

Comparative Analysis of Sign Detections: Mach9 vs. Client Dataset

Evaluating Accuracy, Coverage, and Completeness of Extracted Traffic Signs

Prepared by: Your Company/Team Name
Date: Report Creation Date



Executive Summary

This report compares Mach9's LiDAR-extracted sign features with a legacy client dataset using a 5-meter distance matching approach. Key findings include:

- Total Mach9 Signs (Raw): 1866
- Total Client Signs (Raw): 1338
- Duplicates Removed - Mach9: 125, Client: 0
- Total Mach9 (No Duplicates): 1741
- Total Client (No Duplicates): 1338
- Matched Signs (within 5 m): 908
- Unique to Mach9: 833
- Unique to Client: 430

Approach and Methodology

1. Standardize column names for latitude, longitude, and MUTCD.
2. Remove duplicates based on coordinate precision.
3. Run a distance matching algorithm (5-meter buffer) via a BallTree (haversine metric).
4. Compute key metrics based on the matching results.
5. Generate charts to illustrate distribution, clustering, and discrepancies.

Table 1: Overview Table

Metric	Mach9	Client	Mach9 Percentage	Client Percentage
Total Signs (Raw)	1866	1338	58.24%	41.76%
Duplicates	125	0	6.70%	0.00%
Total Signs (without duplicates)	1741	1338	56.54%	43.46%

Percent Differences Visualization

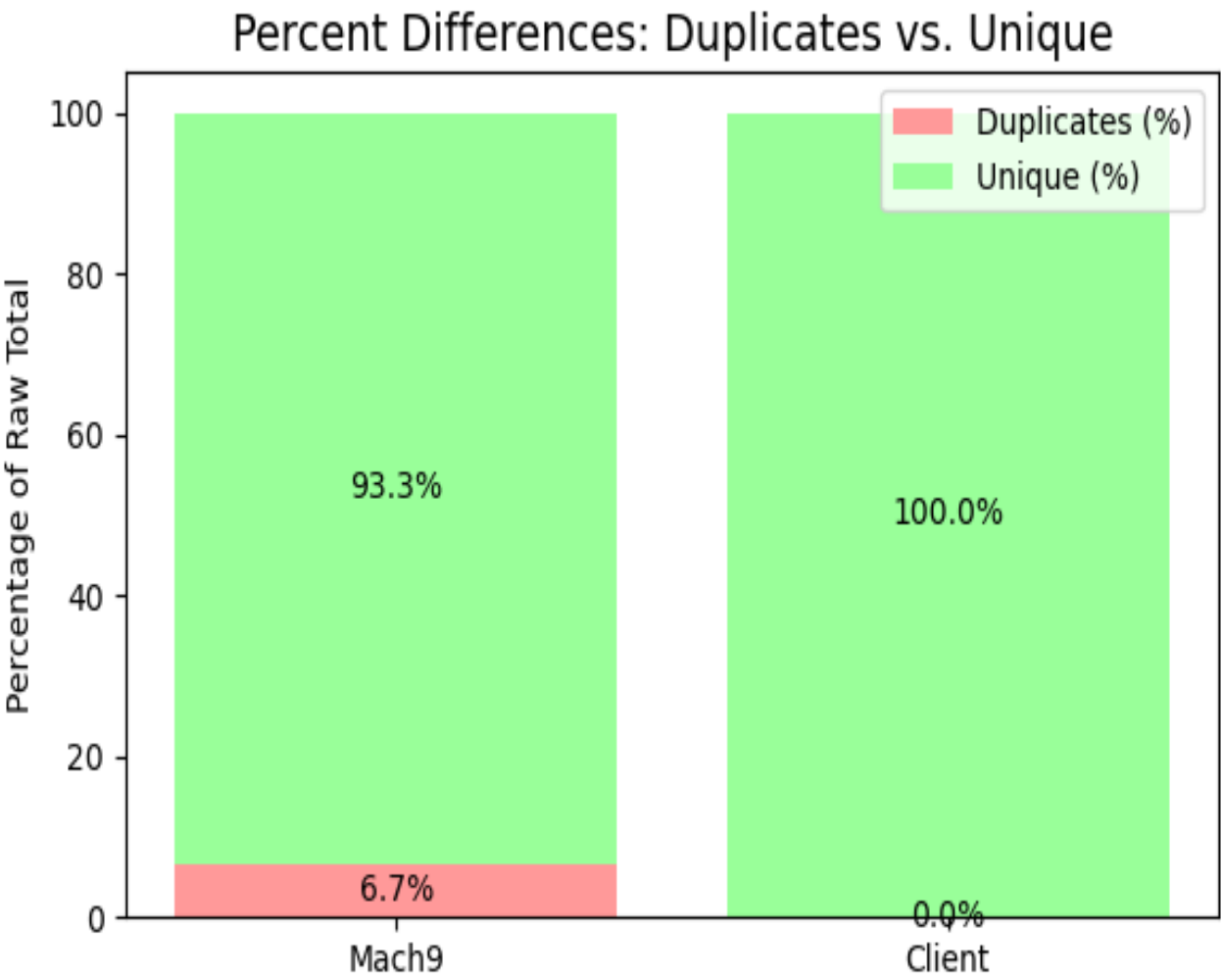
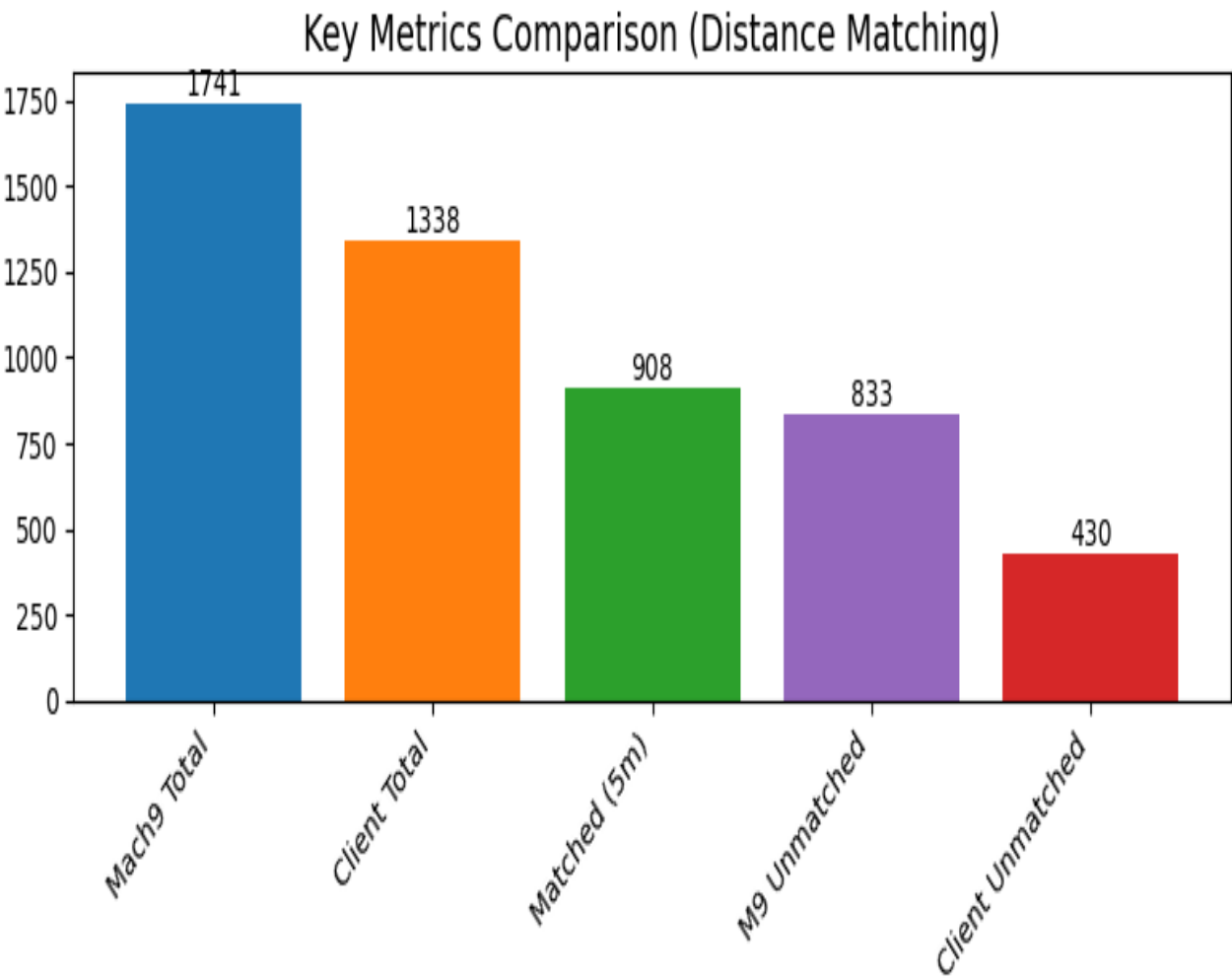


