Comparison of Accident Black Spot Identification Methods based on GPS Coordinates

Sándor Szénási*[1], Gábor Kertész [1], Imre Felde [1]

[1] John von Neumann Faculty of Informatics, Óbuda University, Budapest, Hungary
*E-mail address: szenasi.sandor@nik.uni-obuda.hu

20th IEEE International Symposium on Computational Intelligence and Informatics
November 5-7, 2020, Budapest, Hungary

Introduction

Seeking for potential road accident black spots (also known as hot spots) is one of the most important tasks of safety experts. There are no widely accepted definitions of black spots, but these are usually well-demarcated areas of the public road network, where the number or seriousness of accidents is higher than expected.

Several methods exist in the literature for searching potential black spots, but most of them are based on the traditional road number+section number location identification system. Spreading of the GPS technology made it possible to use a more accurate and convenient way of two-dimensional coordinates to localize road accidents. This paper presents the capabilities of the most used black spot localization techniques (original sliding window, planar sliding window, DBSCAN) based on this new localization system. The evaluation contains both the qualitative and quantitative aspects; considering accuracy, processing speed, convenience, etc.

Sliding Window

The sliding window (SW) method is one of the oldest and most widely used procedures for black spot localization. It is based on two parameters: a window length (*L*; for example, 200 meters) and a minimal accident count (*C*; for example, 4 accidents). The original one-dimensional algorithm can evaluate the accidents of a given road identified by a road number between two given segments.

The base of this method is the sliding window which is an *L* length interval of the road. It is possible to calculate the number of accidents that occurred inside this interval in the given time period. If the number of accidents is higher than the predefined limit, the interval is considered as a black spot.

Density-Based Clustering of Application with Noise

The input parameters of the DBSCAN algorithm are a radius-type variable (ε; for example, 30m) and the minimal number of accidents (*minPts*; for example, 3). The procedure also requires a distance definition between points, but the natural distance between the GPS coordinates is applicable in this task.

An accident is considered as an “inner point” if there are at least *minPts* accidents in its *ε* environment. An *x* accident is “directly densely accessible” from any *y* accident if it is an inner point and the distance between *x* and *y* is no more than ε. Moreover, an *x* accident is “densely accessible” from *y*, if there is a path like $(y, a_1, a_2, \dots, a_n, x)$, where every accident in the path is directly densely accessible from the previous one. The result of the DBSCAN method is the set of densely accessible accidents from a given point. If the number of accidents exceeds a predefined threshold, the accidents of the clusters are part of a black spot candidate.

Conclusion

The standard sliding window method has several advantages (low computational demand, easy to interpret, most commonly used) but it is not applicable to handle accident locations identified by GPS coordinates.

The planar methods have the ability to work with GPS coordinates directly. These are capable to handle accidents of built-up areas and junctions. The only disadvantage is that the unit of the results is not the convenient accident/m instead of accident/m^2. This measure is not widely used and it needs some time to find it convenient and adapt the regularization.

Comparing the two planar methods, it is visible, that the DBSCAN based method has some advantages. It is able to find black spot candidates with irregular shapes.

In this case, the calculation demand is less compared to the planar sliding window method.

TABLE I
COMPARISON OF BLACK SPOT SEARCHING METHODS

	SW	PSW	DBSCAN
Built-up areas	no	yes	yes
Intersections	no	yes	yes
Shape	line	rectangle	irregular
Calculation demand	low	high	medium
Unit	accident/m	accident/m^2	accident/m^2

As a final conclusion, the authors recommend the usage of the DBSCAN procedure.

Acknowledgment

The research presented in this paper was carried out as part of the EFOP-3.6.2-16-2017-00016 project in the framework of the New Széchenyi Plan. The completion of this project is funded by the European Union and co-financed by the European Social Fund. Sándor Szénási would like to thank EPAM Systems for their financial support.