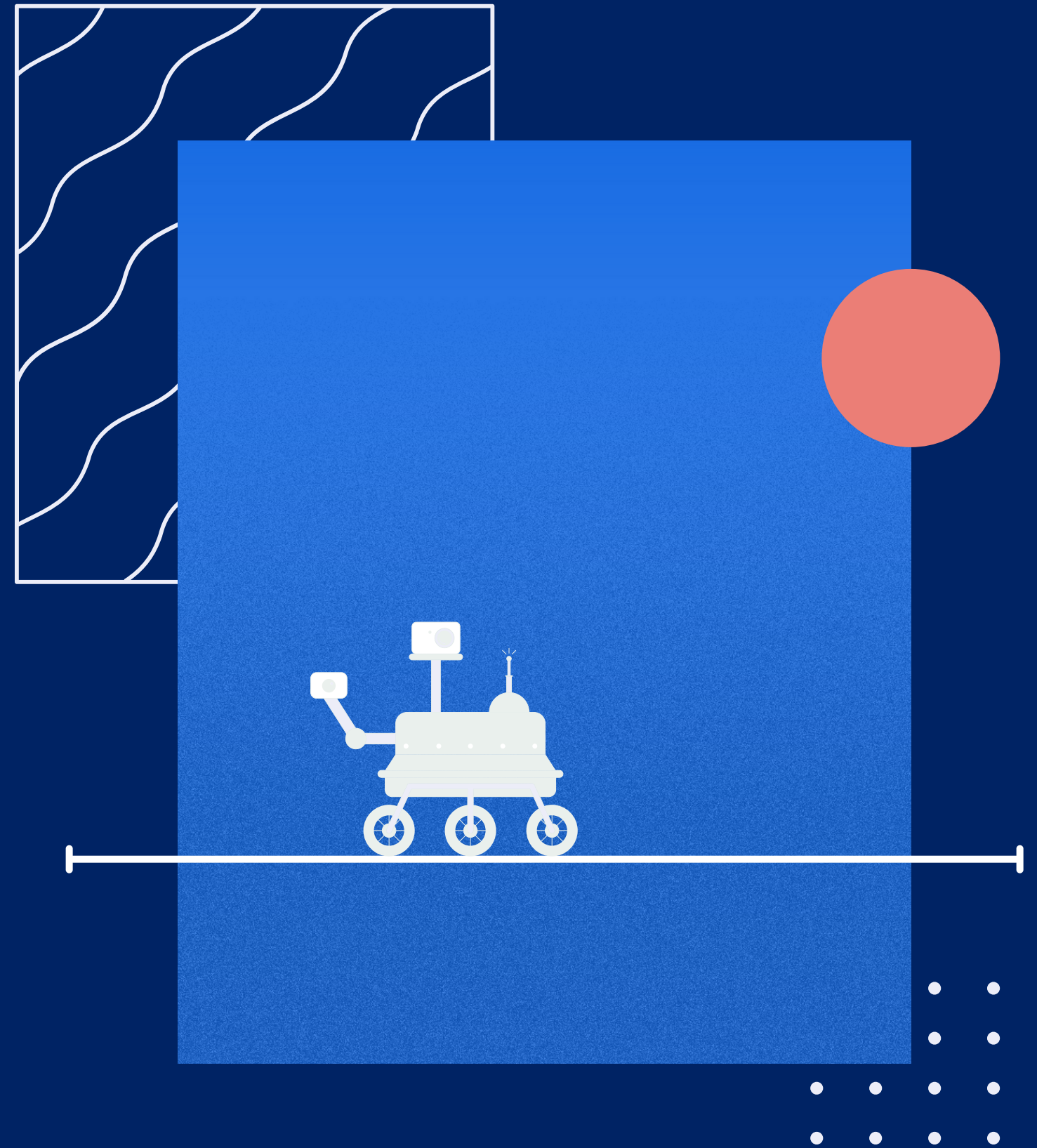


BOE Sidewalk Assessment System

Liasons: Ted Allen, Alisa Blake, Irvin Nguyen, Christopher Tsangaris, Jonathon DeLeon, Miguel Grajeda, Raul Virgen

Advisor: Jungsoo (Soo) Lim

Team: Aquil Alam, Alejandro Chanocua, Omar Eclicerio, Ernesto Garcia, Francisco Gastelum, Henry Gonzales, Gui He, Perla Ramirez, Rishi Shah, Daniel Zeng



Teams

UI



Perla



Francisco

ROVER UI

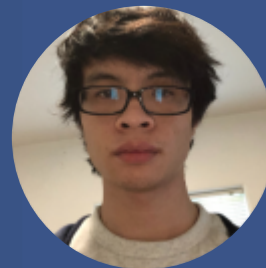


Alejandro



Ernesto

DATABASE



Gui



Rishi

FIELD TESTING



Omar



Daniel

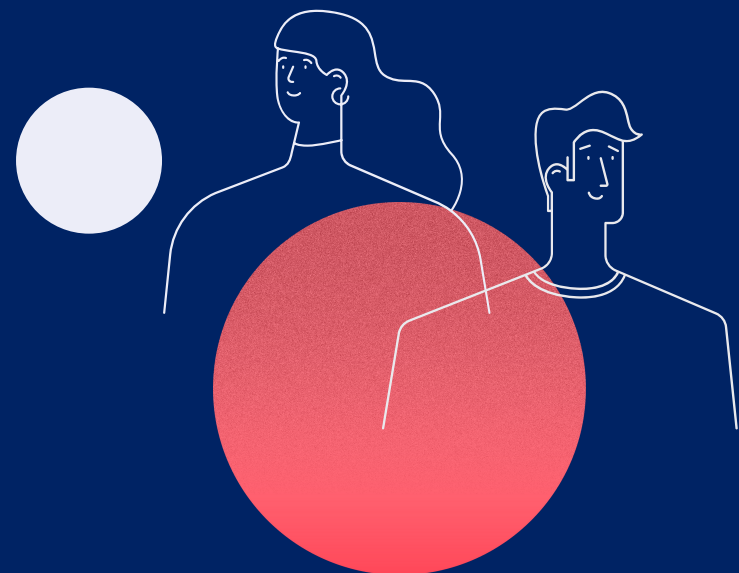
NAV LA



Henry



Aquil



Agenda

1. Motivation and introduction
2. Overview of project flow.
3. Project sub teams
 - a. Technical breakdown

Motivation

- Contains over 11,000 miles of sidewalks.
- City of LA data is used for categorizing sidewalk conditions for Federal ADA standards.
- Rover and data collection speeds up the process of analyzing sidewalks.

Rover in Action

- Rover is driven by a user with the Rover UI.
- The rover collects data of a sidewalk segment:
 - GPS
 - Crossing & Running Slope
 - Time signature
 - Section ID
- This data is processed/stored by the DB team's algorithms to be used as an index for severity of sidewalk segments in Los Angeles.



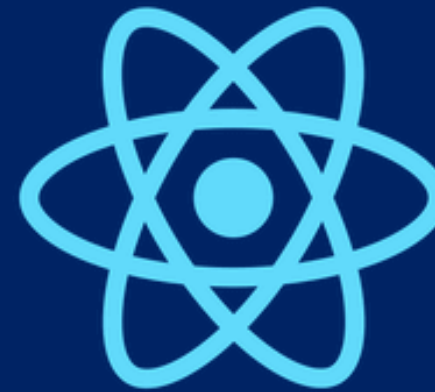
Web UI

Overview

- Interactive user-friendly UI
- Collect Rover slope data and GoPro camera images
- Display Rover and GoPro data

Technologies Used

- React
- Node.js
- GoPro Fusion
- Google Maps API
- Azure Blob Storage
- Languages Used:
 - Javascript
 - HTML



