CIVIL AND ENVIRONMENTAL ENGINEERING DEPARTMENT

CEE25 - MD1-4
Engineering Analysis of Maryland Roadway Infrastructure

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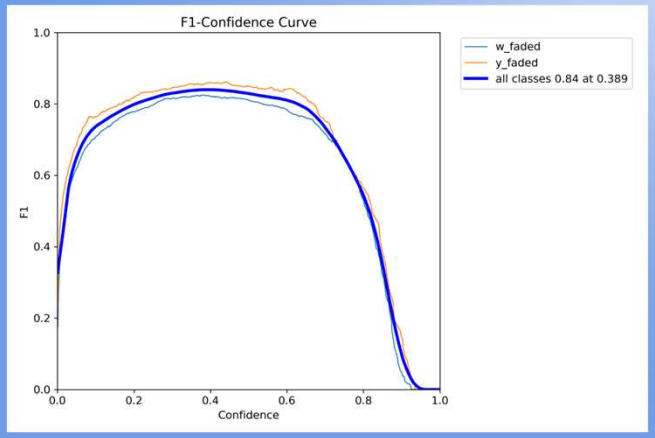
Introduction

As driverless vehicles become more prevalent, road infrastructure will need to keep up with demand. Therefore, improving suboptimal infrastructure in an efficient manner is important. To do this, an object detection algorithm was modified to our specific needs and evaluated on real world conditions - specifically, on Maryland road markings.

The object detection algorithm, YOLOv8 (You Only Look Once), was used to train a custom detection model that could predict instances of faded road markings. This model was then modified to produce metrics that show which roads and areas contain the most degraded infrastructure.

After capturing video footage of roadways, the detection model was able to detect faded road markings with an accuracy (defined by an F1 score) of **84%** and was able to **sufficiently predict which Maryland roads needed the most infrastructure funding and improvement.**



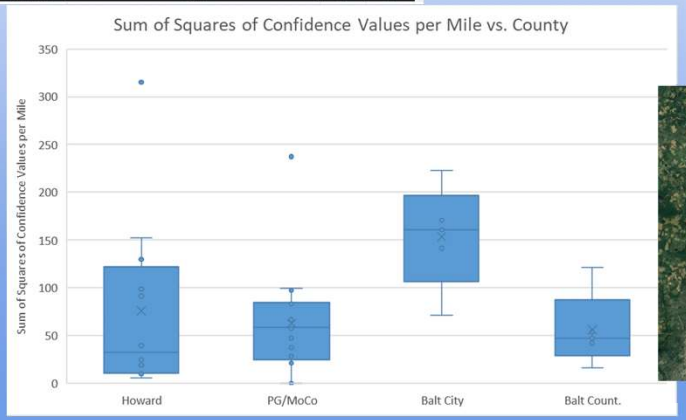
Data and Results

To properly quantify our data, a python script was developed to reduce duplicate detections. Then, the number of faded road markings was counted per mile driven. Additionally, confidence values for each detection were squared (to reduce the impact of low confidence detections) and divided by miles driven.

Comparison for All Roadways Analyzed

County	Road	Value	Rank
Howard	Rt. 216 W	315.48	1
PG/MoCo	Landover Rd - Riverdale Rd	237.28	2
Balt City	MLK Blvd S	222.6	3
Balt City	Rt. 40 W (Baltimore)	170.49	4
Balt City	I-83 S	160.86	5
Howard	Rt. 97 S	152.59	6
Balt City	Baltimore City Local	141.35	7
Howard	Rt. 97 N	129.68	8
Balt Count.	Baltimore County Local (Urban, Inside 695 Beltway)	120.94	9
PG/MoCo	I-495 W	99.37	10
Howard	Rt. 216 E	98.7	11
PG/MoCo	Georgia Ave - Missouri Ave	97.29	12
Howard	Rt. 29 S	91.29	13
PG/MoCo	Adelphi Rd	85.66	14
PG/MoCo	Oakview Drive - New Hampshire Ave	83.95	15
PG/MoCo	Eastern Ave	82.93	16
Balt City	I-395 S	70.82	17
PG/MoCo	Sargent Rd - Riggs Rd	66.51	18
PG/MoCo	I-495 W	60.4	19
PG/MoCo	East-West Highway	58.64	20
PG/MoCo	I-495 S - I-95 S	56.75	21
Balt Count.	I-795 N	53.32	22
Balt Count.	I-795 S	47.36	23
PG/MoCo	Columbia Pike	47.06	24
Balt Count.	I-695 N	41.9	25
Howard	I-70 E	39.55	26
PG/MoCo	Rt. 1 N	37.4	27
PG/MoCo	Lockwood Dr	27.9	28
Howard	Rt. 29 N	24.81	29
PG/MoCo	New Hampshire Ave	21.03	30
Howard	Rt. 175 W	18.73	31
Balt Count.	Baltimore County Local (Rural, Outside 695 Beltway)	16.02	32
Howard	Rt. 32 N	11.77	33
Howard	Rt. 32 S/E	9.75	34
Howard	Rt. 40 W (Howard County)	9.6	35
Howard	I-70 W	5.5	36
PG/MoCo	I-95 N	1.04	37
PG/MoCo	I-270 S	0.02	38
PG/MoCo	I-95 S	0	39

KEY:
Greater Than or Equal to 200
Greater Than or Equal to 100



Conclusion & Recommendations

The main issue we ran into during our analysis was false positives. Even when filtering by framerate, multiple detections for one road marking could still be present. To help counter false positives, the confidence level associated with the markings on each road was squared and summed, then divided by miles driven to minimize the impact of less confident detections. To combat this issue in the future, more data such as vehicle speed could be collected - for example, a large burst of detections that occurs when a car is stopped at a light could be counted as one detection.

We believe that this process can be repeated for other road infrastructure assets, such as signs, lights, visibility issues, etc.

Overall, our results suggest that disadvantaged areas have disproportionately unsafe roads with more suboptimal infrastructure, as many of the roads with the highest squared confidence values per mile were within Baltimore City and County as well as the poorer areas of PG/Montgomery and Howard County. This analysis objectively concludes that these areas require more funding and attention to maintain a safe driving environment if driverless vehicles become mainstream.