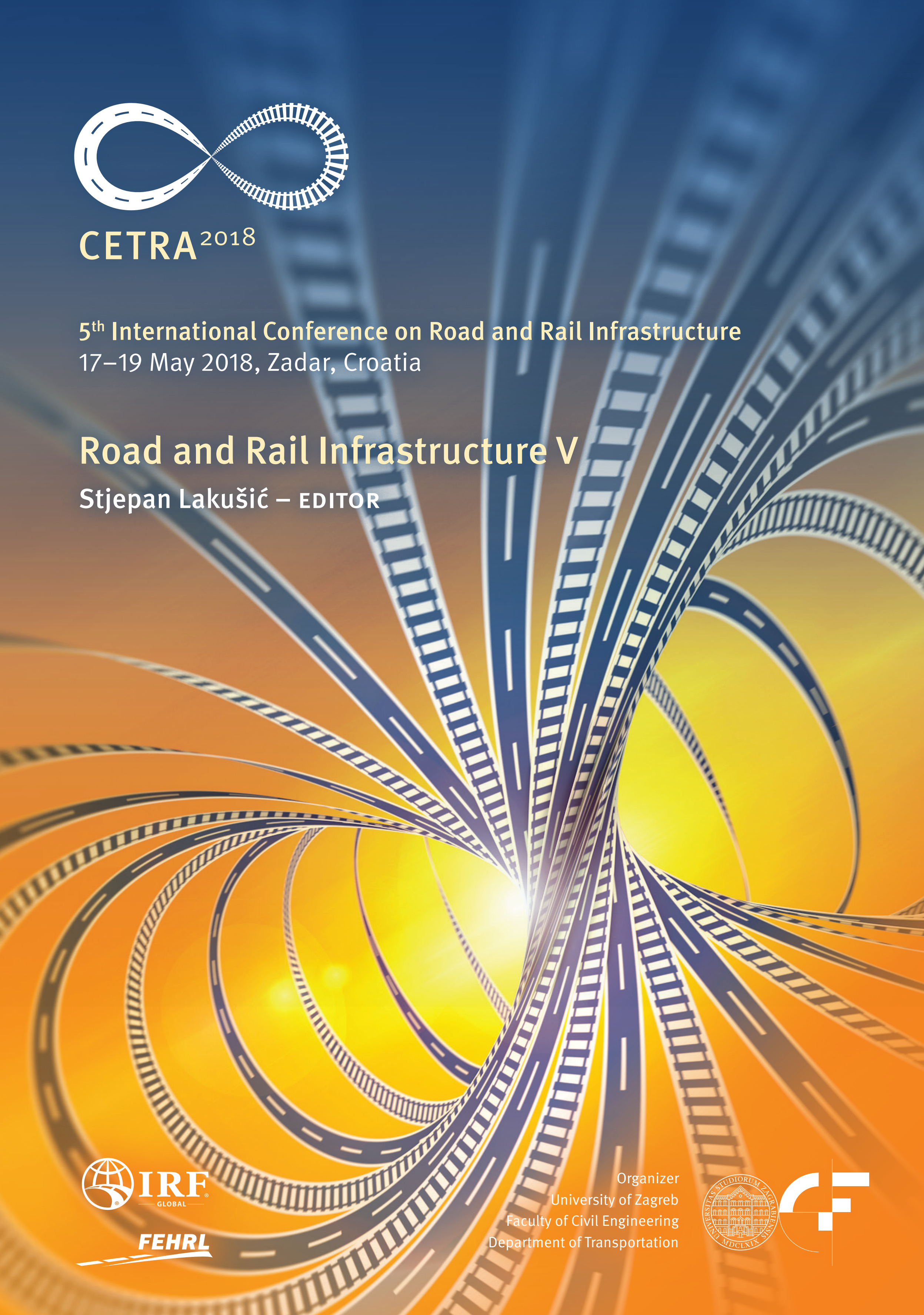

CETRA[2018]

5th International Conference on Road and Rail Infrastructure
17–19 May 2018, Zadar, Croatia

Road and Rail Infrastructure V

Stjepan Lakušić – EDITOR

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DETERMINATION OF ROAD SURFACE CHARACTERISTICS USING PHOTOGRAMMETRY TECHNIQUE

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Abstract

Road pavement is structure with primary function to provide distribution of load from top layers to the subgrade. In addition, condition of road pavement surface provide driving safety and comfort. This paper presents results of the ability to use method called photogrammetry technique, in order to determine the condition of road pavement surface. Research was conducted on a small test site at Faculty of Civil Engineering, University of Sarajevo. This model was used to analyze road surface and to collect data about longitudinal and transverse profile, surface distresses and texture features as well.

