3D Depth Imaging for Assistive Guidance

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Abstract:

The standard cane is the most widely used mobility tool by the blind community. However, traditional cane travel can be difficult, as standard canes are unable to detect fluctuations in terrain. In order to bolster the capabilities of cane travel, a novel "smart cane" has been developed, which implements real-time depth detection mechanisms to help improve the safety and efficiency of cane travel. This system consists of a 3D depth detecting camera, mini computer and haptic feedback device, to locate objects in the way of the user and trigger a vibration to the cane in real time. The combination of these tools will warn the user of the obstructions in their way. This direct feedback mechanism can help the visually impaired navigate with confidence and ease.

Introduction:

We wish to design a system that assists local navigation for the blind and visually impaired people by providing feedback on obstacles and descriptions of identified objects.

Computer vision can be used to enable purposeful navigation and object identification. Purposeful navigation can be defined as guided motion through space toward a desired target while avoiding obstacles. The challenge is to robustly process the sensor feedback from a cane system and to intuitively map the feedback to directions and semantic descriptions of the environment that meet the needs and goals of the blind person. A natural option would be to produce an audio stream that describes the space. However, audio feedback becomes indistinguishable in noisy environments and can interfere with the perception of auditory environmental cues on which blind people depend for situational awareness. Blind users have expressed a strong preference for a miniaturized design packaged in an unobtrusive solution. This limits the choices in sensing, computation, and feedback mechanisms. This research develops an end-to-end smart cane solution to enable purposeful navigation that uses a portable depth- camera to extract information about the local state of the world, such as the range and direction of obstacles, the direction of free space, and the identity and location of target objects within a space. The object detection and recognition algorithm of the system assists the user in navigating around human targets. We have decided to provide navigational cues through sensory feedback from vibration motors that will alert the user when objects are obstructing their path.

Figure 1. Cane Diagram

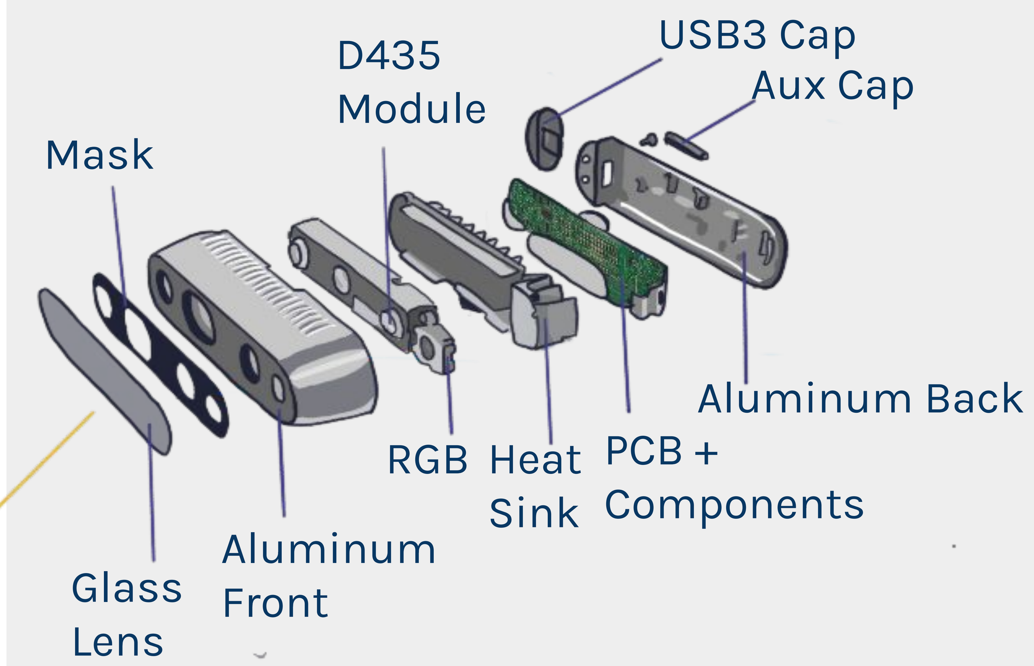

Figure 2. Inside the D435 depth camera.

