Railway Inspection using Non-Contact Non-Destructive Techniques

Eman Abdelhameed, Hany Sobhy, Haitham Zohny, Mohamed Elhabiby

Abstract—**Rail inspection is a critical task in railway maintenance operations that is, periodically, carried out to prevent hazards that can have significant legal and financial consequences on railway organizations and to avoid accidents and provide safety for both operators and passengers. Inspections are usually conducted manually by trained operators walking along the railway track, searching for visual anomalies, or by using traditional surveying techniques such as measurements tapes and total stations. These traditional methods of inspection are time-consuming, with regard to work hours and the efforts of both engineers and technicians; inherently inaccurate (due to the potential for human error); and, thus, inefficient. By applying digital techniques and using non-contact systems, such as terrestrial laser scanning (TLS), these negative aspects can be nullified. Terrestrial laser scanners can provide complete digitization for the environment surrounding the railways' right of way and tracks. Moreover, they are widely applied in rail track surveys, clearance measurements, infrastructure reconstruction, and tunnel mapping, etc.**

This research paper proposes a complete solution for railway non-contact inspection using high definition (HD) phase shift (PS) static TLS. The proposed solution can result in the rapid acquisition of immersive data and data analytics for inspection. The solution will help in monitoring the tracks and their supporting mechanisms, relying on in-depth data analysis from two scans at different epochs to detect the rate of change during the time period. The solution will always use the first collected data before starting construction works in the track environment as the base for the comparison to the rate of change.

***Index Terms*—Railway, Inspection, laser scanning, point cloud.**

1. Introduction

Railway systems require continuous maintenance to keep the track and right-of-way in optimum working order to enable trains to run safely, at the highest permissible speeds, and to provide passengers with a reasonable level of comfort during the ride. This maintenance requires tremendous planning and coordination to avoid service interruptions for the passengers, and to align with traffic management schedules (for the safety of the workers) [1]. Track inspections are a necessary activity in railway maintenance and are required to be periodically performed [2], [3].

Currently, there are several new technologies in use to carry out such inspections. The methodology and quality of the procedures are crucial to ensure that valuable, risk-free mitigation is implemented to avoid any hazardous situations resulting from insufficient inspection data. One solution that is used today applies retro-reflective glass prisms and traditional surveying techniques. However, this requires the costly disturbance of the operation of the trains. Furthermore, the data acquired by traditional surveying techniques are inadequate and can be misleading. Installing any of the contact sensors related ;to these surveying techniques depends on the existing environmental conditions during their implementation (temperature, visibility, etc.) and on traffic management during the rail inspection periods. This complicates the maintenance operations significantly [5], [2], [3].

2. Railway Inspections

2.1 Background

As mentioned in the manual of permanent way maintenance developed by Egyptian National Railways, rail maintenance is divided into four main fields: inspection, manual maintenance, mechanical maintenance, and rehabilitation. The following summary represents the traditional inspection approaches:

2.1.1 Visual Inspection

A visual methodology is a common approach for railway inspection. This divides the railway network into zones; each zone inspection is done periodically (monthly) by one or more engineer who records any significant defects of the track's rails, and sleepers, etc.

This approach is time-consuming for engineers and costly; it also provides no accurate data about the defects found on tracks such as deviation from the ideal gauge measure, misalignment and deviation of curved /tangent track, etc [3].

2.1.2 Manual Inspection

Manual inspections rely on manual measurements for track geometry using simple tools such as tapes, gauges, and strings [6].

With the manual inspection, measurements can be made of any defects on the railway, but there errors can still occur due to the human factor and the accessibility of the track at the time of inspection, which requires significant notice.

2.1.3 Non-destructive Techniques

The development of non-destructive techniques (NDT) for the in-service inspection of railways is the primary method used by most of the railroad companies around the world. This method is based on its positive economic factors due to the fact that inspections can be carried out without dismantling the rail track components.

