Hazard Detection System for Skiers: A Modified Ski Design Utilizing Optimal Sensor Models

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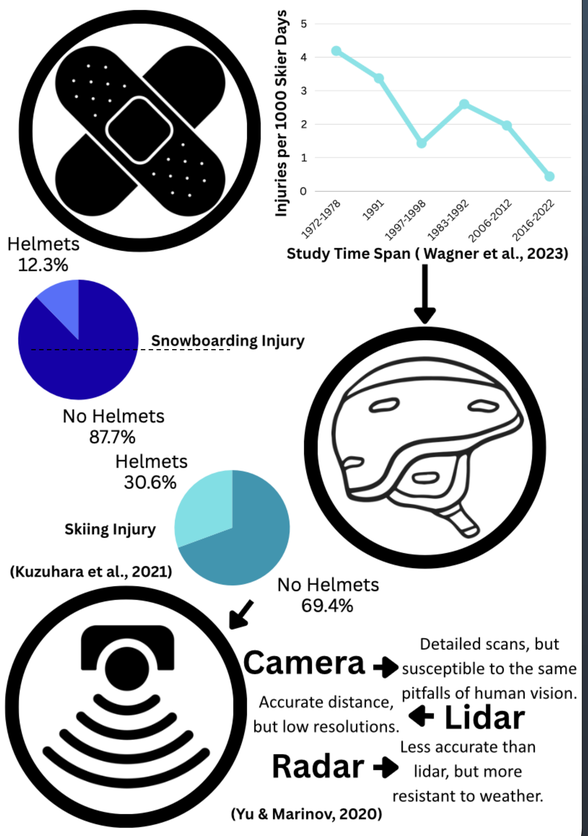
Problem Statement

Current safety equipment for skiing does not focus enough on preventing collisions allowing for more injury and making skiing less accessible for novice skiers.

Engineering Goal

This project aims to explore the feasibility of constructing an improved pair of ski goggles, utilizing sensors to detect and warn the skier of potential obstacles.

Background



Criteria

Must detect incoming obstacles	Must be lightweight	Must be inexpensive	Must be resistant to weather	Must be reliable

Results

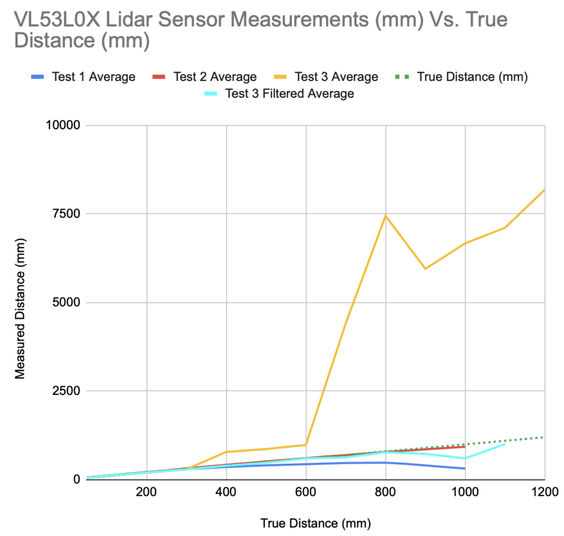


Figure 1: VL53L0X Lidar Sensor Measurements (mm) Vs. True Distance (mm). This graph shows the average distance measured at different set distances, with the different tests having different experimental setups. In addition to this, the dotted green line represents the optimal sensor outputs, given a perfect distance sensor.

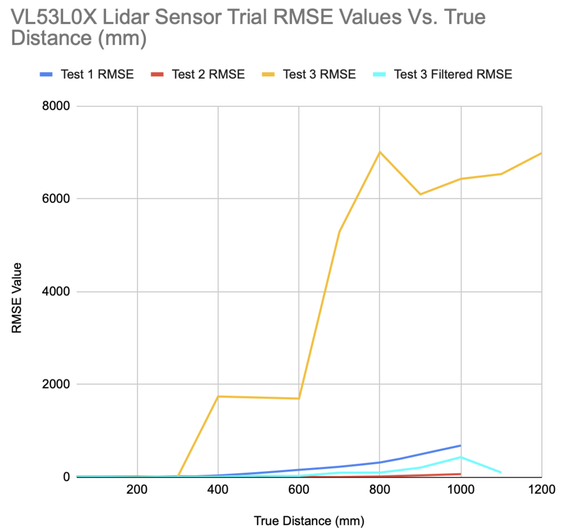


Figure 2: VL53L0X Lidar Sensor Trial RMSE Values Vs. True Distance (mm). This graph shows the RMSE values of each test shown in figure 1. A greater RMSE value indicates a greater level of error in the sensor measurements.

Discussion

As a model sensor:

- Benefits of lidar:
  - Relatively simple setup
  - Numerical output
- Downsides:
  - High error rate in raw data
  - Impacted by environment

As a component:

- Benefits:
  - Small
  - Very inexpensive
- Downsides:
  - Very low range

Future Goals

1. Extend testing to other sensors.
2. Create programs that can use the data to improve sensing capabilities.
3. Construct goggles with user interface.
4. Extend the goggle capabilities to function with other fields, such as biking.

Testing Strategy

Goal: To determine what sensors to use and how to most efficiently use them.

Execution: The test involved taking distance measurements from a lidar sensor, having been hooked up to a raspberry pi 4B.

Test 1: VL53L0X Lidar Sensor, Preliminary testing

- 50mm to 1000 mm, intervals of 50mm
- 10 measurement captures per interval

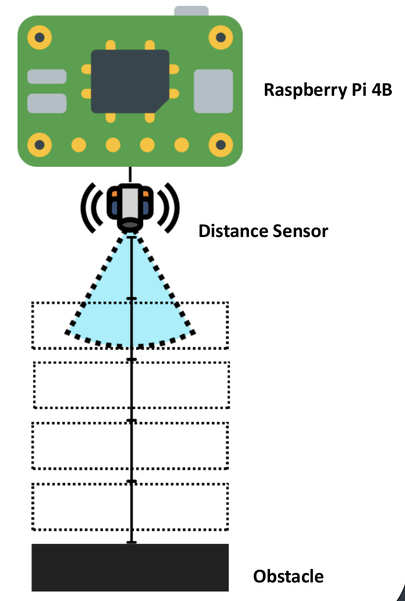
Test 2: VL53L0X Lidar Sensor, Indoors.

- Same as Test 1, with better electrical connections

Test 3: VL53L0X Lidar Sensor, Outdoors.

- 100mm to 1200mm, intervals of 100mm
- 20 measurement captures per interval.

Filtered Test 3: Test 3 data, filtered to get rid of maximum sensor values (8190 or 8191 mm)



Equipment/Materials

- Raspberry Pi 4B
- VL53L0x lidar sensor
- USB Mouse & Keyboard
- Electrical connectors
- Cardboard box with white paper