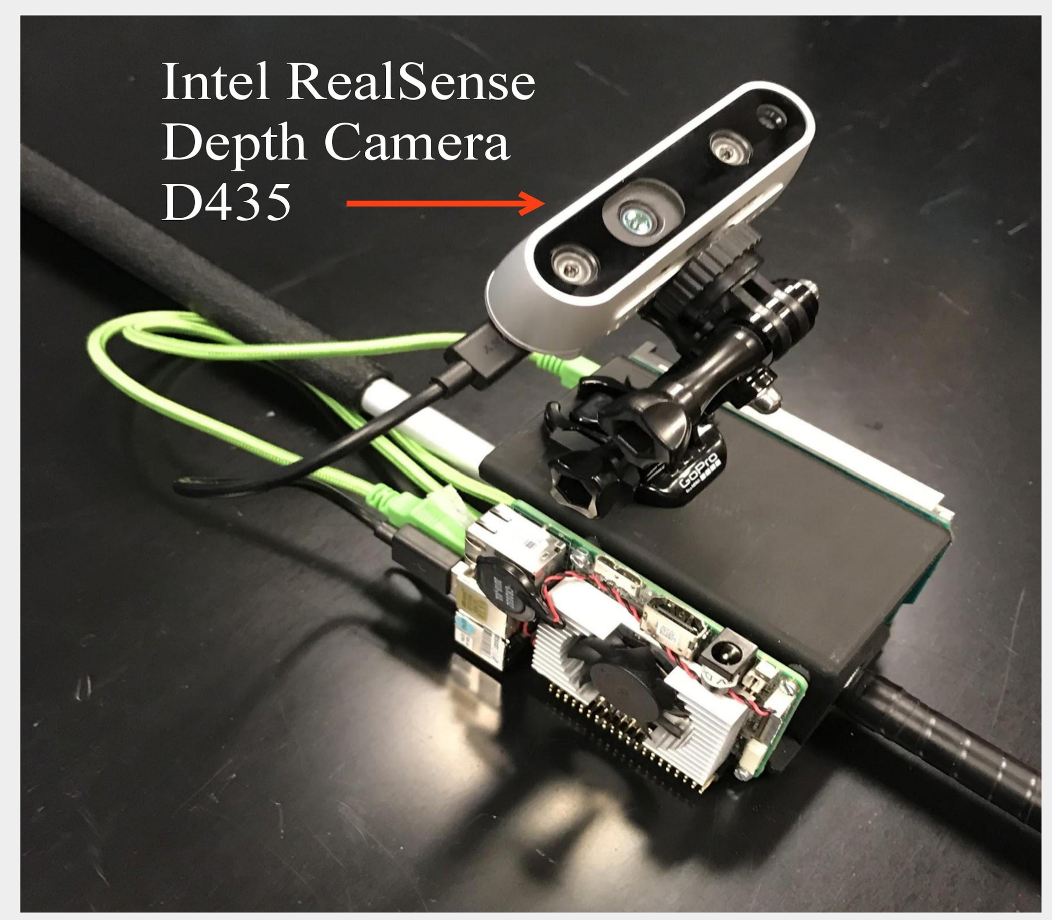

Figure 3. Isometric View

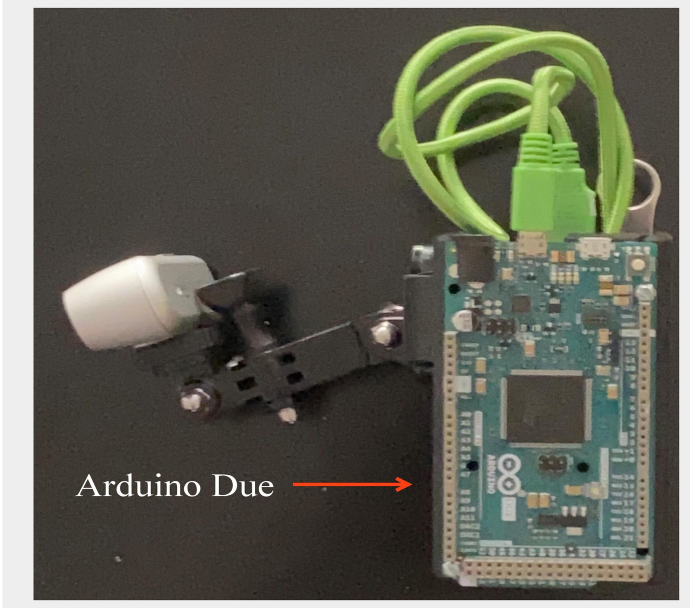

Figure 4. Right View

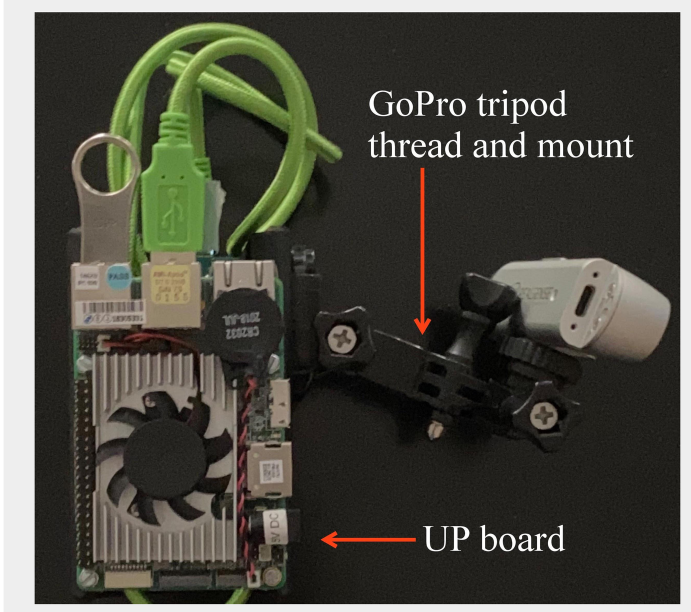

