



Bridge Tower Displacement Assessment based on Dense Structure-from-Motion Point Clouds: Application to Twantay Bridge, Myanmar

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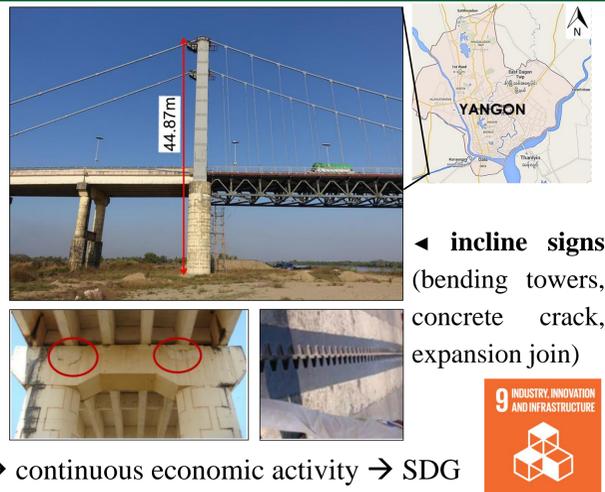


Abstract: Timely inspection of bridge is critical to stall deterioration and prevent its failure. In remote areas and developing countries, inspection resources are not available resulting in low or no regular inspection. A low-cost and scalable method is needed. Structure-from-Motion technique with consumer-grade camera to generate 3D dense point clouds (DSfM) can be a suitable solution. This study aims to answer whether DSfM is capable of assessing bridge tower inclination in actual field application. 3-steps processing were proposed: 1) DSfM reconstruction, 2) Change detection between DSfM and 3D blueprint, and 3) Edge extraction to minimize noise. Results were compared with measurement from terrestrial laser scanner (TLS) and a provided Finite Element Model (FEM) analysis. DSfM can capture structure's geometry and provide displacement trends with RMSE under 3.2cm. Accuracy of DSfM method was shown to be impacted by registration errors. Centimeter level of accuracy may be applicable for initial screening to further allocate advance resources. Accuracy improvement is subjected for future study.

