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Center for Earthworks Engineering Research

Application of LiDAR and Structure from Motion Data for Road Roughness Evaluation

GeoSmart India
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Kyle Younkin
Department of Civil, Construction and Environmental Engineering
Iowa State University
+91 9717095106
kyounkin@iastate.edu

Contributing authors.

Ahmad Alhasan, PhD
Postdoctoral Research Associate
Iowa State University

David J. White, PhD, PE
Professor, Director, CEER
Iowa State University

Kyle Younkin

- B.S. Construction Engineering Iowa State University; Ames, Iowa; USA
- 4 years working experience in residential and highway construction in USA
- Research Assistant at the Center for Earthwork Engineering, Iowa State

  University Research includes
  - LiDAR and remote sensing project for Iowa Department of Transportation
  - Drone inspection of bridges
  - Building Information Modeling (BIM) and Scan-to-BIM LiDAR integration for Facility Management

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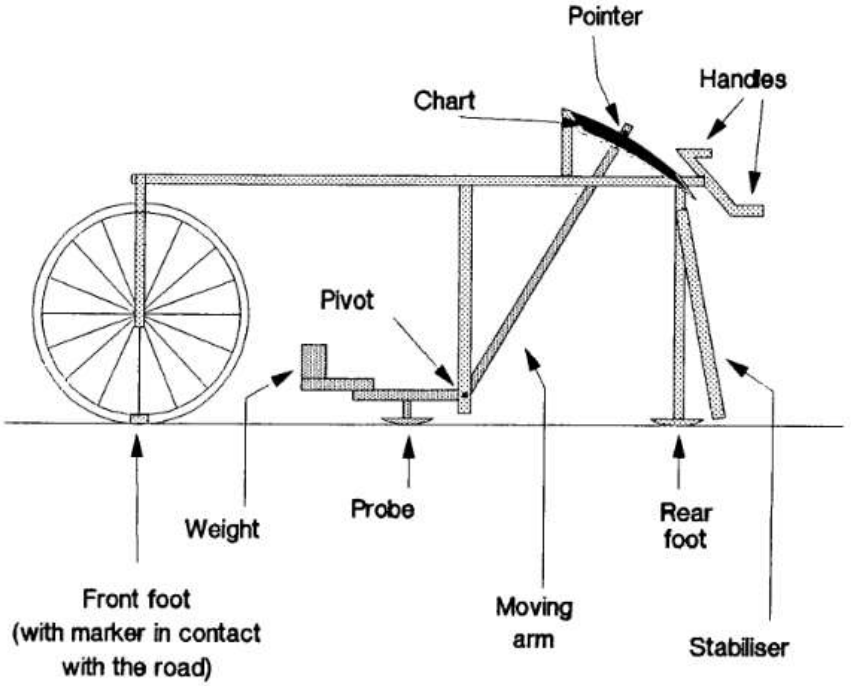
- IRI road roughness and the national highway system
- Methodology of determining IRI
- Results of comparison between LiDAR and SFM
- Applications of SFM IRI collection

Road roughness correlated with increased vehicle repair, fuel costs.*

*(Islam 2012)

Current methods of IRI collection are slow and show only one road profile



LiDAR offers quick and accurate road geometry and IRI calculation

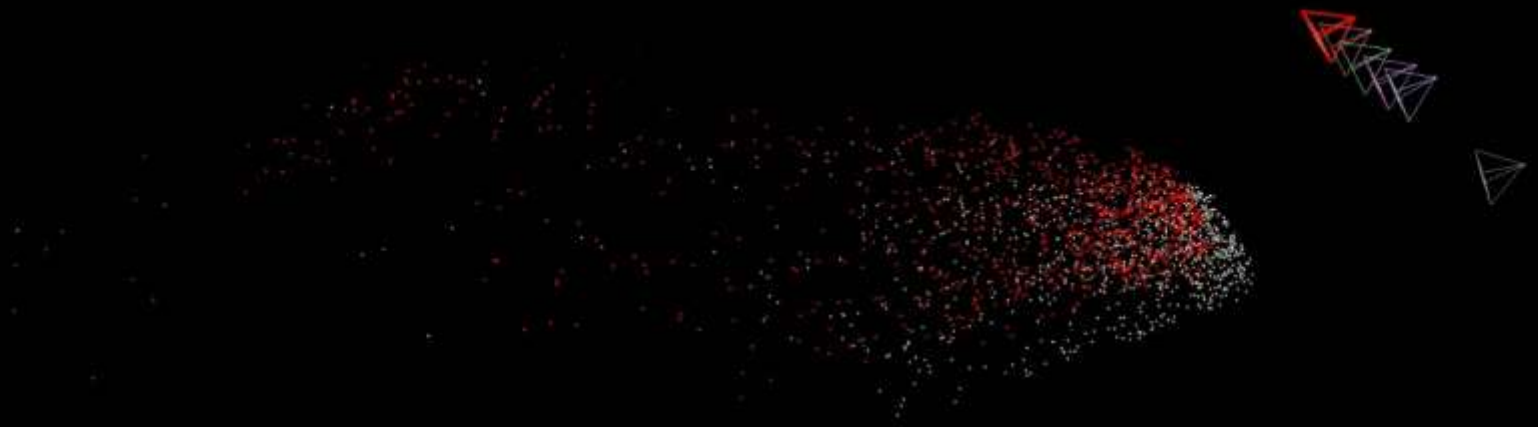
Previous research on LiDAR in pavement roughness calculation is presented in (Alhasan 2015).