1 Introduction

Road pavement is structure with primary function to provide distribution of load from top layers to the subgrade. In addition, condition of road pavement surface provide driving safety and comfort. Currently pavement distress data, in Bosnia and Herzegovina, are usually collected with different techniques. On highways and main roads, pavement distress data are collected using falling weight deflectometer (FWD) or road profilometer. On regional and local road, there are no measuring distresses at all in regular periods, only on projects levels if necessary.

This paper presents results of the ability to use relatively new method called photogrammetry technique, in order to determine the condition parameters of road pavement surface. Research was conducted on a small test site at Faculty of Civil Engineering, University of Sarajevo. In this case terrestrial photogrammetry technique is used for creating point cloud. Primary objective of this study is to explore and popularize this technique, explore possibility to use it in future road pavement surface distresses and create pavement condition data bases as well (specially for regional and local roads) as low cost method.

For the past few years, many researchers presented their research results about ability to use photogrammetry technique (terrestrial and aerial) in exploration road surface features. For example, V. A. Knyaz and A.G. Chibunichev (2016) presented research results about using photogrammetric techniques for road surface analysis. Two photogrammetric techniques for road surface analysis are presented. For accurate measuring of road pavement and for road surface reconstruction based on imagery obtained from unmanned aerial vehicle. The first technique uses photogrammetric system based on structured light for fast and accurate surface 3D reconstruction and it allows analysing the characteristics of road texture and monitoring the pavement behaviour. The second technique provides dense 3D model road suitable for road macro parameters estimation, [1].

David W. et al. (2017) presented study about using close range photogrammetry and how hand-held laserscanning can be used to derive 3D models of pavement surfaces, [2].

Patrick L.Y.T. ez al. (2012) presented paper about using close range digital photogrammetry method for determination road pothole severity. Ten random pothole samples were cho-

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sen randomly and their severity levels were assessed through both the conventional visual approach and the photogrammetric method. The study reveals that digitalclose range photogrammetry method can be used as the alternative way in visual assessment of pothole severity, [3].

2 Methodology

Research was conducted on test site and two model were consider: large scale and small scale model. Large scale model was developed for determination global road pavement surface characteristics such as longitudinal transferse slope and determination of surface distress such as potholes, cracks etc. Small scale model was used for modeling road surface texture model.

Figure 1 shows road pavement test site. First step in procedure of creating point cloud model is to determine survey points and control points on existing road surface. Survey points were used for georeferencing and scaling of point cloud model. Also, their coordinates and elevations were determined. In this case four point were used for survey point (red points). Remaining points are control points. Control points were used for comparison point cloud model elevations and coordinates with control points, and calibraton of point cloud model if necessary (black point). In total, twenty points are determined.

