LiDAR Road Sign Deterioration Team

Ariel Steele, Danny Taylor, Gabby Germanson

Research Problem

- Traffic sign visibility at night is critical to driver safety
- Manually driving roads to detect road sign replacement is inefficient
- Deterioration has not been attributed to any single factor besides age...

Background

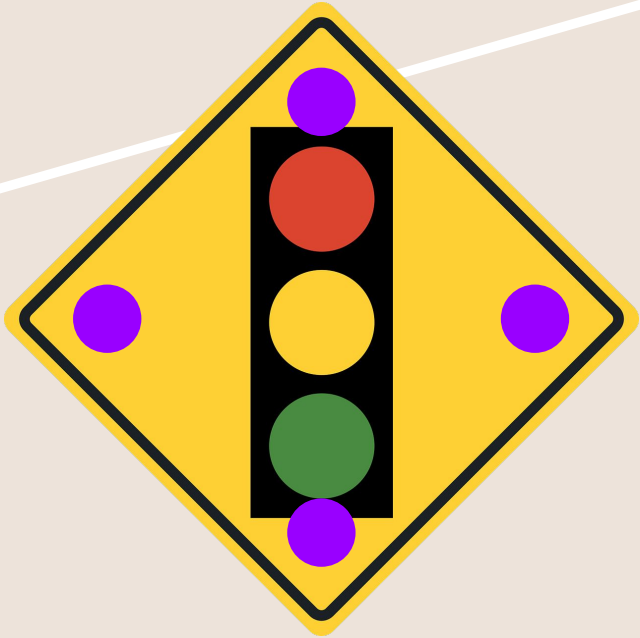
Methods of Evaluation

Visual inspection...

subjective *time consuming* *error prone*

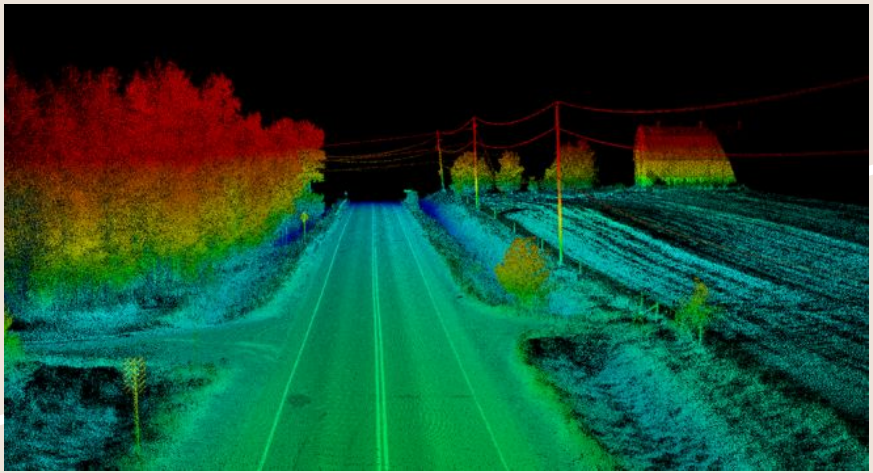
Retroreflectometer...

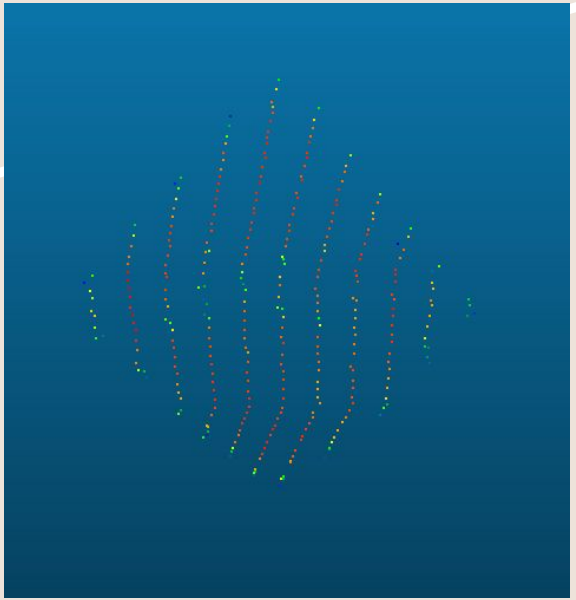
tedious *not sufficient data to predict*



