Problem Statement
- Create two wearable distance range-finding device prototypes to aid in navigation for the visually impaired
  - One device utilizes ultrasonic sensing technology
  - One device utilizes infrared sensing technology
  - Both devices should be scalable for future iterations and small to fit on a hand
  - Sensor acquired distance data sent to a nearby PC through a main control unit (MCU)
  - Develop an optimal waveguide to enhance and improve ultrasonic data acquisition

Requirements
- Accurately and reliably measure distances of objects 2 feet to 15 feet away at ±25% accuracy error
- Relay sensor data to a PC using a USB interface
- Sensor elements occupy an area less than or equal to 210 mm²
- Boards must be able to debug and program simultaneously
- Ultrasonic sensor board and infrared sensor board will be custom designed PCBs

Concepts
- Optimal Waveguide Design

Analysis of Alternatives for Sensor Approaches

<table>
<thead>
<tr>
<th>Requirements (Weight)</th>
<th>Ultrasonic Distance Sensor</th>
<th>Infrared Sensors</th>
<th>Sensor Approach Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size (1-3)</td>
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<td>9</td>
<td>2</td>
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<tr>
<td>Cost (1-3)</td>
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<td>9</td>
<td>2</td>
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<tr>
<td>Availability (1-3)</td>
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<td>3</td>
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<tr>
<td>Programming (1-3)</td>
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<td>3</td>
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<td>Future support (1-3)</td>
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<tr>
<td>Power Consumption (1-3)</td>
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<td>3</td>
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<tr>
<td>Works in Ambient Light (1-3)</td>
<td>2</td>
<td>2</td>
<td>3</td>
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<tr>
<td>Availability (1-3)</td>
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<td>2</td>
<td>3</td>
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<tr>
<td>Total</td>
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<td>15</td>
<td>15</td>
</tr>
</tbody>
</table>

Sensor Approach Selection
- Ultrasonic had trouble detecting objects >6 feet away
- Field-of-View (FOV) of infrared PCB was about 9 degrees
- Accuracy of infrared decreases as objects are further away from the device

Results
- Ultrasonic PCB Layout
- Infrared PCB Layout

Summary
- Both sensors were able to accurately range-find objects up to 6 feet away
- Infrared approach contains a much narrower field-of-view than ultrasonic approach
- Infrared senses objects from 15 feet with some error

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