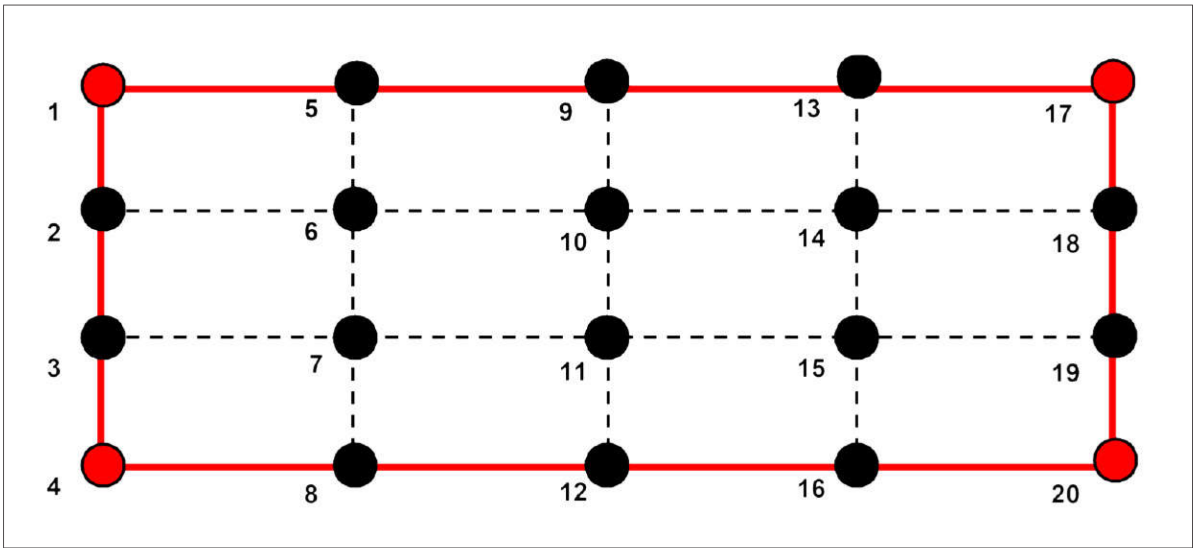

Figure 1 Road test site

In the next stage of project, multiple photos are recorded. Due to terrestrial photogrammetry it was necessary to provide dozens photos with overlapping areas. In this case 75 photos were recorded by hand camera mounted on tripod. Resolution of photos were 3648x2736 pixels and tripod high was 1,2 meter. Figure 2 shows some recorded photos and their overlapping. After recording, the photos are used to build point cloud model. Point cloud model was build using Autodesk software ReCap. Model was georeferenced and scaled using known survey points and tested using control points. There was some local differences between survey and point cloud models (on some points). The model was calibrated on that points which resulted in satisfactory accuracy. Figures 3 and 4 representing high density point cloud made from photos using terestrial photogrammetry and consist about 1,5 milion points. Of course, dependent of our survey objective and desired accuracy, this point cloud model can be rebuild and number of points can be decrease. As we can see from these figures, road pavements surface can be clearely recognised.

Figure 2 Recording and overlapping of photos

Figure 3 High density point cloud – perspective view

Figure 4 High density point cloud – top view

3 Results and discussion

Final result of this process is creation of digital terrain model (DTM) of existing surface from point cloud. Figure 5 shows model of existing road pavement surface with coloured elevation and slopes arrows (based on elevation made from point cloud). This model is also used for determination of longitudinal and transverse profiles (Figure 6 and 7).

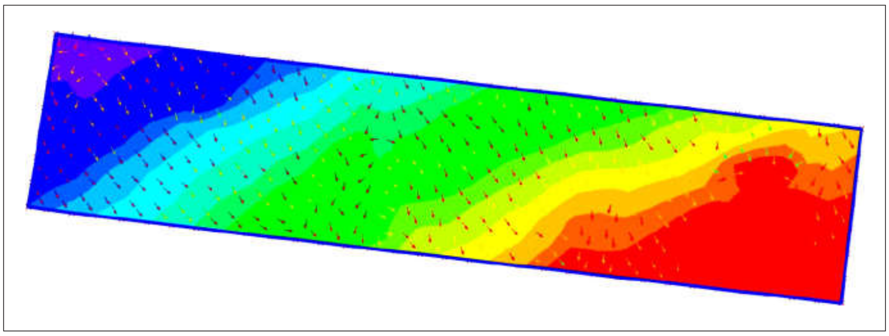

Figure 5 Surface model with slopes arrows and elevation

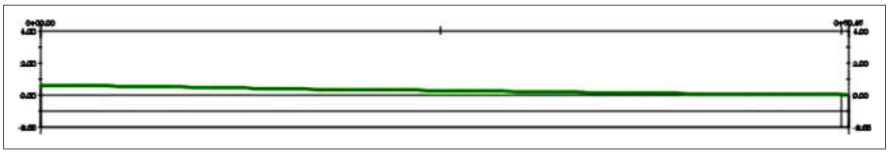

Figure 6 Example of road longitudinal profile

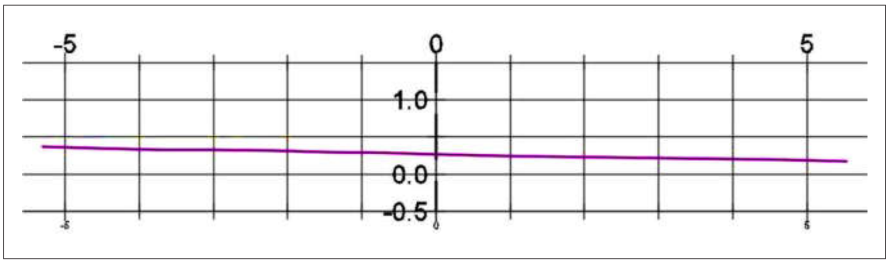

Figure 7 Example of road cross section

One more objective of this project is also creation of the model used for identification road pavement surface distress such as potholes, cracks and damaged patch. These parameters are often used for determination road pavement performance. Figure 8 shows shaded point cloud model where road surface distresses can identified. Based on this model, severity and intensity of these distresses can be estimated (specially for potholes and patches).

