APPLICATION OF RECTIFICATION METHOD FOR PROCESSING OF DOCUMENTATION FROM THE PLACE OF ROAD ACCIDENT

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Abstract

This paper is focused to explain the usability of the rectification method on the place of road accidents. Rectification is a method, using which a documentation after road accidents is processed for further analysis. In praxis often occurs a situation, where is necessary to find a certain value out from the place of road accident retroactively. Original conditions at the place of road accidents are in many cases non-repetitive. As next could happen, that measured distances given by the police units, which are responsible for documentation at the place of road accident, are with significant deviations. But with precise photography documentation, the required information can be reached using rectification method. For further photography processing was used software PC Rect. Paper deals with the methodological process for photography preparation and its rectification, and also includes evaluation of accuracy of this method in graphic charts. From performed measurement it is obvious, using which method should be photography taken in order to achieve the smallest possible deviation in the current condition.

Keywords: photography; photogrammetry; accuracy; rectification; reference cross for rectification; road accident

1. Introduction

In terms of analysis of road accidents is documentation of evidences on the place of road accident one of the most important step for the following procedure in forensic practice. Based on the documentation from the place of a road accident, which is performed by the police units during the examination of the place itself, law enforcement authorities decide about culpability for a road accident. Next, it is necessary to decide about disturbing traffic regulations by each participant of a road accident. Also all circumstances have to be judged, which are relevant for a correct understanding of the situation before, during and

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after a road accident. These data are important inputs for forensic experts and their further examination [4, 11].

Documentation from the place of road accident is process, where the most important evidences are collected. It has to be processed in such a way, which will provide an exact overview about the entire situation in the place of a road accident. Documentation includes road accident protocol, topographic documentation (sketch, ground plan) and photography documentation or video documentation [1, 3, 12].

Photogrammetry is a process, which is based on collecting of available measurements and generating models from photography. It is available in 3D and 2D environment. It differs from other measuring methods, because it does not need direct contact with the inspected object. In the case, when a very high accuracy is required, it is necessary to use special measuring chambers, where a special cameras with laboratory-controlled parameters are used. With photography from a common digital camera, it is necessary to expect decreased accuracy [5, 7, 8].

The principle of digital rectification is in transformation of photography taken under an angle for a flat ground plan of road accident area in footprint. This is enough accurate and allows to measure all distances in a certain scale. The result of rectification is photography, which is like to be taken from the above, perpendicular to the flat area without distortion effect of the camera objective. The advantage of this method is the possibility of additional measurement of certain value or distance, directly on rectified photography. It is also possible to evaluate more photographies, which are aligned with 2 points. This method allows processing a large area of a road accident [5, 7, 8].

One of the most frequently used software for photography processing is PC Rect, as it is possible to process photography into the ground flat plan (footprint). PC Rect is used especially in the case, when complicated marks on the road are present, and manual measurement and further processing is ineffective and complicated. After processing of photography, it is possible to check and measure the distances among all objects and the reference. As reference is used rectification cross. In the daily practice of forensic experts, it is very common a situation, where is necessary to check a certain value retroactively. The reason is, that the value was not measured during an inspection of the road accident by the police units. The personal subjective influence of the person and possible failure of the measuring equipment can be eliminated during inspection directly in the place of a road accident, as each value can be checked from the photography after rectification. An effective method is to rectify each photography, where is possible to measure each parameter of the desired object (height, width, length, etc.) [1, 2, 3].

Rectification method has also certain inaccuracy, which is influenced by more parameters (the height of the camera for taking photography, distance from the reference object-rectification cross, the subjective influence of the person during the evaluation process, etc.). For the case of rectification accuracy is important to know, how big deviations in different conditions are expected [6, 7].

2. Methodological process for preparing photography documentation on the place of road accident

In order to get accurate results after rectification, based on the previous research [10], it is recommended to keep the following steps:

- The first important step is to use as reference a rectification cross, which has very exactly defined dimensions. These distances are measured from the middle of the rectification target, which is on each end of rectification cross. In common practice it is used a distance of 4 m between the targets in the longitudinal direction of the arm of the cross (Figure 1).