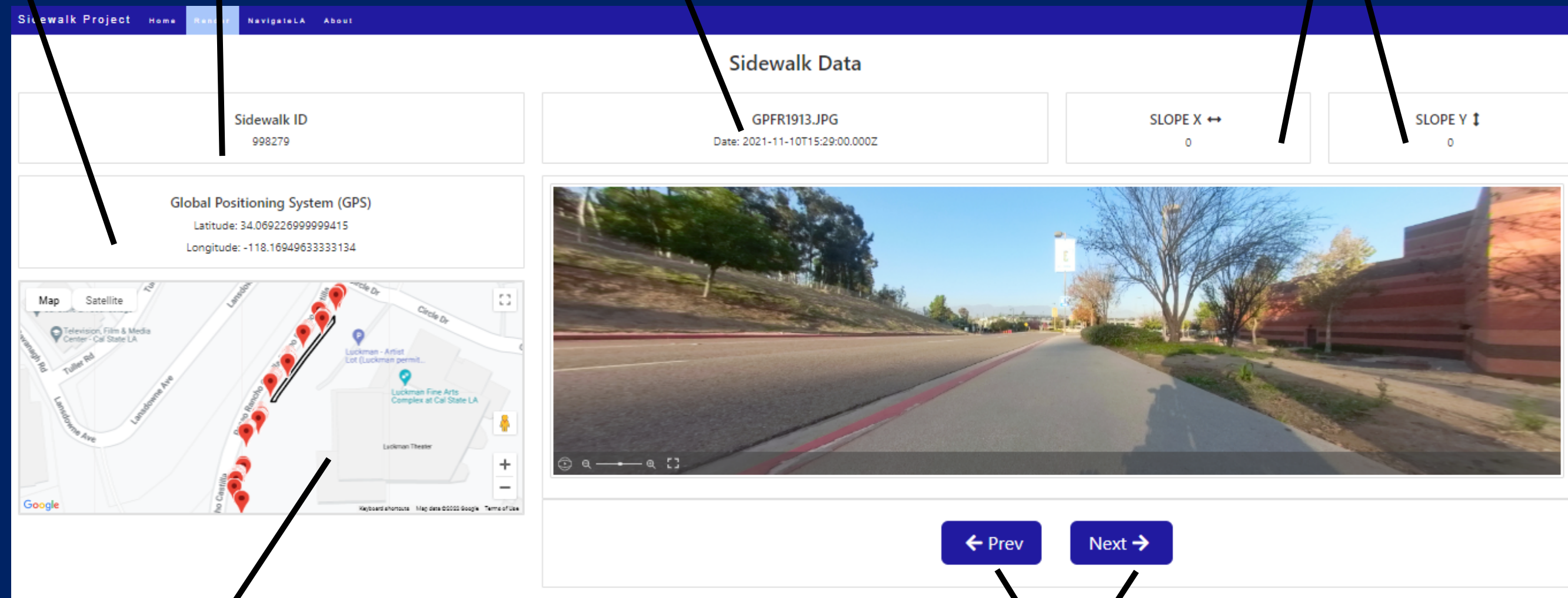
Web App

GPS Rover Data

Section ID

Image name and date

Slope data



Google Map displays GPS points from Rover data

Users can switch back and forth between images

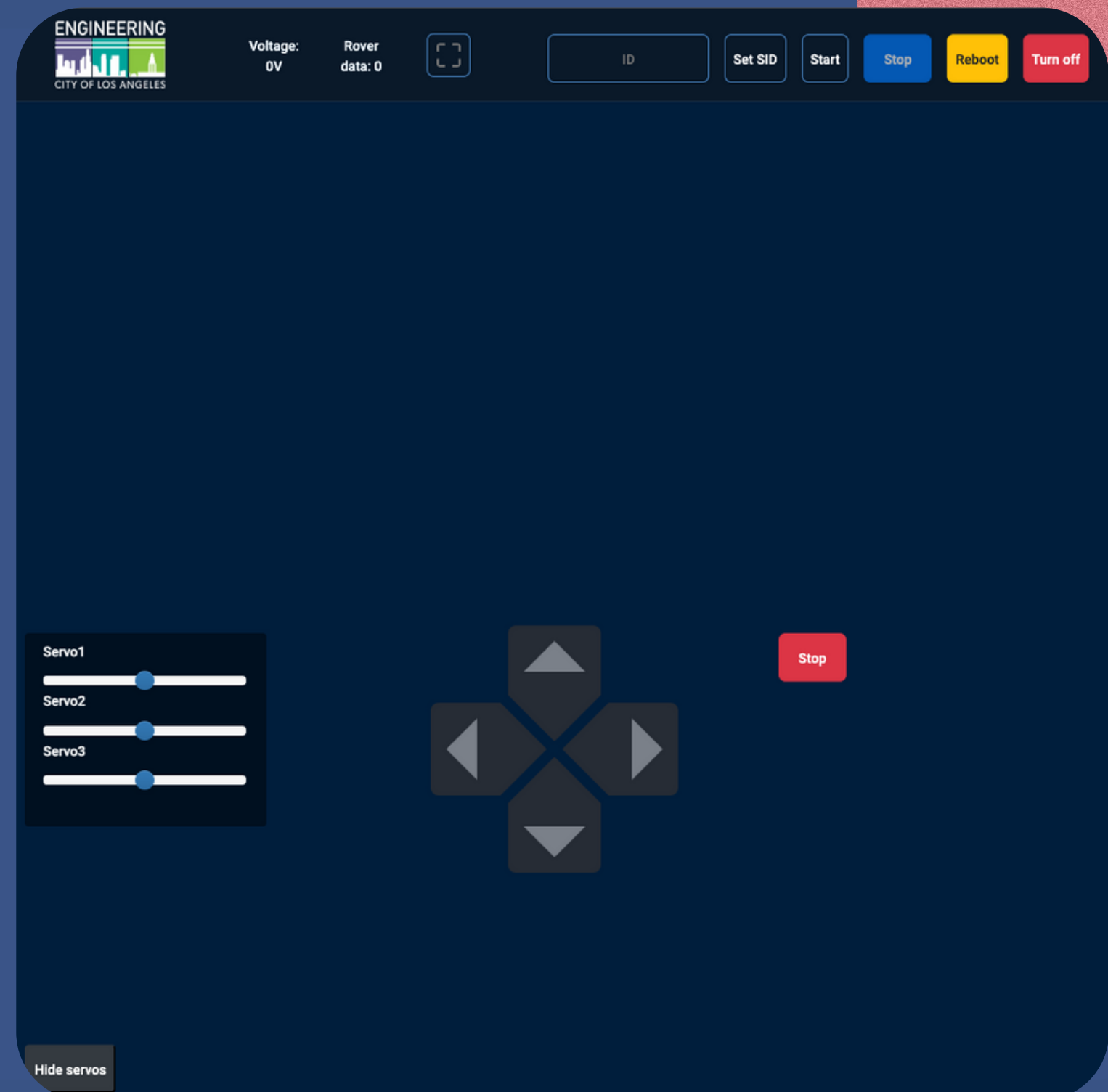
Rover UI

Overview

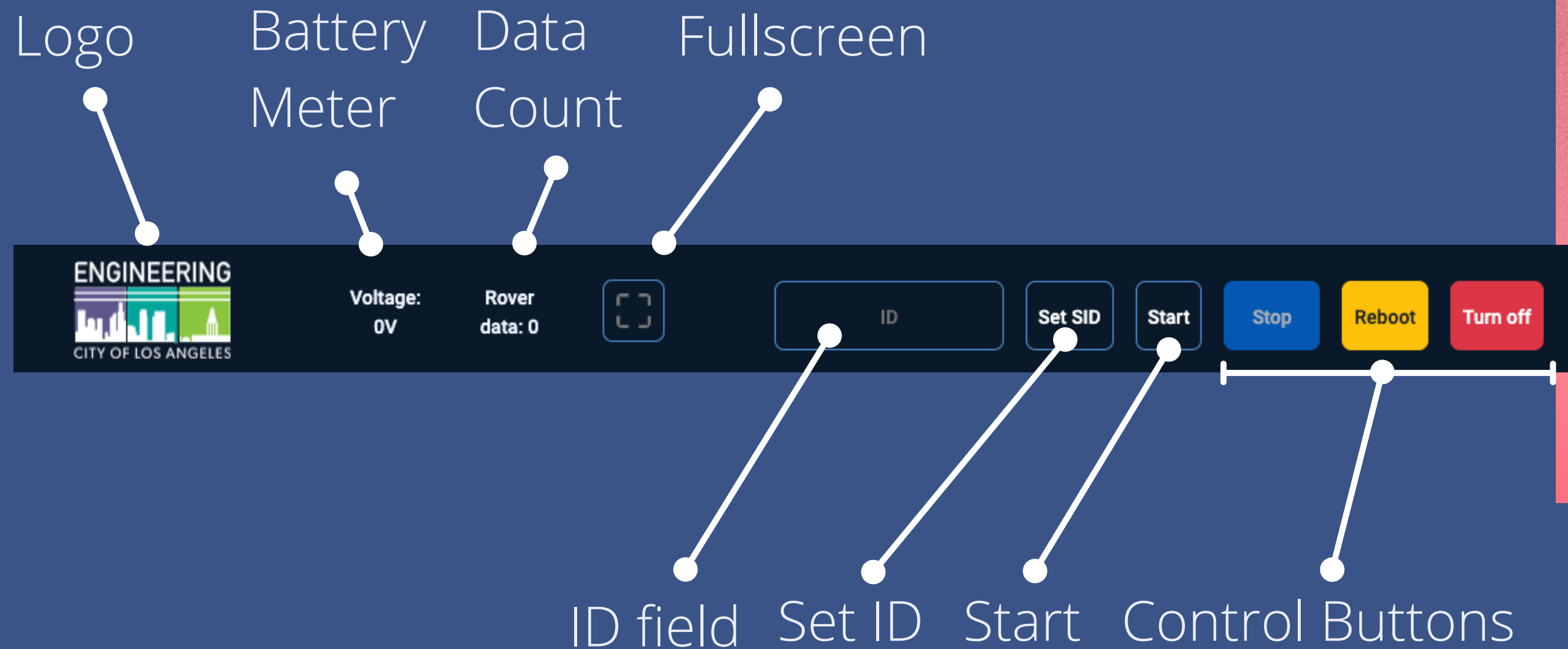
- Intuitive user friendly UI
- Controls speed and direction
- Initial point of data collection