LiDAR!

quick *objective* *retro-intensity point clusters*





Objectives

1. Using only LiDAR data:
    a. Locate
    b. Identify
    c. Classify
2. Be able to send GDOT automated sign locations and conditions so they know when to replace road signs at greatest sign life length.

(eventually *predict* sign deterioration)

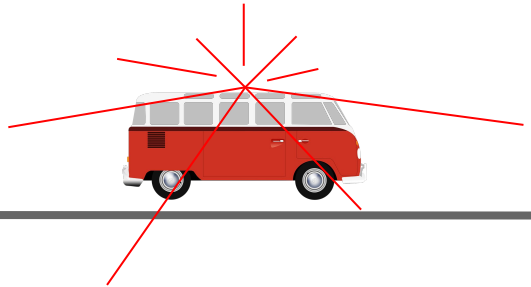
Why should GDOT care?

- Cost savings of over 3 million/annually
  - Very conservative calculation
  - Only labor savings.

- Our work becomes more valuable as autonomous vehicles become more popular.

Current Status

Drove around and collected LiDAR data for the past 6-7 years of various roads



	A	B	C	D	E	F	G	H
1	Id	X	Y	Z	Angle	Distance	Retro	UTC
2	2000000	-84.4529	33.88139	278.7242	-0.61897	4.322	0.224	69034
3	2000001	-84.4529	33.88139	278.7216	-0.6292	4.27	0.349	69034.01
4	2000002	-84.4529	33.88139	278.7308	-0.63941	4.201	0.333	69034.01
5	2000003	-84.4529	33.88138	278.7178	-0.64965	4.169	0.345	69034.01
6	2000004	-84.4529	33.88138	278.7411	-0.65984	4.082	0.357	69034.01
7	2000005	-84.4523	33.88181	284.9044	0.08881	71.696	0.118	69034.02
8	2000006	-84.4524	33.88179	284.0415	0.07852	68.482	0.212	69034.02
9	2000007	-84.4524	33.88172	283.0219	0.06822	57.533	0.224	69034.02
10	2000008	-84.4525	33.88165	282.2211	0.05792	46.243	0.255	69034.02
11	2000009	-84.4526	33.88163	281.7152	0.04763	42.578	0.267	69034.02

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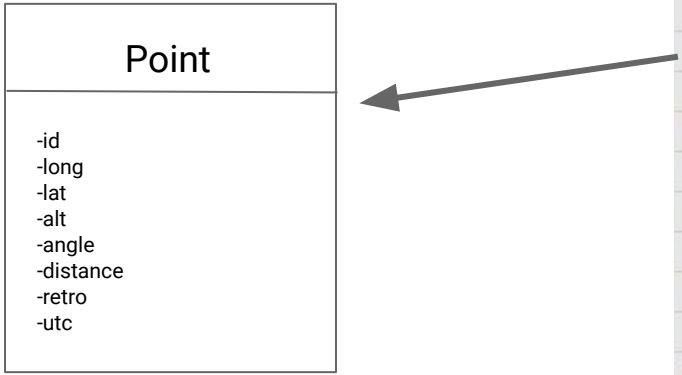