Table 2: Comparison Table

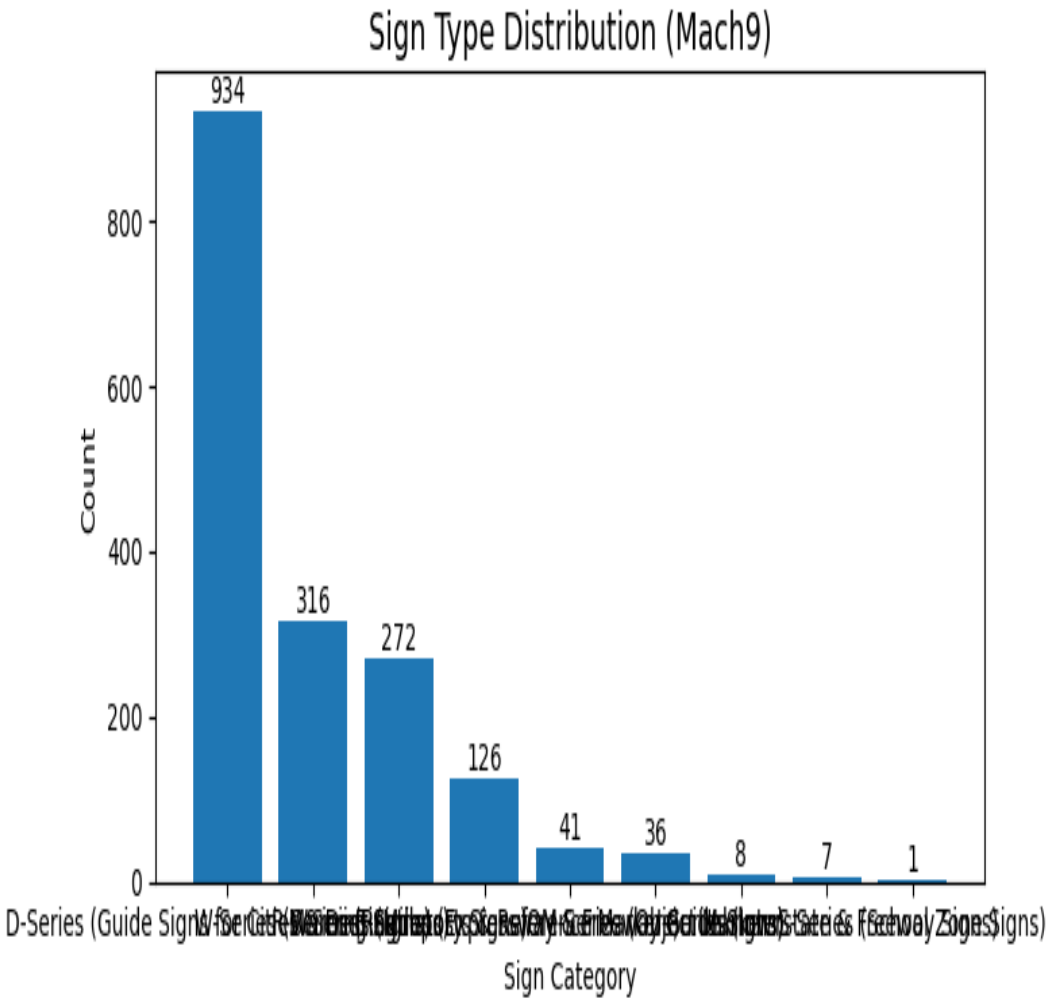
Metric	Count	Total in Dataset	Percentage	Notes
Matched Signs (5m)	908	1741	52.15%	Signs matched across both datasets within 5 m buffer.
Unique Signs in Mach9	833	1741	47.85%	Signs in the Mach9 dataset not present in the Client dataset.
Unique Signs in Client	430	1338	32.14%	Signs in the Client dataset not present in the Mach9 dataset.