Technologies Used

- Languages:
 - HTML
 - Javascript
- Bootstrap
- roslibjs
 - Robot operating system

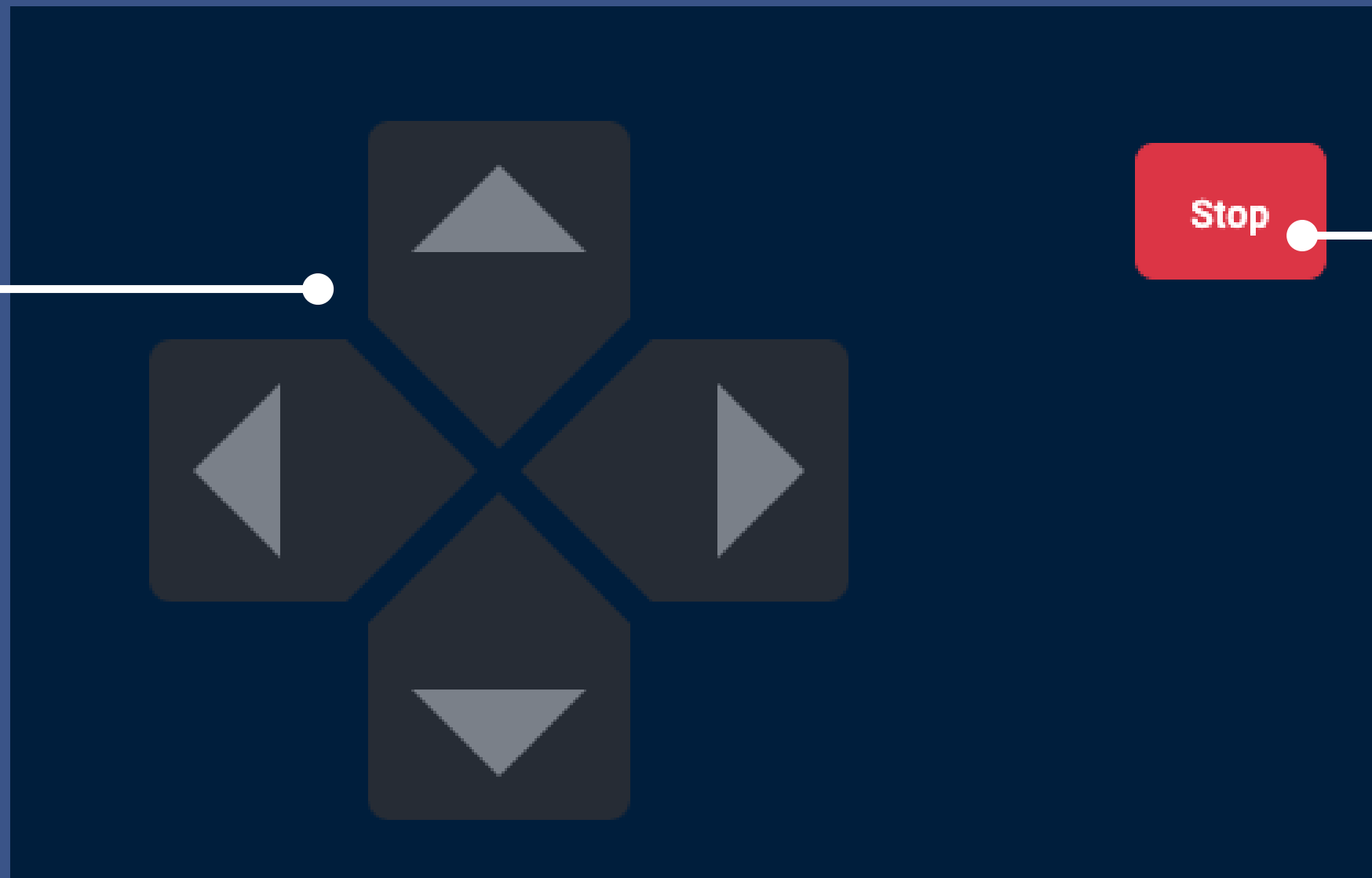


Navbar



Navigation Controls

Directional
Buttons

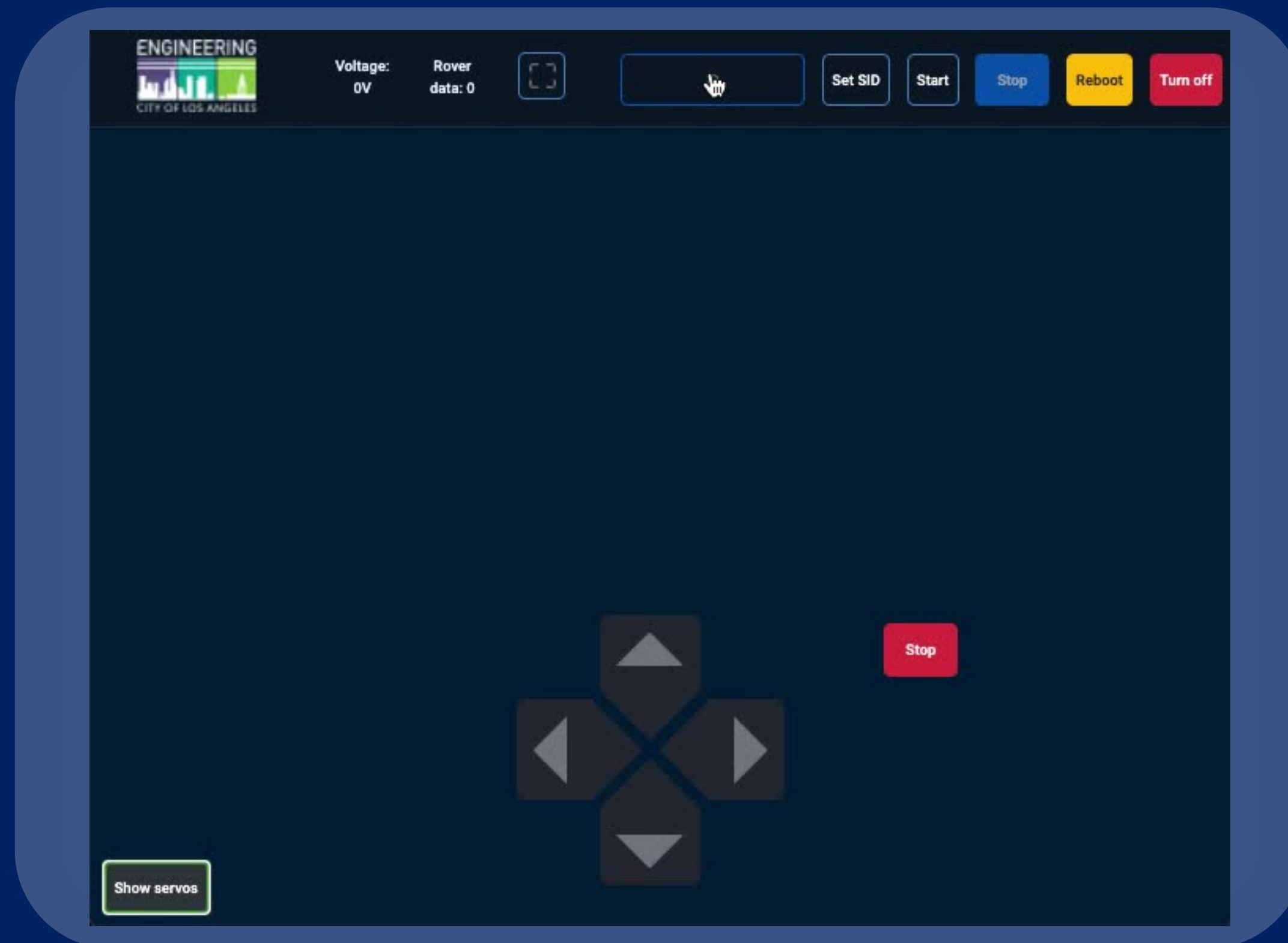


Stop

Stop Button



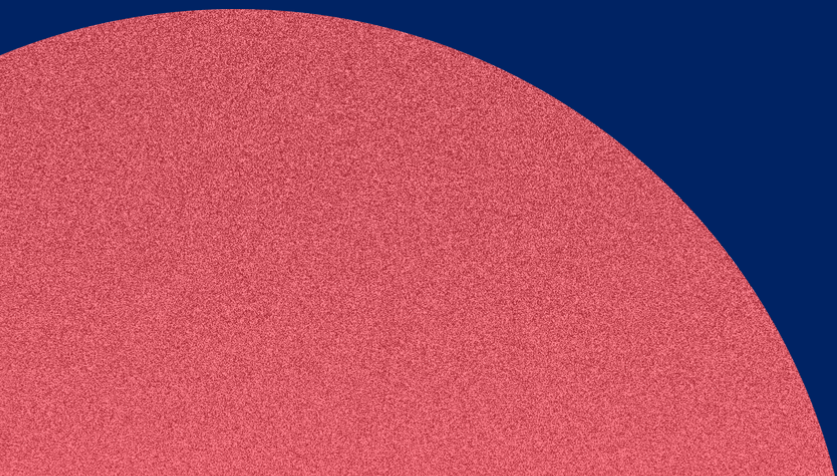
Rover UI Demo



DB/Backend



Overview

- Python code for database input
 - Organize raw data in a SQL view
 - Relate collected slope to percentage
- 

DB/Backend

	LATITUDE	LONGITUDE	DATE	TIME	SLOPE_X	SLOPE_Y	PERCENT_X	PERCENT_Y
1	4037771.40210332	-13117508.5833585	2022-03-03	15:12:38.0000000	-1.444	-1.01	2.52078917131502	1.76296515636331
2	4037771.40210332	-13117508.5833585	2022-03-03	15:12:38.0000000	-1.707	-1.017	2.98015882409553	1.77518628470547
3	4037771.06615009	-13117508.9952406	2022-03-03	15:12:39.0000000	-1.527	-1.373	2.66574894508819	2.39679586174006
4	4037771.06615009	-13117508.9952406	2022-03-03	15:12:39.0000000	-1.541	-1.462	2.6902010781403	2.5522253107045

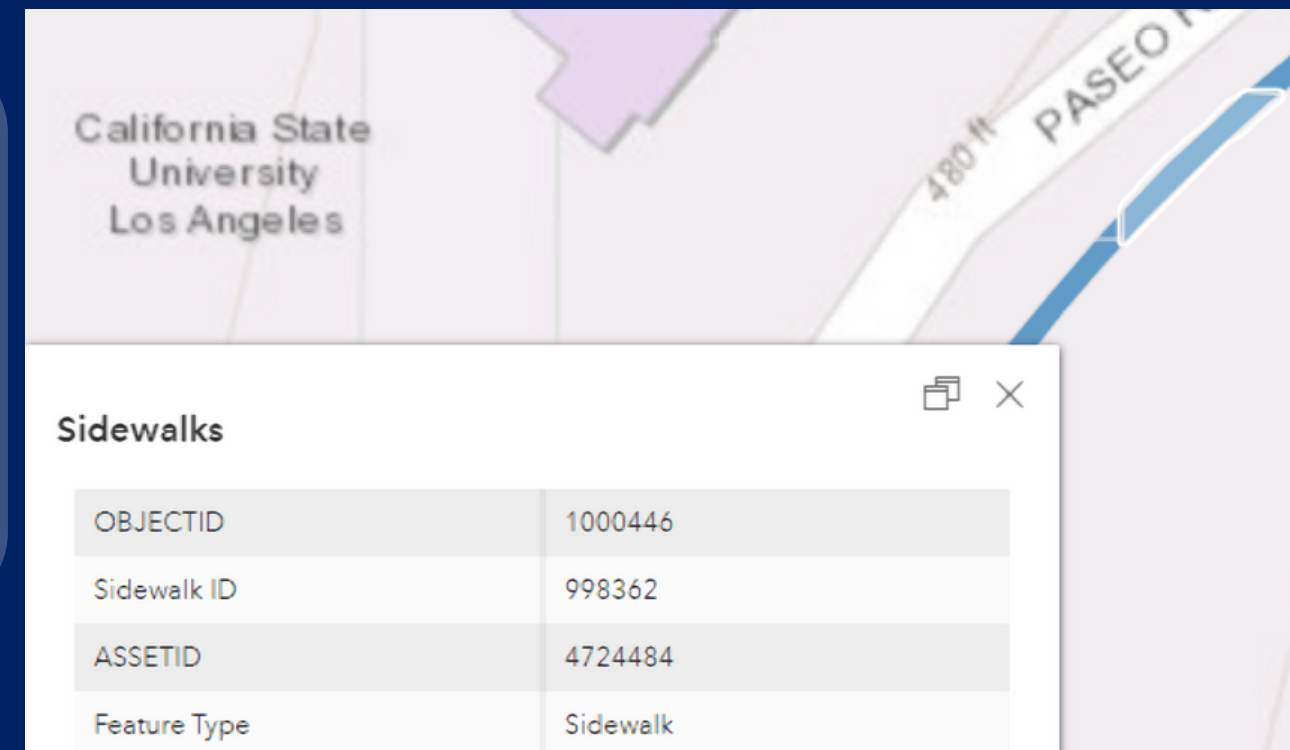
