Student SURVEY Expeditions

Niagara Dam: Deformation Monitoring with Terrestrial Laser Scanning

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Motivation

Terrestrial Laser Scanning (TLS) has become more important and used more frequently for application like deformation monitoring due to its:

- Rapidly quasi laminar data acquisition of 3D-point clouds over large areas,
- No requirement of signalised points and contactless interaction with the surface.

Nevertheless, TLS lacks in certain aspects, namely:

- No statistical assessment of deformation results,
- Neglect of stochastic information for scanner observations,
- The points are not reproducible and discrete.

Full use of TLS' advantages and overcoming its drawbacks can be performed by:

- The implementation of a stochastic model based on intensity values of observations
- Using a spatial cube structure for classic congruency deformation model.

Applying this, movements which are considerable smaller than scanner measurement noise should be detectable as significant values.

History

Originally built in 1897 near the ghost town of Kookynie, the dam was intended to provide fresh water for the locomotives which connected Kalgoorlie and Malcom. During this time Kookynie prospered, triggered by Australian's common gold rush. Nevertheless, the dam was never used for its purpose because of too little rainfall and became unnecessary after gold ran out in this area. Today its location serves as a camping spot and tourist attraction in the wilderness.

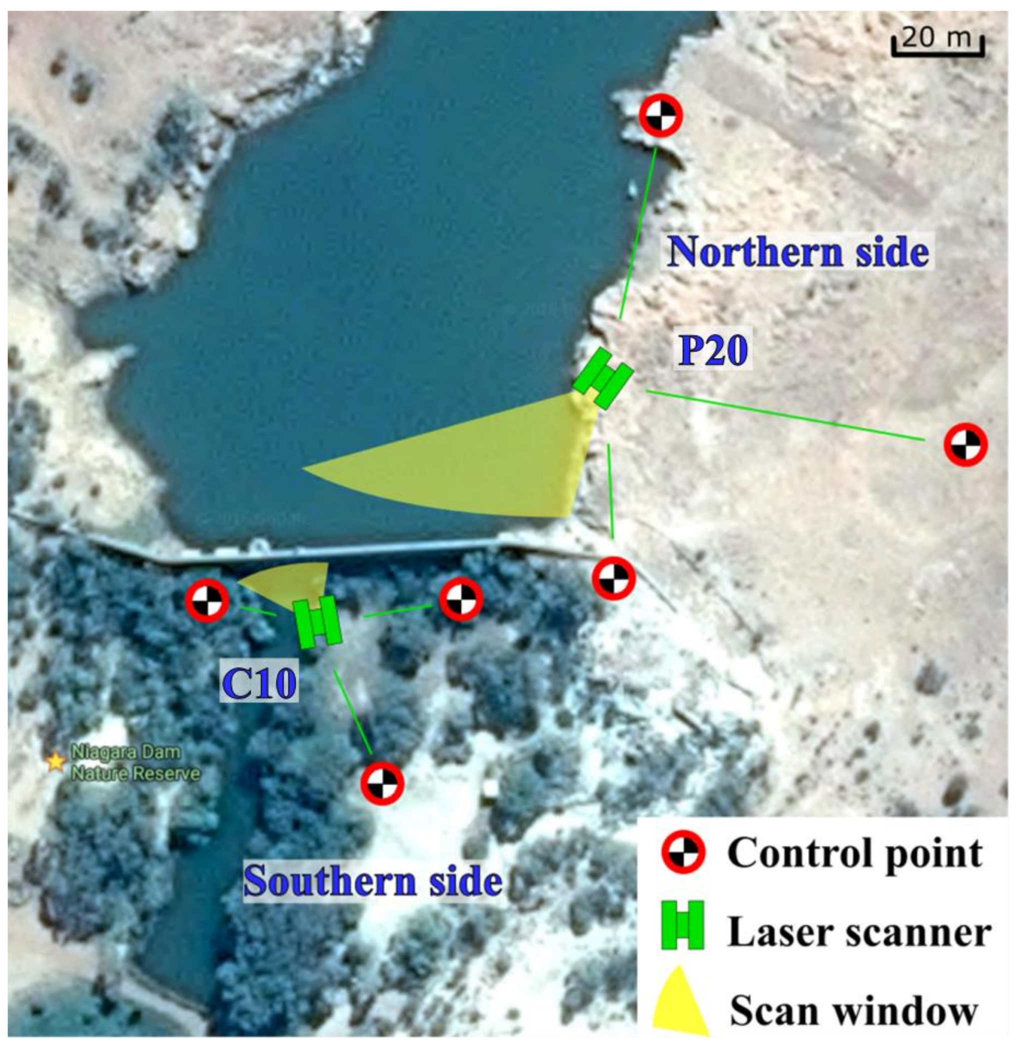
Profile of Niagara Dam

- 225 m length - 18 m height - max 7 m width
- Cement gravity dam
- East-west alignment