Key Metrics Comparison Bar Chart



Sign Category Breakdown

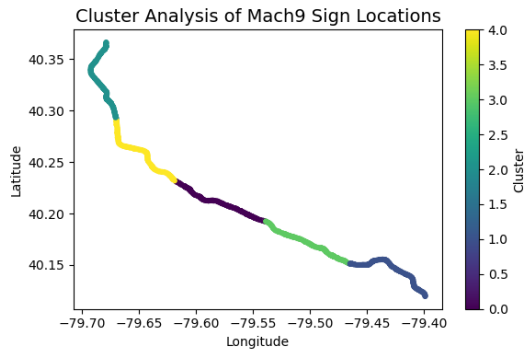
Category	Mach9 Count	Client Count
D-Series (Guide Signs for Cities & Destinations)	934	0
E-Series (Expressway & Freeway Guide Signs)	41	0
I-Series (Interstate & Freeway Signs)	7	0
M-Series (Mileposts & Reference Markers)	126	0
OM-Series (Object Markers)	36	0
R-Series (Regulatory Signs)	272	0
S-Series (School Zone Signs)	1	0
Unknown	8	1338
W-Series (Warning Signs)	316	0



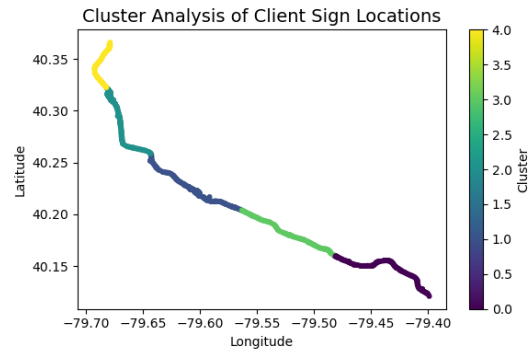
Spatial Distribution and Cluster Analysis

Below are the cluster analysis graphs for sign locations in each dataset.

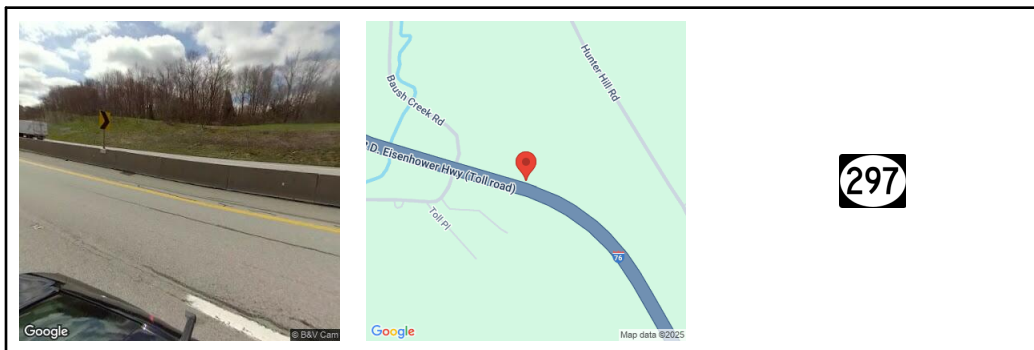
Mach9 Dataset



Client Dataset



Unique Signs in Mach9 Dataset [833]



MUTCD: M1-5

Text: 0.8

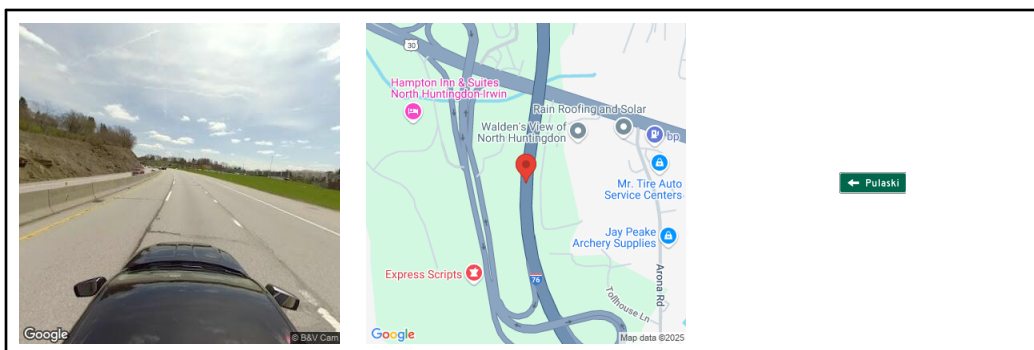
Dataset: Mach9

Lat/Lon: 40.16638886, -79.48946071

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.16638886,-79.48946071

Mach9 URL: <https://cloud.mach9.io/files/92b5f3e7-513f-46f0-ae0d-b0557928ae00/view#object-7503bd33-dcf5-411f-89e0-a05455411d55>