	LATITUDE	LONGITUDE	DATE	TIME	AVG SLOPE X	MAX ...	MIN ...	MEDIAN ...	LIST SLOPE X
1	4037771.06615009	-13117508.9952406	2022-03-03	15:12:39.0...	1.60157142...	1.655	1.527	1.647	1.527, 1.541, ...
2	4037771.40210332	-13117508.5833585	2022-03-03	15:12:38.0...	1.22922222...	1.707	0.743	1.145	0.743, 0.761, ...

- Sample of collected rover data
- SQL View contains aggregate data
- Better way to organize all slope data

DB/Backend

	IMAGE_NAME	LATITUDE	LONGITUDE	DATETIME	SW_ID
1	GPFR2114.JPG	4038394.57208231	-13154486.4023795	2022-03-01 15:25:00	998362
2	GPFR2115.JPG	4038395.32465876	-13154485.1778651	2022-03-01 15:25:00	998362
3	GPFR2116.JPG	4038396.58791219	-13154483.6527881	2022-03-01 15:25:00	998362
4	GPFR2117.JPG	4038398.73813113	-13154482.4394057	2022-03-01 15:26:00	998362
5	GPFR2118.JPG	4038402.63540398	-13154481.3484747	2022-03-01 15:26:00	998362
6	GPFR2119.JPG	4038406.66706696	-13154480.3354673	2022-03-01 15:26:00	998362

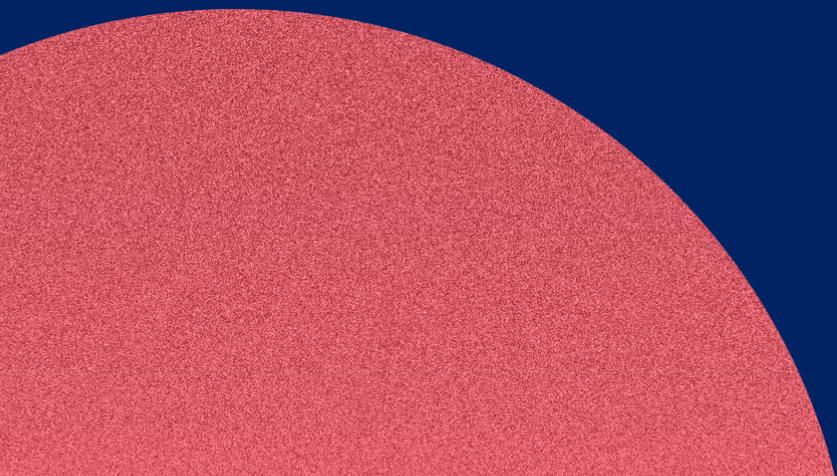
- Sample GoPro image metadata
- No clusters of GPS points
- GPS testing is accurate to field test locations



