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SELECTIVE INTEGRATION: A MODEL FOR DISPARITY ESTIMATION.

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Because local disparity information is often sparse and noisy, there are two conflicting demands when estimating disparity in an image region: the need to spatially average to get an accurate estimate, and the problem of not averaging over discontinuities. We have developed a network model of disparity estimation based on disparity-selective neurons, such as those found in the early stages of processing in visual cortex. The model can accurately estimate multiple disparities in a region, which may be caused by transparency or occlusion.

The model consists of several stages and computes its output using only feedforward processing. One-dimensional binocular retinal input is preprocessed with disparity energy filters at a range of spatial frequencies and phases. The output of these disparity energy filters forms the input to two separate pathways: the local disparity pathway, and the selection pathway. The local disparity pathway computes an estimate of the disparity in a local region of the image. Because these local disparity measurements may be unreliable, a process is needed to determine which signals to integrate. The selection pathway fulfills this role by selectively gating those disparity signals that reliably indicate the true disparity of the object. The output of this stereo model is a distributed representation of disparity.

This selective integration of reliable local estimates enables the network to demonstrate stereo hyperacuity (i.e., sub-pixel disparity estimation from pixel-based inputs) on normal and transparent random-dot stereograms. Analysis of the model suggests that the selection units appear to respond to disparity contrast — that is, edges in depth. We predict that neurons in visual area MT will demonstrate a similar selectivity to disparity contrast.