Automation in Orienteering Map Production – Fiction or Reality

Dušan Petrovič

University of Ljubljana, Faculty of Civil and Geodetic Engineering, Jamova 2, Ljubljana, Slovenia

Abstract. Automated production of orienteering maps seemed to be completely impossible due to extreme detainees and terrain adaptation of those maps. Use of dense LiDAR data point clouds, captured in non-vegetation season, that include also very small relief details and vegetation objects brought such ideas possible. The aim of described research was to evaluate the quality and usability of automated produced orienteering maps. Positional accuracy, thematic correctness, legibility, use of map generalization's principles is discussed, based on two different methods, comparisons between existing orienteering maps (based on field work) and automated produced ones in the office and making the training course on the terrain never before mapped with orienteering map.

Keywords: orienteering maps, automation, LiDAR data

1. Introduction

Orienteering maps are maps, specially designed for orienteering sports disciplines. Since the aim of these maps are to familiarize the competitor with the area where control points are positioned in the terrain and where he should find the optimal route, they have to be detailed, presenting all major terrain features that can serve as a place for putting control points and also those that influence on the correctness of the competitors decision about the fastest route to next control point. Therefore production of orienteering maps has taken a lot of field work since ever. The amount of field work in general depends on complexity of the terrain and quality and detainees of available source data, where use of lidar data as a source data brought a significant advantage in preparation of base map, a template for the field work.

But, nowadays we are faced with some applications that enable the use of lidar data as the only source for completely automated creation of orienteering maps. Such created maps naturally can't follow all the standards and requirements that have to be performed and such maps can't be used for orienteering competitions, but of those applications propose such automated produced maps for trainings. The goal in our research was to find out, if this can be the case in different terrains.

2. Possibilities of deriving objects for O-maps

Traditionally national database data is used as a background data for preparing template for orienteering maps. The main source for national topographic databases data are usually aerial photographs or satellite images, where we can't recognise a lot of objects in forest covered areas, even if aerial survey is done in early spring. The final work, however, have to be done on the terrain by skilled mapmaker. The production of orienteering maps is due to extreme detainees of content very expensive, time consuming and it requires a lot of terrain work.

2.1. Manual and visual interpretation

The technology of laser scanning has importantly affected the principles of spatial acquisition of topographic and other physical data about the environment. The very important advantage of LiDAR capturing is its speed; it allows capturing large area in a short period with high density. The main results of airborne LiDAR survey are clouds of georeferenced points containing data on the reflection order and the intensity of the returned pulse. The airborne laser scanning data therefore seem to be a very useful source data for mapping different objects and phenomena, even vegetation or terrain feature in vegetation covered areas.

Recognition of objects, phenomena and edges from those data enable capturing different abject, that has to be presented also on orienteering maps. Some methods, like edge detection and building extraction mostly in urban environment; or forest type, density, three-heights in forestry are already very successfully automated, while for the most nature made ones, small water objects, relief features, etc. such automated methods are not efficiently performed yet, however some tests between orienteering map makers and also in topographic mapping field were done (Gartner at al, 2009). For those features manual recognition of objects in different derived presentations (eg. hillshading) is probably still the most efficient method, while some software is able to create appropriate images (The orienteering map makers can use shareware las-tools programs, while OCAD11 ™ as the most popular software for orienteering map production also affers some procedures to create different derived images, as presented on figure 1.