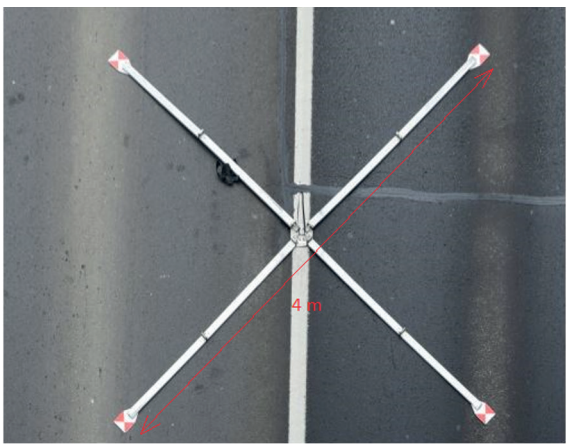

Fig. 1. Rectification cross with rectification targets

- Rectification cross is placed in the near of the object (evidence, tire track, tire track after braking, parts from damaged car, etc). As next a photography can be taken in a way, that the middle of the cross, evidence and a lens axis of the camera are aligned (lying on the same line), as it is obvious in Figure 2 on the left side. If it is possible, it is recommended to keep angle 45° between arm of the cross and aligning axis (see Figure 2 on the right side).

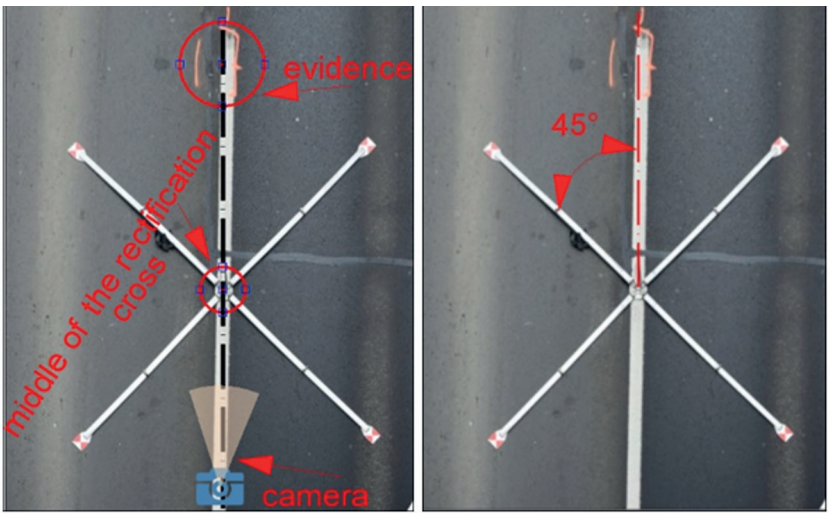

Fig. 2. Position of the rectification cross towards to the evidence

- For photography processing into the desired state (flat ground plan without distortion), software PC Rect is usually used, where the rectification process is performed, as it is shown on Figure 3. A difference between photography before rectification and after rectification is shown on Figure 4.