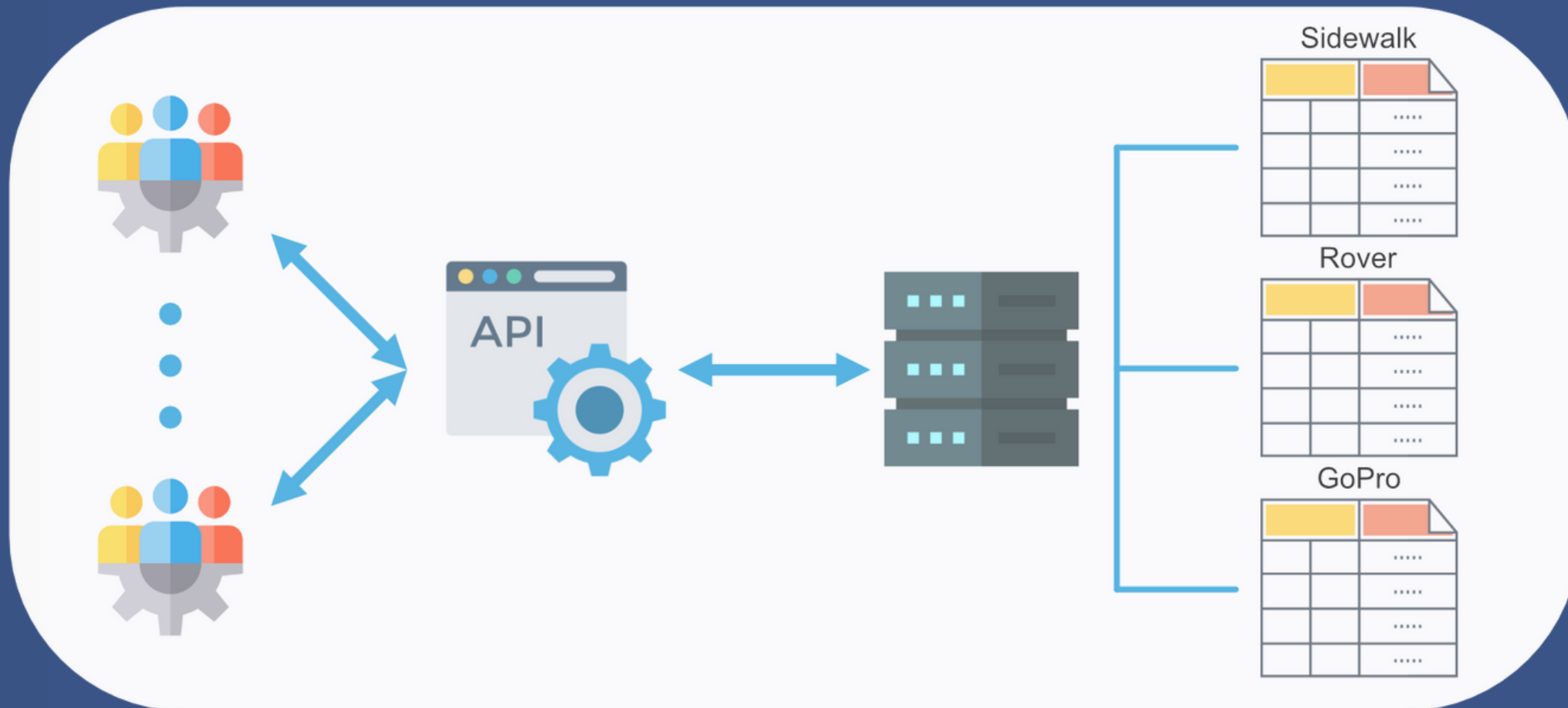
Backend API



Overview

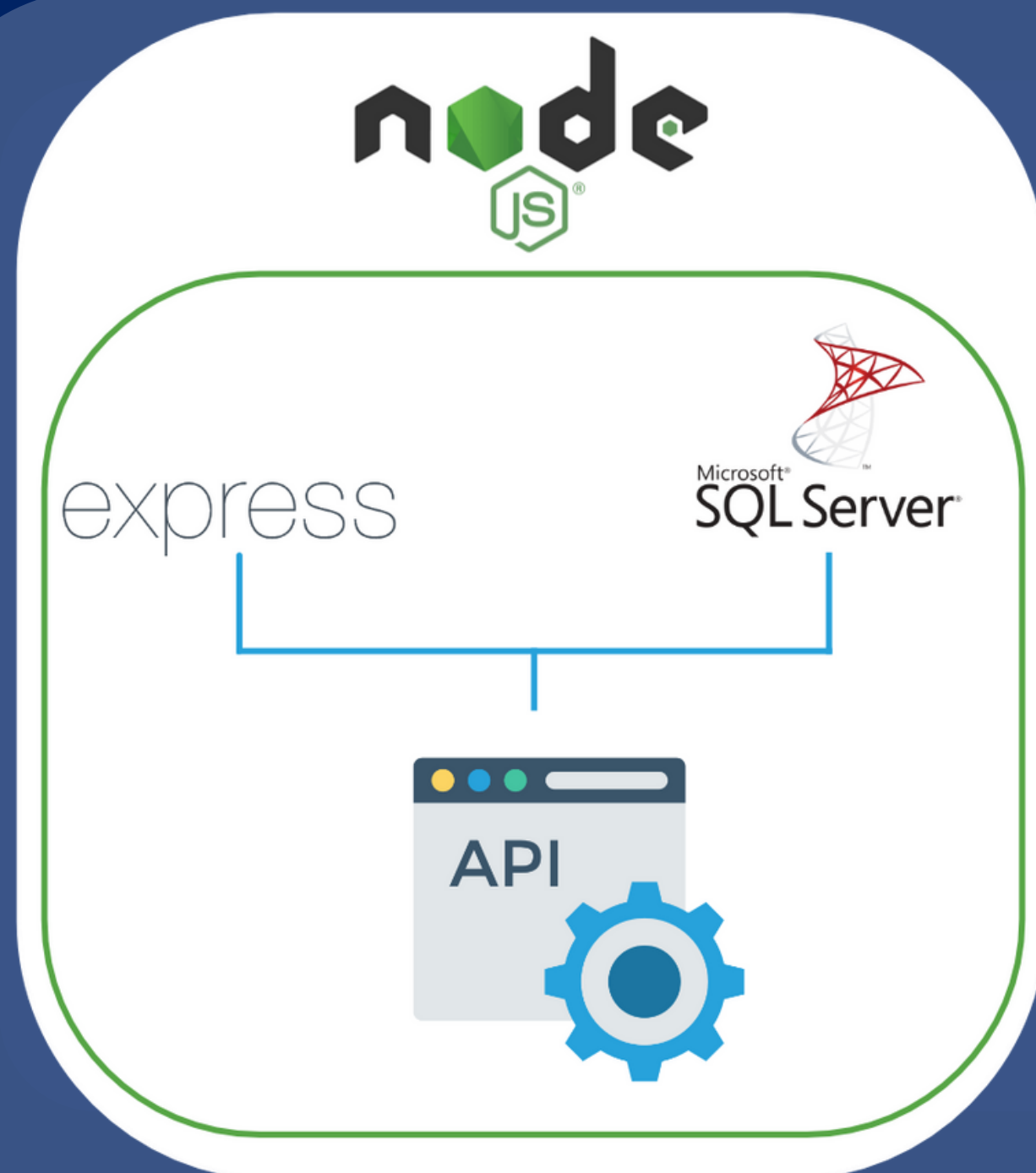
- Web API's role
 - Tech stack
 - Features
- 

Web API - Role



- Provide data accessibility across different teams.
- Reduce overhead by centralizing data handling at a single source.
- Promotes separation of concerns.