Several studies, such as those by Pohl et al. (2004) [7], and Hechel (2009) [8], have focused on the field of NDT in track inspections to determine the integrity of a material, component, or structure (railway wheel, rail, and gauge) using different approaches of ultrasonic, magnetic, and radiography methods, etc., and take into consideration the advantages of each method regarding its ability to detect defects and ascertain the best component to which it is applied (lee et al. 2015) [9]

2.1.4 Total stations

Total stations (TS), which are also used to survey the track area and detect any horizontal or vertical displacement [11], [12], are monitoring systems that evaluate railway infrastructure during construction projects.

This kind of monitoring, which depends on fixing targets for the TS around the area of the tracks, has its drawbacks, such as missing data due to occluded lines of sight between the TS and the targets caused by passing trains, and the fact that these targets may be moved or lost.

The setup of the required number of targets and the TS needs to be planed to avoid these problems, which also requires a lot of time-consuming paperwork. Moreover, the data acquired using TSs are minimum and, although they can be used for immersive data analysis, they will fail to facilitate any comprehensive reporting, which is required for such an application.

2.1.5 Photogrammetry

Visual railway inspections using digital cameras have had significant progress recently, whereby cameras are installed under a train to capture images for the track components. The processed images can provide information about gauge detection, bolts detection, fasteners, and missing elements [13].

This approach is a high speed, low cost, and efficient method to use to determine surface defects. This technique has many general issues like the lighting challenges, accuracy of processing, edge detection and weather conditions, technicality for rail inspection, it has the following shortfalls: traffic management, limitation of features available for recognition, and the variety of reflection properties from the rail surface [14].

3. Related Work

Several research papers, including Cheng et al. (2015) [15], have discussed the validity of using terrestrial laser scanning (TLS) for railway track monitoring and compared its use to that of inspection and monitoring railway tunnels. The focus in Cheng et al.'s (2015) study was mainly on the tunnel bricks in the walls.

In Farahani et al.'s (2019) [16] study, 3D geometric acquisition was used to model a tunnel and the deformation took place within the tunnel and integrated it with TLS and imaging systems. This part of the study compared the referenced profile of the tunnel to that of the deformed profile. The researchers used real scale TLS data for complete data analytics.

Soni et al. (2015) [4], focused on the detection of the geometry of the railway tracks using TLS at the platform level. These researchers made a comparison between the design cross-section and the point cloud of the edge of the tracks. They did registration and fitting between the point cloud and the model. The comparison was based on the iterative closest point (ICP) algorithm fitting with a 2D computer-aided design (CAD) model. Soni et al. (2015) also focused on the comparison between different scanners, such as Time of Flight (TOF), and Phase Shifts (PS).

Other research papers, such as (ex: Jennifer Luk,2011, [11], focused on the inspection of deformation monitoring of the railway itself or its supporting structures. This paper showed that ultra HD scanning with phase shift technology will contribute further to the inspection operation of rail tracks by increasing the resolution and detecting more deficiencies with high relative accuracy. Furthermore, 3D data analytics will significantly improve the quality of reporting and decision making for inspection work and, consequently, the relative maintenance work. These points will be the new contribution of this research paper in comparison to the literature on the related work.

4. Problem Statement

Railway inspections are vital maintenance practices which are required in Egypt for the construction of the new Metro line and the upgrading of some stations on the existing lines. With regard to this, it is necessary to develop an efficient inspection technique to speed up the inspection and maintenance processes accordingly.

4.1 Case study

In this case study, a laser scanning dataset was taken in the region between the stations El-Marg and the New El-Marg, on the first line of the Metro network in Cairo, Egypt (see Figure 1). These data were taken during a revamping project of the track in this zone in June 2019. This project focused on track geometry detection using a single scan to avoid any level of processing errors from occurring and, therefore, keeping the condition of the real site environment in the results.