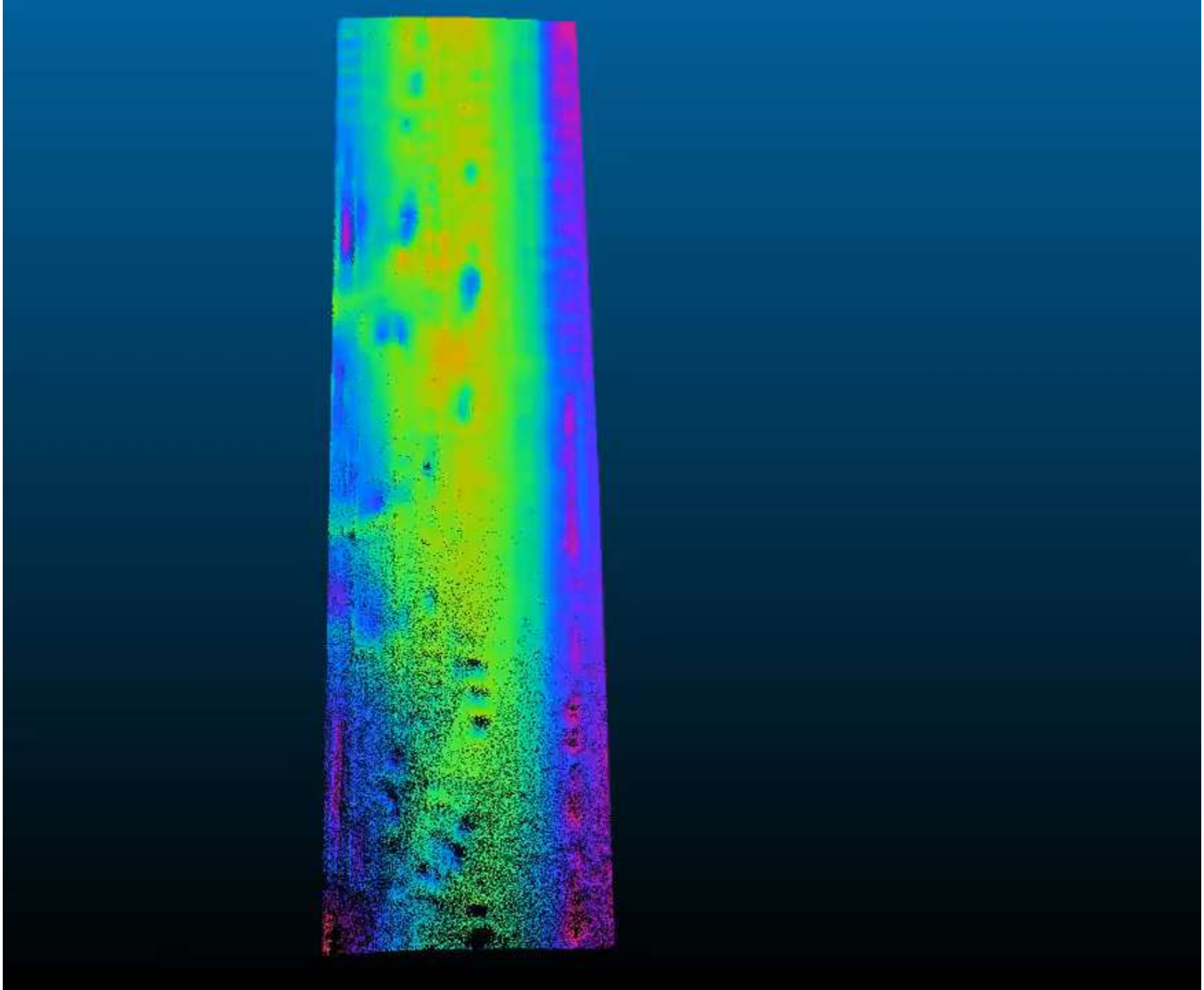
Imaged based structure from motion provides an inexpensive alternative to collect 3D roadway data.