Niagara Dam – northern side

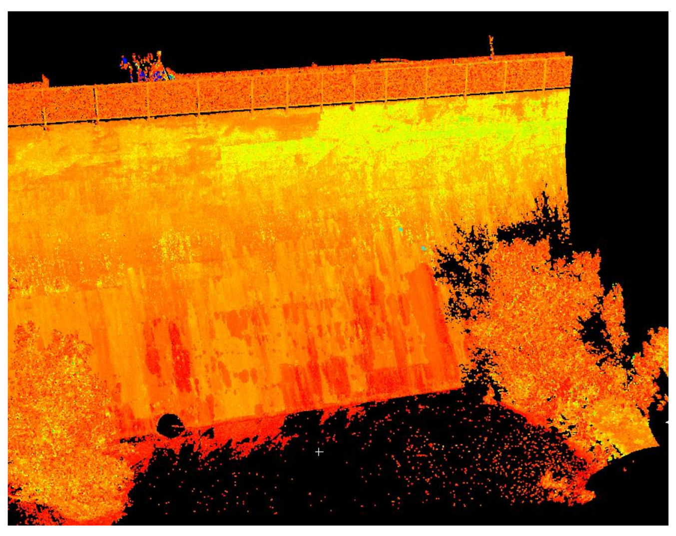
Monitoring process

- Scanning by Leica laser scanners C10 and P20
- 11 scans over 27 hours from both dam sides
- Resolution of points on dam: 3-10 mm
- Single point precision: > 5 mm
- Quality registration < 1 mm