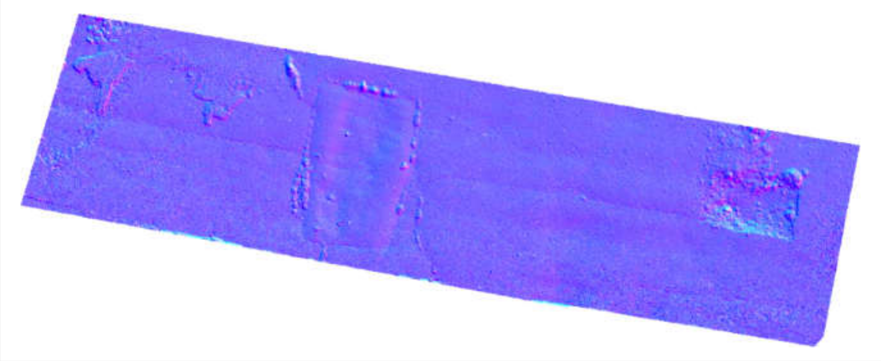

Figure 8 Shaded point cloud model with ditress identification

Small scale model was used for modeling of road surface texture model. This model is developed using close range photogrammetry. Process is similar as large scale model with differences in the height of the position from which the images are taken. Figure 9 shows recorded images and their overlaping. For scaling of this model two markers with known length are used.