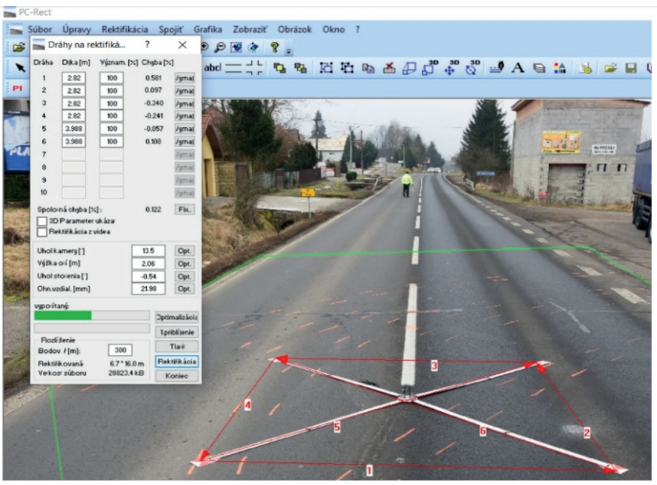

Fig. 3. Rectification window in PC Rect

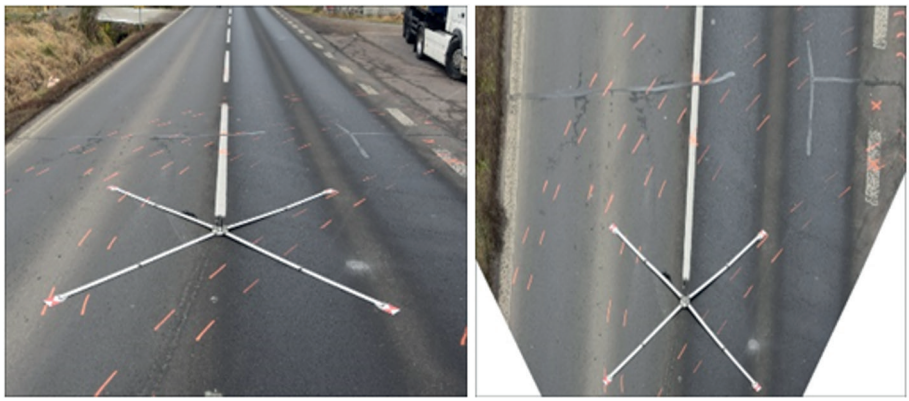

Fig. 4. Photography before rectification (left) and after rectification (right)

- Result of rectification in PC Rect is a flat ground area without distortion, which can be used for further processing for measuring the distances. One of the possibilities is to use software PC-Crash, which is often used for simulation of road accident. Here it is possible to scale photography using known dimension of rectification cross and to measure required value, as it is shown in Figure 5.

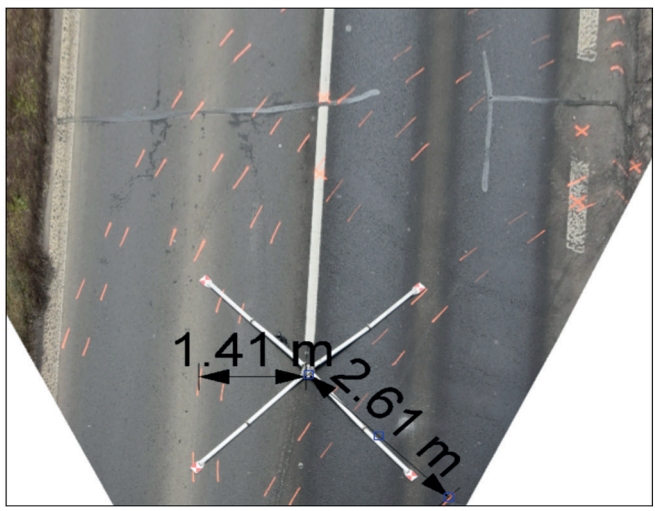

Fig. 5. Measurement of the distance from photography after rectification in PC Crash

3. Advantage of the rectification method for documentation on the place of road accident

With rectification a reasonable results can be reached, especially in case, when several distances and other values from the place of road accidents were measured by police units with certain error [11]. As example can be used a sketch from the place of road accident measured by police (Figure 6), where occurred a deviation approximately 1 meter for the end position of the car, and more than 1 meter for the truck.

After rectification a flat ground plan of the place of a road accident was prepared, and errors were corrected (Figure7). This is helpful for further calculation for forensic experts, as some important parameters (impact speed, impact place) can be calculated more exactly. Otherwise it would lead to bad results, which will automatically lead to wrong interpretation of the road accident.

