Fixations on Low-resolution Images

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Goal: to understand how image resolution affects fixation locations and consistency

Most prior work on gaze tracking focuses on high resolution images. We want to understand how image resolution affects fixation locations and consistency across humans.

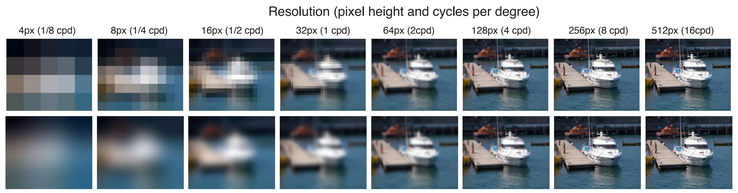
Eye tracking experiments

Models of Saliency

(a) Original image (b) Hou and Zhang (c) Itti and Koch

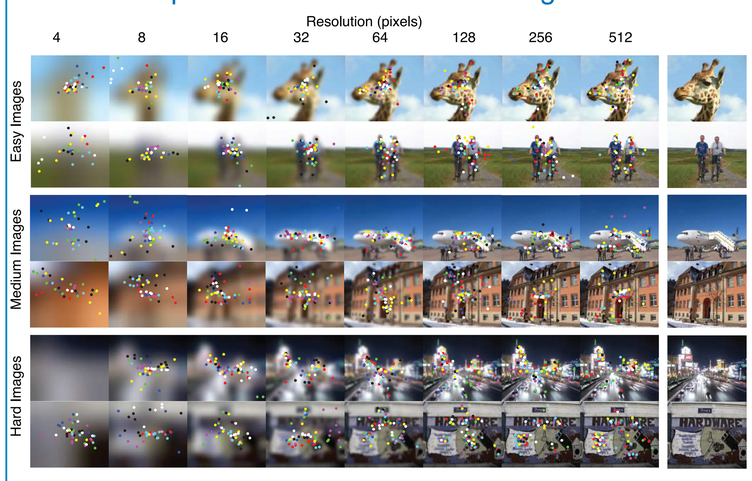
Images > 256px

Eye tracking experiment: we showed 168 images at 8 resolutions to 64 observers

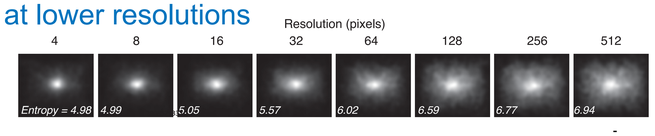


Top row shows downsampled images and illustrates the amount of information available. The upsampled images were shown to viewers.

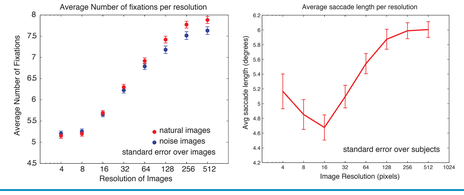
Fixations captured in 3 seconds of viewing



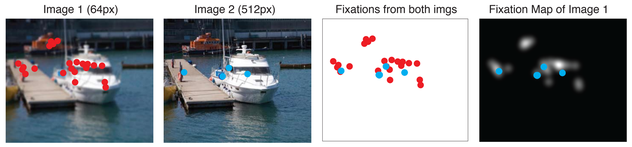
Human fixations become more biased toward the center at lower resolutions



Saccade length and number of fixations decreases at lower resolution

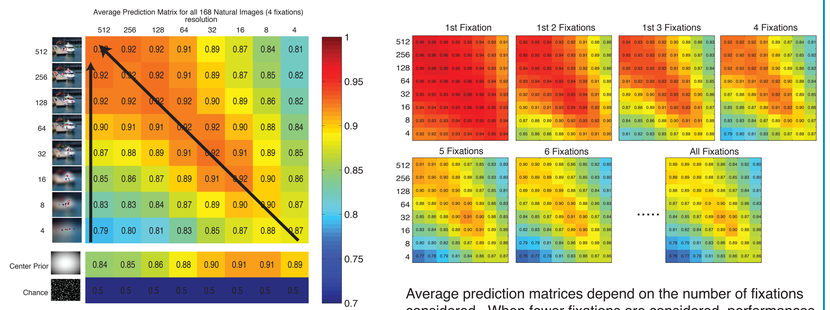


We use an receiver operator curves to measure fixation consistency



We use an ROC curve to measure how well a fixation map for an image created from the fixations of several users predict the fixations of a different user on the same image at either the same or a different resolution.

