Technical diagnostic of a fleet of vehicles using rough set theory

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Abstract

The paper presents a process of technical diagnostic applied to a fleet of vehicles utilized in the delivery system of express mail. It is focused on evaluation of diagnostic capacity of particular characteristics, reduction of a set of initially selected characteristics to a minimal and satisfactory subset, recognition of a technical condition of vehicles resulting in their condition-based classification. In addition, the decision rules facilitating technical diagnostic and management of a fleet of vehicles are generated and utilized. N-fold cross validation is applied to estimate the efficiency of the decision rules. The rough set theory is applied to support the diagnostic process of vehicles. Classical rough set (CRS) theory is compared with the dominance-based rough set (DRS) approach. The results of computational experiments for both approaches are compared.

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1. Introduction

Each transportation company manages a fleet of vehicles, usually in a different technical condition. This condition strongly influences on availability and operational productivity of vehicles. It can be also translated into a certain standard of transportation services and a defined level of customer satisfaction. Technical diagnostic of vehicles is performed on the basis of characteristics of their technical condition, such as: maximum speed, fuel consumption, compression pressure etc. Several authors (e.g. Žak and Stefanowski, 1994; Žak, 1999; Žak et al., 1999) prove that some characteristics can be more useful than the others and agree that one cannot a priori predict which of them are the most important in a particular diagnostic process (Kelley and Harris, 1987; Sawicki, 2003; Žak and Stefanowski, 1994). Thus, discovering practical diagnostic importance and informational capacity of particular characteristics is essential for rationality and efficiency of the technical diagnostic process.

Another important issue in technical diagnostic of vehicles is the definition of the characteristics’ limit values. There are several regulations and norms as well as service manuals that determine acceptable values of certain characteristics. The limits (boundary points) divide the range of the characteristics’ values into a certain number of intervals corresponding to concrete technical conditions of vehicles. If there are only two intervals the classification has a binary character, e.g. vehicles in a good or bad technical condition. If the number of intervals is larger classification can be more flexible and different classes characterizing the technical condition of vehicles in a more precise way can be distinguished, e.g. vehicles in an excellent condition, vehicles requiring tune-up/maintenance, vehicles requiring an overall repair, vehicles requiring breaking.

The relationship between description of particular vehicles by means of certain characteristics’ values and the global (overall) classification of vehicles is another issue worth investigating. Finding a correlation between those two classifications is an important factor influencing on the design and fulfillment of the technical diagnostic as well as fleet maintenance and fleet management policies.

While carrying out technical diagnostic of vehicles one can deal with different types of diagnostic characteristics.