Web API - Tech Stack

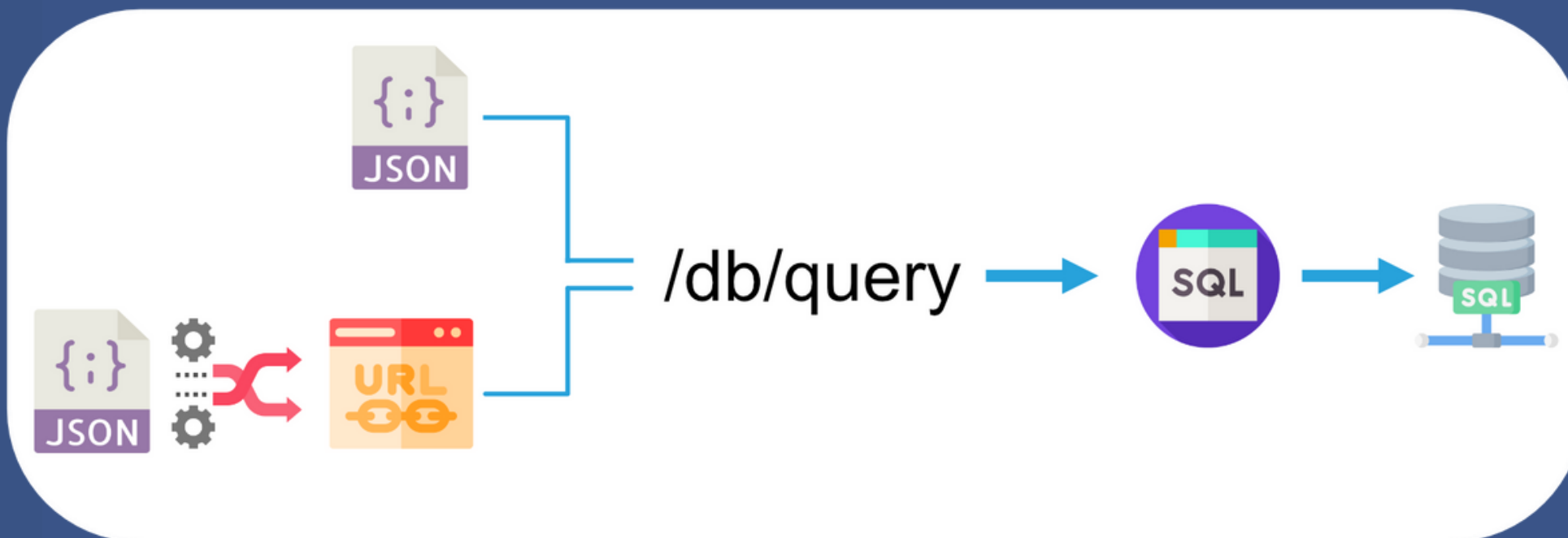


NodeJS: Cross-platform back end JavaScript runtime environment.

ExpressJS: De facto standard web server framework for Nodejs. Used to build API

Ms-sql: Microsoft SQL Server client for NodeJS.

Web API - Features



- Primary endpoint for accessing data from database.
- Accepts JSON in body requests or JSON encoded in URL.
- Offers flexibility in data requests.

Web API - Features

```
{
  "limit": 50,
  "attributes": [],
  "where": {
    "DATE": {
      "gt": "2021-11-10"
    }
  },
  "table": ["sdwk.rover_data"],
  "orderBy": {
    "cols": ["DATE"],
    "order": "ASC"
  }
}
```



[https://exampleurl.com/db/query?limit=50&where\[DATE\]\[gt\]=2022-11-10&table\[0\]=sdwk.rover_data&orderBy\[order\]=ASC](https://exampleurl.com/db/query?limit=50&where[DATE][gt]=2022-11-10&table[0]=sdwk.rover_data&orderBy[order]=ASC)



```
SELECT TOP(50) * FROM sdwk.rover_data WHERE DATE > "2022-11-10" ORDER BY DATE ASC;
```

Supports:

- LIMIT/TOP & OFFSET
- Column functions (COUNT, DISTINCT, etc)
- WHERE clause(s) (=, >, NOT IN, etc)
- Attribute selection
- GROUP BY & ORDER BY functions
- Multiple table selections
- Simple joins

Web API - Features

/find/closest



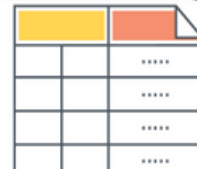
Given a coordinate, finds the sidewalk closest to the coordinate and return its data.

/convert/coordinates



Converts a given list of coordinates from one spatial reference to another.

/insert/csv



When a rover or GoPro CSV file is uploaded, the file is processed and inserted into the appropriate database table.

Field Testing

Overview

- Collected field data
- Editing collected data
- Used Excel to:
 - display thresholds
 - calculated the data

Field Testing



Digital Level Comparisons

1	Digital Level Running Slope			Digital Level Crossing Slope			Rover Slopes		Running Slope Difference			Crossing Slope Difference			
2	Bosch_run	Stabila_run	Johnson_run	Bosch_cross	Stabila_cross	Johnson_cross	Rover_run	Rover_cross	Rover-Bosch-run	Rover-Stabila-run	Rover-Johnson-run	Rover-Bosch-cross	Rover-Stabila-cross	Rover-Johnson-cross	
3	3.1	3.1	2.613	1.2	1	1.172	2.327	1.082	0.773	0.773	0.286	0.118	0.082	0.09	
4	3.4	3.2	3.382	0.6	0.4	0.656	2.611	1.185	0.789	0.589	0.771	0.585	0.785	0.529	
5	2.7	2.7	2.887	0.9	0.8	0.664	2.134	1.155	0.566	0.566	0.753	0.255	0.355	0.491	
6	2.3	2	2.337	0.8	0.8	1.039	1.566	1.499	0.734	0.434	0.771	0.699	0.699	0.46	
7	2.1	2.1	1.991	1.8	1.7	1.952	1.387	2.331	0.713	0.713	0.604	0.531	0.631	0.379	
8	2.1	1.9	2.090	1.8	1.8	2.297	1.344	2.187	0.756	0.556	0.746	0.387	0.387	0.11	
9	1.5	1.6	1.783	1.5	1.6	1.511	1.001	2.126	0.499	0.599	0.782	0.626	0.526	0.615	
10	1.7	1.8	1.799	2.1	1.8	1.970	1.260	2.280	0.44	0.54	0.539	0.18	0.48	0.31	
11	1.7	1.5	1.649	1.5	1.4	1.569	0.932	1.885	0.768	0.568	0.717	0.385	0.485	0.316	
12	2.1	2	2.090	1.7	1.6	1.854	1.341	2.245	0.759	0.659	0.749	0.545	0.645	0.391	
13	1.7	1.7	1.631	1.7	1.9	1.614	1.001	2.197	0.699	0.699	0.63	0.497	0.297	0.583	
14	1.5	1.7	1.361	2.2	2.1	2.158	0.937	2.499	0.563	0.763	0.424	0.299	0.399	0.341	
15	1.7	1.8	1.517	1	1.1	0.872	1.066	1.238	0.634	0.734	0.451	0.238	0.138	0.366	
16	1.6	1.6	1.374	1.1	1	2.313	0.890	0.941	0.71	0.71	0.484	0.159	0.059	1.372	
17	1.2	1.3	0.833	1.5	1.5	1.080	0.471	1.462	0.729	0.829	0.362	0.038	0.038	0.382	
18	1.6	1.5	1.439	1.3	1.4	1.393	1.029	1.615	0.571	0.471	0.41	0.315	0.215	0.222	
19	1.3	1.7	1.566	1.3	1.5	1.641	0.843	1.364	0.457	0.857	0.723	0.064	0.136	0.277	
20	1.9	1.9	2.367	2.1	2.2	1.954	1.509	2.533	0.391	0.391	0.858	0.433	0.333	0.579	
21	1.2	1.2	1.125	1.8	1.9	1.793	0.700	1.859	0.5	0.5	0.425	0.059	0.041	0.066	
22	1.2	1.3	1.276	1.8	2	2.126	0.807	2.217	0.393	0.493	0.469	0.417	0.217	0.091	
23	1.2	1.2	1.195	1.4	1.4	1.375	0.625	1.760	0.575	0.575	0.57	0.36	0.36	0.385	
24	2.1	1.9	2.060	1.6	1.7	2.001	1.550	1.887	0.55	0.35	0.51	0.287	0.187	0.114	
25	0.7	0.9	0.776	1.6	1.7	1.806	0.391	1.796	0.309	0.509	0.385	0.196	0.096	0.01	
26	1	1.4	1.095	2.2	2.2	1.953	0.666	2.307	0.334	0.734	0.429	0.107	0.107	0.354	
27	1.5	1.6	1.611	1.8	1.9	1.991	1.106	2.062	0.394	0.494	0.505	0.262	0.162	0.071	
28	1.7	1.7	1.791	1.3	1.4	1.363	1.173	1.484	0.527	0.527	0.618	0.184	0.084	0.121	
29	1.5	1.75	1.508	1.3	1.4	1.131	0.947	1.626	0.553	0.803	0.561	0.326	0.226	0.495	
30	1.3	1.5	1.313	1.5	1.5	1.399	0.763	1.773	0.537	0.737	0.55	0.273	0.273	0.374	
31	1.9	1.7	1.812	1.3	1.4	1.404	1.316	1.582	0.584	0.384	0.496	0.282	0.182	0.178	
32	1.2	1.5	1.157	1.6	1.6	1.547	0.646	2.010	0.554	0.854	0.511	0.41	0.41	0.463	
33	1.7	1.8	1.901	1.4	1.6	1.223	1.003	1.722	0.697	0.797	0.898	0.322	0.122	0.499	
34	1.4	1.6	1.360	1.8	1.9	1.900	1.007	1.971	0.393	0.593	0.353	0.171	0.071	0.071	
35	1.9	1.7	1.673	1.8	2	1.642	1.037	2.223	0.863	0.663	0.636	0.423	0.223	0.581	
36															
37									0.585	0.62	0.575	0.316	0.286	0.354	Average