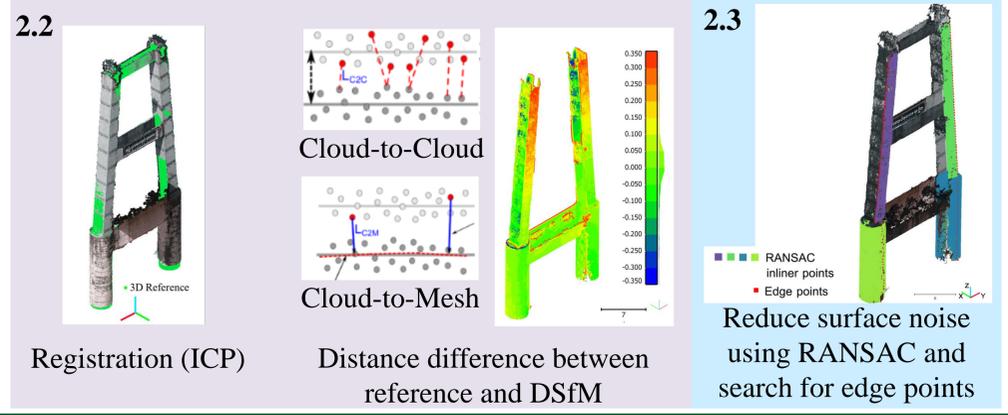
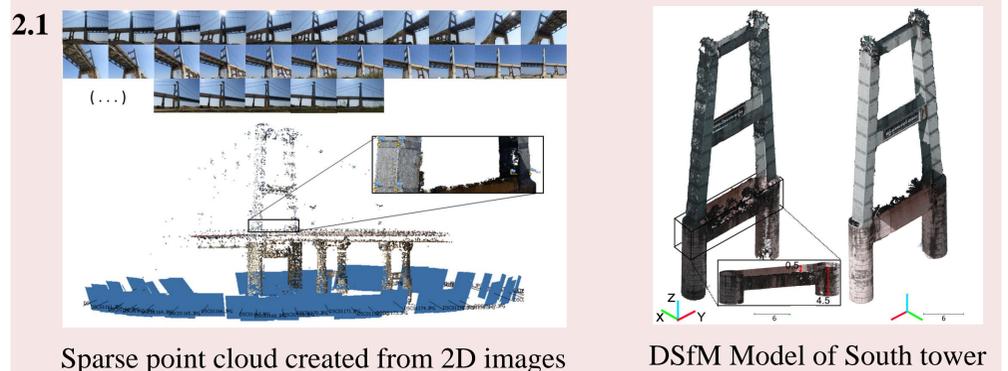
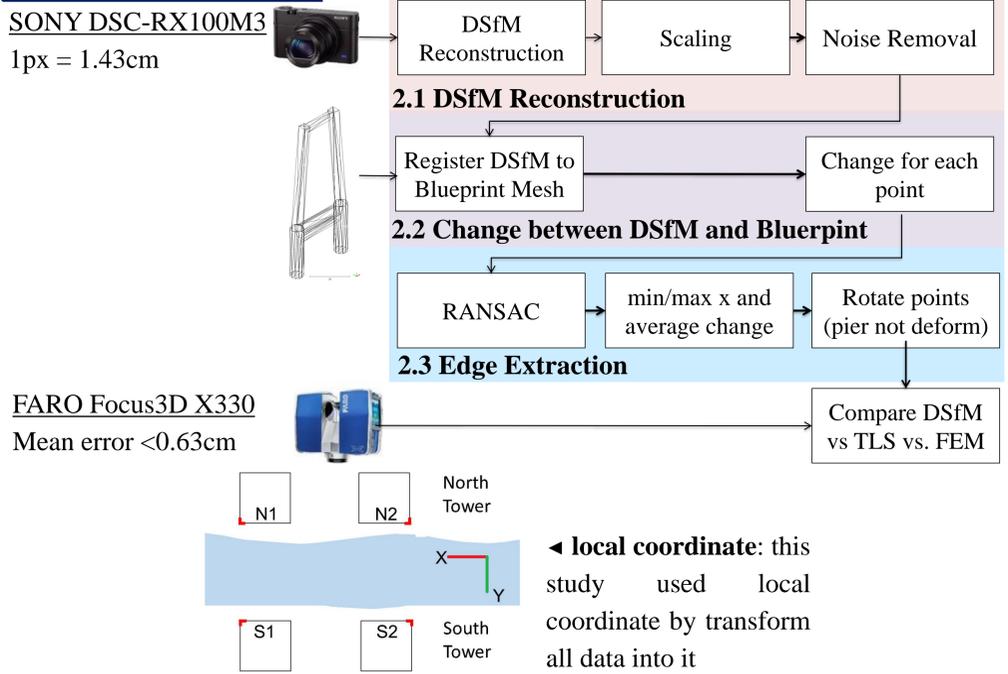
1. BACKGROUND

Twantay Suspension Bridge
Towers incline toward deck, no direct check & limited resources.

- **DSfM** → Low-cost/scalable
Can it be used?
- **Objective:** apply DSfM technique for assessing bridge tower displacement in actual field limitation
- **Significant:** Promote inspection to ensure infrastructure health → continuous economic activity → SDG