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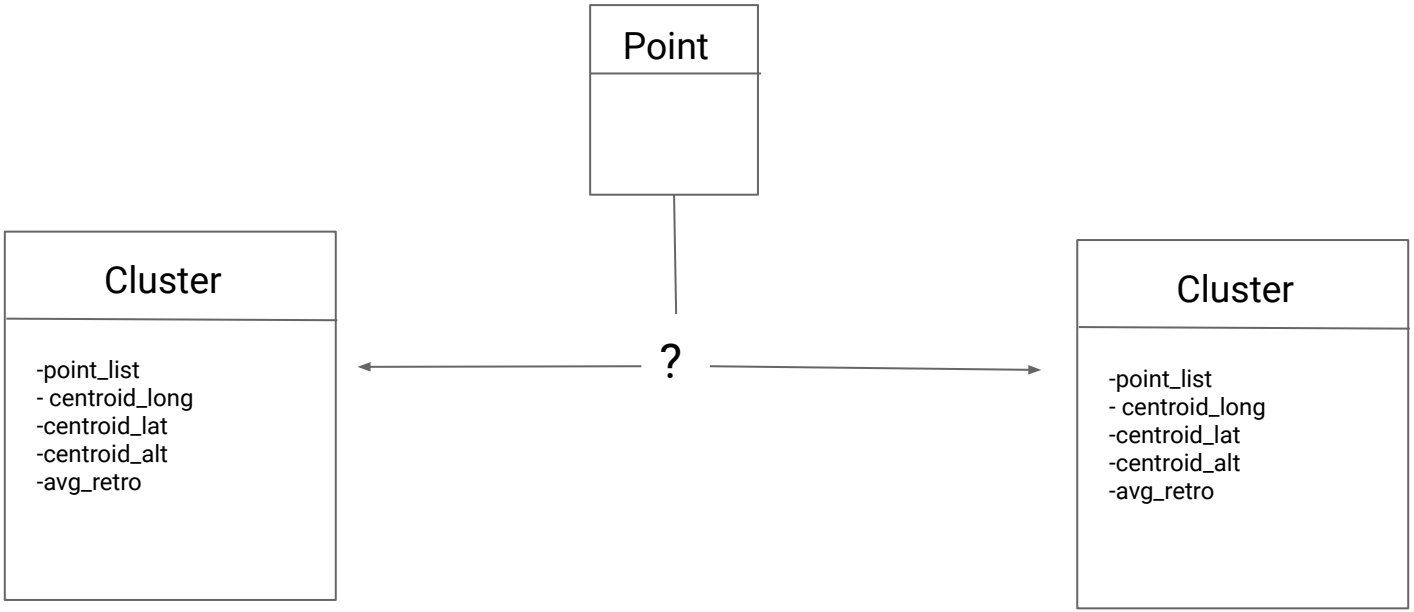

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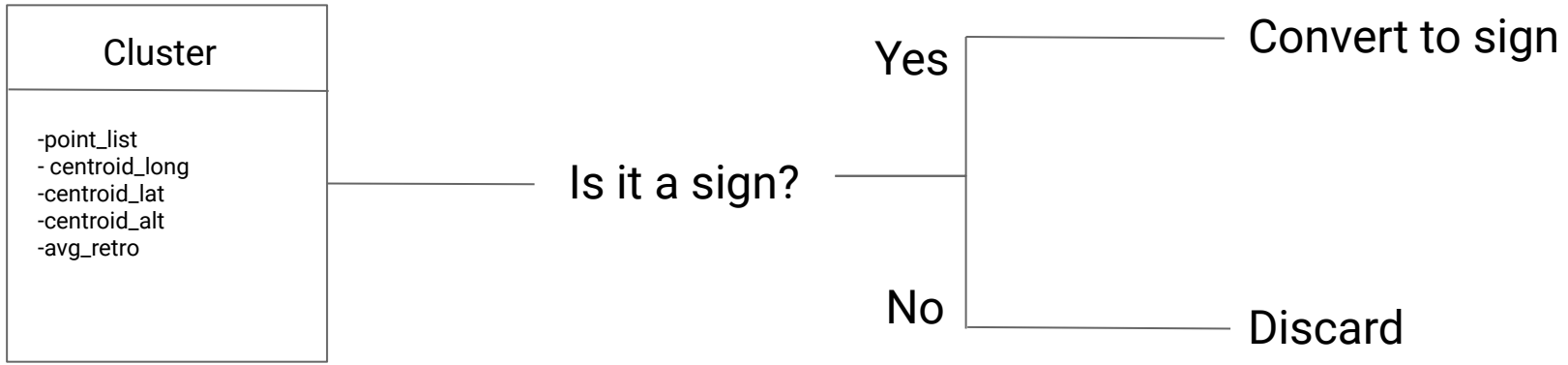


