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## An Integration of Different Computing Approaches in Traffic Safety Analysis

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### Abstract

Traffic safety is one of the crucial problems of many countries in the world. To handle this problem, a great deal of research has been conducted considering various methods. This study includes analyses of black spots using different computing approaches. Integration of cluster analysis, entropy approach and fuzzy logic approaches are used in the analyses. The conventional black spot identification method includes marking the location of each accident with a pin and investigation of black spots considering density of the pins on a map. In this study, a systematic approach is employed. Firstly, the traffic accidents data of Denizli city have been analyzed using the fuzzy clustering methods. The spots that are densely located around the cluster centers are determined as “black spots”. Secondly, the safety levels of black spots’ are determined by Shannon Entropy Approach considering accident types and effective factors on accident occurrence. Geometrical and physical conditions, traffic volumes, average speeds and average accident rates at around black spots are considered as effective factors on occurrence of accidents. Entropy values are calculated using these parameters. Thirdly, the safety levels are classified by both fuzzy logic and crisp approaches based on calculated entropy values. Validation of entropy approach is tested by Chi-Square and truth value methods. The results are evaluated regarding all features of the black spots, and a series of recommendations to improve traffic safety are reported.

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## 1. Introduction

Traffic accident data can be analyzed in different ways, based on the amount and types of data. The analysis is not complicated if the data are smooth and not dispersed. But it is not an easy task if the data are scattered. Although there is not a general definition for black spots, locations where at least more than one accident occurred are treated as black spots (Meuleners et al, 2008). Based on this definition, the more the number of black spots, the more difficult their analyses become.

Several methods can be used for determination of black spots and centers (Abdel-Aty and Pande, 2007; Flahaut et al., 2003). De Luca et al. (2012) applied Bayesian model based cluster analysis on road safety management problem. Gregoriades and Mouskop (2013) studied on accident risk quantification issue. In their study, accident risk quantification was achieved through a Bayesian Networks (BNs) Model. De Pauw et al. (2014) evaluated the safety effects of an extensive black spot program that had been implemented in Flanders – Belgium. Pesic et al (2013) proposed a new method so called Benchmarked Traffic Safety Level (BTSL) to evaluate the traffic safety levels. Nghiem et al. (2016) examined the determinants of road traffic crash fatalities in Queensland for the period 1958 – 2007 using a state-space time-series model. Ghaffari et al. (2013) proposed a new method based on the reliability analysis to identify black spots. In their study, they compared proposed method with Frequency and Empirical Bayesian methods using simulated data.

Black spots can be determined by eye using simple observations. But this simple approach can include subjective perceptions and also results obtained cannot be sensitive and scientific. Besides, other specifications of black spots should be taken into consideration for a scientific analysis. Developing countermeasures and classifying by characteristics for black spots that are intensified and covered whole area on the map is not an easy task (ITE, 1993; Murat et al., 2008). Although some black spots can have common characteristics, they can be located far away from each other. On the other hand, characteristics of black spots that are closely located to each other can be different. Therefore definition and analysis of black spots include uncertainties and conventional approaches cannot be used for this purpose (Murat et al., 2008). In this study, firstly cluster analysis approach is used for determination of black spots' center and definition of the centers. Then Shannon entropy approach is used to determine entropy value of black spots' centers and safety levels are classified by fuzzy logic approach.

## 2. Study Area and Data

In this paper, the city of Denizli, a medium sized city (current population is about 700000), Turkey is studied. Traffic accident records are used in analyzing accidents. The distributions of accident data are given in Table 1.

Table 1. Traffic Accident Data and Distribution (the figures in the table are the number of accidents).

Intersection or Road Section (Black Spot)	Type of Accident		
	Dead+Injured Accidents	Economically Damaged (ED) Accidents	ED+Injured Accidents
Ucgen Karayolları	1	229	17
Cinar	1	46	4
Kiremitci		86	1
Yeni Adliye		25	0
İstasyon	1	27	6
Sevindik		107	12
Emniyet	1	93	8
Ulus		76	9
Hastane-M.Efendi		94	4
25. cadde	1	50	1
		200	26

The accident reports are provided by the Local Police Department. The following information (FHWA, 1991) are collected from the reports (Table 2).

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