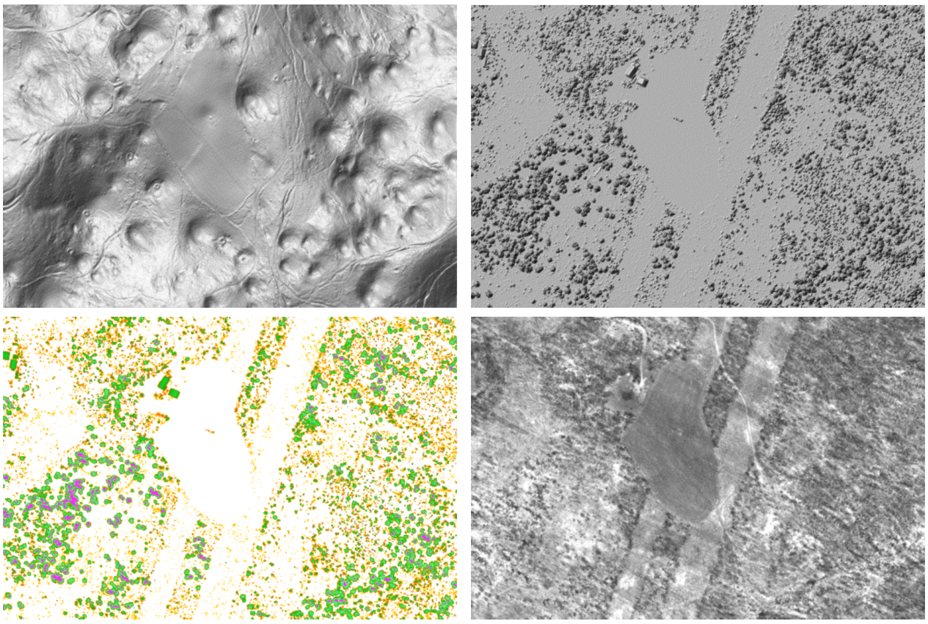

Figure 1. images , that can help mapmaker with visual interpretation ground relief shading, trees canopies, vegetation height and intensity image (created with OCAD11 ™).

Samo additional images can be used as well, like slope image, surface shading etc, and of course, generation of contour lines. In every case the orienteering map can be created with manual recognition, capturing and composing map.

2.2. Automated O-map creation

At the moment there are at least two software that enable creation of "whole" map, both are shareware. The first one is O-Laser ©, produced by Swedish Jarker Borman, while the other, Karttapullautin ©, was programed by Finish Jarkko Ryyppo. Both programs can create O.map with contours, cliffs and vegetation. Since there are no big difference in final results we decided to use Ryyppo's Karttapullautin © for further tests.

3. Results

3.1. Comparison to existing maps

Few examples were made for areas where orienteering maps already existed to compare the content. Figure 2 shows the partly urban area.

Figure 2. Automated created O-map and corresponding O-map of urban area near Domžale

Figure 3 shows the continental forest area, the original map is rather old (1991) and made using very poor template, but we can see, that except cliffs, that present gullies and ditches, the maps fits very well.

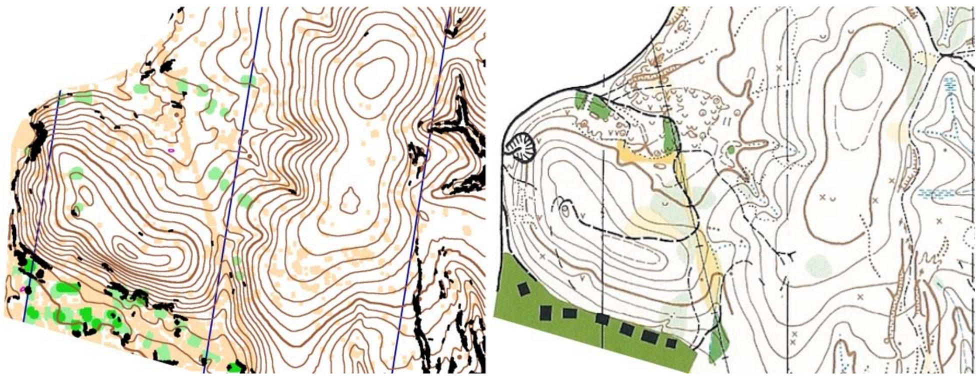

Figure 3. Automated created O-map and corresponding O-map of continental forest area near Radomlje.

Figure 4 shows the karstic forest area, with low density of trees, where the original map was made few years ago, using much better source data.