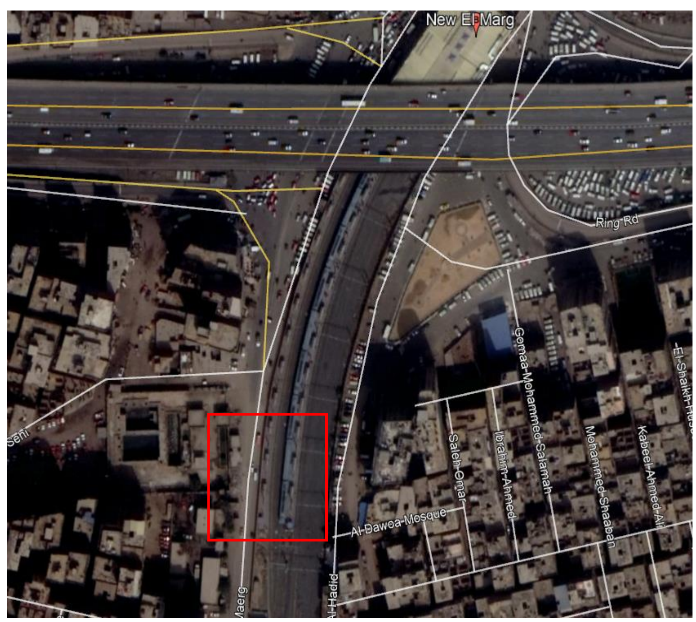
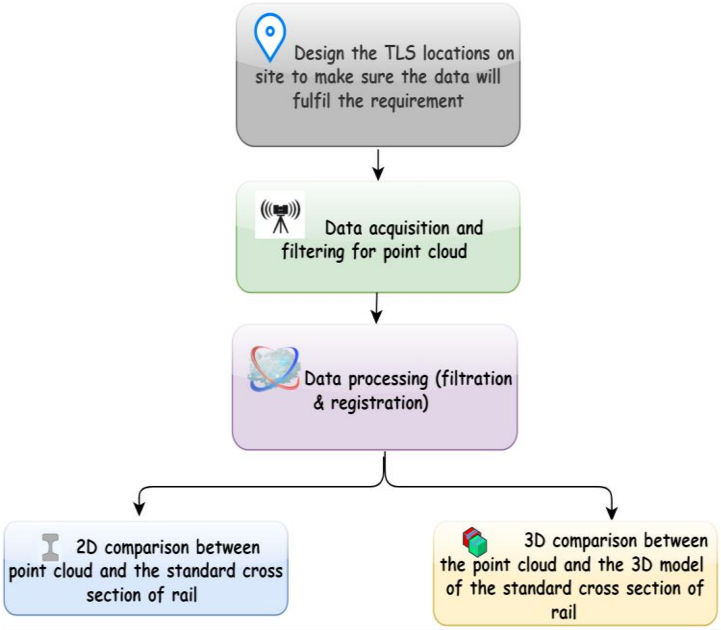


Fig. 1. Location of captured laser scanning data

The methodology was designed to achieve a less than 2mm precision level of accuracy to detect deformation of the railways' tracks, supporting structures, and the tunnel through which the railways run within this envelope. The steps applied in this method are described in Figure 2.



4.1.1 Sensor's specifications

This proposed method of inspection applied a digital transformation concept using a state-of-the-art scanner and a phase-based ranging principal. This accuracy was proven on the rail by Soni et al. (2016) [12], who compared the time of a flight scanner of a given lower level of accuracy, the FARO S120, with the manufacturer's quoted ranging capability, of 2 mm RMS at the medium distances (see Table 1 for specifications of this instrument). [17]

Ranging unit

Unambiguity interval	153.49m
Range Focus3D 120	0.6m - 120m indoor or outdoor with low ambient light and normal incidence to a 90% reflective surface
Measurement speed (pts/sec)	122,000 / 244,000 / 488,000 / 976,000 points/sec
Ranging error1	±2mm at 10m and 25m, each at 90% and 10% reflectivity