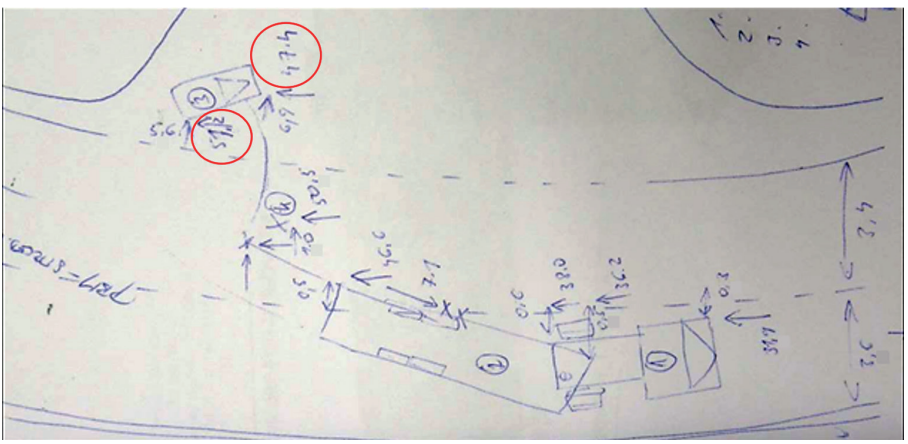

Fig. 6. In the red circle are distances measured by police units, which are incorrect

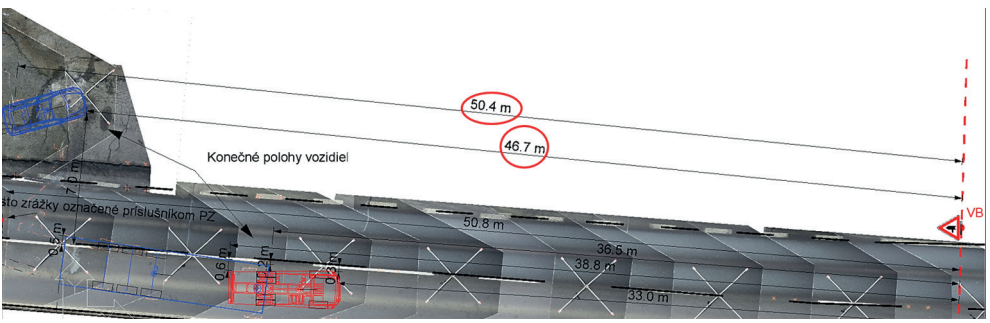

Fig. 7. In the red circle are distance measured in PC-Crash from rectified photography

4. Analysis of rectification accuracy

The accuracy of the rectification method was performed in [9, 10]. As it is obvious from the result, it is possible to reach acceptable accuracy for further analysis of the road accident. Accuracy was verified by measuring a deviation in distance between reference raster and original raster (Figure 8.).

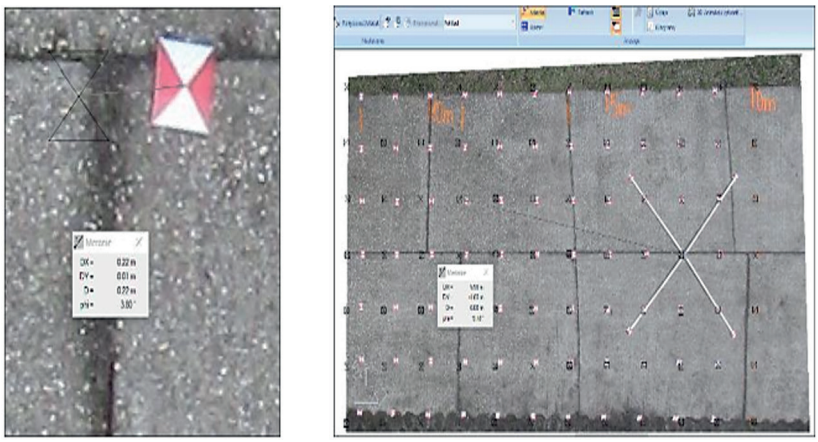

Fig. 8. Measurement of the deviation between reference raster and raster after rectification [10]

With the raster comparison of rectified photography with reference raster in PC Crash, a deviation was measured. This deviation occurs with changing of some parameters (position of the camera, distance from rectification cross, the position of rectification cross in raster). In order to eliminate failure by using just one device (camera, smartphone), an average of all 4 devices was used for data evaluation [9, 10].

