FingerSight: Vibrotactile Ring for Guidance of Hand-Held Tools by Visually Impaired

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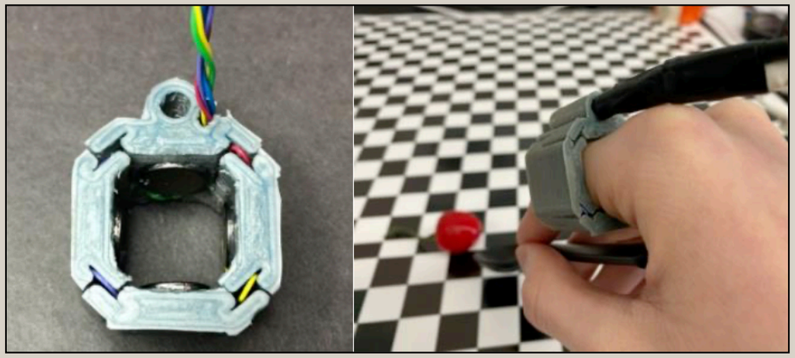
ABSTRACT

Although various assistive technologies have been developed for the visually impaired for navigation while walking, the commonplace problem of finding nearby objects remains troublesome. Accurate localization and feedback are needed particularly when objects are not suitable for touching with the hand and require tools to handle. “FingerSight” is a wearable device intended to help the visually impaired locate a target within close range and manipulate it. The presented research developed novel computer vision methods for identifying handheld tools in real time and redesigned the hardware. Preliminary results show the system’s promise in real-life scenarios.



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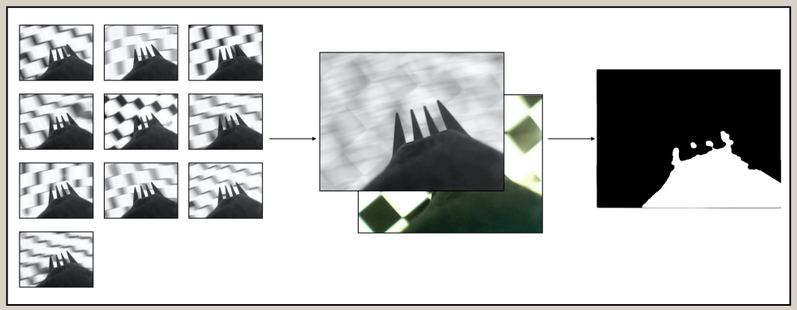
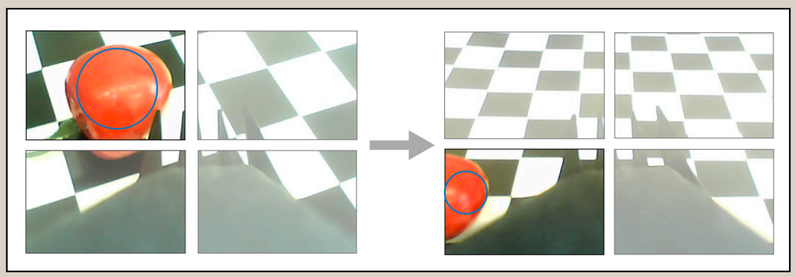
MATERIALS & METHODS

The device combines computer vision and tactile feedback using a small device worn on the finger. It includes a miniature video camera and four vibrators that give tactile cues for directions relative to the hand. The vibrators are embedded into a soft plastic ring with expandable joints to permit variation in finger size and reduce cross-transmission. A portable Raspberry Pi 4 computer runs the following functions in real time:

- tool detection: by comparing each pixel in the current frame with a running mean, we can segment the moving part (background) from the stationary part (tool);
- target detection utilizing (for now) color filtering;
- acquisition guidance: by dividing the camera frame into four quadrants and taking samples from each, we can detect target motion caused by contact with the tool (rolling off, bumping, etc.), and by comparing two consecutive frames, immediately suggest corrective maneuvers via vibrations.





DISCUSSION & CONCLUSION

Initial testing was performed by a sighted subject using a blindfold and attempting to scoop up a plastic cherry with a spoon. The subject’s hand started at an elevated position from a checkerboard surface and was guided by FingerSight towards the target. Bumping and missing was detected and corrected for appropriately. Several limitations became evident with the present system. The present tool detection algorithm requires a non-homogeneous background (the checkerboard) and the target detection algorithm is admittedly simple(color).

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