

OVERVIEW OF THE METHODS FOR ORTO-IMAGE GENERATION FROM THE COLOURED LASER SCAN DATASET

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***Abstract:** Laser scanning is a modern technology suitable for culture heritage documentation. More and more it becomes the standard for accurate metric documentation of larger sites, historical buildings as well as sculptures, archeological findings etc. From the beginning it was always problem how to present the data for non-specialist in the field of laser scanning (historians, conservators, restorations, public etc.). One of the simplest way is to generate the so called orto-images in 2D dimension which is very simple for viewing and editing in all kind of CAD-based software. This paper reviews the most common simple methods for orto-image generation from the colored laser scan dataset and introduces the new technique, which is more reliable for additional editing, especially image vectorization. The new method is based on a computation of the histogram of the laser scan dataset in 3D. The values of the function for x-coordinates and y-coordinates are the number of points pertaining in the square defined by pixel size of the orto-image. This one channel representation of the laser scan data density in 2D is combined with the color representation of the data and fused in the final colored density model of the measured object. The fusion is done by using the L^*a^*b color space model.*

1. INTRODUCTION

Laser scanning technology is a very powerful and demanding solution, especially for culture heritage applications. There is a many ways of how to process the data and how to export the results to the customer [1]. For the surveyor, it is advantageous to deliver the results in such a state and look, that the customer can clearly see the difference between the standard surveyor measurements, and the laser scanning technology. For these reasons, the method of creating so-called ortoimages is very popular. This article brings a very short overview of several different methods that can be used. The key part of the article is the proposing the new method, that is very suitable in case where the scanned object will be vectorised in CAD application software.

2. ALGORITHMS FOR CREATING ORTOIMAGE

Based on the data captured by the laser scanner, it is possible to generate several types of ortoimages. The input data can contain not just the Cartesian coordinates, but also the intensity of the incoming laser beam, the color value (from fusion with images obtained from internal, or external digital camera) or normal vectors for each measured point. The first step in creating ortoimage is the right definition of the projection plane and the direction of the ortoview. The plane is defined with at least three points, marked on the model. More points leads to least square adjustment process. The direction of the ortoview is defined with one point, lying in front of the projection plane. Next step is the optimal settings for the raster. This means the setting of optimal pixel size of the final raster and the matrix size. Finally, the intensity values for each pixel has to be computed and the ortoimage saved in proper format. In standard ortoimage, the intensity value represents the rgb colour of the point (fig 2b). Grayscale ortoimage can be created in two ways. Firstly, the intensity can be the function of the laser beam intensity. Secondly, the greyscale value can be transformed from full colour image (fig 2a). If the Z coordinate (in our case, Z is the axis perpendicular to the projection plane) of the points is scaled and recorded instead of the rgb value, than the ortoimage is similar to digital terrain model (DTM). This type can be saved in a grayscale colormap (similar to range image), or as a hypsometry model (fig 1a, fig 4). The visibility of the grayscale colormap can be improved by adjusting the gamma curve (fig

1b). The new type of ortoimage with enhanced edges, more proper for vectorizing in CAD software, will be proposed in the next paragraph.

3. DENSITY ORTOIMAGE

The new method of creating ortoimage will be proposed here. During ortoimage generating process, each pixel usually contain much more points, than it is needed. If this happen, the algorithm usually takes only the point, that is closes to the view point and all other points are dropped off. We propose a simple algorithm that computes and consequently record the point density in each pixel. The advantage of this solution is the major enhancement of the model edges. Vectorization of the ortoimage is than much more comfortable and faster. However, the data from laser scanner are usually not consistent in density all over the model, because each scan pose has a different position and therefore different scanning resolution. The borders of each separated scan pose would be visible, therefore disturbing the ortoimage (fig 5). For this reason, the algorithm is improved to overcome this problem. First, the Z coordinate of each point is sampled with predefined step value. Than, in each pixel, only points with different Z coordination are used to compute the density. This means, that the Z coordination of points in pixels can lie only in a certain high levels and not between them. The number of high levels in pixel represent the density and not the number of all points in pixel. The step value (high level differences) should be somewhere around the size of the noise of the pointcloud. This improvement leads to proper density ortoimage (fig 3a). There is also possibility to add colour. The rgb color model of standard ortoimage is transformed to L*a*b colour model. Than, the L component is replaced with density ortoimage, and saved back to the rgb colour model. The final result has all the advantages of the density and coloured ortoimage (fig 3b).