Ranging Noise specs

Ranging Noise	@10m	@10m noise compressed	@25m	@25m noise compressed
@ 90% refl				
@ 10% refl	1.2mm	0.6mm	2.2mm	1.1mm

Table 1: Laser scanner specifications

4.1.2 Design for the laser scanner's position

The scanner's position was chosen based on the purpose of every dataset; this was to provide a high-density point cloud for the railway tracks, or supporting structures (see Figure 3). The scanner was located on track gauge between the two rails in the hours when the line was out of service, to ensure a complete representation of the tracks' geometry.

Fig. 3. Cross section showing the scanner's position

4.1.3 Data processing

a) Data importing

Raw scans will be imported as a grid point cloud: a 3D point cloud organized according to a regular grid, this grid format has 2D pixels in row and column format, 3D points are included in the scan with RGB color values of each point (see Figure 4).

26	824	19.537	19.537	-283.069	99	76	87
26	825	19.593	19.537	-283.069	95	73	85
27	190	-15.588	19.403	-281.923	92	73	92
27	191	-15.528	19.396	-281.828	93	73	91

Fig. 3: Grid point cloud format

data, respectively (values typically range from 0 to 255).

b) Data processing & filtration

The raw scans imported to the grid point cloud have to be filtered to extract information that is needed during further processing, registration, and analysis of the data, and to remove the noise within the scan data samples of these filters, as mentioned by Xian-Feng Han et al. (2017) [18].

A set of algorithms are applied on point cloud for noise removal, normal computing, and edge detection–noise removal is the first stage in the filtration process for point cloud data; it removes outlier samples and, hence, the used algorithm balances the noise removal and the scanned features by deleting only the lone points outside the targeted surface. Here, outliers are detected based on the number of neighbors close to it (the ICP): If a point has neighbors, but these neighbors have no others close by, they aren't considered as part of the same surface, it means that this is an outlier.

A neighborhood-based filter is an efficient technique for point cloud noise removal; it is applied on the point cloud based on adjacent point positions and intensity.

$$ws = \exp\left(-\frac{(i-x)^2 + (j-y)^2}{2\sigma s^2}\right)$$

$$wr = \exp\left(-\frac{\left(I(i,j) - I(x,y)\right)^2}{2\sigma r^2}\right)$$

(Where spatial weight is *ws*; range weight is *wr*; (i, j) is in the neighborhood of (x, y); $I(i, j)$ presents the intensity at (x, y); σs and σr are the standards of Gaussian functions.)

Additional algorithms are used also for effective point cloud filtering such as local plane fitting algorithm for computing normal , edge detection depth and orientation discontinuity algorithm, and for computing confidence, a weighted average algorithm is used.

All these filter algorithms were developed decades ago and are undergoing continuous development even now [19], [20], in order to achieve better filtering for point cloud data.

c) Data registration

Registration is performed between the point cloud data and the standard cross section of rail (UIC 54), registration here was performed among two steps: Manual pre-registration; and Fine registration.

Manual pre-registration. Selecting three or more couples of points among the reference and moving the grids, a rigid alignment transformation (4*4) matrix is computed (T); this includes a (3*3) rotation matrix represented in α,β and γ, the translation vector in the fourth column t_x,t_y and t_z; the bottom row is always filled with three zeros and a one (see equation below).