Figure 5. Left View

Figure 6. Back View

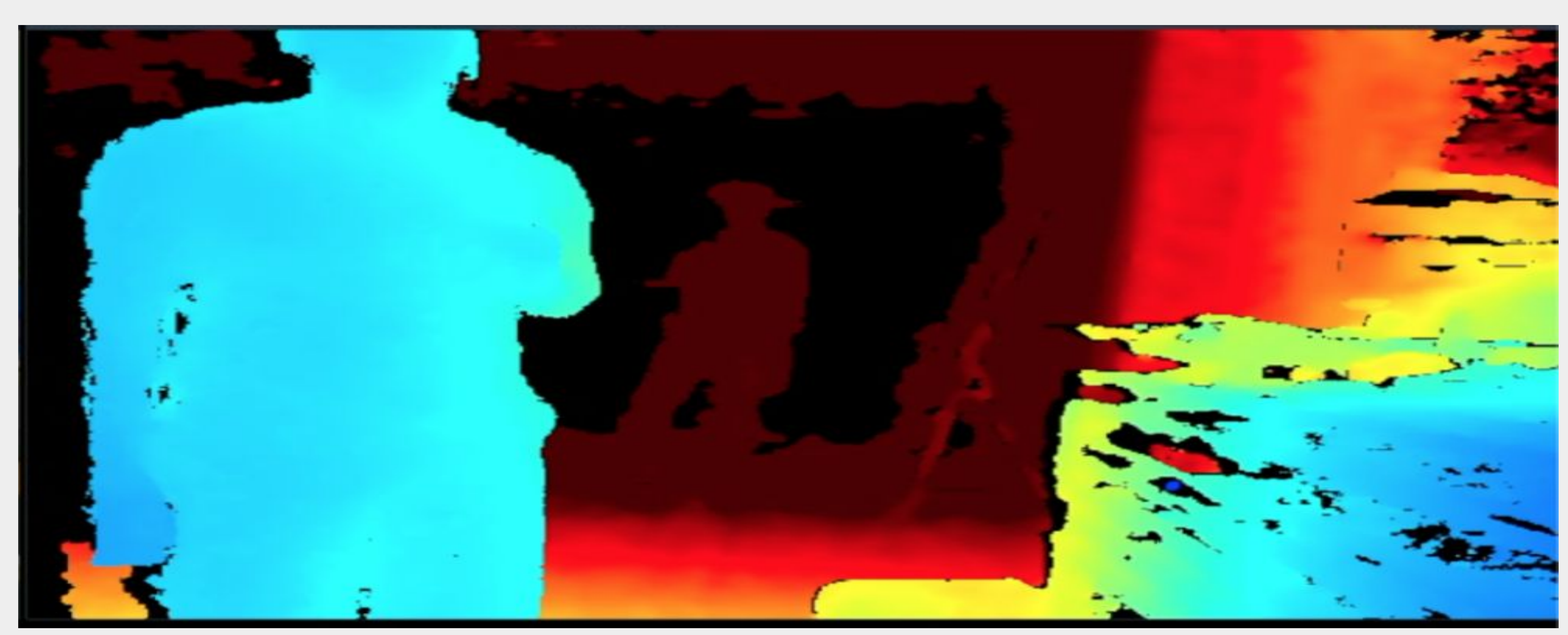

Figure 7. Intel Realsense D435 displaying depth to screen using RGB values.