Raw Rover Data		Raw % Slope		Adjusted % Slope		Adjusted Slope Data	
RunningSlope	CrossingSlope	%RunningSlope	%CrossingSlope	%RunningSlopeAdj	%CrossingSlopeAdj	RunningSlopeAdj	CrossingSlopeAdj
3.819	0.353	6.675300957	0.616093431	5.667905833	0.001745329	3.244	-0.001
1.969	-0.034	3.437906781	0.059341188	2.433469155	0.558511168	1.394	-0.32
5.653	0.181	9.898485992	0.315903544	8.886060478	0.301942878	5.078	-0.173
2.696	0.061	4.708883468	0.106465044	3.703535229	0.511385929	2.121	-0.293
2.696	0.061	4.708883468	0.106465044	3.703535229	0.511385929	2.121	-0.293
2.71	0.126	4.73337254	0.219911131	3.728003575	0.39793717	2.135	-0.228
2.805	0.748	4.8995635	1.30543212	3.894050708	0.687670565	2.23	0.394
3.671	0.246	6.415885367	0.429348358	5.408804641	0.188495782	3.096	-0.108
3.671	0.246	6.415885367	0.429348358	5.408804641	0.188495782	3.096	-0.108
3.671	0.246	6.415885367	0.429348358	5.408804641	0.188495782	3.096	-0.108
3.703	0.719	6.471967819	1.254825867	5.464820267	0.637053795	3.128	0.365
2.451	0.534	4.280413309	0.931978836	3.275408242	0.314160299	1.876	0.18
2.451	0.534	4.280413309	0.931978836	3.275408242	0.314160299	1.876	0.18
2.451	0.534	4.280413309	0.931978836	3.275408242	0.314160299	1.876	0.18
1.814	0.198	3.167085534	0.345573816	2.16280008	0.272272036	1.239	-0.156
2.872	0.974	5.016788045	1.699786967	4.011170474	1.082146375	2.297	0.62
2.872	0.974	5.016788045	1.699786967	4.011170474	1.082146375	2.297	0.62
2.872	0.974	5.016788045	1.699786967	4.011170474	1.082146375	2.297	0.62
2.504	1.073	4.373088938	1.872519401	3.368012764	1.254957608	1.929	0.719
2.504	1.073	4.373088938	1.872519401	3.368012764	1.254957608	1.929	0.719
1.721	0.958	3.004615313	1.671869635	2.000414091	1.05421792	1.146	0.604
1.721	0.958	3.004615313	1.671869635	2.000414091	1.05421792	1.146	0.604
1.721	0.958	3.004615313	1.671869635	2.000414091	1.05421792	1.146	0.604
1.721	0.958	3.004615313	1.671869635	2.000414091	1.05421792	1.146	0.604
1.721	0.958	3.004615313	1.671869635	2.000414091	1.05421792	1.146	0.604
1.721	0.958	3.004615313	1.671869635	2.000414091	1.05421792	1.146	0.604
1.721	0.958	3.004615313	1.671869635	2.000414091	1.05421792	1.146	0.604
1.721	0.958	3.004615313	1.671869635	2.000414091	1.05421792	1.146	0.604
3.17	-0.044	5.538345971	0.076794472	4.532228822	0.541057348	2.595	-0.31
3.17	-0.044	5.538345971	0.076794472	4.532228822	0.541057348	2.595	-0.31

Navigate LA



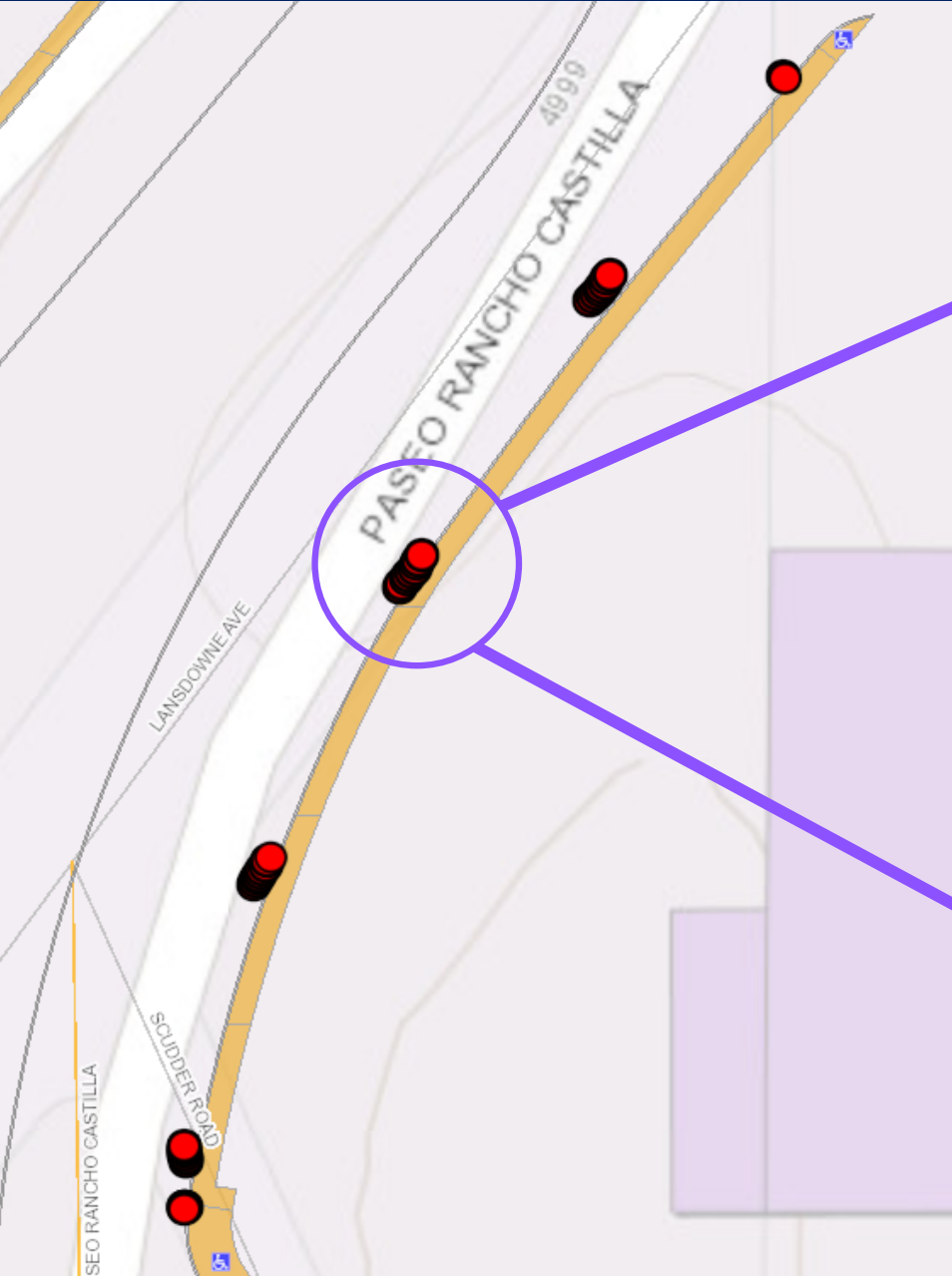
Overview

- Collected data will serve as geographical reference points for the GoPro data and the rover data listed.
 - Mapping files will be hosted on NavigateLA as a layer of sidewalk data for the Bureau of Engineering to view.
- 