On the pictures below is a comparison of the rectification accuracy with different position of rectification cross in raster (45° and 90°), different height of the digital device (1.7 m; 2.7 m; 3.7 m; 4.7 m; 5.7 m) and desired deviation 10 cm, 20 cm and 30 cm. The vertical axis "Accuracy" shows a distance from the middle of the rectification cross. This value represents a distance from the middle of rectification cross, where all rectification targets on rectified photography are in defined deviation (10 cm, 20 cm or 30 cm) from the reference targets. All objects within current distance from the middle of rectification cross, would be measured with a deviation not bigger, than defined deviation (10 cm, 20 cm, 30 cm). The horizontal axis "Distance" shows a distance from the middle of rectification cross, with the visible area in the entire width of photography. The position of the camera was from 3 meters to 4 meters farther. This rule was valid for all devices and all photographies.

For the deviation of 10 cm shown in Figure 9 is clear, when a position of rectification cross is under the angle of 90°, and distance rises, accuracy is significantly decreasing for each

camera height. Already for the distance of 9 meters, accuracy for all camera heights is shorter than 2.5 m. It means, when the distance is 9 meters, max. deviation 10 cm will be just within the area of 2.5 m from the middle of rectification cross. With cross position under angle 45°, it is different. Accuracy for each camera height (except 1.7 m) is increasing till a distance 6 m (for heights 2.7 m and 3.7 m) and 9 meters (for heights 4.7 m and 5.7m). After a distance 9 m, accuracy is decreasing. With this position of rectification cross, it is obvious, how increased camera height is influencing an accuracy.

For the deviation of 20 cm shown in Figure 10 is clear, how significant influence has a position of rectification cross and camera height. Position of rectification cross under angle 45° together with increasing camera height lead to increased accuracy [9]. This significant influence of cross position and camera height is also clear from Figure 11, where is a deviation of 30 cm evaluated.

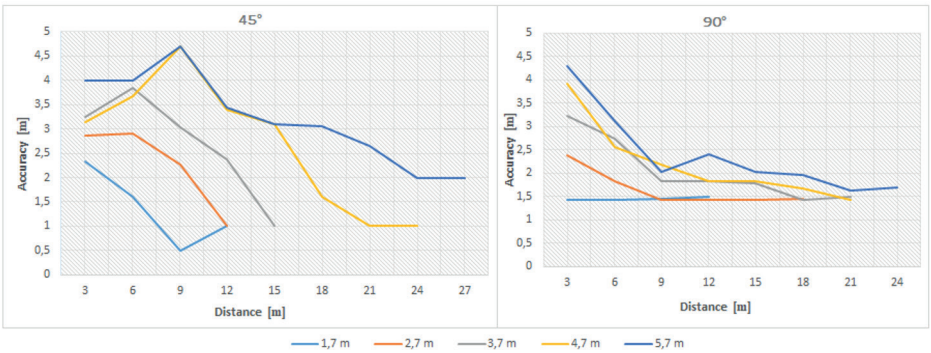

Fig. 9. Comparison of accuracy for rectification method for deviation not bigger than 10 cm for different position of rectification cross (45° and 90°) [9]