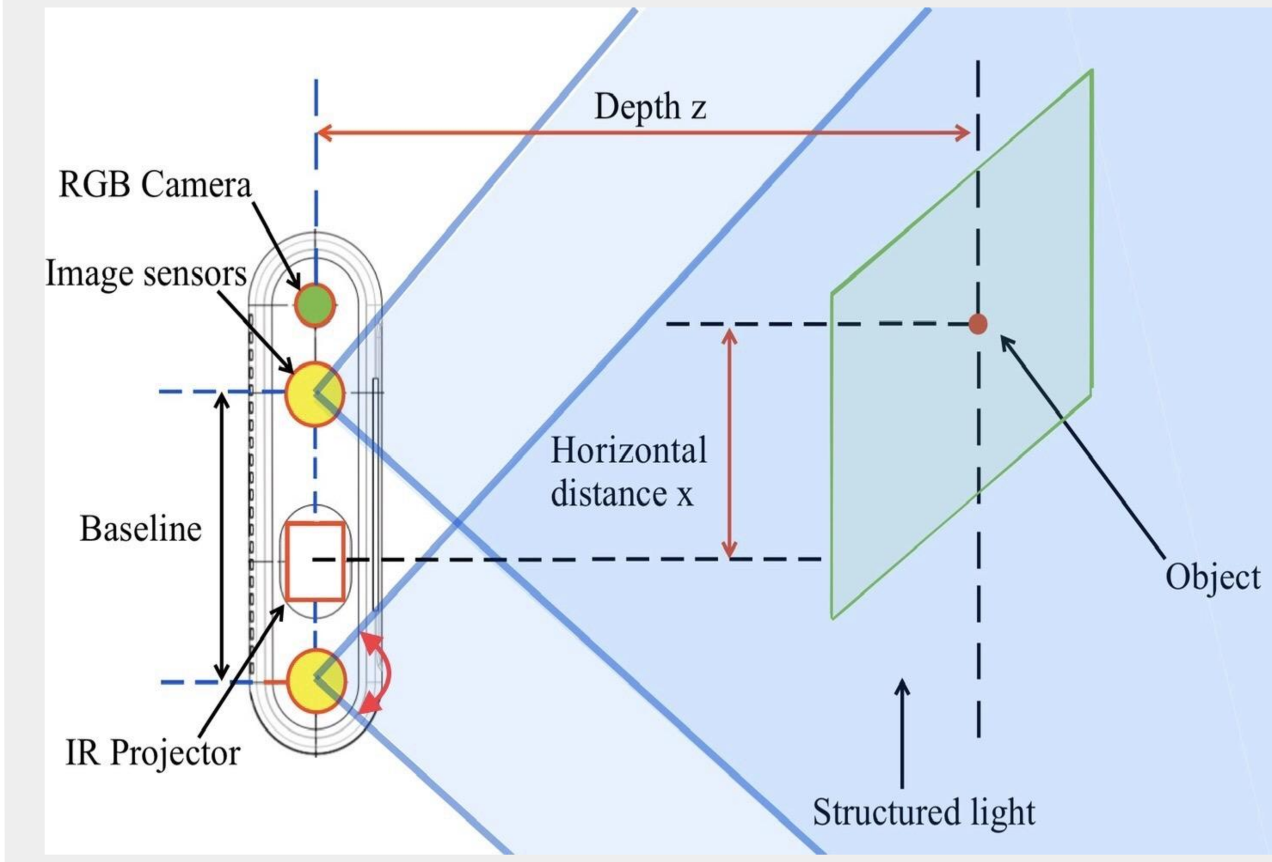

Figure 8. The depth perception based on active infrared stereo vision technology

The Intel Realsense D435 camera uses active infrared (IR) stereo vision technology, which is shown in Figure 3. The stereo vision system uses two image sensors and one infrared (IR) projector. The infrared projects invisible IR patterns to improve the depth accuracy in the scenes. The depth value for each pixel can then be calculated by the relation made by points on the left image to the right image.

Experimental Apparatus:

The system is attached to a standard white cane and uses the Intel RealSense D435 as the main stereo camera to detect the raw depth data. The depth camera will be secured to the cane by a casing. The raw depth data will then be converted into viable information that can be used to trigger the vibration motors which are placed inside the cane. Based on the distance of the closest object the cane will trigger the vibration motors warning the user of the obstacle ahead. The computer will run the algorithms needed to compute the distance and the difference in distance to trigger the vibration motors, based on distance the vibration will vary from soft to hard vibration.

Conclusion:

This device has the potential to help the visually impaired. By using this smart cane system, users will be able to comfortably travel without solely relying on the standard white cane. The additional features allow users to have more confidence and give them the freedom to travel without worry.

Acknowledgements: