MINE HAUL ROADS: DATA VISUALIZATION OF MAINTENANCE CONDITION

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Introduction

Material haulage is the single largest cost for surface mines. Haul roads are the backbone that connect the various mine locations and support the trucks moving material. In the last few decades, larger and larger tucks have been introduced straining the capabilities of current road construction. Large weights, constant traffic and harsh weather conditions lead to near constant maintenance, averaging at least once per week. The poor conditions of unmaintained roads cause damage to equipment, decrease production and injure operators.

Background

Currently, visual inspection is the primary method to identify areas to perform road maintenance. [1] This is subjective, often inaccurate, and delays corrective action. Some novel methods are being used, but have their limitations:

- Suspension strut pressures can detect various defects, but thresholds must be set to indicate severity.
- Imaging technology (LIDAR) can provide precise surface roughness, but doesn't indicate subsurface structural defects.

Objective

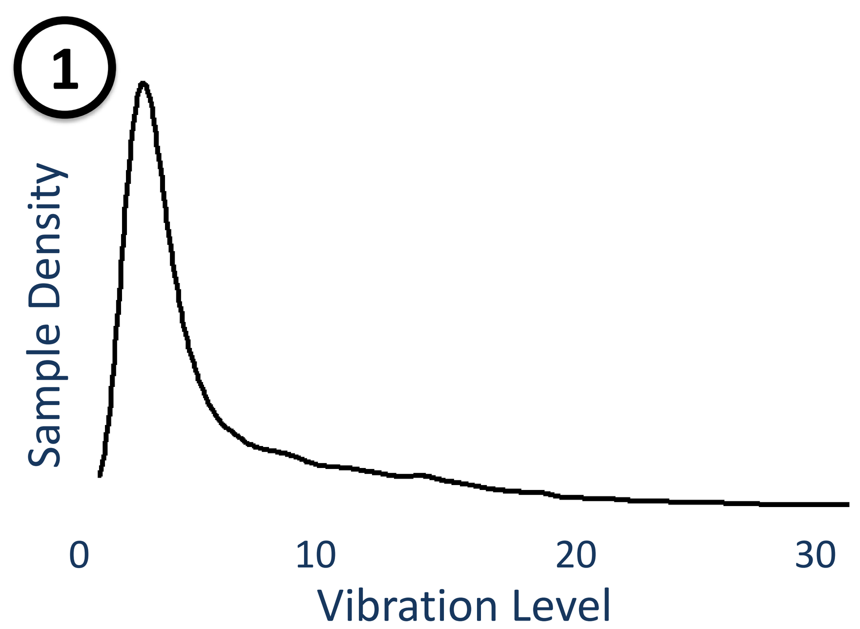
Predictive modeling of road condition will allow optimization of road maintenance resources, resulting in lower total mining cost. Vibration level, an indicator of road condition, along with GPS and other telemetry data, in the past only used for truck maintenance and dispatching, is analyzed to find patterns in haul trucks' vibration response. This work aims to find the most influential factors for vibration response and determine correction coefficients to be used in a predictive model.

