Title: A Neurally-Inspired Object Recognition Algorithm for a Wearable Aid for the Visually-Impaired: Attention-Biased Speeded Up Robust Features (AB-SURF)

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Abstract: The neural substrates that explain the ease with which humans recognize objects – in spite of changes in scale, position, and illumination – are largely a mystery. Emulating human recognition in machines thus remains a challenging task in the field of computational neuroscience. However, neurally-inspired computer vision algorithms that harness features characteristic of human visual attention, including color, orientation, and intensity, can be used to make the recognition task more tractable. Here we describe the development of computer vision algorithms aimed at helping visually-impaired people locate and recognize objects in their surroundings. Our neurally-inspired computer vision algorithm, called Attention Biased Speeded Up Robust Features (AB-SURF) functions in two key stages: first, an attention biasing algorithm selects the most task-driven salient regions in an image, narrowing the search space only to those regions most consistent with a user's object query. Next, the high-performing SURF object recognition algorithm is applied on this narrowed subsection of the original image. Testing on images containing 5 different household objects exhibits accuracies ranging from 80% to 100%. Furthermore, testing on images containing 10 objects yields accuracies between 63% and 96% for the 5 objects that occupy the largest area within the image subwindows chosen by attention biasing. A five-fold speed-up is attained using AB-SURF as compared to the time estimated for sliding window recognition on the same images. This attention-biased object recognition algorithm has already been integrated with a voice/touch command module, which allows for a user to query for a desired item, and is in the process of being integrated with object tracking as well as audio feedback modules, paving the way for a prototype wearable aid system which will allow visually-impaired users to locate, recognize, and grasp desired objects.

Fig. 1. (Above left) Wearable Visual Aid System Overview: (a) Head-mounted camera, integrated within glasses, to capture the external scene; (b) Voice command module for user query; (c) Attention biasing to narrow the region of interest (shown in red box); (d) Queried object recognized by comparison with the best match from the database (image shown in cloud), [(c) and (d) together comprise AB-SURF]; (e) Confirmed object location marked in yellow box, subsequently tracked over time in multiple frames; and (f) Audio cues provided back to the user via bone conduction headphones.

Fig. 2. (Above right) Example of top-down attention biasing. Red boxes surround desired objects, to which attention has been focused in the biased saliency map, as compared to the unbiased saliency map, which highlights all salient objects equally.