Capture Date: 2018-04



MUTCD: D1-1

Text: Exit 16 Edinburg 11 Newberry (area) 40

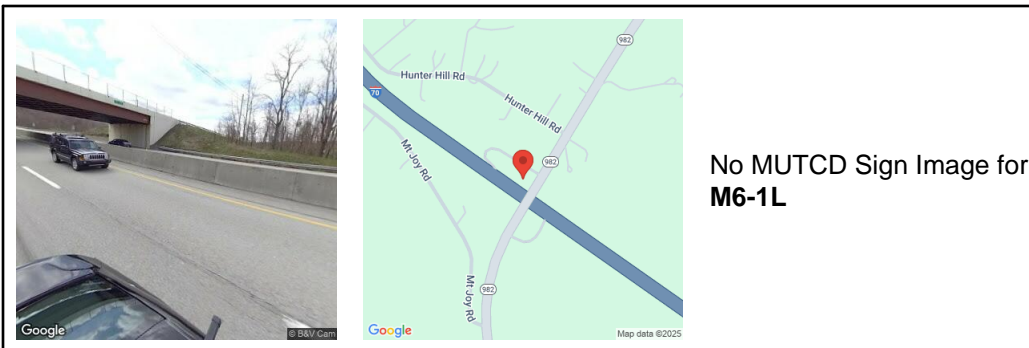
Dataset: Mach9

Lat/Lon: 40.31351783, -79.67859072

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.31351783,-79.67859072

Mach9 URL: <https://cloud.mach9.io/files/92b5f3e7-513f-46f0-ae0d-b0557928ae00/view#object-ad3ed5d8-767d-4892-98a7-1767949fba29>

Capture Date: 2018-04



MUTCD: M6-1L

Text: nan

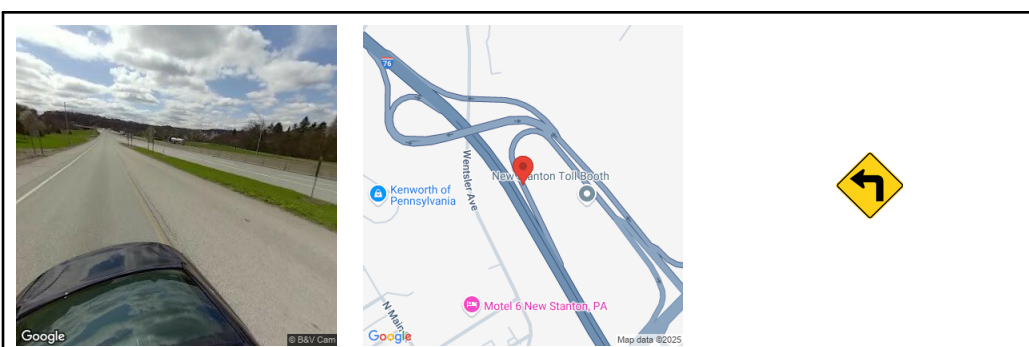
Dataset: Mach9

Lat/Lon: 40.15906835, -79.47945572

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.15906835,-79.47945572

Mach9 URL: <https://cloud.mach9.io/files/92b5f3e7-513f-46f0-ae0d-b0557928ae00/view#object-ee60b69d-7eed-4fbd-be82-2a77d3adba20>

Capture Date: 2018-04



MUTCD: W1-1

Text: 20

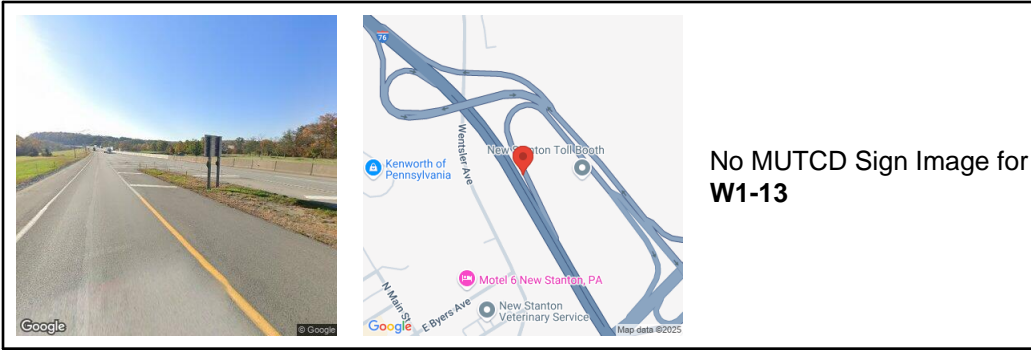
Dataset: Mach9

Lat/Lon: 40.2229892, -79.60488097

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.2229892,-79.60488097

Mach9 URL: <https://cloud.mach9.io/files/92b5f3e7-513f-46f0-ae0d-b0557928ae00/view#object-681f60be-ff5e-4f4a-94a1-3e1b9c2057a7>