Navigate LA Interface



Navigate LA Data

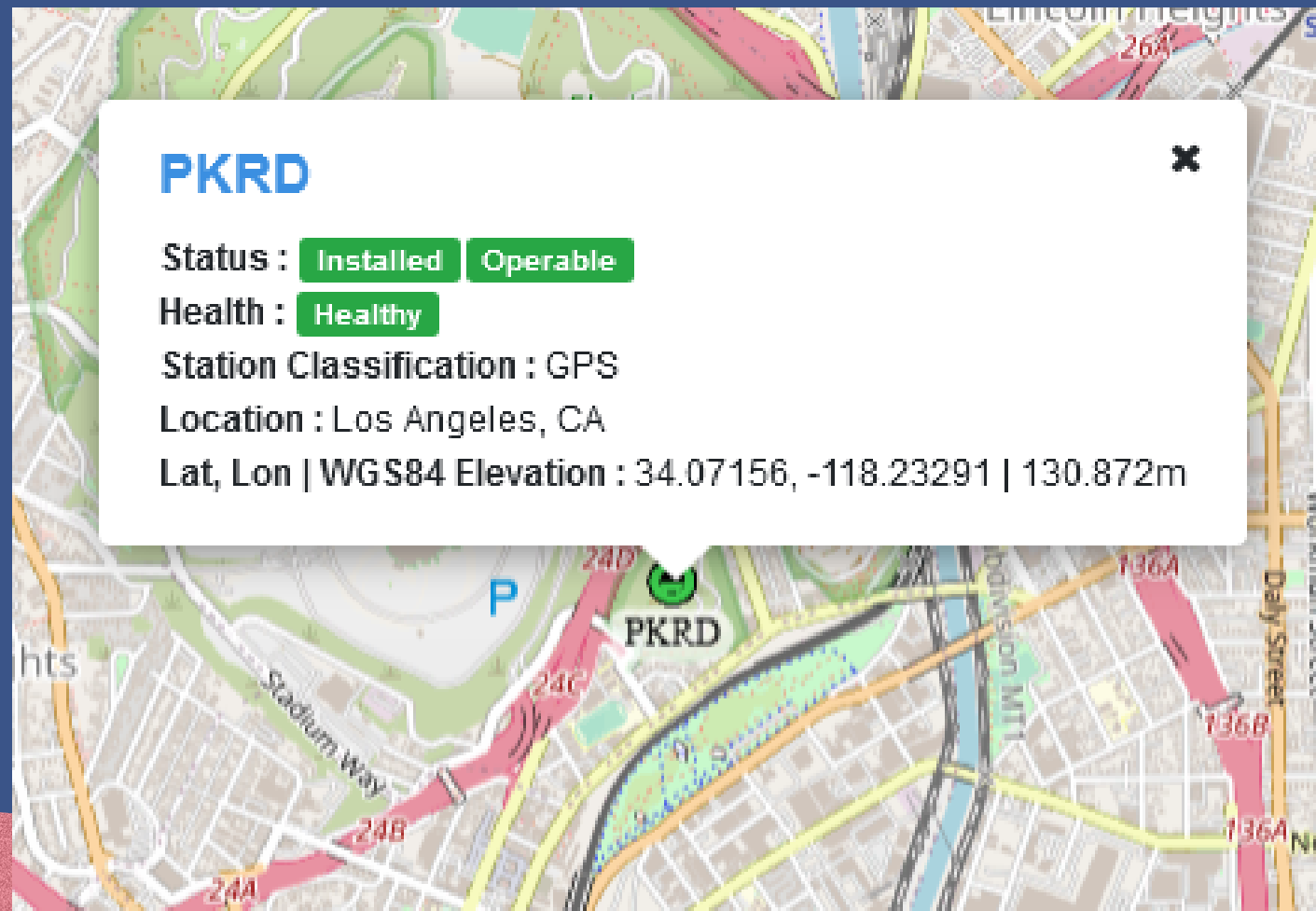


Categorizing:
Cross slope used
for Severity
Index

Damage Severity Matrix		
Severity Index	Vertical Displacement (Uplift)	Sidewalk Cross-slope
5 Very Severe	$\geq 12''$	$\geq 20\%$
4 Severe	$< 12'' \text{ to } \geq 6''$	$< 20\% \text{ to } \geq 10\%$
3 Moderate	$< 6'' \text{ to } \geq 1''$	$< 10\% \text{ to } \geq 5\%$
2 Minor	$< 1'' \text{ to } \geq 1/4''$	$< 5\% \text{ to } > 2\%$
1 Very Minor	$< 1/4''$	$\leq 2\%$

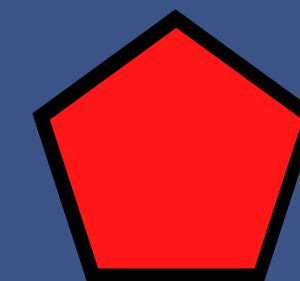
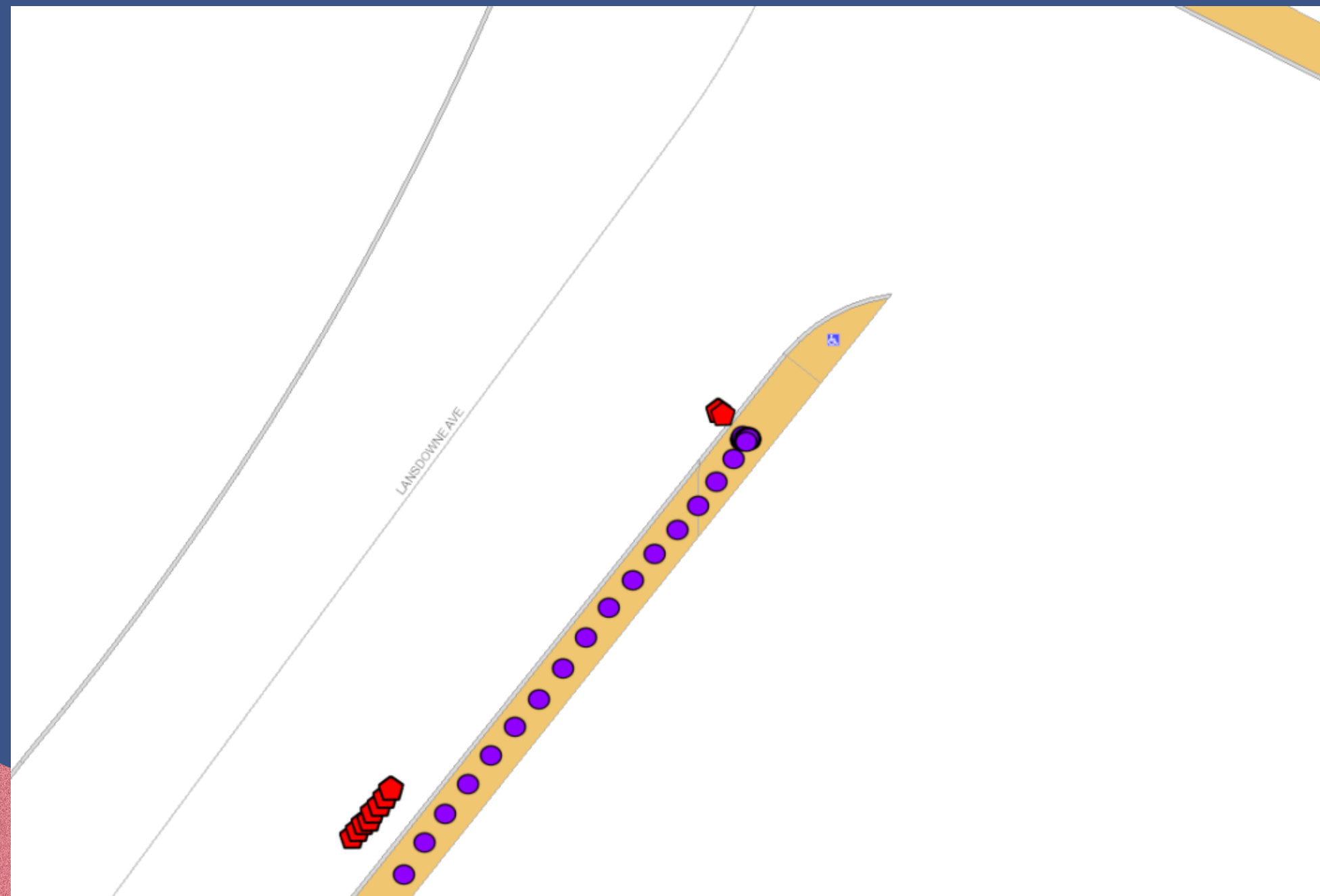
RTK Viability

Base Station

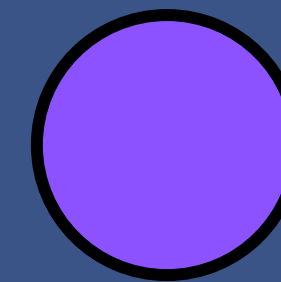


Reach RS2
RTK Positioning
&
GNSS Receiver

Rover GPS vs RTK



Rover GPS Data



Reach RS2 Data



Sidewalk Segment

Future Recommendations

Web UI

- Set default data to current network location
- Implementation of automatic photo conversion rather than manual

Rover UI

- Create a mobile application

Database

- Implement authentication for insert, update, and delete actions
- Add support for batch csv file uploads
- Add support for locating nearest Section ID

Field Testing

- Check if it's possible to get a survey from civil engineers

NavLA

- Color code records based on Severity Index
- Host layer on NavLA so there is no need to drag & drop records

Q & A



Thank you



- Sponsors: City of LA and B.O.E for the opportunity to work on this project.