$T=T(\alpha,\beta,\gamma,t_x,t_y,t_z) =$

$$\begin{pmatrix} \cos\alpha\cos\beta & \cos\alpha\sin\beta\sin\gamma-\sin\alpha\cos\gamma & \cos\alpha\sin\beta\cos\gamma+\sin\alpha\sin\gamma & tx \\ \sin\alpha\cos\beta & \sin\alpha\sin\beta\sin\gamma+\cos\alpha\cos\gamma & \sin\alpha\sin\beta\cos\gamma-\cos\alpha\sin\gamma & ty \\ -\sin\beta & \cos\beta\sin\gamma & \cos\beta\cos\gamma & tz \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

Fine registration. This final step of registration is done by applying the ICP algorithm; this automatic algorithm runs under several parameters. Registration delta-change and the number of iterations are the most effective parameters which define when the ICP stops at one. The ICP will stop at iteration n, if the error-delta between three iterations is smaller than parameter d (see equation below):

$$[(e(n-3)-e(n))\,/\,e(n)\,] < d$$

(Where e(n) is the mean registration error of iteration n.)

d) Data comparison

Different comparisons will be made on the laser scanning data to ensure the accuracy of this method of track inspection:

- 2D comparison between point cloud data and the design section; and
- 3D comparison between 3D point cloud and 3D design cross section of rail track.

These comparisons will be performed between the point cloud and the triangular mesh created from the standard cross section of the rail; this process results in creating a new color layer that will be assigned to the point cloud. For each point, this color layer carries its measured distance from the reference model, herein referred to as heatmap; a histogram with a corresponding color scale also will be generated with the mean error value (see Figure 4).

Alba et al.'s (2006) [21] study presents an example of computing the difference between a triangular mesh of a point from a scan and the surface of a baseline scan of a dam.

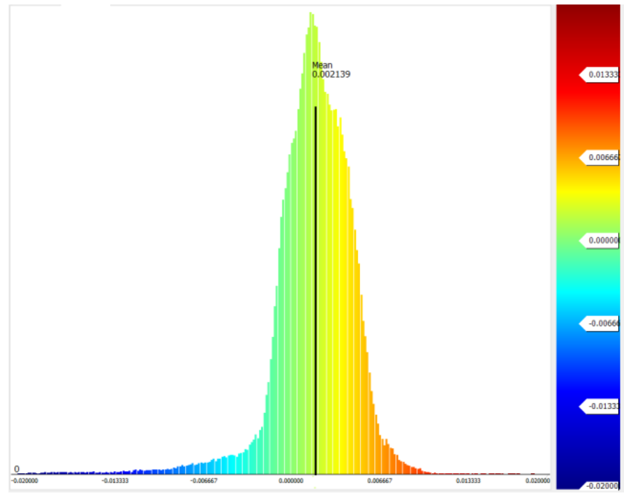


Fig. 4. Color map histogram representing the differences between the point cloud and the triangular mesh created from the standard cross section.

5. Results and Analysis

Using high-density scanning for the inspected rail and applying the proposed methodology of point cloud processing, mentioned in the previous section, the point cloud was imported as a grid point cloud and filtered. Next, for comparison, the point cloud of the rail was registered to the standard cross section of rail (UIC 54).

Registration was performed with a mean error of approximately 1 mm; a nominal error is vital as this will affect the accuracy of the track geometry measurements when using the registered point cloud for comparison. For further comparison, a single scan was used to ensure the higher accuracy of the measurements and to avoid any registration errors between scans. (See the sample of the transformation matrix provided in Table 2.)

	Rotation matrix			Translation X,Y,Z
	0	1	2	3
0	1	0.002	0.008	-0.134
1	-0.002	1	-0.01	0.143
2	-0.008	0.01	1	-0.097
3	0	0	0	1

Table 2. Transformation matrix sample

5.1 2D and 3D benchmarks design verification

5.1.1 Comparison between 2D point cloud and design cross section of the rail

A point cloud section from the second case study dataset (B) is used when the scanner is located very close to the rail track, to ensure the density of the point cloud and to facilitate the comparison between the rail geometry on site and the design cross section of rail (UIC 54), which, in this case, is the standard cross section. This matches what was proven by Soni et al. (2016) [12], for a similar test. The thin, or 2D, cross section of point cloud was unsuccessful for this comparison, so a straight length of rail (100 mm) was compared with the standard cross section mesh; the RMS error which was found (presented in Table 3) took into consideration the different faces of the rail cross section and the effect of the position of the scanner.