Metrics

Comparison to previous implementation:

- Got rid of duplicates
  - Old: 157 duplicates New: 0 duplicates
- Missed fewer signs
  - Old: 18 missed New: 4 missed
    - Stacked signs
    - Found smaller signs
    - Found signs hidden in brush
- More false positives
  - Old: 0 fp New: 3 fp

Our Progress

Sign ID	Year	Median	25%	75%	StDev
1953	2015	0.729	0.714	0.761	0.037
	2016	0.767	0.745	0.780	0.023
	2017	0.763	0.744	0.776	0.031
	2018	0.741	0.722	0.749	0.027
4026	2015	0.753	0.737	0.794	0.041
	2016	0.851	0.796	0.859	0.038
	2017	0.792	0.757	0.859	0.058
	2018	0.796	0.784	0.831	0.043

- Virtual meeting with Sai Siddarth Maram
- Structuring batch analysis output in CSV format with Java to easily analyze data for deterioration analysis.

Old Expected Outcomes

- OOP implementation should help us test modularly and eliminate duplicates.
- Catch all signs (at least those on the side of the road) and eliminate false positives.
- Have a more accurate way of measuring ground truth and improvements.

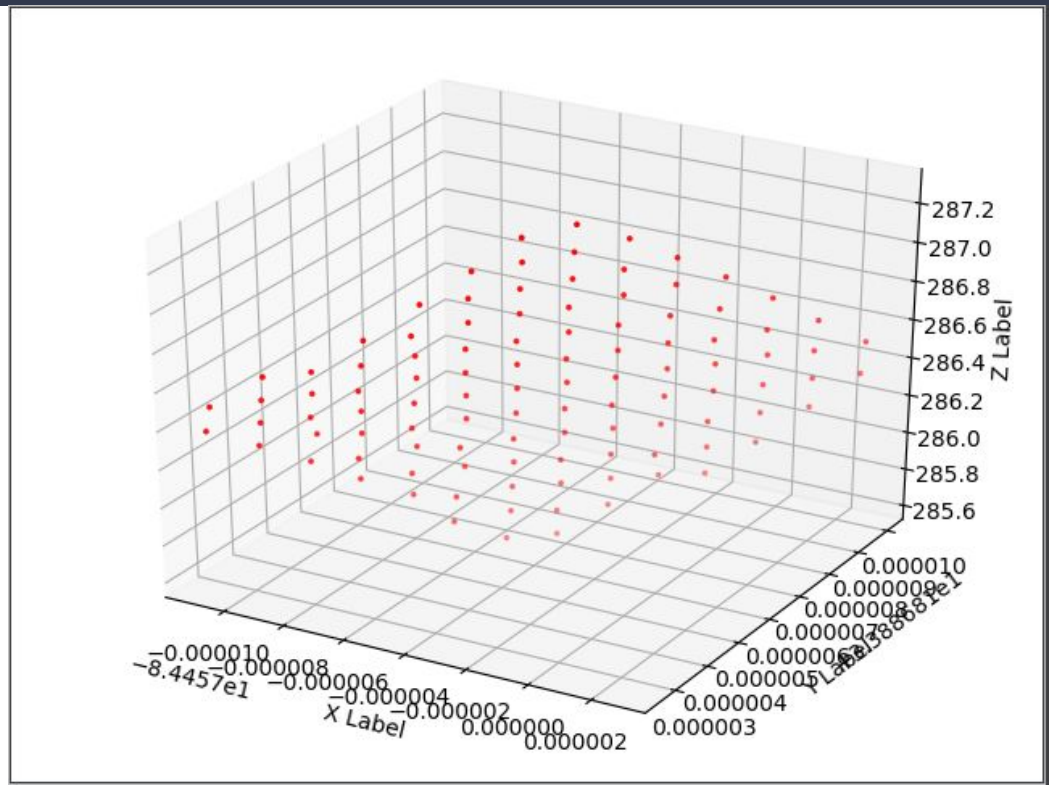
Realization

- Duplicates are almost all eliminated.
- Only missed 2 signs that had minimal noise.
- Still need a more accurate way of measuring ground truth.

