edge spectra. Paradoxically, the spectral receptive fields (SRFs) of the front-end motion sensitive neurons that are commonly exposed to edge stimuli have none of these properties. Directionally selective neurons in area V1 of primate visual cortex have SRFs which have bandpass tuning in the temporal and spatial dimensions, but the temporal tuning (Transient) is very broad (~3 octaves) and the main axes of the spectra exhibit little or no orientation (Foster et al., 1985). This paradox can be resolved by incorporating the properties of a second class of V1 neuron which are non-directionally selective and have low-pass temporal tuning (Sustained). We propose a mechanism which produces a large response whenever the output of these two filter types is both high and equal (e.g., [logT + LogS]/|LogT - LogS| + 0.4). If the peak spatial frequency of the T filter is shifted slightly towards lower spatial frequencies relative to the S filter, the combined filter mechanism has an SRF that is oriented in STF space. Furthermore, a simple weighting of the S filter output can change the orientation of this SRF to match a wide range of edge speeds. Recent attempts to model speed tuning in MT neurons (e.g., Grzywacz & Yuille, 1990; Simoncelli & Heeger, 1998) require a more complete set of spatio-temporal filters than exist in V1 to generate the many preferred speeds apparent in MT. The mechanism proposed above can generate a wide range of speed tunings from a minimal set of filters with the restricted range of TF tunings found in V1. (*NASA NAG 2-1168)*