Section compared	Half section	Head	Web	Foot
Point cloud extracted vs the reference rail cross section (UIC 54)				
RMS(mm)	**2.7**	**2.3**	**2.4**	**2.0**

Table 3. RMS values of fitting point cloud to standard rail cross section

5.1.2 3D comparison between 3D point cloud and 3D design cross section of rail

The following Table (4), summarize the histogram of the points deviations from the standard rail cross section using the same case study data used in the previous section

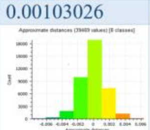
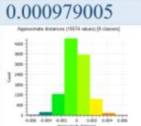
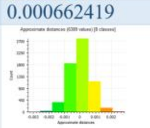
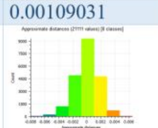
Section	Half section	Head	Foot	Web
Point cloud extracted vs the reference rail cross section (UIC 54)				
RMS (mm)	1.52208	1.42794	0.668432	1.67995
Sigma	0.00103026	0.000979005	0.000662419	0.00109031
Histogram				

Table 4. 3D comparison between 3D point cloud and rail cross section

6. Conclusion

The results of this paper represent the following points:

- The quality of comparing the point cloud of the left side of the rail, which is facing the scanner, with the 3D model of the standard rail (design section), the ICP algorithm achieved 2.7 mm.
- When applying the same algorithm on a separate segment of rail, it achieved 1.4 mm for the head, 1.7 mm for the web, and 0.7 mm for the foot.

7. Future work

- The results achieved in this paper showed that terrestrial laser scanning (TLS) can be considered as a successful technique for railways' spot inspections, though it may require more specific development and integration with other inspection systems to cover all information needed for these asset management purposes and to help in decision making.
- 3D comparisons using the same methodology can be applied on the railway track, and other elements. Furthermore, the accuracy of TLS is comparable to another technique, e.g., Total station.
- Mobile laser scanning (MLS) could achieve useful inspection data if it integrated with the current inspection machines, or if it is fixed on the locomotive of trains with speeds that fit the specified speed for the used mobile laser scanning system.

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9. References

[1] T. Lidén, "Railway Infrastructure Maintenance - A Survey Of Planning Problems And Conducted Research," *Transportation Research Procedia*, vol. 10, pp. 574-583, 2015, doi: 10.1016/j.trpro.2015.09.011

[2] A. Belkhade, S. Kathale, "Automatic Vision Based Inspection of Railway Track," *International Journal of Research in Engineering and Technology*, vol. 3, pp. 12-15, 2014, doi:10.15623/IJRET.2014.0302003

[3] S. Bahatkar, V. Tidke, M. Bhalavi, and S. Bongade, "Automated Visual Inspection of Railroad Track," *International Journal of Computer Science and Mobile Computing*, vol. 4, issue. 3, pp.121 – 125, 2015, *https://www.ijcsmc.com/docs/papers/March2015/V4I3201571.pdf*

[4] A. Soni, S. Robson, and B. Gleeson, "Optical Non-Contact Railway Track Measurement with Static Terrestrial Laser Scanning to Better than 1.5mm RMS," *FIG Working Week Commission* 6, *http://www.fig.net/resources/proceedings/fig_proceedings/fig2015/papers/ts02h/TS02H_soni_robson_et_al_7493.pdf*

[5] A. Soni a *, S. Robson a, B. Gleeson b "Extracting Rail Track Geometry from Static Terrestial Laser Scans for Monitoring Purposes" *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XL-5, 2014*

[6] Zdenka Popović, Luka Lazarević "The Importance of Rail Inspections in the Urban Area -Aspect of Head Checking Rail Defects" *Procedia Engineering 117 (2015) 596 – 608*