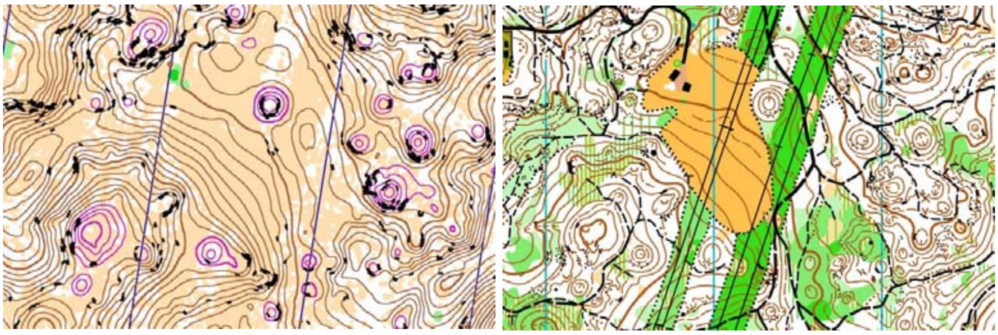

Figure 4. Automated created O-map and corresponding O-map of continental forest area near Domžale.

A huge part of Slovenian territory is karstic and such terrains are very detailed and challenging both for map makers and for runners. But some areas in high mountain environment can be even more difficult. Figure 5 shows large area of one of the first Slovenian maps showing the ancient glacier moraine area next to Bohinj Lake.

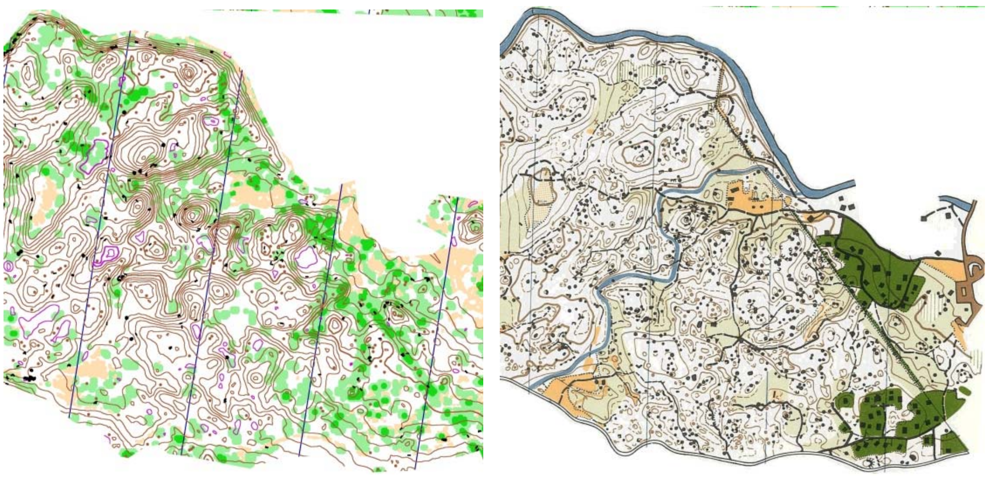

Figure 5. Automated created O-map and corresponding O-map of moraine area next to Bohinj Lake, Ukanc.

We can see that content fits very well, although the source data for the map were different. That fact encourages us that automated produced maps are quite similar to originally made ones and therefore can be used at least for trainings. At the last example we compared the automated created map with the map made manually from the same lidar source data (figure 6).