Capture Date: 2018-04



MUTCD: W1-13

Text: nan

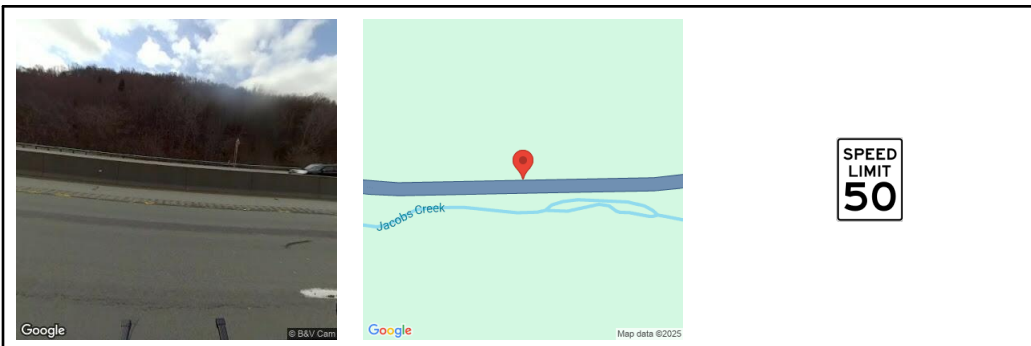
Dataset: Mach9

Lat/Lon: 40.22266125, -79.60474152

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.22266125,-79.60474152

Mach9 URL: <https://cloud.mach9.io/files/92b5f3e7-513f-46f0-ae0d-b0557928ae00/view#object-7ba22afe-2062-46e4-86bd-540c7aede8da>

Capture Date: 2024-10



MUTCD: R2-1

Text: nan

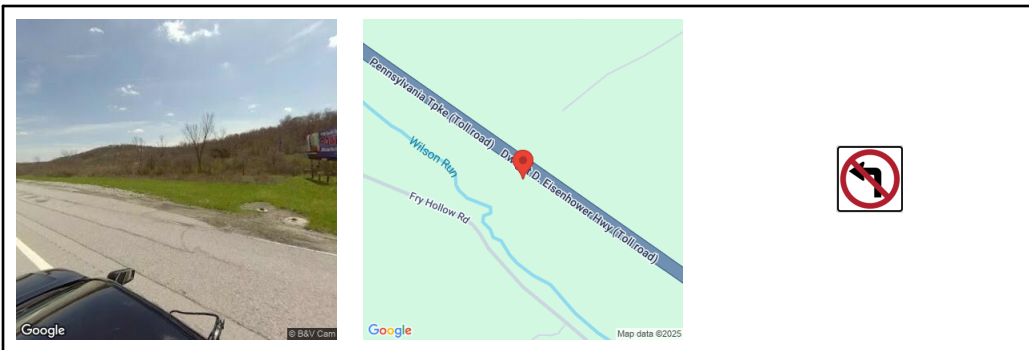
Dataset: Mach9

Lat/Lon: 40.15024062, -79.45390447

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.15024062,-79.45390447

Mach9 URL: <https://cloud.mach9.io/files/92b5f3e7-513f-46f0-ae0d-b0557928ae00/view#object-4718ba92-9ac3-48c2-9edd-c7e9c9ecc885>

Capture Date: 2018-04



MUTCD: R3-2

Text: NO LEFT TURN

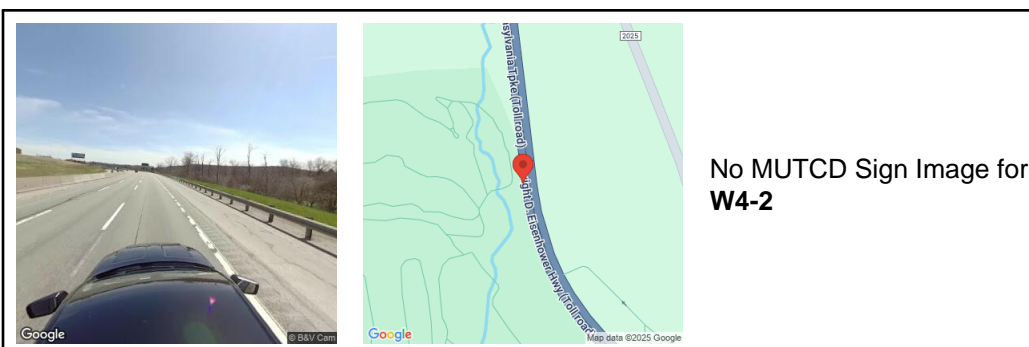
Dataset: Mach9

Lat/Lon: 40.19950516, -79.5557785

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.19950516,-79.5557785

Mach9 URL: <https://cloud.mach9.io/files/92b5f3e7-513f-46f0-ae0d-b0557928ae00/view#object-06ee9990-c72a-44fb-942c-4babbd10fa25>

Capture Date: 2018-04



MUTCD: W4-2

Text: nan

Dataset: Mach9

Lat/Lon: 40.1307514, -79.40879655

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.1307514,-79.40879655

Mach9 URL: <https://cloud.mach9.io/files/92b5f3e7-513f-46f0-ae0d-b0557928ae00/view#object-c739f3b6-415a-4110-91a7-c9119e9bf694>

Capture Date: 2018-04



MUTCD: OM3

Text: nan

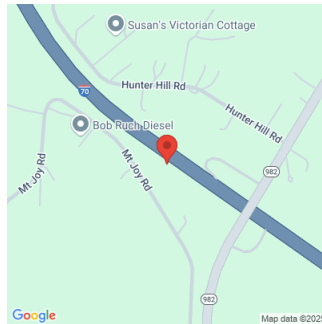
Dataset: Mach9

Lat/Lon: 40.22399139, -79.60598958

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.22399139,-79.60598958

Mach9 URL: <https://cloud.mach9.io/files/92b5f3e7-513f-46f0-ae0d-b0557928ae00/view#object-0951e7a4-bc36-4250-8600-7cbe826d1be2>

Capture Date: 2024-12



No MUTCD Sign Image for
M6-1

MUTCD: M6-1

Text: nan

Dataset: Mach9

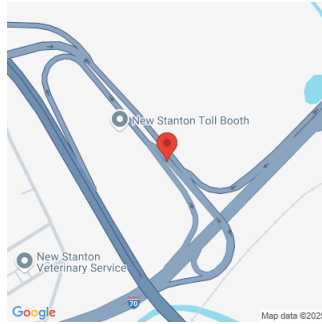
Lat/Lon: 40.15957424, -79.48151364

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.15957424,-79.48151364

Mach9 URL: <https://cloud.mach9.io/files/92b5f3e7-513f-46f0-ae0d-b0557928ae00/view#object-631d781e-1d89-4619-a182-43d3db0cd955>