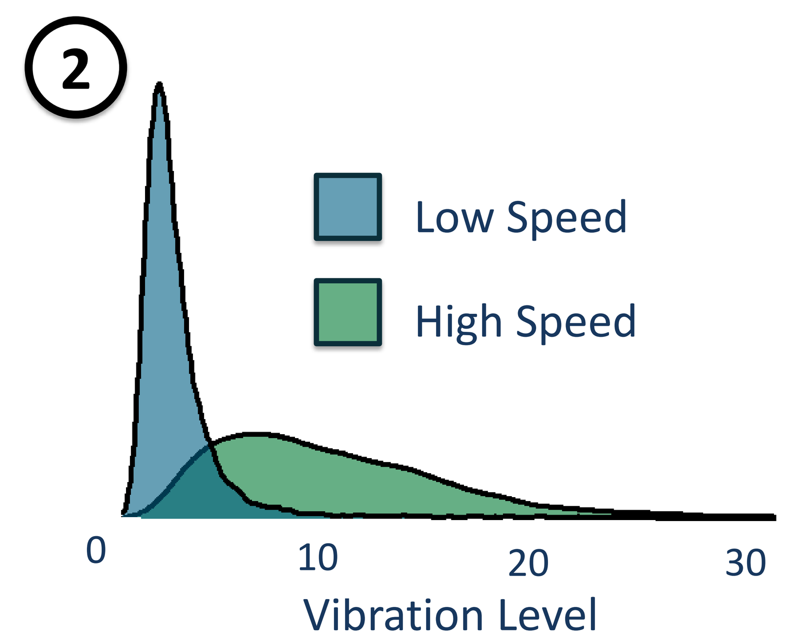
Data Collection

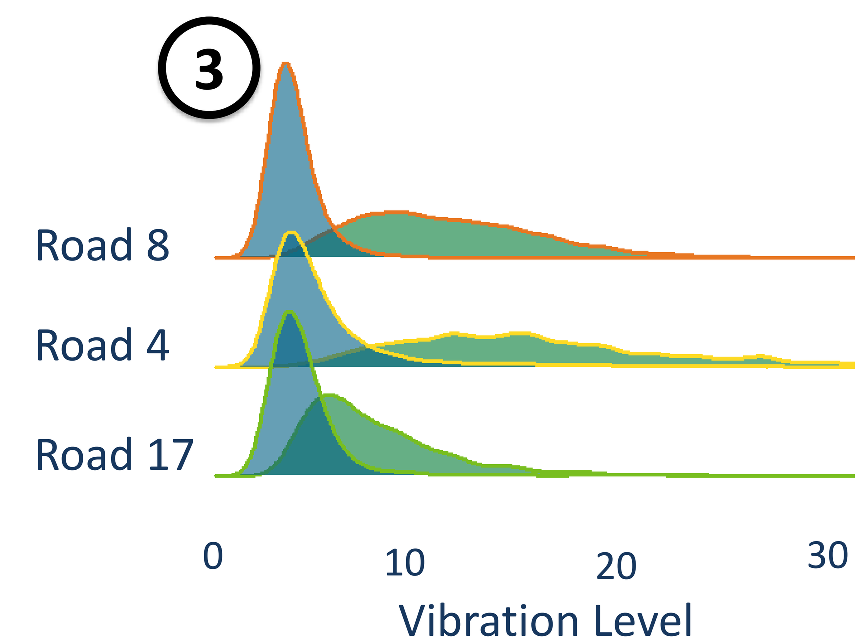
http://www.jaws.co.za

The GPS and vibration data of two haul trucks from a metal mine are collected for a 1-week time frame. The GPS unit natively produces the location, speed, heading, and slope. The mine is subdivided into small road sections, approximately the size a road maintenance crew would service. In total, over 400,000 observations were collected. [2]