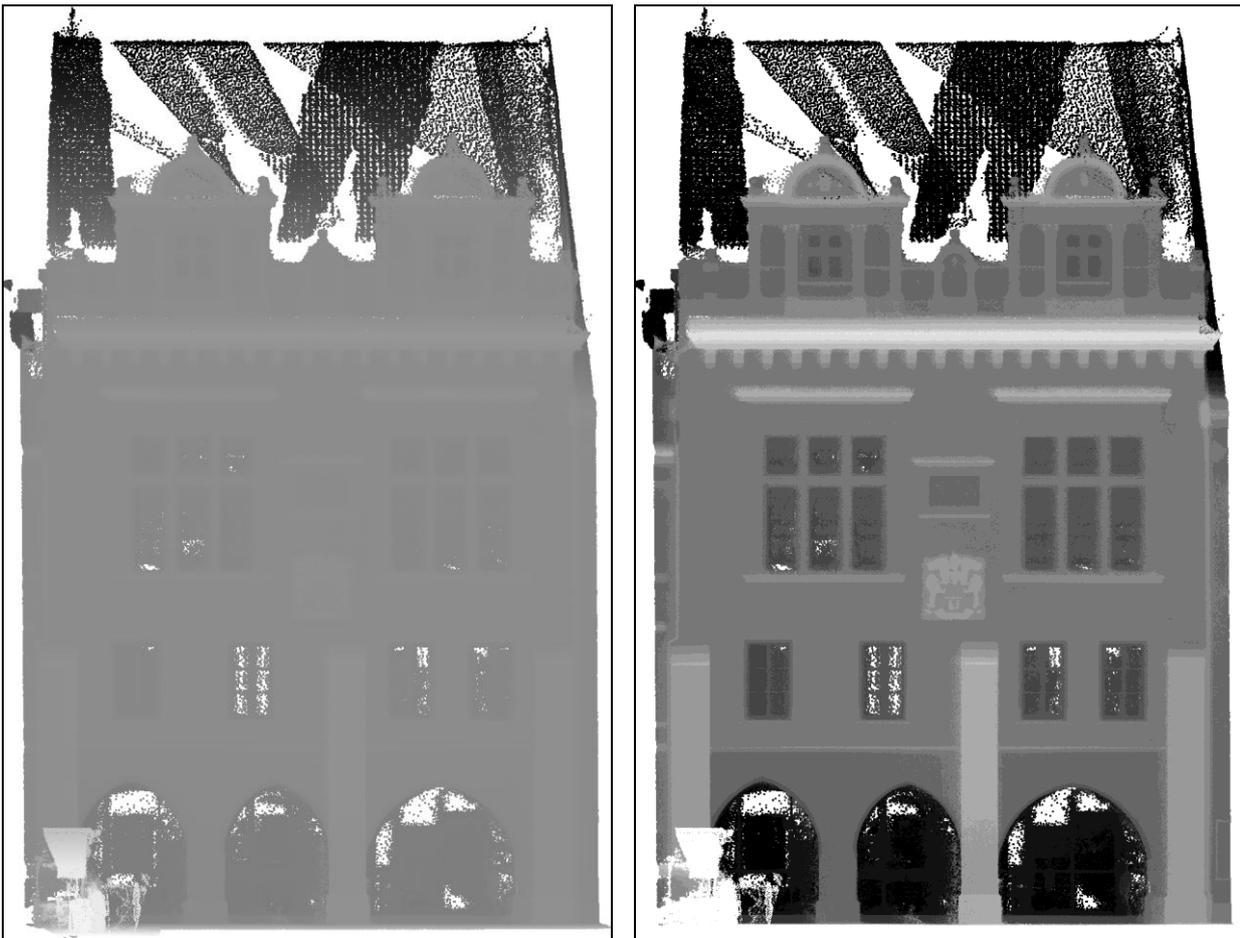


Figure 1: a – Ortoimage as a range image. Intensity represents the Z-coordinate value. b – The same ortoimage as *a*, but with adjusted gamma curve in software Photoshop.

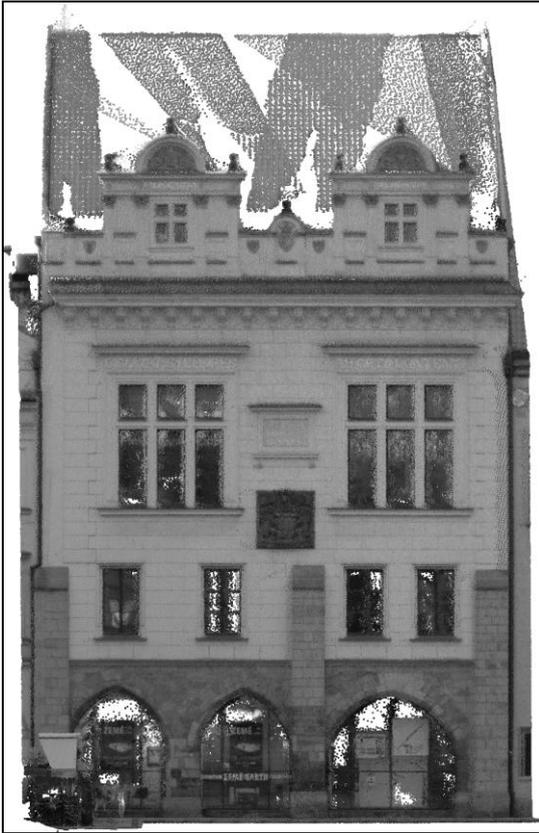


Figure 2: a – Greyscale ortoimage. Intensity represents the greyscale value. b – Full RGB colour ortoimage. Intensity represents the RGB value.