Capture Date: 2018-04

Unique Signs in Client Dataset [430]



No MUTCD Sign Image for
Unknown

MUTCD: Unknown

Text: nan

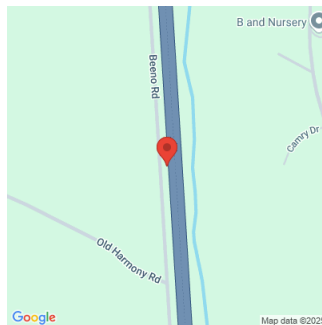
Dataset: Client

Lat/Lon: 40.22195204, -79.60189621

Street View URL: <https://www.google.com/maps/@40.22195204,-79.60189621,15t/data=!3m1!1e3!1s40.22195204,-79.60189621>

Mach9 URL: nan

Capture Date: 2018-04



No MUTCD Sign Image for
Unknown

MUTCD: Unknown

Text: nan

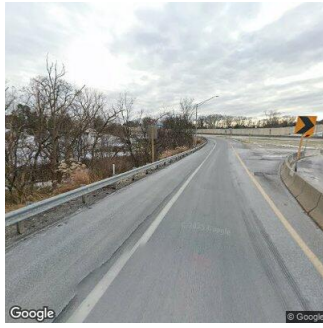
Dataset: Client

Lat/Lon: 40.280045, -79.669072

Street View URL: <https://www.google.com/maps/@40.280045,-79.669072,15t/data=!3m1!1e3!1s40.280045,-79.669072>

Mach9 URL: nan

Capture Date: 2018-04



No MUTCD Sign Image for
Unknown

MUTCD: Unknown

Text: nan

Dataset: Client

Lat/Lon: 40.310306, -79.675899

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.310306,-79.675899

Mach9 URL: nan

Capture Date: 2024-12



No MUTCD Sign Image for
Unknown

MUTCD: Unknown

Text: nan

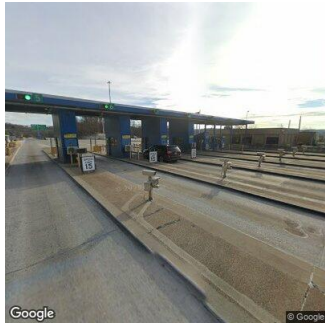
Dataset: Client

Lat/Lon: 40.321274, -79.681065

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.321274,-79.681065

Mach9 URL: nan

Capture Date: 2018-04



No MUTCD Sign Image for
Unknown

MUTCD: Unknown

Text: nan

Dataset: Client

Lat/Lon: 40.22288606, -79.6030447

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.22288606,-79.6030447

Mach9 URL: nan

Capture Date: 2024-12



No MUTCD Sign Image for
Unknown

MUTCD: Unknown

Text: nan

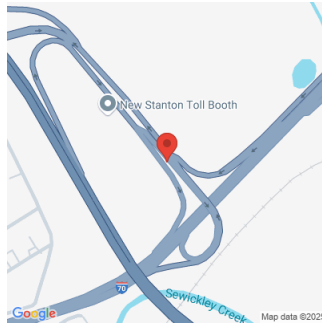
Dataset: Client

Lat/Lon: 40.22269632, -79.60304467

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.22269632,-79.60304467

Mach9 URL: nan

Capture Date: 2018-04



No MUTCD Sign Image for
Unknown

MUTCD: Unknown

Text: nan

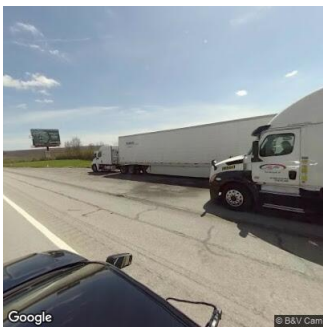
Dataset: Client

Lat/Lon: 40.221611, -79.601578

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.221611,-79.601578

Mach9 URL: nan

Capture Date: 2024-12



No MUTCD Sign Image for
Unknown

MUTCD: Unknown

Text: nan

Dataset: Client

Lat/Lon: 40.172665, -79.504156

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.172665,-79.504156

Mach9 URL: nan

Capture Date: 2018-04



No MUTCD Sign Image for
Unknown

MUTCD: Unknown

Text: nan

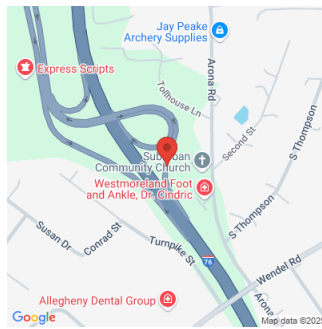
Dataset: Client

Lat/Lon: 40.219568, -79.600633

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.219568,-79.600633

Mach9 URL: nan

Capture Date: 2024-12



No MUTCD Sign Image for
Unknown

MUTCD: Unknown

Text: nan

Dataset: Client

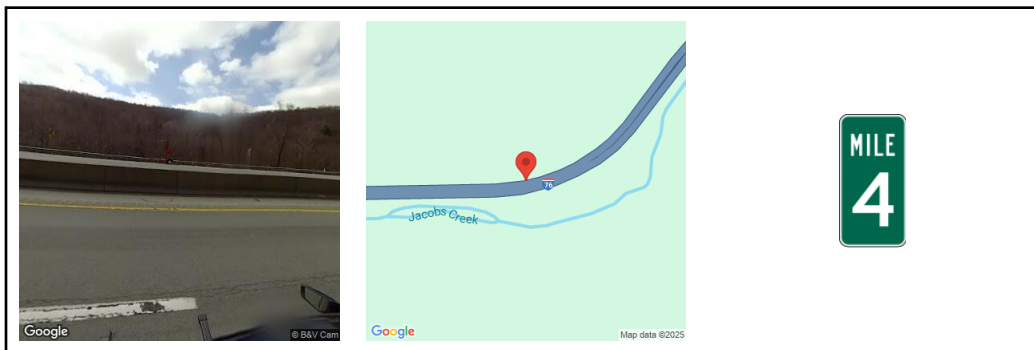
Lat/Lon: 40.309674, -79.676167

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.309674,-79.676167

Mach9 URL: nan

Capture Date: 2024-12

Matching Signs [908]