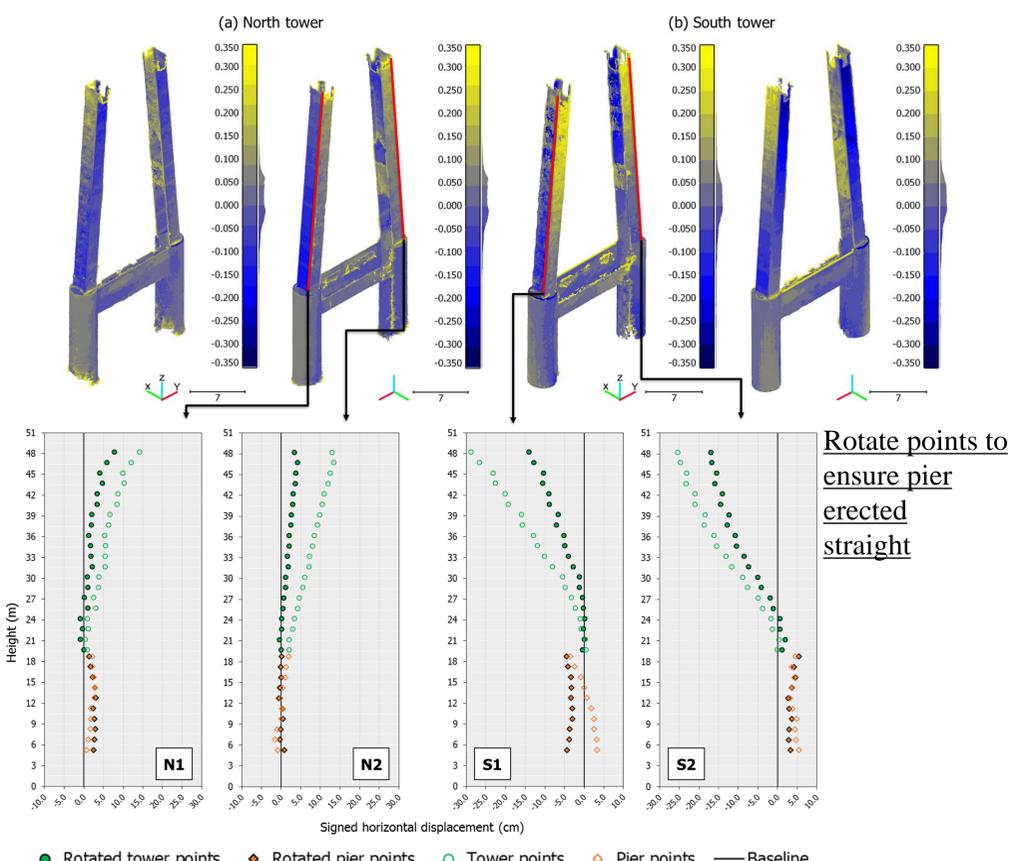
2. METHODOLOGY



3. RESULTS

Inclination Results

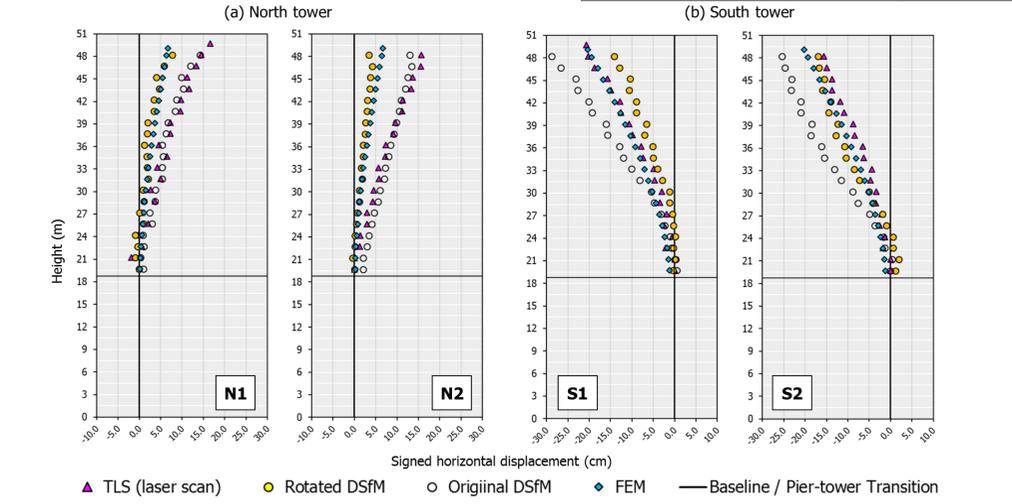
- Highest change from South tower in y-axis
- Facets (x-direction), larger than blueprint as height increases



Comparison: DSfM vs. TLS vs. FEM

RMS error considered TSL as most accurate

	N1	N2	S1	S2
DSfM (original)	1.1	1.5	5.1	7.5
DSfM (rotated)	3	6.4	3.2	2.7
FEM	4.5	5.4	1.2	4.9



4. DISCUSSION & FUTURE WORK

- Error from registration (ICP) can mislead the result (south tower) → target
- Discrepancy between blueprint drawing and as-built condition impact the outcome → time-series with multiple epoch
- Higher camera model (require training for operator) should be tested
- Integration with multiple sensors (TLS + DSfM) and identifying appropriate application should be studied

REFERENCE

Lague, D., Brodu, N. and Leroux, J., Accurate 3D comparison of complex topography with terrestrial laser scanner : application to the Rangitikei canyon (N-Z), 2013, ISPRS journal of Photogrammetry and Remote Sensing
Wahl, R. and Klein, R. Efficient RANSAC for Point Cloud Shape Detection. *Computer Graphics Forum*, 26(2), 214-226, 2007