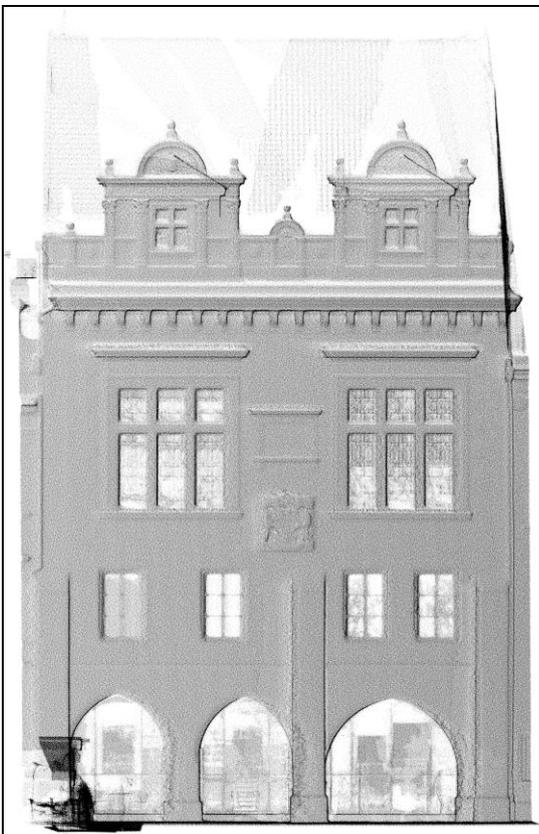


Figure 3: a – Density ortoimage. Intensity represents the point density in pixels. b – The same ortoimage as *a*, including “false” colours.



Figure 4: Ortoimage in a hypsometry model. Intensity represents the Z-coordinate value.

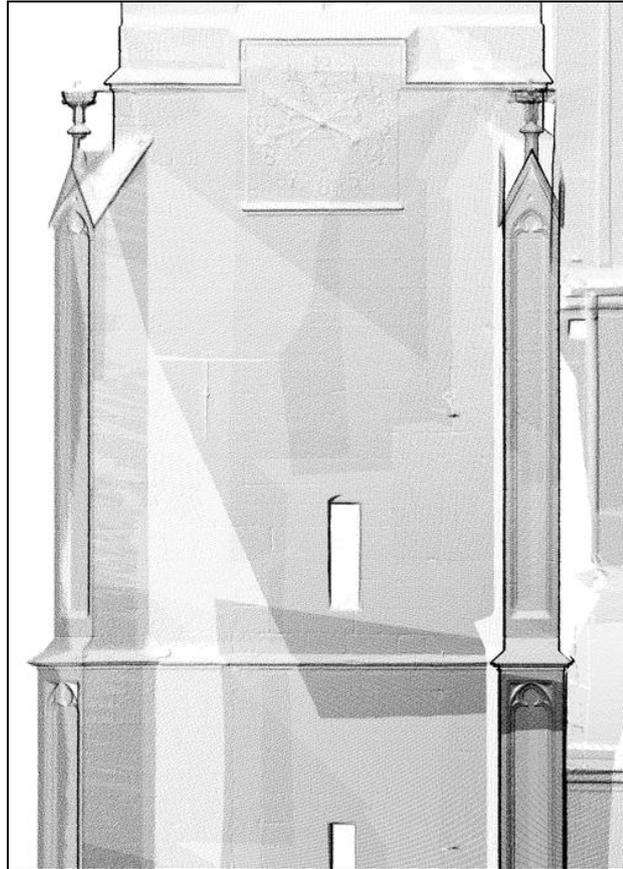


Figure 5: Density ortoimage before correction from non-uniform point spacing.

4. RESUME

The new method for ortoimage generation was proposed. The major advantage of such an ortoimage is in enhancing the visibility of the real edges and corners of the model, which makes the vectorization work more comfortable and faster. The ortoimage can be combined with a true rgb colour taken from digital camera, creating “false” colours, used for additional objects distinguishing. This type of ortoimage fully exploit the nature of laser scanning technology fused with standard photogrammetrical images. All examples were computed in self developed software for ortoimage generation in Matlab language.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

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