[7] Rainer Pohl, "NDT techniques for railroad wheel and gauge corner inspection", *NDT&E International 37 (2004) 89–94*

[8] Thomas HECKEL1 , Hans-Martin THOMAS1 , Marc KREUTZBRUCK1 and Sven RÜHE2"High Speed Non-Destructive Rail Testing eith Advanced Ultrasound and Eddy-Surrent Testing Techniques"

https://www.researchgate.net/publication/228901588_High_Speed_Non-Destructive_Rail_Testing_with_Advanced_Ultrasound_and_Eddy-Current_Testing_Techniques

[9] Applications of Non-Destructive Testing in Rail Tracks, lee et al. 2015

[10] Manual maintenance of permenant way ,Egyptian National Railways ,Permenant way Department.

[11] Calvin Tse and Jennifer Luk "Design and Implementation of Automatic Deformation Monitoring System for the Construction of Railway Tunnel" *https://fig.net/resources/proceedings/2011/2011_lsgi/session_3h/tse_luk.pdf*

[12] Anita Soni "Non-contact monitoring of railway infrastructure with terrestrial laser scanning and photogrammetry at Network Rail", *https://discovery.ucl.ac.uk/id/eprint/1477352/1/AnitaSoni_EngDThesis_April2016.pdf*

[13] Gimy Joy and Jyothi R.L "A Real Time Visual Inspection System for Rail Flaw Detection" *IOSR Journal of Computer Engineering (IOSR-JCE)e-ISSN: 2278-0661,p-ISSN: 2278-8727,PP 07-15*

[14] SAJJAD PASHA MOHAMMAD "Machine Vision for Automating Visual Inspection of Wooden Railway Sleepers" *https://www.diva-portal.org/smash/get/diva2:518382/FULLTEXT01.pdf*

[15] Han-Mei CHEN, Cristian ULIANOV and Ramy SHALTOUT "3D Laser Scanning Technique for The Inspection and Monitoring of Railway Tunnels" *TRANSPORT PROBLEMS, Volume 10 Special Edition*

[16] Behzad V. Farahania,b,∗, Francisco Barrosb, Pedro J. Sousaa, Pedro P. Cacciaric, Paulo J. Tavaresb, Marcos M. Futaic and Pedro Moreirab "A coupled 3D laser scanning and digital image correlation system for geometry acquisition and deformation monitoring of a railway tunnel" *Volume 91, September 2019, 102995*

[17] FARO_-Focus_3D_data sheet *https://knowledge.faro.com/Hardware/3D_Scanners/Focus/Performance_Specifications_for_the_Focus3D*

[18] Xian-Feng Han, Jesse S. Jin, Ming-Jie Wang, Wei Jiang, Lei Gao and Liping Xiao "A review of algorithms for filtering the 3D point cloud" *https://www.researchgate.net/publication/317146336_A_review_of_algorithms_for_filtering_the_3D_point_cloud*

[19] Chao Chuan Jia, Chuan Jiang Wang, Ting Yang, Bing Hui Fan and Fu Gui He "A 3D point cloud filtering algorithm based on surface variation factor classification" , *Procedia Computer Science 154 (2019) 54–61*

[20] Marie-Julie Rakotosaona, Vittorio La Barbera, Paul Guerrero, Niloy J. Mitra and Maks Ovsjanikov "Learning to Denoise and Remove Outliers from Dense Point Clouds, Marie-Julie Rakotosaona1", *Volume xx (200y), Number z, pp. 1–17*

[21] M. Alba, L. Fregonese, F. Prandi, M. Scaioni and P. Valgoi "Structural Monitoring of A large Dam by Terrestial Laser Scanning" M. Alba *https://www.researchgate.net/profile/Luigi_Fregonese/publication/228653597_Structural_monitoring_of_a_large_dam_by_terrestrial_laser_scanning/links/0fcfd50b6272b606cd000000.pdf*

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