

DYNAMICALLY ADJUSTED SURROUND CONTRAST ENHANCES BOUNDARY DETECTION

MOTIVATION

Psychophysical and physiological studies suggest that:

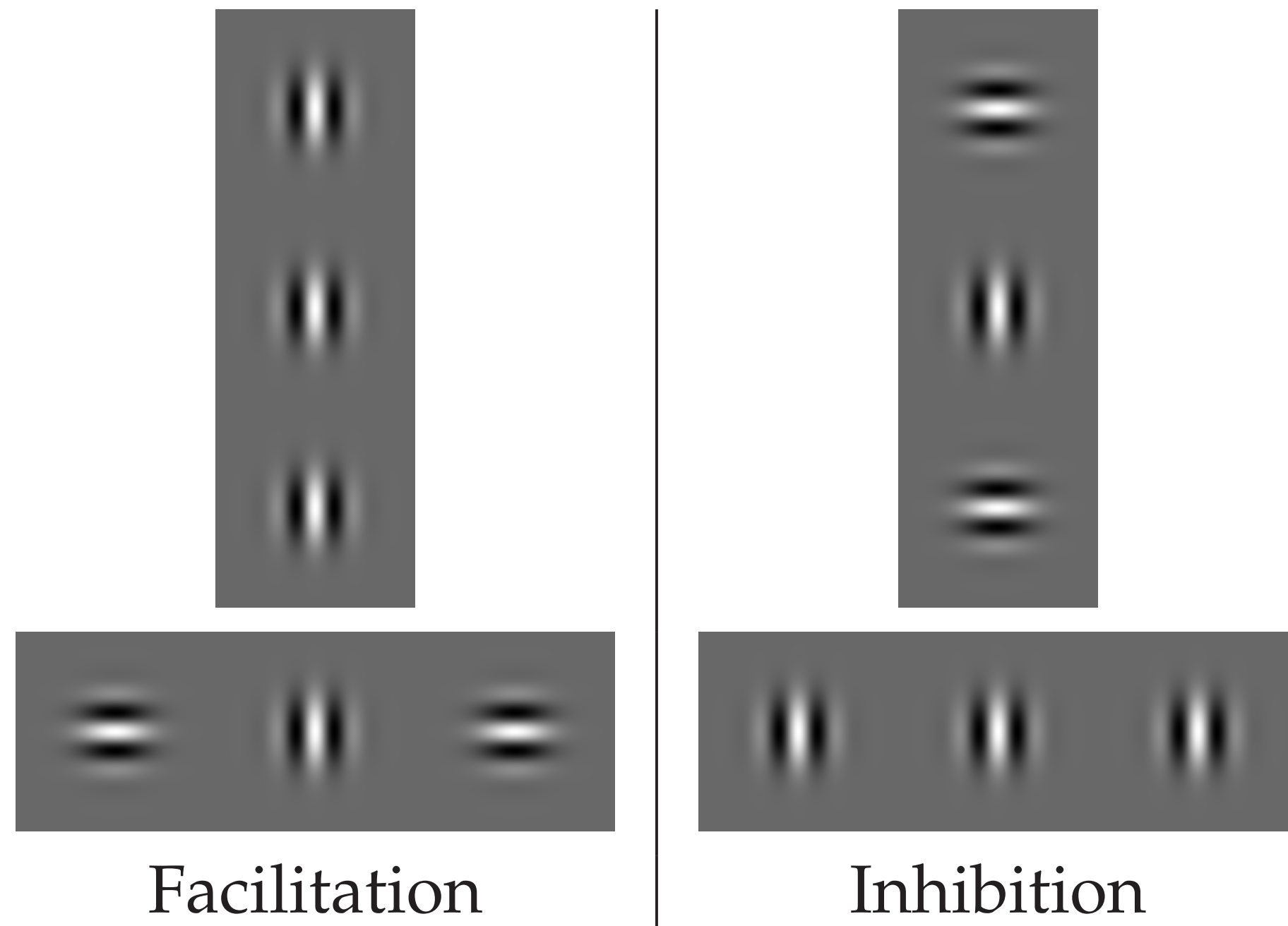
- Double-opponent cells are responsive to colour edges [2].
- The influence of the surround on the centre depends on the contrast and configurations of the stimuli [1].
- V2 receptive fields combine V1 responses over larger regions to compute extended arches and lines [3].