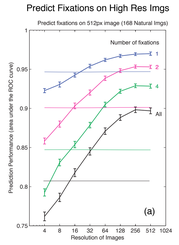
Prediction matrices show fixation consistency across resolutions



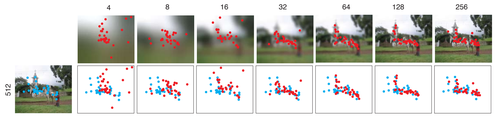
This average prediction matrix shows how well fixations of images down the rows predicts fixations of images along the columns.

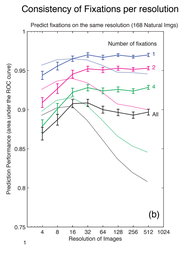
Average prediction matrices depend on the number of fixations considered. When fewer fixations are considered, performances are higher illustrating that humans are more consistent on their earliest fixations.

Findings:

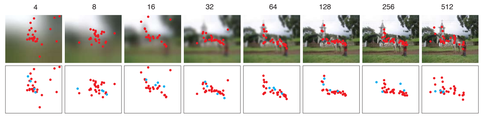


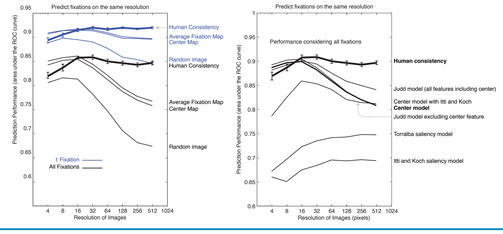
Fixations from low-res images can predict fixations on higher-res images





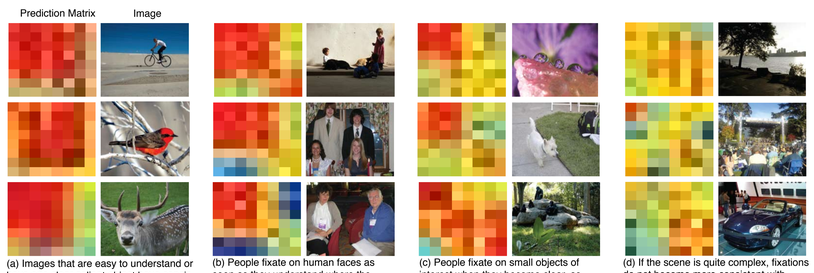
As resolution increases to ~32px, consistency of humans increases. Afterwards, consistency remains constant despite spread of fixations





Humans predict each other better than several baselines and saliency models

Consistency depends on image complexity: the more complex the image, the lower the consistency

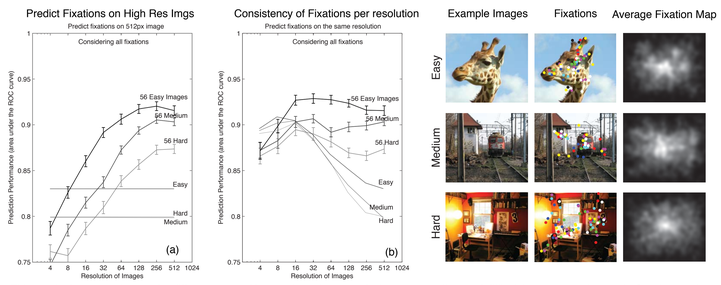


(a) Images that are easy to understand or have one clear salient object have consistent fixations even at very low resolutions.

(b) People fixate on human faces as soon as they understand where the faces are.

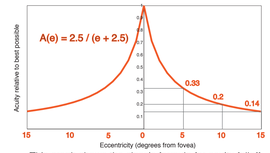
(c) People fixate on small objects of interest when they become clear, as seen here on the relections of the flower, the dog, and the chimps.

(d) If the scene is quite complex, fixations do not become more consistent with resolution.



This graph shows consistency for different types of images based on complexity: easy, medium and difficult images to understand. Consistency is much higher for "easy" images as compared to "hard" images. In addition, consistency peaks and then declines more strongly for the hard images as resolution increases.

Falloff in visual acuity may affect fixations

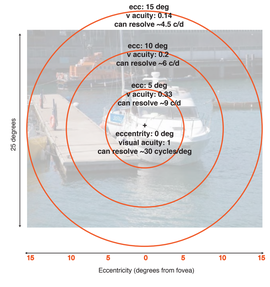


This graph shows the classic formula for acuity falloff where acuity is normalized to 1 in the fovea.

When looking at high resolution images, viewers cannot resolve all details and must actively move their eyes.

When looking at an images of 64px (2cpd) or below, one is able to resolve all image information even in the periphery. This lessens the need to actively saccade.

This could help explain why consistency is so high and so biased to the center for images of 16-64px



Main take-away: for some applications, working with fixations on images of mid-level resolutions (16-64px) could be perceptually adequate and computationally attractive.

Acknowledgements

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More inofmraiton at http://people.csail.mit.edu/tjudd/LowRes/