Effects of Image Size on Clutter Perception: More Evidence for Proto-Object Segmentation

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Introduction

- **Question:** Screens are getting really large or really small.

  How is clutter perception affected by retinal image size?

- **Goal #1:** Characterize effects of retinal image size on relative and absolute clutter perception.

  Relative judgments: Would small scenes be ranked similarly for clutter as large scenes?

  Absolute judgments: Do small scenes appear more or less clustered than large scenes?

- **Goal #2:** Can the proto-object model of clutter perception [1] explain observed effects of image size?

Images and Behavioral Methods

- 90 images of real world contexts from [2].

  - 800×600 (large) and 200×150 (small) pixel versions

    - Selection was based on object counts (even division into 6 groups).

- Procedure

  - Raters (20 in relative task, 18 in absolute task) rank ordered the 90 image set from least to most cluttered using a GUI developed in Matlab. Participants were told to use their own definition of clutter.

  - 2 screens were used. An image was selected randomly from the set and displayed on the bottom screen. The top screen showed 2 images from the set of images that were already rank ordered.

  - Raters would scroll through the top list to decide where the bottom image should be inserted into the ranked set.

- Relative Clutter Ranking

  Images were either all large (27°×20°) or all small (6.75°×5°) and interleaved.

- Absolute Clutter Ranking

  Half small and half large images, randomly selected and interleaved.

Proto-object Segmentation Method


2. Use Mean-shift [4] to cluster the median superpixel colors, then merge those superpixels sharing the same color cluster (Hue) to form a larger perceptual fragment that we define to be a proto-object.

3. Clutter is estimated as the normalized count of the number of proto-objects extracted from an image.

Examples of scenes with different levels of clutter:

- Left to right: Original image, superpixel segmentation with k = 500, 385 proto-objects post merging, score = 0.187, proto-object visualization.

  - Model ranking position: 3/90, behavioral ranking position: 1/90.

- Left to right: Original image, superpixel segmentation with k = 500, 126 proto-objects post merging (score = 0.292), proto-object visualization.

  - Model ranking position: 1/90, behavioral ranking position: 1/90.

- Left to right: Original image, superpixel segmentation with k = 600, 48 color clusters, normalized score = 0.463, proto-object visualization.

  - Model ranking position: 3/90, behavioral ranking position: 0/90.

- Left to right: Original image, superpixel segmentation with k = 600, 48 color clusters, normalized score = 0.582, proto-object visualization.

  - Model ranking position: 3/90, behavioral ranking position: 0/90.

Results

- Left plots show that small and large (from [1]) clutter images were not ranked similarly for relative clutter: relative clutter perception is invariant to image size. High correlations (post show) were also found between the small (p=0.620) and large (p=0.783) image rankings from the relative clutter perception model. Relative clutter perception is also invariant to image size.

- The right plot shows that the proto-object model is highly correlated with the relative ranking of small images and less so with large images. Similar high correlations were found for the absolute task (p=0.77 for small, p=0.77 for large).

Model Robustness

- The proto-object model is very robust over a wide range of parameter settings. At it’s worst it still correlated 0.71 with small images in the relative clutter task.

Model Comparison

- The left plot shows that the proto-object model outperforms other clutter estimation methods for both small and large images (relative task).

  - Absolute clutter perception is more invariant to image size than relative clutter perception.

Answers to Questions

- **Q:** How does clutter perception change with retinal image size?

  - A: it doesn’t; both relative and absolute clutter perception judgments are invariant to image size (over the range tested).

- **Q:** Can the proto-object model capture this size invariance in clutter perception?

  - A: it sure can! Not only was it the best predictor of small and large image clutter rankings out of the methods tested, it was the least affected by change in image size. This further supports the suggestion that clutter perception varied with the number of mid-level perceptual fragments extracted from an image, proto-objects.

References & Acknowledgments


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