CONTRIBUTION

1. Modelling a contrast-dependant surround modulation of V1 receptive fields.
2. Considering four different types of surround: full, iso-orientation, orthogonal-orientation, and far.
3. Introducing a V2 centre-surround mechanism to pool perpendicularly-oriented V1 signals.
4. Accounting for a shape-sensitive feedback connection from higher visual areas, i.e. V2, to V1.

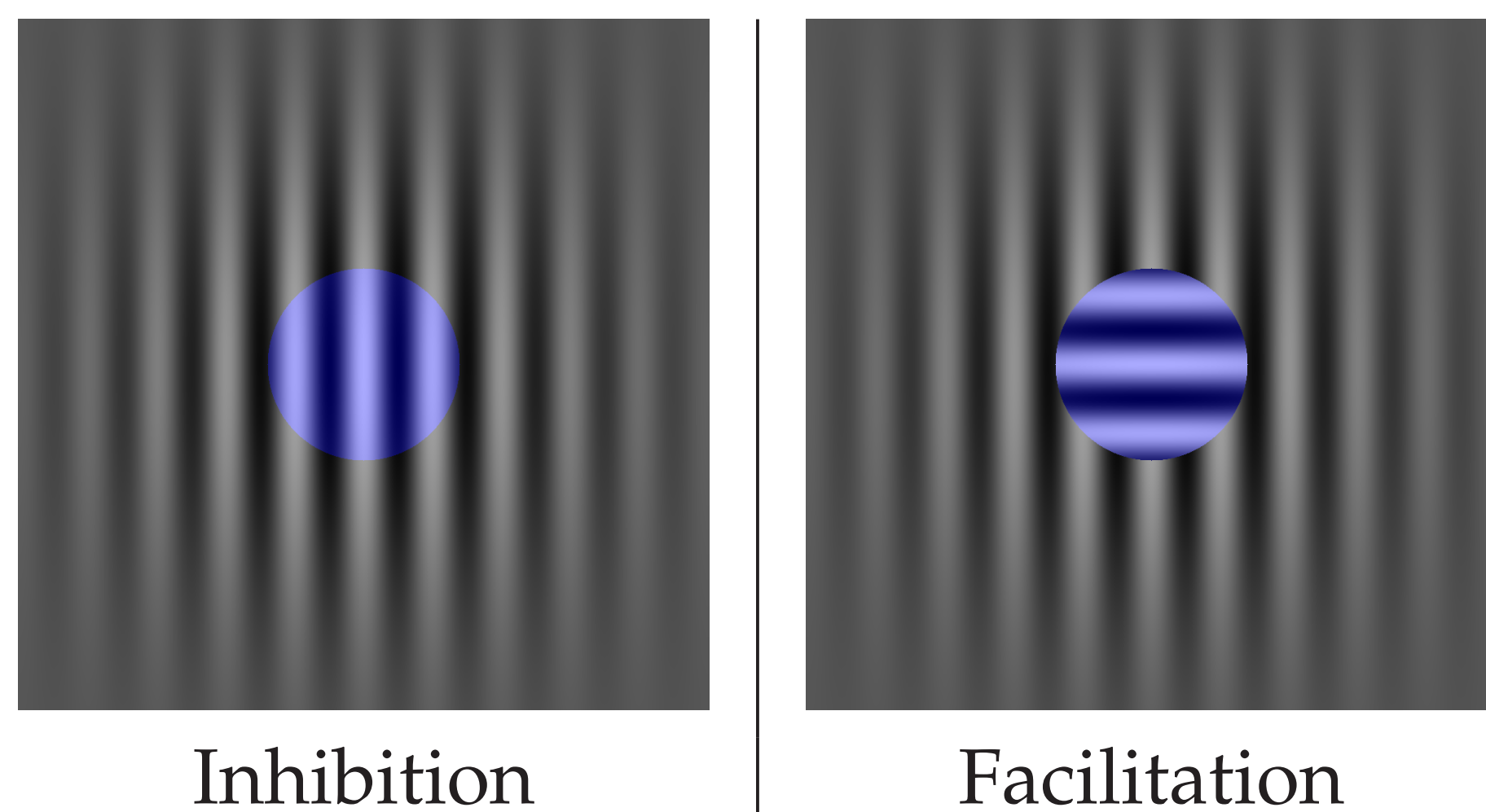
BACKGROUND

Iso- and orthogonal-orientation surrounds



Stimulus presented at the same orientation to the main axis of a receptive-field produces facilitation, whereas stimulus orthogonal to the main axis causes inhibition [3].