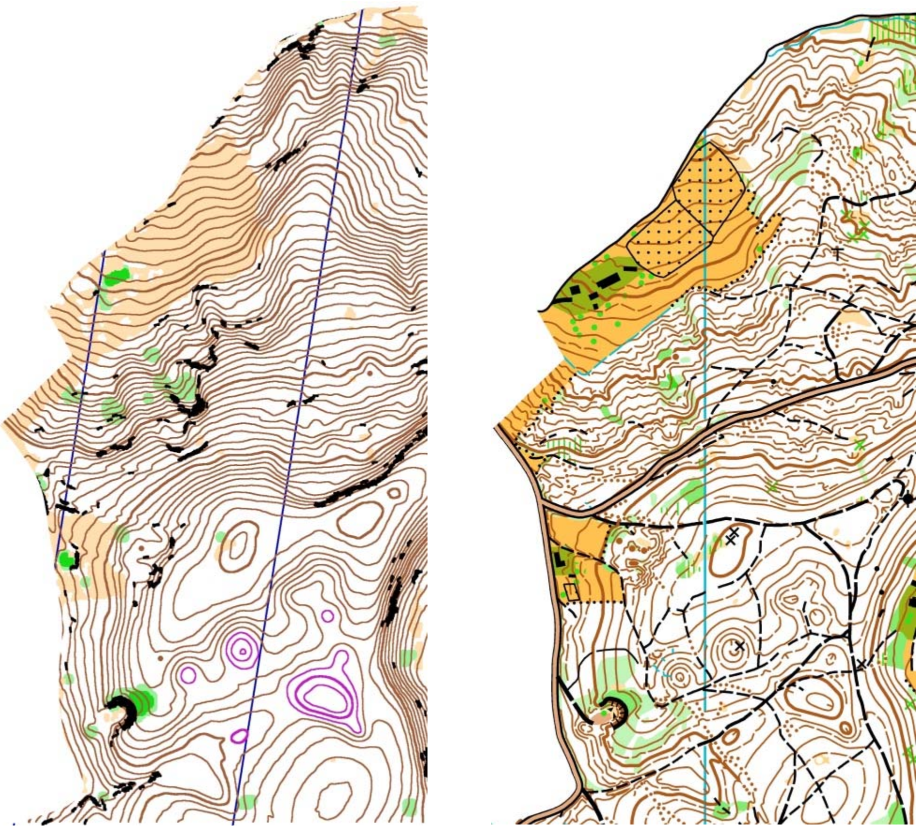

Figure 6. Automated created O-map and corresponding O-map, made for lidar data, too, from hilly, partly karstic area near Maribor

3.2. Creation of new map

When we tried to prepare the real course on the map, created exclusively with available source (mainly lidar) data, we realised, that runners could always be partly influenced with the existing map, based on the terrain check. I was obvious that the correct answers can be collected only on the entirely new terrain, where no O-map were ever available before. The selected terrain is mostly flat, what shouldn't be very common for lidar produced map, where we expect especially good presentation of terrain features. Different stages of maps were prepared. The very first one, created automatically form lidar point cloud using Karttapullautin ™ programme consisted of generalised contour lines, some relief point features (knolls, pits), vegetation (open area – presented in yellow and vegetation density – shown in green) and cliffs. The second version (figure 7 left) was upgraded with national topographic database data – buildings, roads outside of the forest, water streams, lakes and, land use (mostly vegetation). The third version of map (figure 7 right) was completed with manual visual interpretation of features prom ground model hill-shading image. Three different courses were prepared and Slovenian competitors were asked to make training and evaluate the map they used. Within one week, 20 athletes, prom youth national team, to seniors, from recreate runners to Slovenian top ones, few of them tried both maps.

