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Analysis of Pavement Conditions through Sensor Vibration Data

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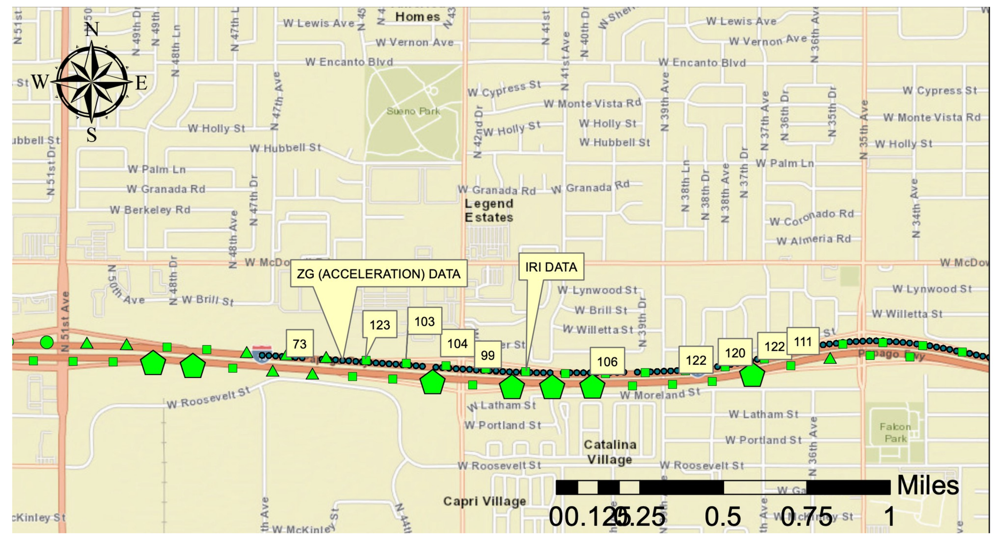
Homeland Security Challenge

Our team's challenge was focused on infrastructure and monitoring pavement conditions through vibration data. Pavement conditions and how to measure them have become an important focus for highway agencies. The more damage the roadway has, the more damage to the cars there is and the same is true as to the people inside. Without proper maintenance and a way to monitor the damage, the infrastructure, car, and person inside can suffer the consequences. IRI (International Roughness Index) has been the method for measuring the pavement conditions, however it can be costly and ineffective, so our method involves using a cheaper method that also provides more in-depth data through vibration data attached on each tire's suspension. So, our main objective was to integrate a vehicle-based sensing system and a full car model to better estimate the asphalt roughness and identify critical cracking locations with better accuracy.

Approach / Methodology

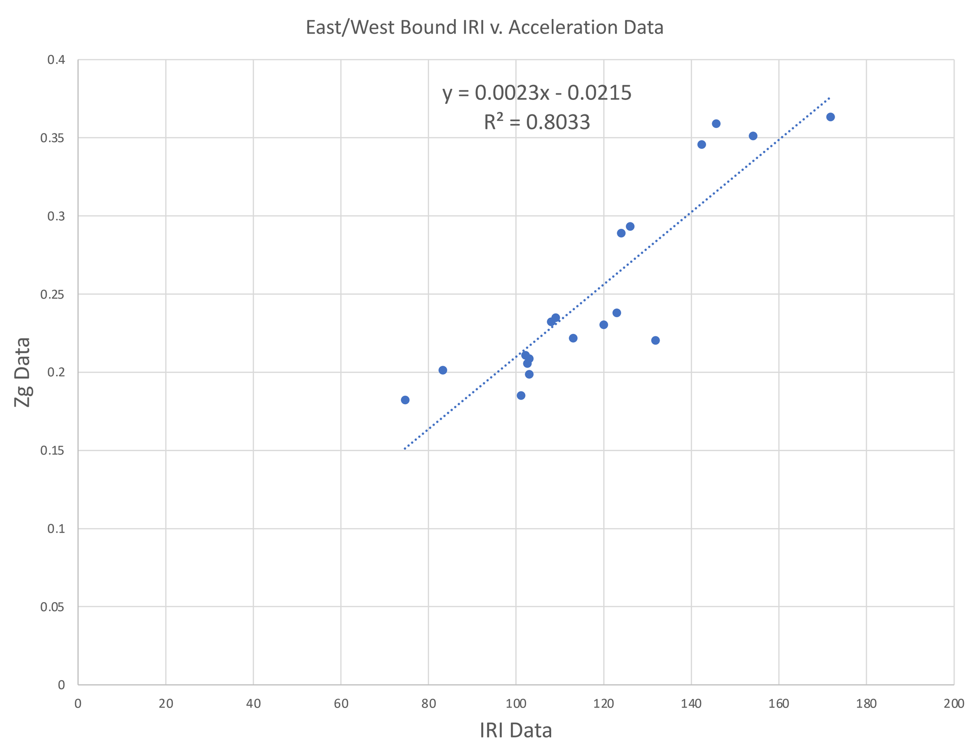
Our data examined two stretches of freeway in Phoenix Arizona. The first area being a north and south bound freeway which was the I-10 from Chandler Blvd to Baseline road. The second are was east and west bound on the I-10 between 27th and 51rst ave. The other student on this project did the north/southbound region and I did the east/west bound area. The approach that was followed was a series of numerical analysis done using ArcGIS and Excel. Both the IRI data from ADOT and the collected vibration data were uploaded into ArcGIS to be able to compare the data and find common points of poor conditions. After a common point was found, the respective IRI data was put into excel as well as the range of Zg (acceleration) data surrounding the point. Next, an average of the surrounding Zg data was taken from the two front tires in order to get a single number to compare to the IRI data. This was done over and over to gather a wide range of corresponding acceleration data points with IRI points. Finally, all these points were put into a table and graph to show the correlation between the vibration data and IRI. These graphs can be seen to the right in addition an ArcGIS map of the section worked on and the sensors used can be seen below.