Full surround (i.e. isotropic region)



When the full surround shares the same orientation as the target, the modulation is inhibitory. Strong facilitation emerges at orthogonal full surrounds [1].

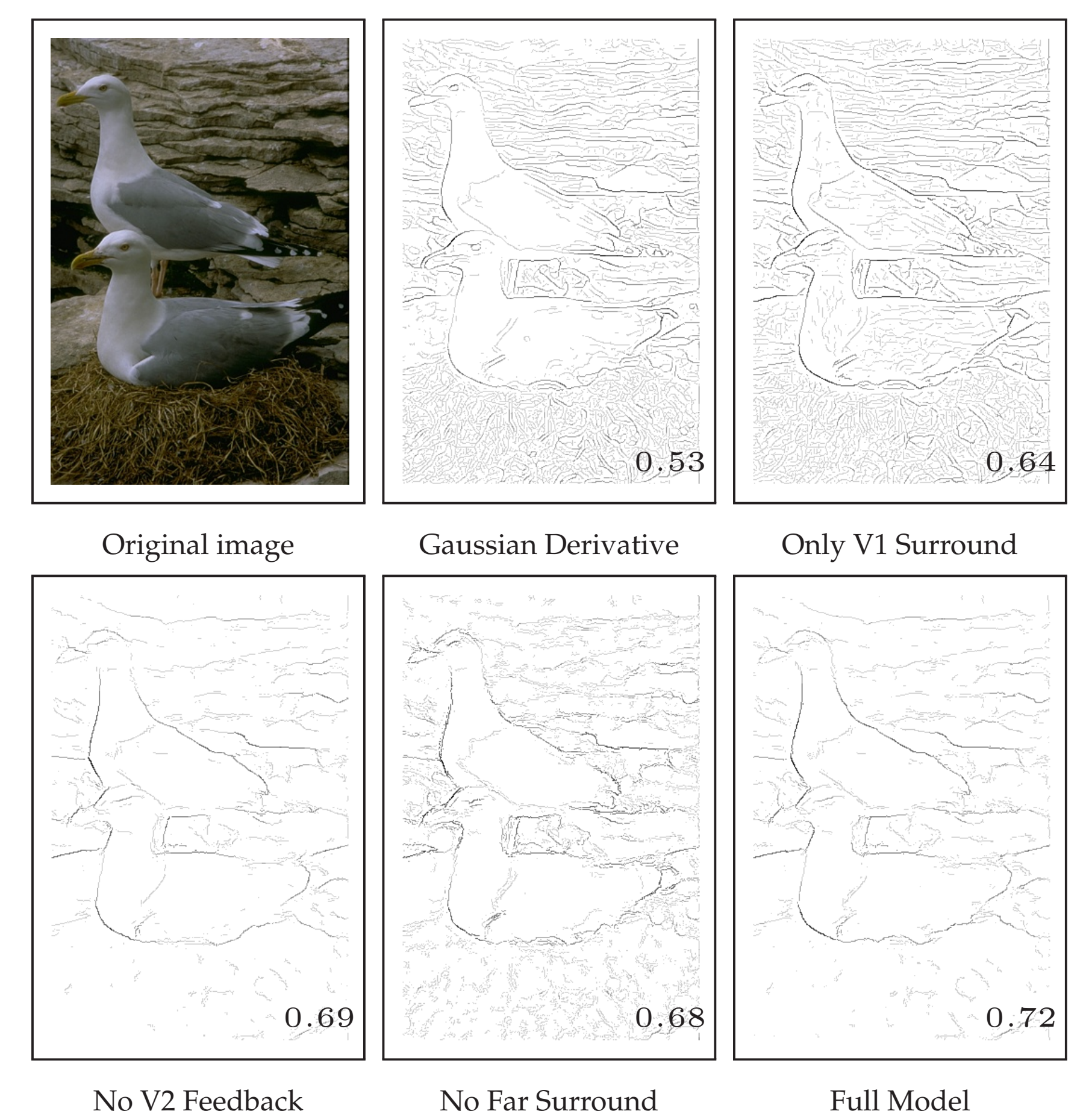
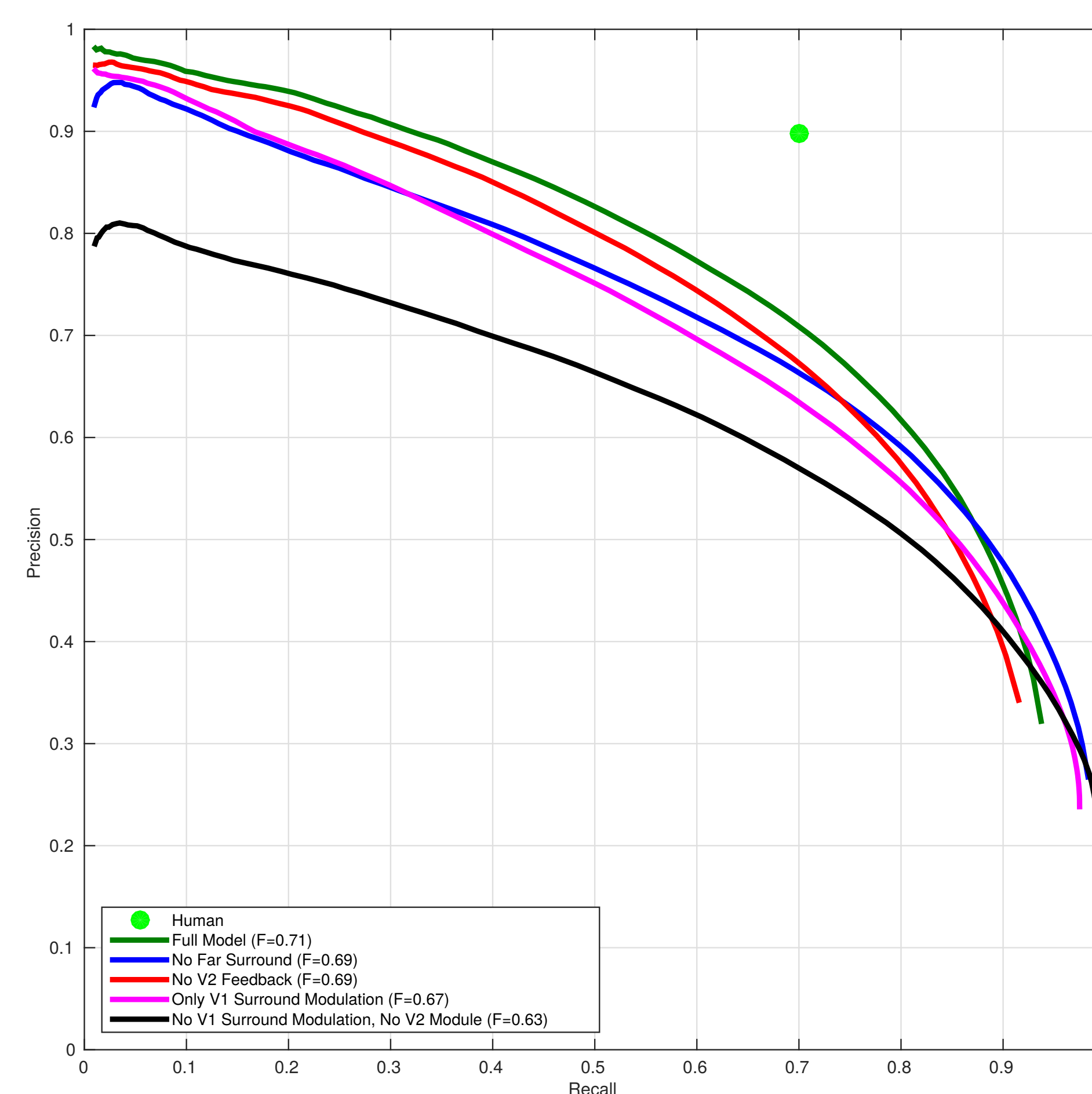
ACKNOWLEDGEMENT