MUTCD: D10-1

Text: MILE 85 3

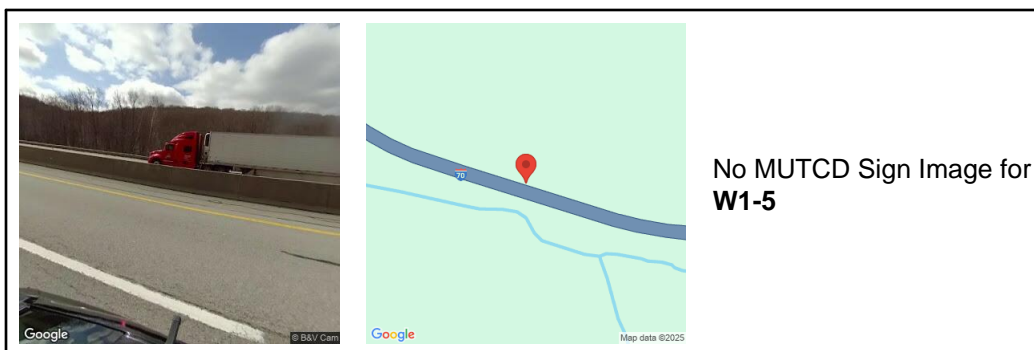
Dataset: Mach9_Matched

Lat/Lon: 40.15034183, -79.44957058

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.15034183,-79.44957058

Mach9 URL: <https://cloud.mach9.io/files/92b5f3e7-513f-46f0-ae0d-b0557928ae00/view#object-13b0ad86-9fbe-4f46-a51e-dfd0f4af4837>

Capture Date: 2018-04



MUTCD: W1-5

Text: nan

Dataset: Mach9_Matched

Lat/Lon: 40.15109165, -79.46242634

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.15109165,-79.46242634

Mach9 URL: <https://cloud.mach9.io/files/92b5f3e7-513f-46f0-ae0d-b0557928ae00/view#object-e1c4dd56-85ec-4543-ae97-fc60dbf4efc9>

Capture Date: 2018-04



MUTCD: D10-1

Text: MILE 84.3

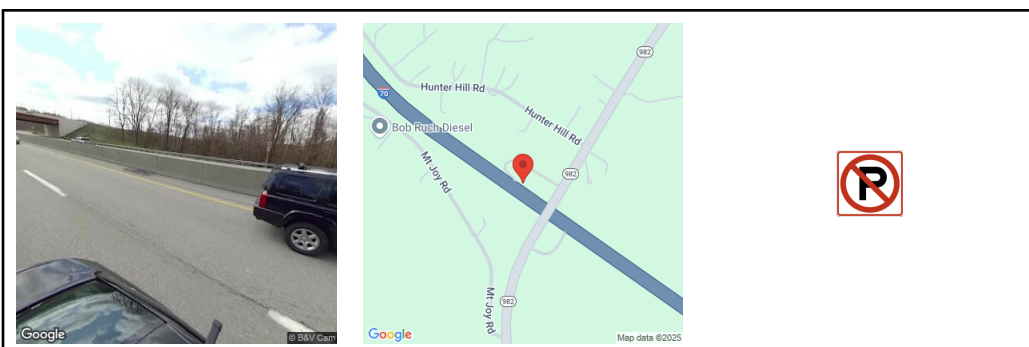
Dataset: Mach9_Matched

Lat/Lon: 40.1526474, -79.46787425

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.1526474,-79.46787425

Mach9 URL: <https://cloud.mach9.io/files/92b5f3e7-513f-46f0-ae0d-b0557928ae00/view#object-6465d146-031d-497f-b544-33df1c5f159b>

Capture Date: 2018-04



MUTCD: R8-3

Text: No Parking

Dataset: Mach9_Matched

Lat/Lon: 40.1592358, -79.4799866

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.1592358,-79.4799866

Mach9 URL: <https://cloud.mach9.io/files/92b5f3e7-513f-46f0-ae0d-b0557928ae00/view#object-c2dfe1dc-6239-435b-945d-9194991da995>

Capture Date: 2018-04



MUTCD: D10-1

Text: MILE 87.5

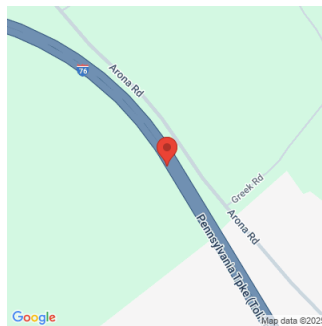
Dataset: Mach9_Matched

Lat/Lon: 40.14208894, -79.41775688

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.14208894,-79.41775688

Mach9 URL: <https://cloud.mach9.io/files/92b5f3e7-513f-46f0-ae0d-b0557928ae00/view#object-fa5bdf75-cc43-46f0-8dc3-31899ac87ef5>