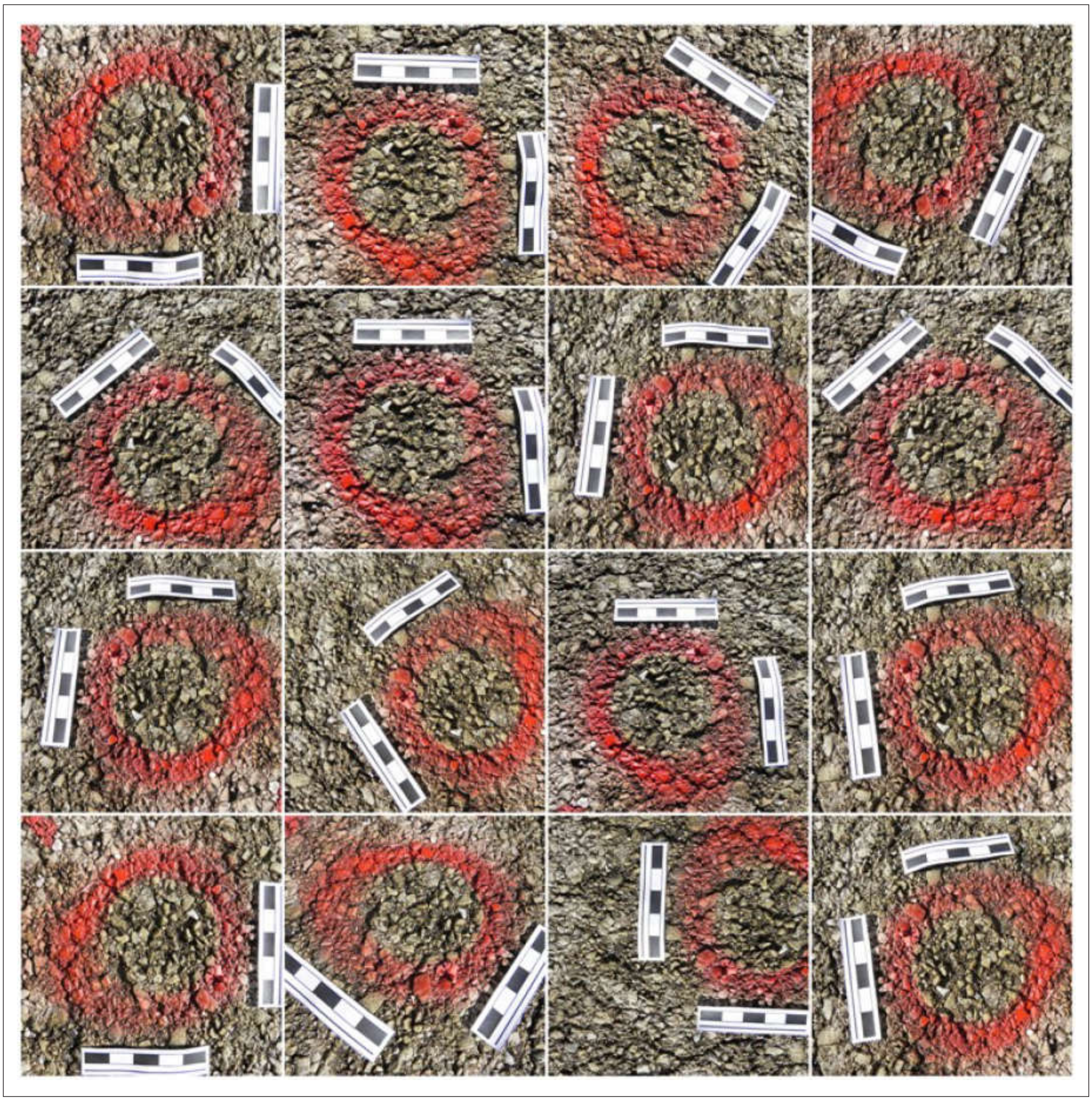

Figure 9 Recording and overlapping of photos

Finally high density point cloud model is developed (Figure 10). Based on this model, mesh and surface model is created and it can be used for determination macro texture or texture depth.

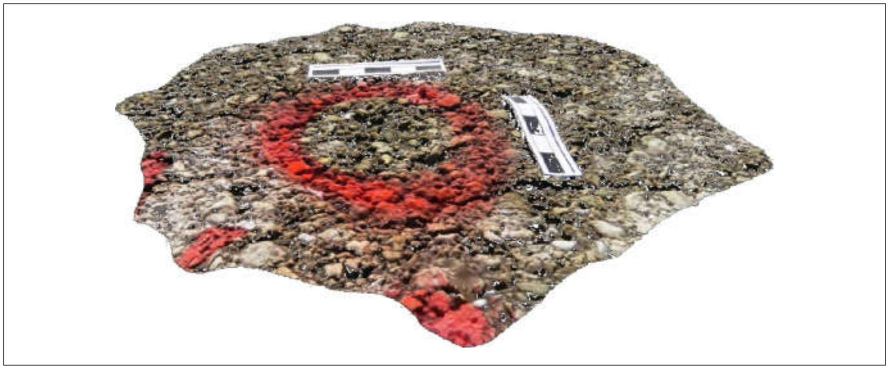

Figure 10 Point cloud model

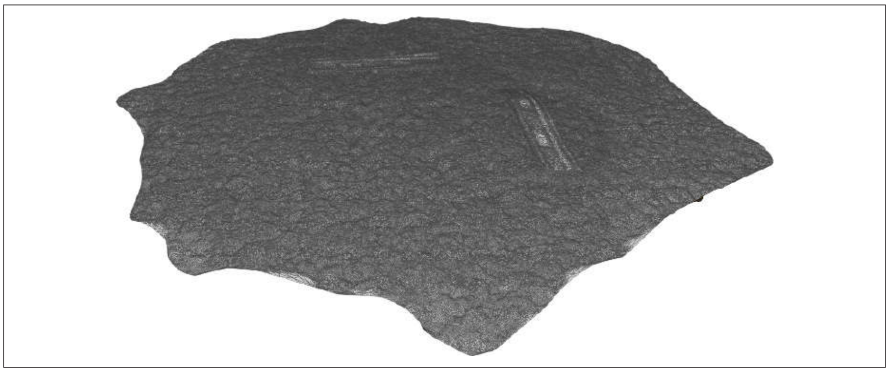

Figure 11 Road surface mesh model

Figure 12 Surface model of road texture

4 Conclusion

This project is conducted using terrestrial photogrammetry. Based on developed model it can be concluded that this technique can be used for determination of road pavement surface features in process of assessment of road pavement performance. Length of tested road in this project is relatively small. Of course, for bigger project it will be difficult to use terrestrial photogrammetry. So, in next phase of project aerial photogrammetry will be used on real road section on main road and results will be compared with known date from existing database. Also, nest step of the project is examination of how texture depth measured using the volumetric sand patch (most used method) correlates with data derived from 3D models.

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