Multi-target analysis of point cloud data

CSIC Cambridge Centre for Smart Infrastructure & Construction

Challenge

Terrestrial Laser Scanners (TLS) are a common tool to capture the 3D dimension of structures such as bridges. The output, a 3D point cloud (PC), has a good accuracy but difficult to exploit due to heavy size and lack of context. In most cases, the PC is transformed manually into a more readable format like mesh. Not only this process is time consuming, but it will reduce TLS's advantages as the required simplification can remove the accuracy.
To make the most of point cloud data, it is crucial to optimise automatic processing and to consider multiple output targets.

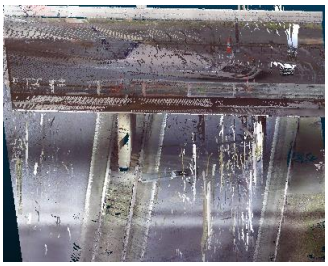

Fig 1 : Example of point cloud data of a bridge with noise and unwanted objects

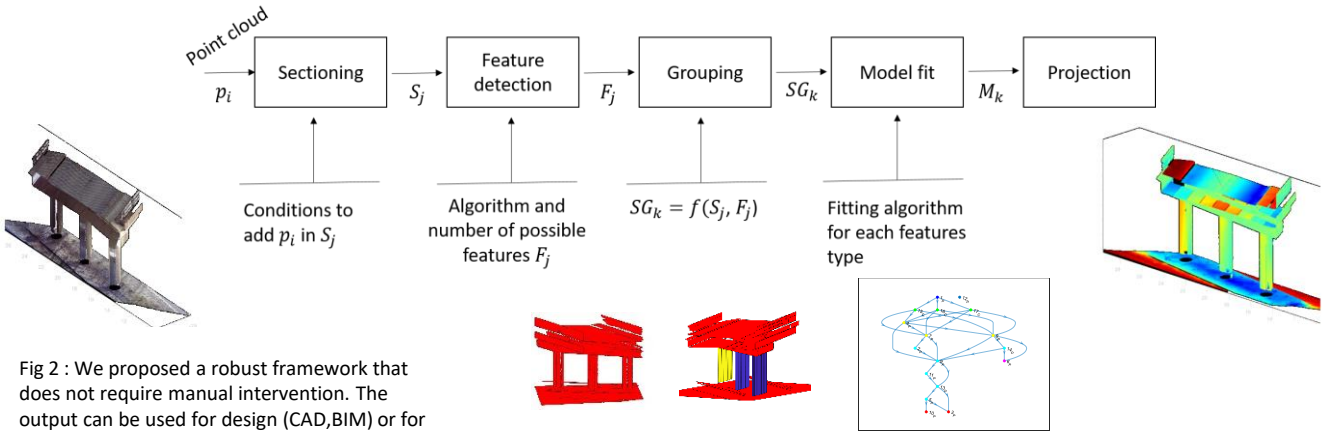

Fig 2 : We proposed a robust framework that does not require manual intervention. The output can be used for design (CAD,BIM) or for maintenance (damages, defects..)

Case study: highway

The algorithm was used on different type of structures (bridges, roads, buildings) despite the size of the point clouds or the noise. At this stage, the focus was to find errors and damages, such as misplaced beam or irregularities in a wall. The figure 3 shows an example from a highway section scanned from a car. The algorithm highlighted the cracks in the road despite the obstruction caused by the traffic. It also flagged damages on a bridge due to water.
As the geometric is extracted, the next step would be to feed a BIM model or generating a detailed map. Future collaboration will enable such outputs.

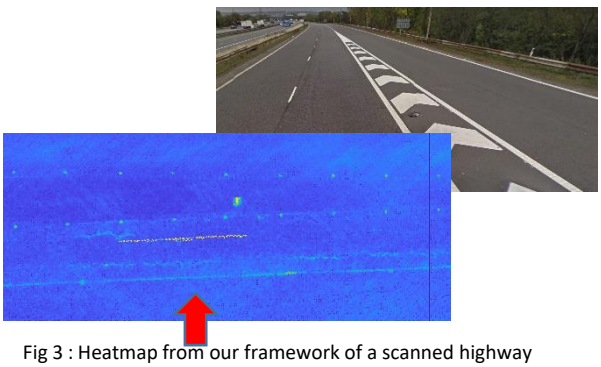

Fig 3 : Heatmap from our framework of a scanned highway (left) and the corresponding street view (right)

	Our			RANSAC		
Models	Pr	Rc	F1	Pr	Rc	F1
Bridge01	0.91	0.93	0.92	0.52	0.67	0.58
Bridge10	0.86	0.95	0.91	0.38	0.51	0.44
MarketplaceFeldkirch	0.20	0.46	0.28	0.27	0.79	0.40
STGallenCathedral	0.39	0.93	0.55	0.37	0.53	0.44
Bridge virtual	0.96	0.59	0.73	0.15	0.71	0.25
street virtual	0.87	0.82	0.85	0.97	0.58	0.73

Fig 4 : The detection of cylinders from different scene comparing to RANSAC method show higher accuracy for our framework in most cases. The virtual scene were produced from simulated laser scan, providing an excellent benchmark for comparison.

Conclusion

The algorithm is fully automatic with no pre-processing required, the result is the PC with a scalar field showing irregular areas such as the ground around the piers and the road curvature. The detection of geometric shape such as cylinders is better than the traditional RANSAC methods. From the geometric shape, it is also possible to assess the exact orientation of deck and piers which can provide useful information for monitoring as well as future planning.

Pătrăucean & al (2015). State of research in automatic as-built modelling. *Advanced Engineering Informatics*, *29*(2), 162-171.
Lu & al(2018). Detection of Structural Components in Point Clouds of Existing RC Bridges [Data set]. Zenodo.

Vladimir Vilde, Joan Lasenby vlmv2@cam.ac.uk

@CSIC-IKC www.smartinfrastructure.eng.cam.ac.uk

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