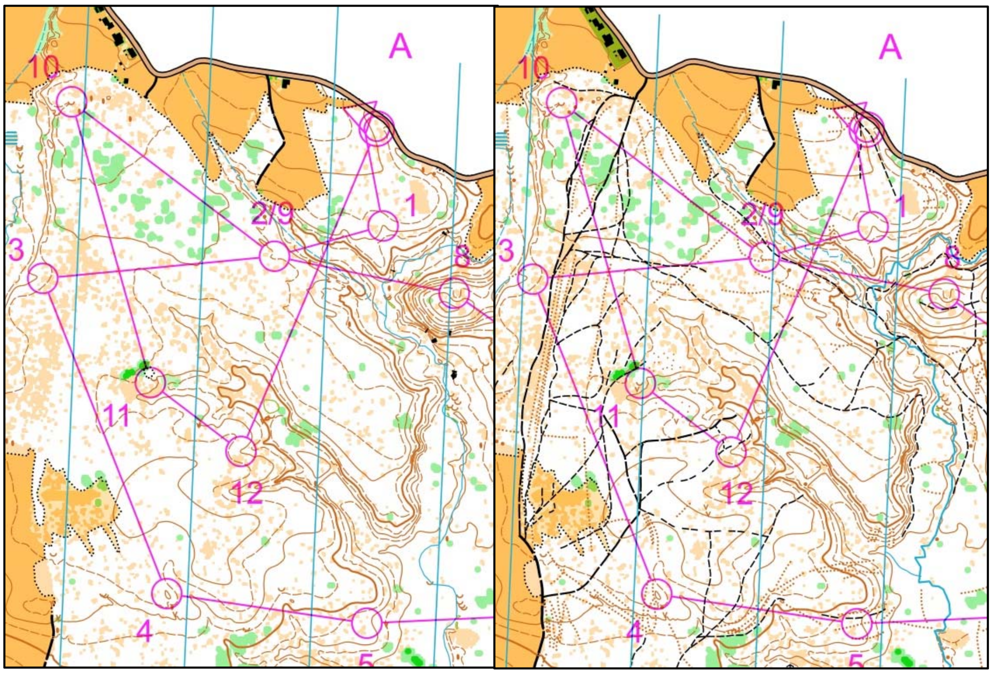

Figure 7. Maps for training, automated lidar and national topographic database only (left); additional manual visual interpretation and capturing (right)

All participants were asked to answer short questionnaire and give their opinion about the map they used, either automated either manually upgdaded one. They were ask about the legibility, about colours, correctness and usability of presentation of deferent object types, about harmonization of overall objects' presentation, and finally, can such kind of map can be used for trainings od for competition. Every statement or answer were graded with grade from 1 – very bad, 2 – acceptable, 3 – fair, good, 4 – very good, 5 – excellent, 0 – didn't notice, have no opinion. Resits are presented in Tables 1 (for automated map) and 2 (for updated map).

Automated produced map

Criteria	mean	stdev
Readability of map:	3,9	0,8
Suitability of colours:	3,5	1
Correctness of contour lines:	4,6	0,5
Relief point objects (pits, depressions, knolls):	2	0,8
Presentation of vegetation - yellow:	2,9	0,6
Presentation of vegetation - green:	2,9	0,8
Presentation of water objects:	2,6	0,8
Harmonization of overall objects' presentation (generalization, mapping criteria):	3,7	0,6
Suitability for trainings:	4,3	1
Suitability for competitions:	1,4	0,7

8 answers

Table 1. results of research for automated produced map

Upgraded map

Criteria	mean	stdev
Readability of map:	4,8	0,4
Suitability of colours:	4,5	0,6
Correctness of contour lines:	4,5	0,6

Relief point objects (pits, depressions, knolls):	3,6	1,4
Relief line objects (ditches, gullies):	3,8	1
Presentation of vegetation - yellow:	3,3	1,1
Presentation of vegetation - green:	3,6	0,8
Presentation of water objects:	3,4	1,3
Tracks and paths:	3,4	0,7
Harmonization of overall objects' presentation (generalization, mapping criteria):	4,2	0,8
Suitability for trainings:	4,8	0,6
Suitability for competitions:	3	1,3

14 answers

Table 2. results of research for manually upgraded map

4. Conclusion

We realized that even automated produced orienteering maps on most of the terrains could never adequately replace the traditional ones, based on field check, some specific terrains or for some orienteering disciplines (eg. SKI-O or MTB-O) those maps might be recognized as suitable for use. But the main advantage is also, that such maps can be fully applicable for trainings and training events, especially for bearing trainings.

References

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