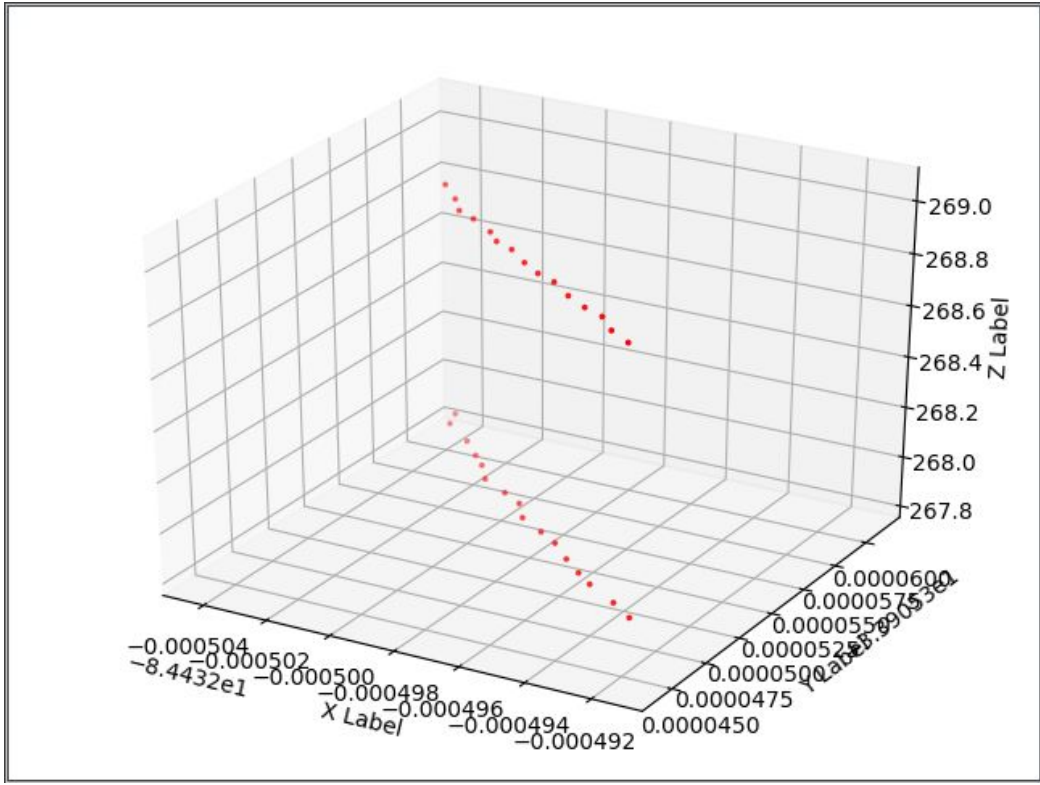
Issues

Have no real way of understanding false positives… currently

Establishing Correctness



Understanding False Positives



Design Considerations

- Possibly not as efficient as keeping all data in a data frame
- Clustering algo (assigning points to clusters) needs to be robust
- Whether point cluster on a plane or not
- Stationary checks

Tasks

- Develop visualization methodology to correlate with real world objects
- Optimization: work out false positive & negatives
  - Look into even more causes
- Continue developing ground truth
  - total sign count, accuracy, and pairing images

Expected Outcomes

- Have quick and efficient results
    - will allow us to test more roadway and new datasets
- Catch all signs that have minimal noise
- Optimal sign detection with only LiDAR data (no sign inventory)