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RESULTS

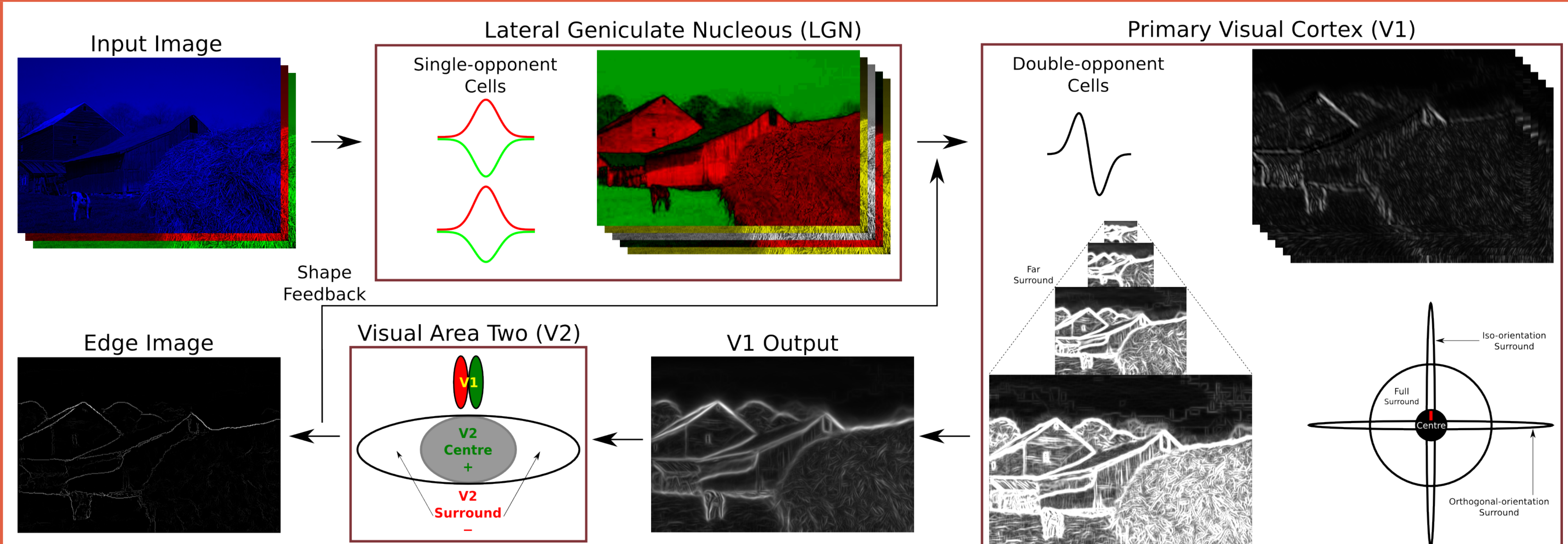


Harmonic means (referred to as F-measure) are indicated on the bottom right corner.



Evaluation of the different components of proposed method. The graph on the left is the precision-recall curve on the BSDS500 benchmark dataset. In the legends the optimal scale for the entire dataset F-measures are indicated. The images on the right show the result of our full model on one exemplary image along with the four experiments we conducted.

METHOD



The flowchart of our model. Balanced and imbalanced colour opponent channels are created in the retina and sent through the LGN. Orientation information is obtained in V1 by convolving the signal with a derivative of Gaussian at twelve different angles. We model four types of orientation-specific surround: full, far, iso- and orthogonal-orientation. In V2 the signal is further modified by input from surrounding areas in a directional orthogonal to that of the original RF. Shape feedback is sent to V1 as an extra channel.

REFERENCES

- [1] G. Loffler. Perception of contours and shapes: Low and intermediate stage mechanisms. Vision Research, pages 2106–2127, 2008.
- [2] R. Shapley, M Hawken. Color in the cortex: single- and double-opponent cells. Vision Research, pages 701–717, 2011.
- [3] D. Field, J. Golden, A. Hayes. Contour integration and the association field. The new visual neurosciences, pages 627–638, 2013.