SFM processes images to recognize unique keypoints.

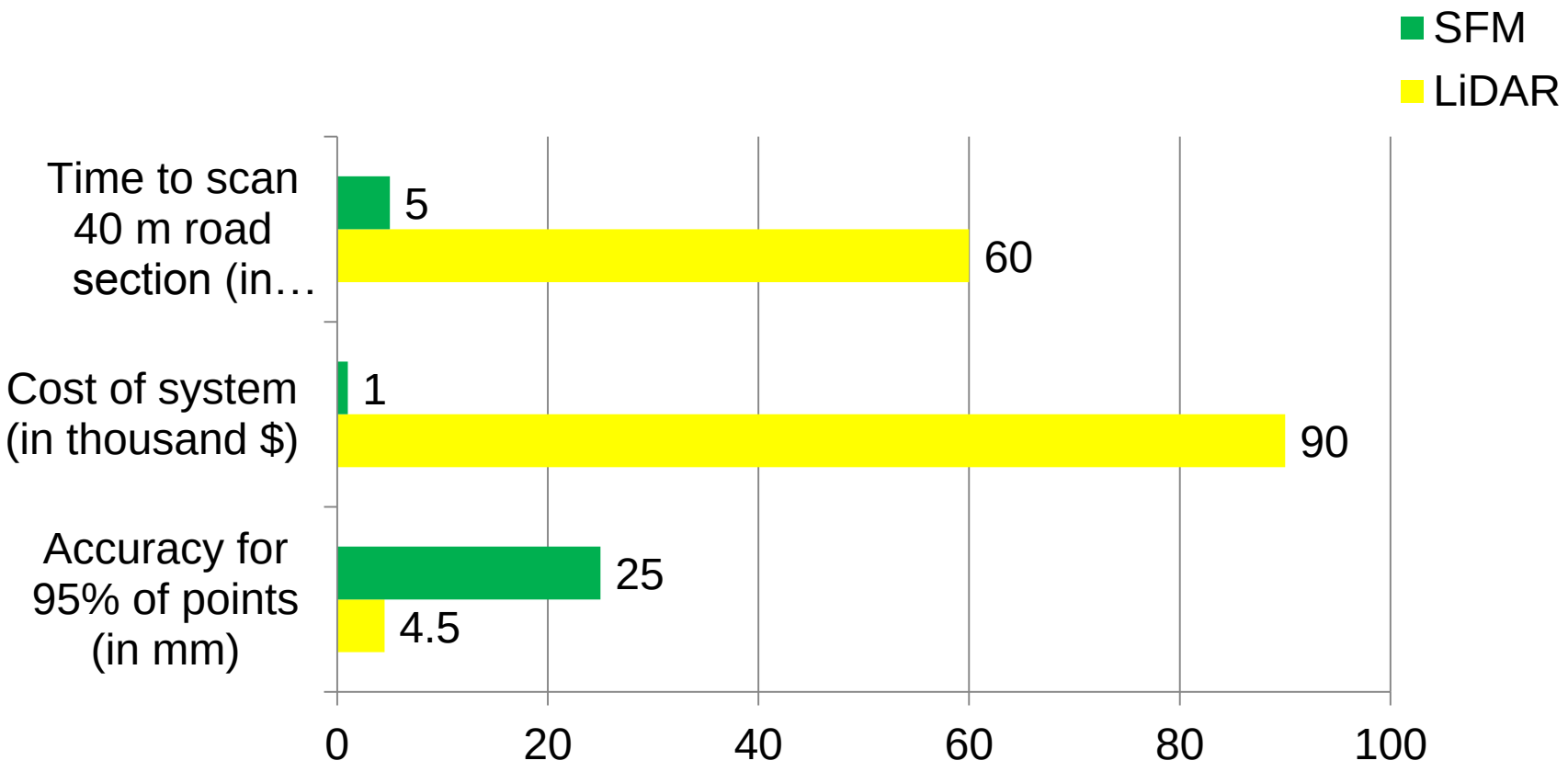
Keypoints are used to simultaneously calculate camera position (motion) and point location (structure).

Image from data processed with Visual Structure from Motion (Wu 2011).

