Problem

Currently, visually impaired people understand and navigate their surroundings through the use of guidance canes (requiring active probing) and service dogs (limiting a user to indirect information).

Objective

Use sensory substitution to create a passive and direct way for visually impaired people to avoid immediate obstacles.

Current Solutions

Design Principles

This project aims to simulate perception in our natural biological system by replacing it with a sensor and a haptic grid.

- Vest design is removable and adjustable
- Haptic grid stimulates torso area, allowing for hands/ears-free operation
- Easily turn on/off haptic feedback depending on situation
- Noiseless

VisionVest

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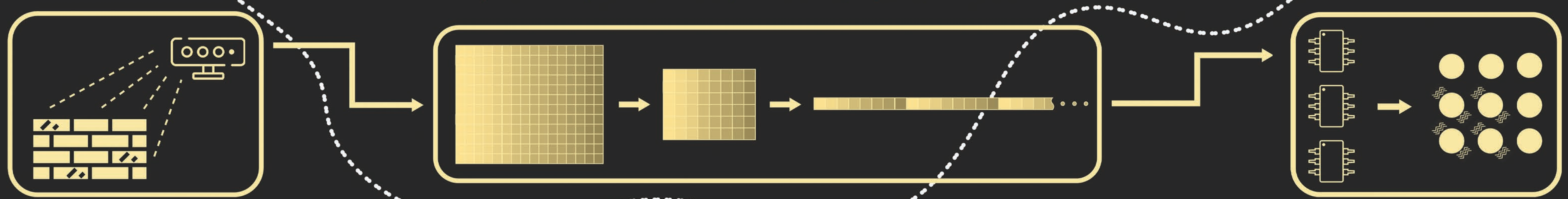
Results

Specification	Design Points	Outcome
Weight	<10% Avg. body weight	1.05 kg
Dimensions	<24" tall	50 cm x 42 cm x 4.5 cm
Range	0.05 m to 1.75 m	0.1 m to 2 m
Battery Life	>30 mins	2.5 hrs @ max power
Flexibility	One size fits all	Yes

Alternative Designs

Alternate Design	Pros	Cons
Sensing		
Ultrasonic Grid	• Works well in varying light conditions • Easier data processing	• Expensive • Large and bulky sensor
Stereoscopic Camera	• Cheap • High resolution, accurate	• Complex data processing • Does not perform well in low light
Feedback		
Auditory	• Leverages existing headphone hardware • Small form factor	• Reduces hearing, an important sense for the visually impaired • Lack of direct detailed information to user
Haptic Wristband	• Small form factor, unobtrusive • Direct haptic feedback	• Inconsistent one-dimensional feedback
Haptic Headband	• Direct haptic feedback • Unobtrusive, allows freedom of movement	• One-dimensional feedback



Environment Sensing

- Environment sensing is done through a Time-of-Flight (ToF) sensor mounted on the chest of the user
- Provides 100° (W) x 85° (H) field of view
- Vertical-cavity surface-emitting laser (VCSEL) sends out modulated IR light
- The reflection of the modulated light is received by the 3D imager
- 3D imager measures phase shift of the modulated light and determines the distance to the target

Data Processing

- All processing occurs on internally powered Raspberry Pi
- Sensor sends raw data to Raspberry Pi at 10 FPS
- Noise removal using sliding window-spatial filter
- Data compression from 42 x 48 data value array to 6 x 8 data value array representative of the motor array
- Synchronous (master & slave) processes using shared memory object to transfer frames from array compression algorithm to motor mapping algorithm

Actuation

Shift register PCB

- Serialized data sent to daisy chained shift registers
- Parallel output actuates grid of 48 haptic motors
- Transistors used for powering the motors

Motor boards

- Vibration intensity calibrated for optimal distance
- Foam layers to dampen motor noise and provide user comfort