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Civil, Construction and Environmental Engineering (CCEE)

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Quantifying Unpaved Road Roughness from Terrestrial Laser Scanning

INTRODUCTION

- Unpaved roads represent a major component of the roadway network in Iowa and require regular surface grading to control roughness (e.g., corrugation). This research presents how terrestrial laser scanning can characterize road roughness of two gravel sections in terms of:
  - Spatially analyzed 2D international roughness index (IRI)
  - Fast Fourier transform (FFT) spectral analysis
  - Surface texture characterization using statistical analysis

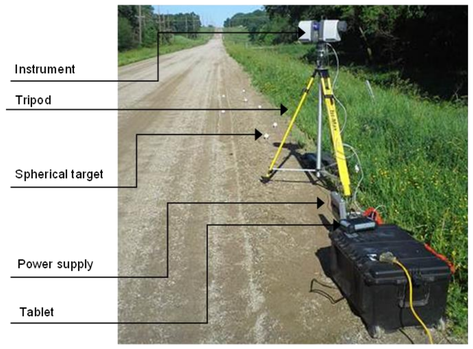
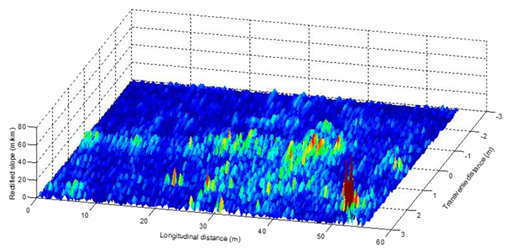


FIGURE 1 Trimble CX 3D laser scanner set-up.

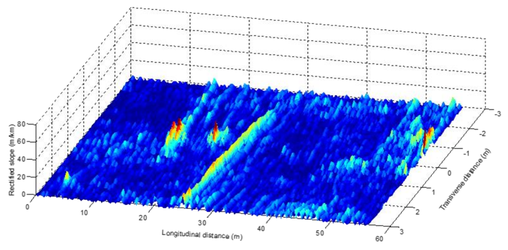
FIGURE 2 Registered point cloud for data acquired from two stations.

2D ROUGHNESS MAP

- One of the problems faced in quantifying roughness is the use of single parameter (i.e., IRI) to quantify the road roughness.
- To over come the issue algorithms were developed to process the point clouds acquired using Trimble CX 3D.
- The algorithm simulates a quarter- car model to produces surface maps of the road with roughness level at each point, representing the suspension rate of that model.
- Lines sampled from the maps were analyzed in the frequency domain using FFT, to identify the frequency content of roughness features.



(a)

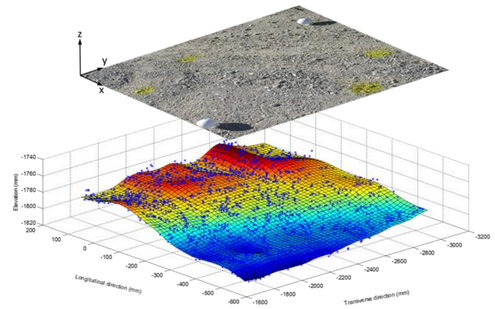


(b)

FIGURE 3 Rectified slope maps for (a) 160th street and (b) 170th street.

SURFACE TEXTURE

- Densely scanned patches (i.e., 2 million point per m^2) were analyzed using statistical analysis tools to identify the effect of aggregate gradation of loos material on the surface texture.
- The analysis starts by filtering the acquired 3D images using a spline fitting filter. This removes large features (e.g., corrugation).
- Then using the filtered image, three statistics were used to characterize the surface:
  - Root mean square height (S_q)
  - Skewness (S_{sk})
  - and kurtosis (S_{ku})



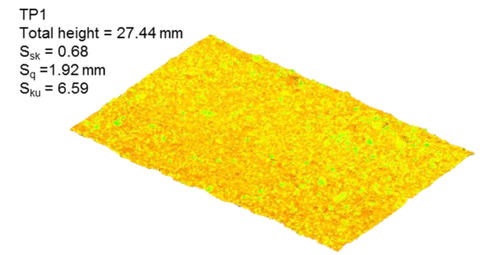


FIGURE 4 3D surfaces for a densely scanned patch with the calculated areal parameters.

CONCLUSIONS

- Terrestrial laser scanning is a promising technology to assess a range of surface conditions for unpaved roads.
- Algorithms used in producing 2-D roughness maps are semi-automated, and further developments are expected to introduce fully automated algorithms that can process the data directly after scanning.
- Corrugation is a major factor affecting ride quality in the absence of other major distresses.
- Areal field parameters hold important characteristics of the surface material, and more investigation is needed to correlate these parameters with the surface material characteristics and features.

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