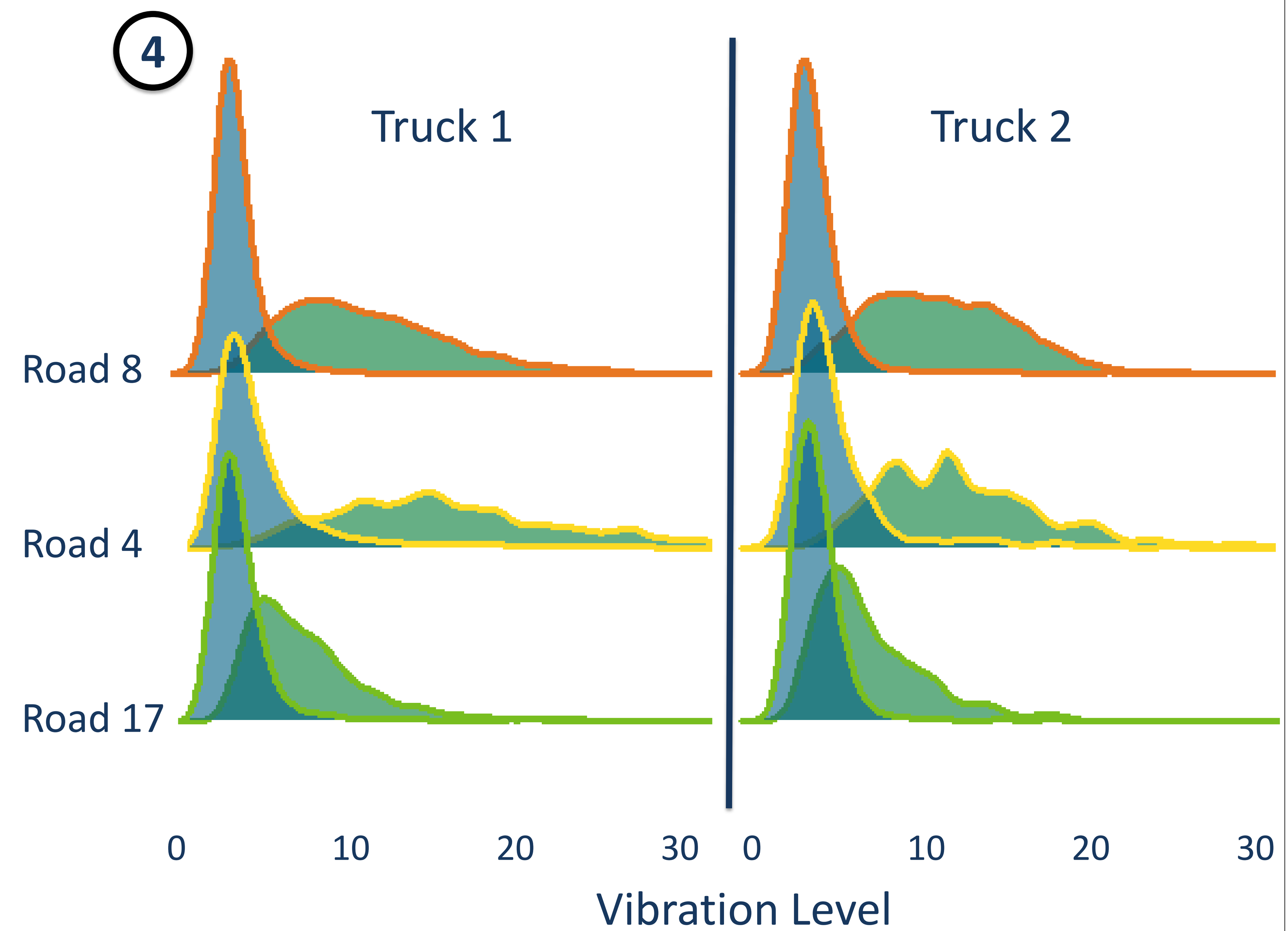
Analysis







False positives and meaningless true positives are concerns with large sample sizes. Therefore, initial analysis is conducted using a data visualization approach. The density distribution plot (1) shows positive skew, indicating influence of factors. These factors can be plotted separately indicating relative influence. The divisions are made across speed (2), location (3), and vehicle (4). The final distributions allow estimation of mean and variance. Targeted statistical analysis can then be conducted to produce coefficients for modeling.



Conclusions

- Vibration response is higher and has greater variance at faster operating speeds.
- Different sections of road create significantly different vibration levels. These road sections are geographically similar in the mine.
- Trucks have comparable vibration, but an unidentified factor appears to have interaction with road section.

Future Work

- Factors creating multimodal distributions will be identified and correction factors applied to the model.
- Road condition and maintenance is time dependent. A time series analysis is needed over a longer timeframe using additional trucks.

References

[1] Hugo, D., Heyns, P. S., Thompson, R. J., & Visser, A. T. (2008). Haul road defect identification using measured truck response. Journal of Terramechanics, 45(3), 79–88.

[2] Douglas, A. (2019). "Haul road roughness measurement using georeferenced truck vibration", New Trends in Production Engineering, 2(1), 416-423.

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