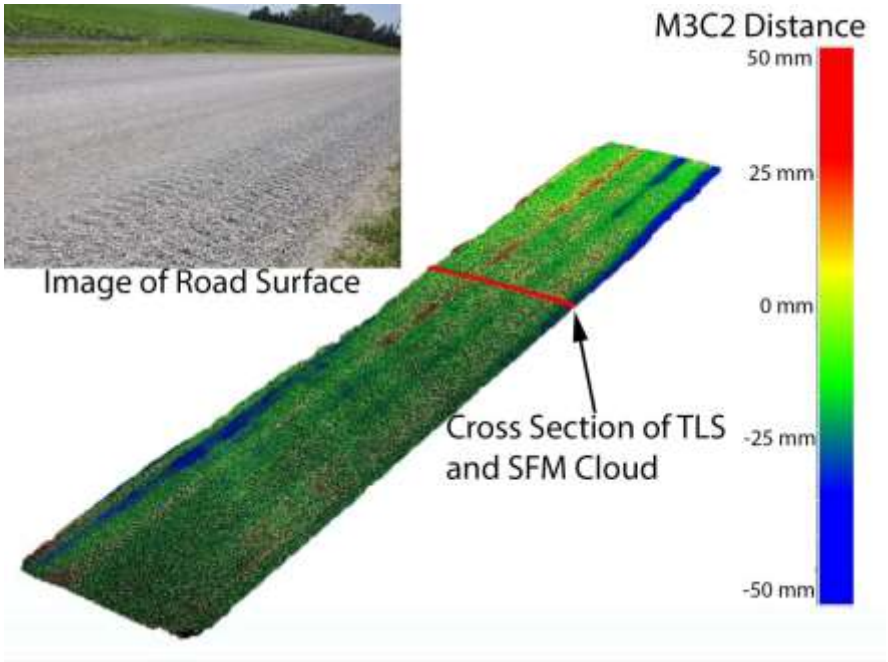


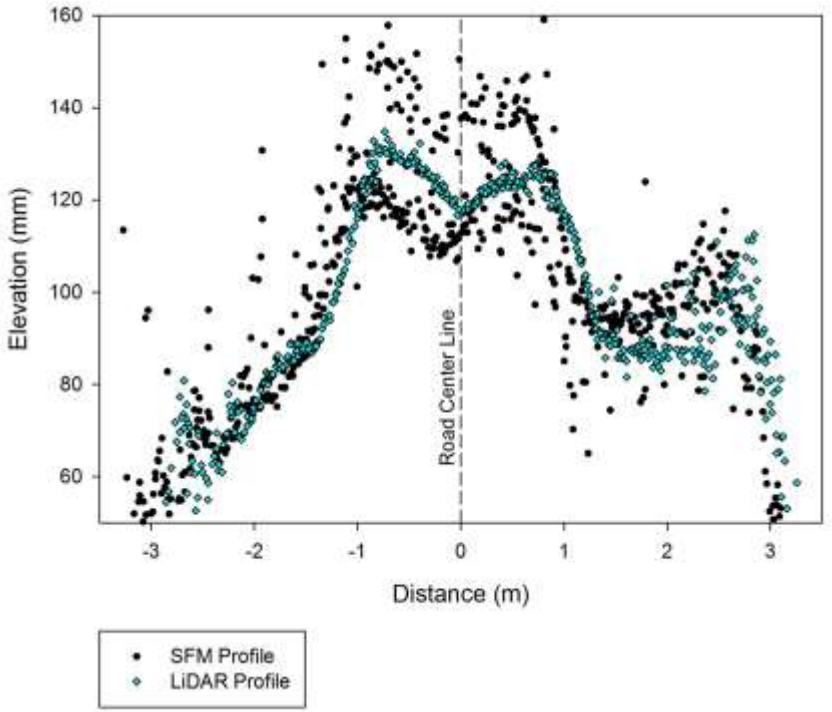


SFM reduces time and cost of 3D scanning, and is only slightly less accurate.



Methodology of comparison using Cloud to Cloud (C2C) and Multiscale Model to Model Comparison (M3C2).





For more information on M3C2 and C2C comparison see (Lague 2013).

Point cloud comparison shows that SFM clouds are accurate to within 25 mm for 95% of points.

	M3C2 Distribution Quantiles		M3C2 Distance (Signed)			C2C Distance (Absolute)		
Road Type	5%	95%	*Mean*	STD	% Points Outside CI	Mean	STD	95%
Gravel	-15.12	14.20	0.02	11.11	24.02	11.54	10.76	32.57
Concrete	-20.98	24.06	2.92	22.62	19.05	8.36	9.41	22.06
Asphalt	-10.24	7.16	-1.62	12.30	15.01	5.07	6.26	14.26
Total Average	-14.56	13.59	-0.04	13.09	20.74	9.24	9.28	25.83

TABLE 2. Comparison of LiDAR and SFM Point Clouds using M3C2 and C2C. Units in mm unless otherwise noted.

Future applications of SFM for road reconstruction.

Tools for deployment of SFM reconstruction may include:

- UAVs (Zhang 2015)
- Vehicle based SFM (Kertesz 2007)
- Smartphones

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