Capture Date: 2018-04



No MUTCD Sign Image for
E1-2a

MUTCD: E1-2a

Text: NEW STANTON WEST 70 119 TO TOLL 66 Greensburg Wheeling WV 1 MILE EXIT ONLY

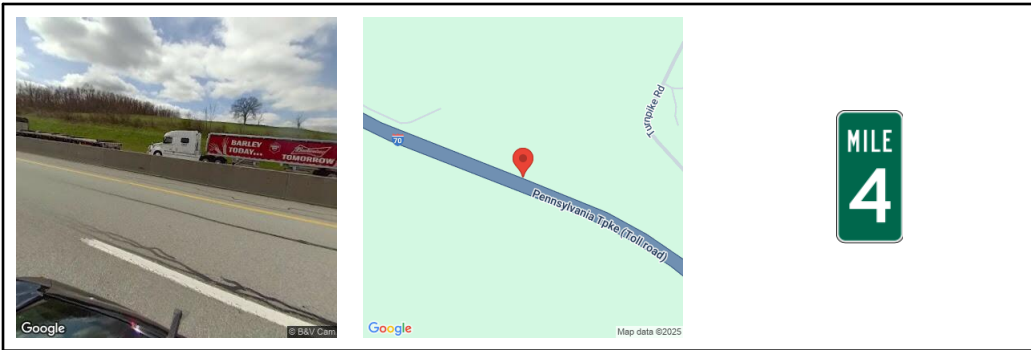
Dataset: Mach9_Matched

Lat/Lon: 40.23721828, -79.62326221

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.23721828,-79.62326221

Mach9 URL: <https://cloud.mach9.io/files/92b5f3e7-513f-46f0-ae0d-b0557928ae00/view#object-a9d3147c-ff69-4c5d-9a82-27580ed80476>

Capture Date: 2018-04



MUTCD: D10-1

Text: MILE 79.4

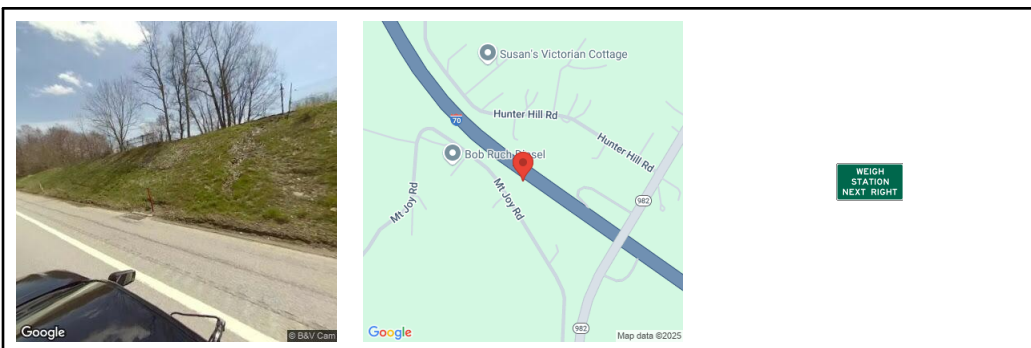
Dataset: Mach9_Matched

Lat/Lon: 40.19322552, -79.54107891

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.19322552,-79.54107891

Mach9 URL: <https://cloud.mach9.io/files/92b5f3e7-513f-46f0-ae0d-b0557928ae00/view#object-c8465927-8e43-4c24-818f-46a9951f63f1>

Capture Date: 2018-04



MUTCD: D8-2

Text: EMERGENCY STOPPING

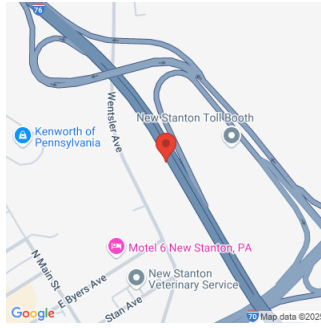
Dataset: Mach9_Matched

Lat/Lon: 40.15982182, -79.48193612

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.15982182,-79.48193612

Mach9 URL: <https://cloud.mach9.io/files/92b5f3e7-513f-46f0-ae0d-b0557928ae00/view#object-b5c8a47f-5a11-44fa-b5e7-02eaa8d09086>

Capture Date: 2018-04



MUTCD: W1-1

Text: nan

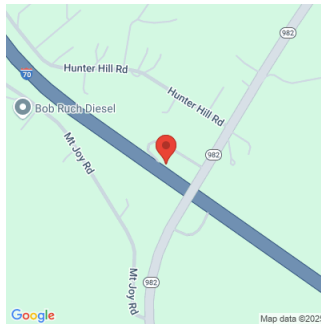
Dataset: Mach9_Matched

Lat/Lon: 40.22226401, -79.60492182

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.22226401,-79.60492182

Mach9 URL: <https://cloud.mach9.io/files/92b5f3e7-513f-46f0-ae0d-b0557928ae00/view#object-7e555629-f6f8-42f6-8cd8-27b66f09aab4>

Capture Date: 2024-12



MUTCD: D3-1

Text: nan

Dataset: Mach9_Matched

Lat/Lon: 40.15923479, -79.47998579

Street View URL: https://www.google.com/maps/@?api=1&_action=pano&viewpoint;=40.15923479,-79.47998579

Mach9 URL: <https://cloud.mach9.io/files/92b5f3e7-513f-46f0-ae0d-b0557928ae00/view#object-a45866d5-3fec-4d88-a192-4ff52f61f6dd>

Capture Date: 2018-04

Extended Methodology and Glossary (Appendix)

Extended Methodology:

- Data standardization: Columns were aligned across datasets.
- Duplicate removal: Duplicates were removed based on geographic coordinates (5 decimal precision).
- Distance matching: A 5-meter buffer was used with a BallTree and haversine metric for matching signs.
- Spatial and cluster analysis: Data was analyzed for clustering and coverage patterns.
- Quality metrics: Confidence scores and sign dimensions were evaluated.

Glossary:

- *Matched Signs (5 m Buffer)*: Signs within 5 meters across the two datasets.
- *Unique Signs*: Signs present in one dataset but not in the other (by distance threshold).
- *Duplicates Removed*: Duplicate sign entries removed during preprocessing.
- *MUTCD Codes*: Standardized sign classification codes used by Mach9.