Location at Niagara Dam

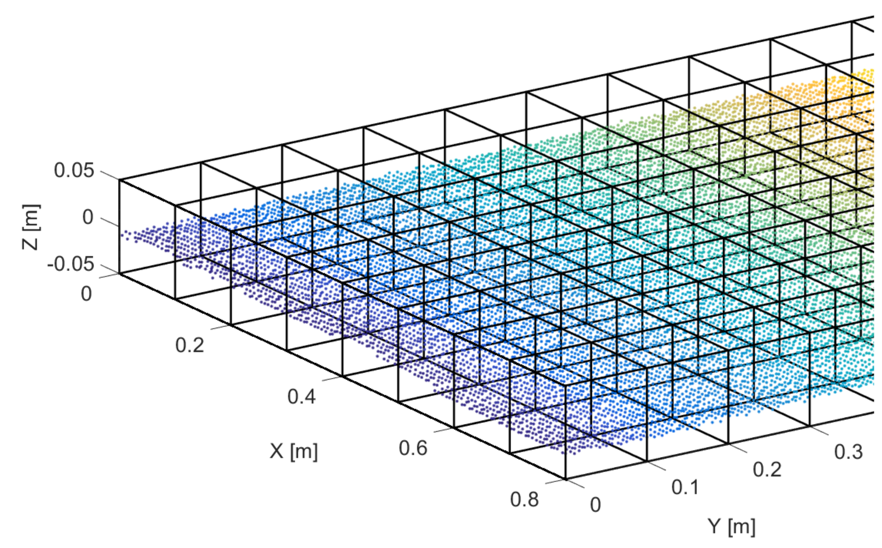
Leica laser scanner C10

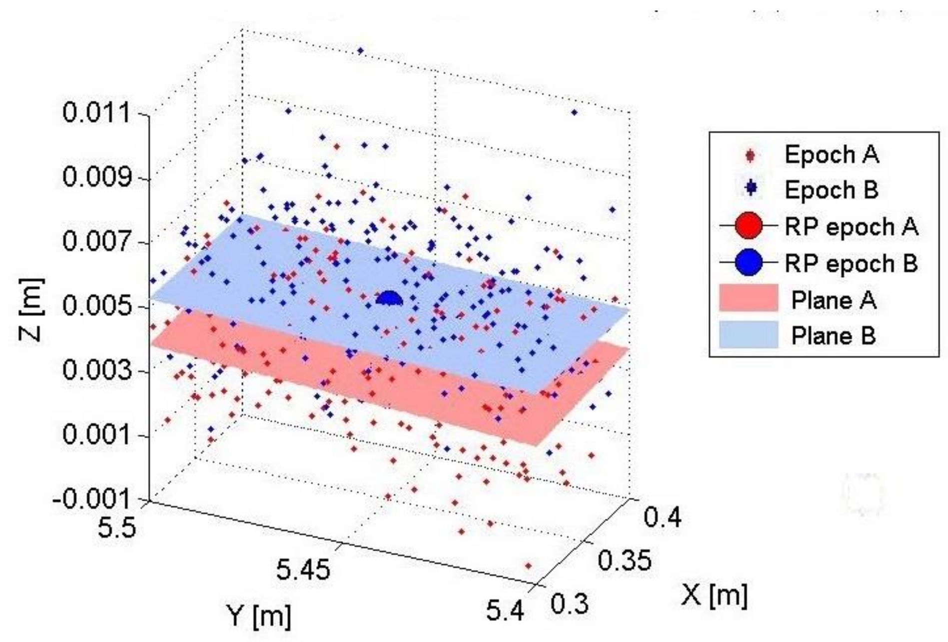


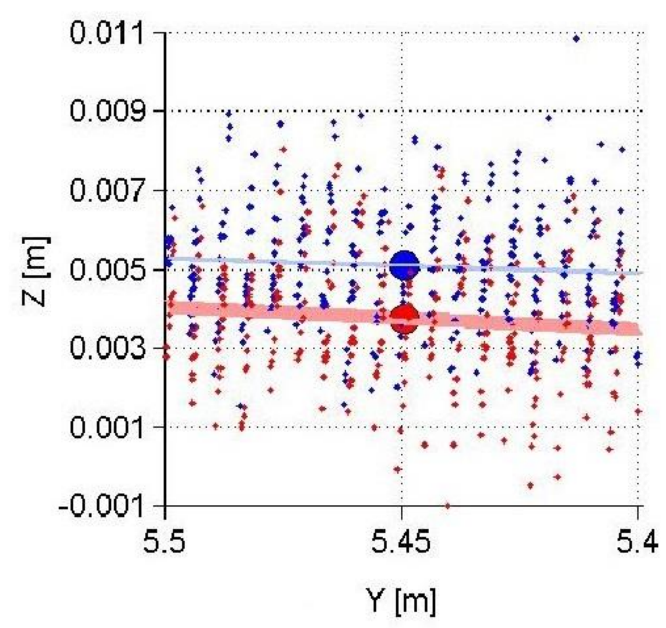
3D-point cloud

Post processing

- Definition of box grid coordinate system
- Sorting all points into boxes
- Implementation of a stochastic model
- Best plane fit for each box
- Derivation of representative points (RP) per box and epoch
- Deformation analysis via congruency model including statistical evaluation

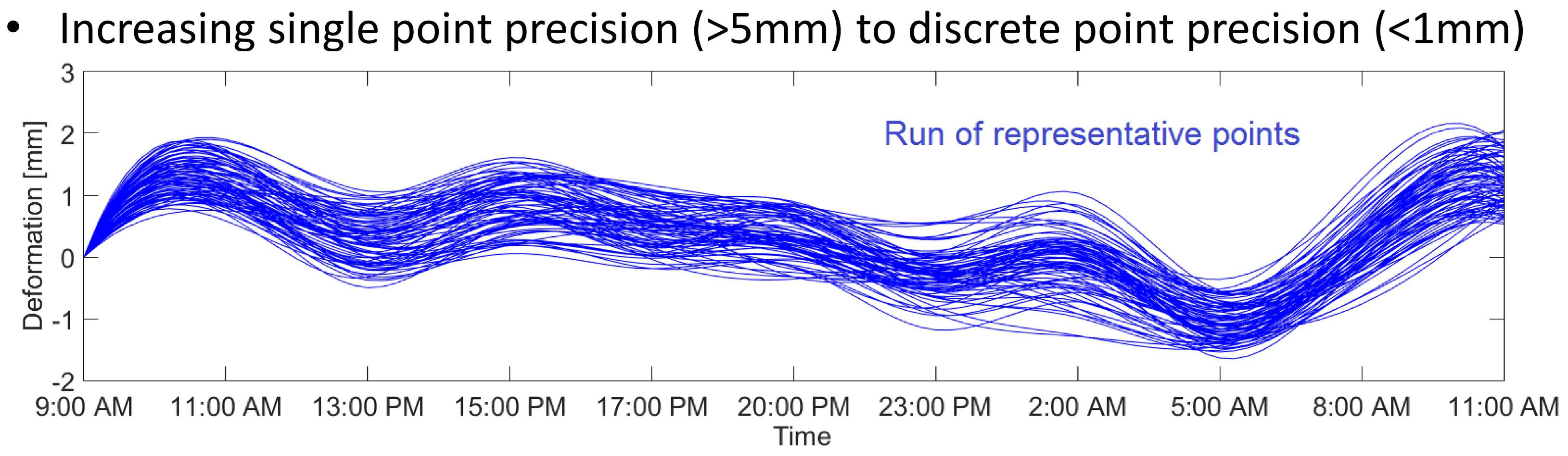






Results

- Significantly periodic movement over on day with max. amplitude of 3 mm were observed.
- Increasing single point precision (>5mm) to discrete point precision (<1mm)



Conclusion

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- Stochastic model based on intensity values improves the adjustment procedure
- Geometry based model (spatial cube structure) allows a deviation of representative as well as reproducible points for congruency analysis
- Statistical evaluation is possible

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- Results are influences by surface properties and changing environmental conditions
- Geometric changes in surface plane are not detectable

Acknowledgements

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