Outcomes / Results

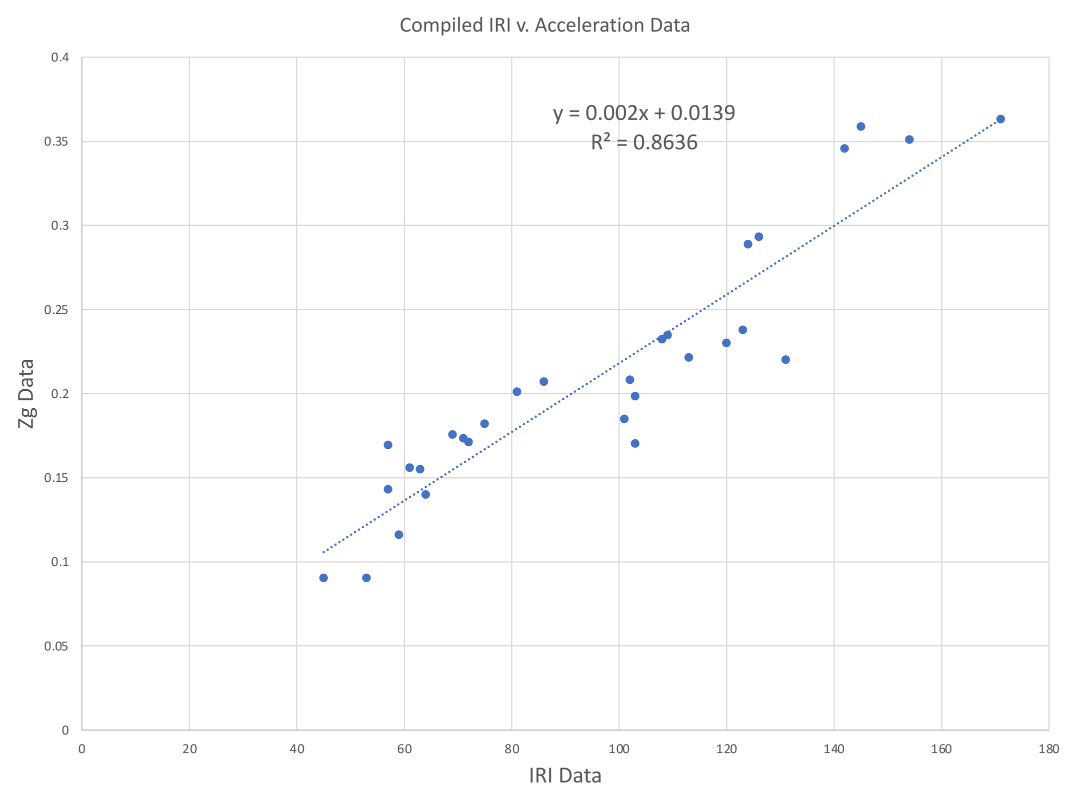
East/West Bound Data

Pavement Conditions	IRI 2019	Avg_zg1_zg2
	171.7711	0.36331058
	154.125	0.35109179
Severe	145.6487	0.35889295
	142.3477	0.34576102
	131.853	0.22022061
	126	0.293255
	124	0.2888732
	123	0.23802542
	120	0.23025957
Poor	113	0.22168049
	109	0.23497441
	108	0.23235901
	103	0.19860181
	102.95	0.20876971
	102.5667	0.20545311
	102.1262	0.21086436
	101.0984	0.18516434
	83.2827	0.20120567
Fair	74.6326	0.18209643



North/South and East/West Bound Compiled Data

	IRI 2019	Avg_zg1_zg2
	171	0.36331058
Severe	154	0.35109179
	145	0.35889295
	142	0.34576102
	131	0.22022061
	126	0.293255
	124	0.2888732
	123	0.23802542
	120	0.23025957
	113	0.22168049
	109	0.23497441
Poor	108	0.23235901
	103	0.19860181
	103	0.17035022
	102	0.20836239
	101	0.18516434
	86	0.20729124
	81	0.20120567
	75	0.18209643
Fair	72	0.17138058
	71	0.17350931
	69	0.17580492
	64	0.14020141
Good	63	0.15521222
	61	0.15596558
	59	0.11619852
	57	0.14313643
	57	0.169669
	45	0.09042025
	53	0.09042025



Conclusions

Our results showed that the vibration data was in fact accurate and could be used in the future as a method of analyzing pavement conditions. As can be seen in the figures on the left, the R^2 value, or the correlation coefficient is .8 for the specific East/West bound section and is .86 for the compiled data between North/South and East/West bound. These are both very high correlation coefficients and are evidence that the data is accurate. The IRI and the Zg (acceleration) data match, as IRI goes up as does the Zg data. This shows that the use of GIS mapping and excel data analysis in conjunction with syntax programming provides a systematic, fast, and accurate approach to retrieve data points among a huge amount of raw data essential for further regression analysis.

References

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Acknowledgements

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