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Preliminary Development of PalmSight: Letting the Visually Impaired See using a Hand-Held Device

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Introduction: According to the 2012 National Health Interview survey, as referenced by the American Foundation for the Blind (AFB), there are approximately 20.6 million adults in the United State reporting significant vision loss [1]. Those with severe vision loss are left to navigate the world reliant on white canes, service dogs, and most importantly, their sense of touch. If those with visual impairment were given the ability to more accurately identify objects in their surroundings at a distance, they could subsequently complete everyday tasks more effectively. PalmSight is a device that imitates vision through a camera on the user's palm and provides vibrotactile feedback that directs the user to an identified object until it is in their grasp. It is an extension of previous work in our laboratory on a device called FingerSight, for navigation by the blind [2].

Materials and Methods: While ultimately PalmSight will be a device that identifies arbitrary objects, it is initially being developed to simply detect any orange-colored object. Device development was split into three main systems: object identification, vibrotactile feedback, and communication between these two systems. To allow the palm camera to see the color orange, OpenCV, an open-source computer vision library, was used. Images produced from the palm camera were split into red, green and blue (RGB) color channels, and the distance between each individual colored pixel and a specific RGB value for orange was calculated in a 3D feature space. Thresholding and morphological operations were used on the distance image to produce a segmented image containing a single object. The centroid of the object was then calculated and localized to one of nine equally sized portions of the display, corresponding to an array of five *tactors* (vibrating mechanisms) on the back of the hand. These tactors consisted of specially adapted speakers (GC0301K; CUI, Inc.) driven by 210 Hz sinusoidal waves, gated by 3.0 Hz square waves. A Wixel microprocessor provided the interface between the vibrotactile system and the computer vision software running on a Microsoft Surface-Pro computer, allowing the vibrating tactors to be controlled to correspond to the location of the orange object in the camera image.

Results and Discussion: To date, the orange identification system has been fully developed and identifies orange objects from the surroundings, outputting a binary image from which the location of the dominant object can be found (Fig. 1). The program determines which of the nine regions of the screen contains the orange object and uses this information to activate the corresponding tactor(s) on the back of the hand (Fig. 2).

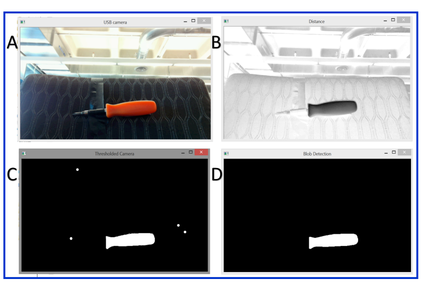

Figure 1

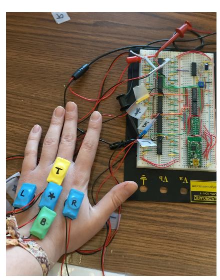

Figure 2.

Figure 1. Image output from Orange Identification System. (A) Raw image capture, (B) Distance from the color orange, (C) Thresholded image, (D) Morphological Operations applied to the final image to remove outliers.

Figure 2. Vibrotactile Feedback System consisting of five-tactor array and support circuitry. Individual tactors or pairs of tactors are activated to identify which of 9 regions of the screen contain the orange object.

Conclusions: The new PalmSight device shows promise in assisting the visually impaired individual to find and grasp objects. After further developing of the orange identification and vibrotactile feedback systems, we will test our initial hand-held prototype on non-visually-impaired, blindfolded volunteers to verify its effectiveness and usability at picking up orange objects.

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References:

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