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Transportation Research Procedia 27 (2017) 341–348

Transportation Research Procedia

www.elsevier.com/locate/procedia

20th EURO Working Group on Transportation Meeting, EWGT 2017, 4-6 September 2017, Budapest, Hungary

# Locating roadworks sites via detecting change in lateral positions of traffic signs measured relative to the ego-car

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**Abstract**

Roadworks can be hazardous for both road workers and road users. Even with state-of-the-art safety measures in place, serious accidents do happen there, particularly when drivers do not heed roadwork signs and speed limits. Crashes at roadworks that involve killed or seriously injured (KSI) casualties account for about 2% of all KSI crashes in developed countries, even though the roadworks are normally well-signaled and are also marked in quick-reaction road/traffic maps. These media provide several means for the drivers – and for the on-board advanced driving assistance systems (ADAS) helping them – to duly detect roadworks. In the paper, an approach based on statistical inference is presented for detecting roadwork zones. The approach takes into account the engineering regulations and practice concerning setting up temporary road configurations near and along roadworks. Such configurations often involve narrower traffic lanes and traffic signs installed closer to traffic. The approach detects change in – among other type of collected data – the lateral positions of the traffic signs measured relative to the ego-car along the road. In a practical implementation, the traffic sign detection and recognition, the lateral distance measurement and the data recording are carried out by some traffic sign recognition (TSR) system. The traffic sign data is seen as a realization of a marked Poisson process and the minimum description length (MDL) principle – set to work in the form of Page-Hinkley change detectors – is applied for detecting roadworks.


Peer-review under responsibility of the scientific committee of the 20th EURO Working Group on Transportation Meeting.

*Keywords:* Traffic sign recognition systems; Change detection; Accident prevention; Minimum description length principle.

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2352-1465 
Peer-review under responsibility of the scientific committee of the 20th EURO Working Group on Transportation Meeting.
10.1016/j.trpro.2017.12.004

## 1. Introduction

Roadworks can be hazardous for both road workers and road users. Even with state-of-the-art safety measures in place, serious accidents do happen near and along roadwork sites. Some instructive statistical data on accidents which had happened near and along roadwork zones are presented in Section 2. The data presented there underline the criticality of this road safety issue and suggest that any meaningful support given to the drivers in this regard could potentially save human lives.

Herein, a statistical inference approach is presented for detecting roadwork zones on roads, more specifically for detecting roadwork zones on motorways. The approach is closely related to the one proposed by Fazekas et al. (2016) for detecting transitions between topographical road environments based on traffic sign location and type data. The change detection task pursued there was chosen as an easy-to-verify test case for the approach (i.e., using traffic sign data as input for change detection) and the methodology (i.e., the application of the minimum description length principle), but was not practical enough to be implemented as a function for advanced driver assistance systems (ADAS).

A more practical task, which is more suitable for implementation as an ADAS function, was addressed by Fazekas et al. (2017). The same approach and methodology was applied as described above, but in this case for urban road environment detection. A straightforward implementation approach was proposed that would involve the enhancement of a traffic sign recognition (TSR) system with a minor additional functionality. Thereby turning it into a low-cost surrogate for a comprehensive vision-based road environment understanding and recognition system.

The present task, that is the detection of roadwork sites in an automatic manner, also has the potential to be converted into an ADAS function. The method presented here takes into account the road safety regulations and the engineering practices concerning setting up temporary road configurations near and along roadworks. Such configurations often involve narrower traffic lanes and traffic signs installed closer to the traffic, as well as repeated warning and speed limit signs placed at regular intervals along the road, especially when longer stretches of roads are affected by the construction or maintenance work.

Over the last few months, a car-based traffic sign data collection was carried out along the motorways. The data concerning the stretches of motorway affected by roadworks and their vicinity were used in the work presented herein. The details of the data collection procedure are given in Section 4.

The proposed method detects change in the spatial frequency of the traffic signs installed along the road and in their type probabilities, as well as change in their lateral positions which is measured from the midline of the current lane. Empirical spatial distributions of the traffic signs and their lateral distances from the actual traffic lane – on stretches of motorway in normal use, as well as on stretches along roadwork zones – are computed based on the data measured and logged during the data collection trips.

The traffic sign data is seen as a realization of a marked Poisson process and the minimum description length (MDL) principle – set to work in the form of Page-Hinkley change detectors (PHCDs) – is applied for detecting change in the spatial frequency of the traffic signs along the road, as well as in their lateral positions. The necessary mathematical background is summarized in Section 3. In Section 5, the output signals of three differently tuned PHCDs are shown for a particular roadwork zone. In Section 6, conclusions are given.

## 2. Roadwork sites and traffic safety

Although negotiating road work zones – particularly if they occur in large numbers along a route, or include longer stretches of road – is frustrating for vehicle drivers, the presence of roadwork zones are concomitants of the standard and responsible road maintenance. Conducting road construction or maintenance work in traffic is hazardous for the workers toiling at the site, but it poses serious dangers also for drivers. For the reasons given above, the transportation planners responsible for planning and managing roadwork zones try to improve the road safety and keep up the close to normal vehicle mobility by

- making road work projects as concise in time as possible,
- better informing drivers about the roadworks ahead, e.g., by installing appropriate warning signs and variable message signs (see Fig. 2),