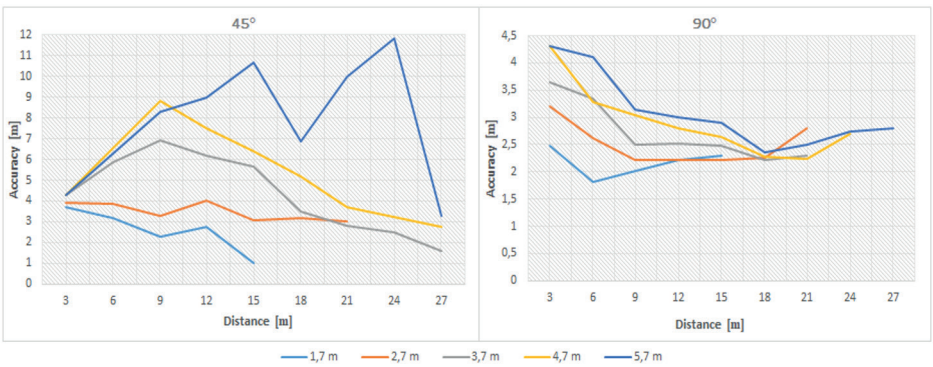

Fig. 10. Comparison of accuracy for rectification method for deviation not bigger than 20 cm for different position of rectification cross (45° and 90°) [9]

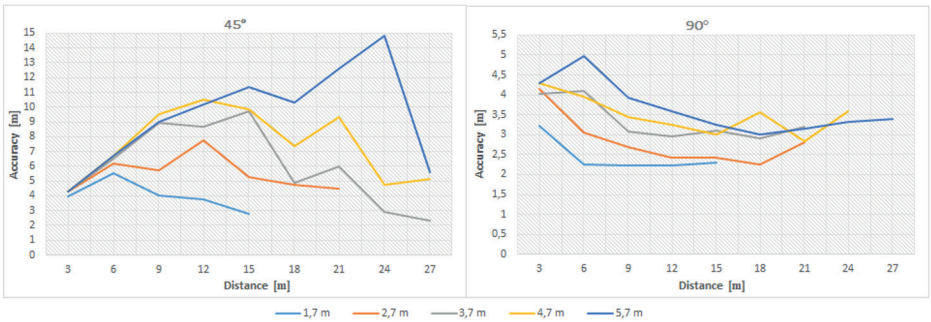

Fig. 11. Comparison of accuracy for rectification method for deviation not bigger than 30 cm for different position of rectification cross (45° and 90°) [9]

5. Conclusion

This paper analyses the topic of rectification, its accuracy, and factors, which directly influence the accuracy. Rectification is a modern method for road accident documentation, which is very frequently used by police units during documentation of the place of a road accident. This method is also frequently used by forensic experts. Rectification of photography is a transformation of photography taken under an angle for a flat ground plan of road accident area in footprint. This transformation is relatively accurate, but on the other hand, it is necessary to know available limits and deviations [10, 11].

From the results of accuracy analysis for the rectification method it is obvious, that the most important influence on rectification accuracy has a position of rectification cross in raster. It can be achieved higher accuracy of rectification method with the position of the cross under the angle of 45° to longitudinal direction to significantly bigger distances, like with the position of the cross under the angle of 90°. Another parameter, which has a significant influence on rectification accuracy, is the height of the camera. With an increasing height of the camera also a distance from the middle of rectification cross can be increased, where it is possible to achieve the desired accuracy.

Using different types of digital devices in order to take photography has also influence on rectification accuracy. In general, with a higher resolution of the camera, the accuracy is also higher. In the case of a smartphone with a camera it can happen, that with photography taken from the bigger distance between the middle of the rectification cross and camera, the accuracy is worse. It is due to the fact, that quality of an optical system of smartphones is not so precise, as the quality of an optical system of cameras with the same resolution.

Based on the results, how different parameters are influencing a rectification accuracy, the following recommendations for the preparation of documentation from the place of a road accident can be stated [5, 7, 10]:

- taking the photography with position of rectification cross under angle of 45° to the longitudinal direction,
- if possible, taking the photography from the higher point, optimally (5-6) meters (it is possible to use a ladder, fire hose truck, etc.),
- using a digital device with higher resolution,
- to take a photography in a way, that axis of the camera lens, documented object and the middle of rectification cross are aligned. To the side direction from the axis of the camera lens, a deviation is increasing,
- to prepare a bigger batch of photographies in order to have a selection possibility. With a bigger distance from the middle of rectification cross, the middle of rectification target is not always properly visible in PC Rect. In the end, it has an impact on the quality of rectified photography.

6. References

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