

Chapter 66

Analysing the Performance of a Fuzzy Lane Changing Model Using Data Mining

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ABSTRACT

Heavy vehicles have substantial impact on traffic flow particularly during heavy traffic conditions. Large amount of heavy vehicle lane changing manoeuvres may increase the number of traffic accidents and therefore reduce the freeway safety. Improving road capacity and enhancing traffic safety on freeways has been the motivation to establish heavy vehicle lane restriction strategies to reduce the interaction between heavy vehicles and passenger cars. In previous studies, different heavy vehicle lane restriction strategies have been evaluated using microscopic traffic simulation packages. Microscopic traffic simulation packages generally use a common model to estimate the lane changing of heavy vehicles and passenger cars. The common lane changing models ignore the differences exist in the lane changing behaviour of heavy vehicle and passenger car drivers. An exclusive fuzzy lane changing model for heavy vehicles is developed and presented in this chapter. This fuzzy model can increase the accuracy of simulation models in estimating the macroscopic and microscopic traffic characteristics. The results of this chapter shows that using an exclusive lane changing model for heavy vehicles, results in more reliable evaluation of lane restriction strategies.

INTRODUCTION

There is potential for lane changing manoeuvres to have a substantial impact on macroscopic and microscopic traffic flow characteristics due to the interference effect they have on surrounding vehicles (Hoogendoorn & Bovy, 2001; Daganzo, 2002; Sasoh & Ohara, 2002; Wall & Hounsell, 2005; Laval & Daganzo, 2006).

The interference effects of heavy vehicles' lane changing manoeuvres on surrounding traffic are likely to be greater than when passenger cars execute lane changing manoeuvre. While they account for a minority of traffic stream, heavy vehicles have a pronounced effect on traffic flow and produce a disproportionate effect particularly during heavy traffic conditions. Heavy vehicles impose physical and psychological effects on

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surrounding traffic (Uddin & Ardekani, 2002; Al-Kaisy et al., 2005). These effects are the results of physical characteristics of heavy vehicles (e.g. length and size) and their operational characteristics (e.g. acceleration, deceleration and manoeuvrability). The effect of heavy vehicles' operational characteristics becomes more important under heavy traffic conditions.

The number of heavy vehicles on roadways of the U.S. has increased by 75% over the past three decades and this trend is likely to continue at least over the next decade (Bureau of Transportation Statistics, 2002). Typically, the proportion of heavy vehicles ranges from as low as 2% to as high as 25% of total traffic during the day (Al-Kaisy et al., 2002). According to a series of traffic surveys conducted in December 2004 in Australia, the proportion of heavy vehicles could increase to 30% of total vehicles in the morning peak and 20% in the afternoon peak on some freeways (Conway, 2005).

Despite the increasing number of heavy vehicles on freeways, previous studies have predominantly focused on the behaviour of passenger car drivers. In the previous lane changing models, the differences between heavy vehicles and passenger cars is primarily accounted for through differences in vehicle length, maximum speed and acceleration/deceleration capabilities (Gipps, 1986; Wiedemann & Reiter, 1992; Ahmed, 1999; Hidas, 2005; Toledo, 2009). In other words, heavy vehicles are accommodated in current lane changing models by calibrating the parameters of a general lane changing model for heavy vehicles rather than by incorporating a lane changing model developed specifically for the heavy vehicle drivers. However, heavy vehicle and passenger car drivers have fundamentally different lane changing behaviour (Moridpour et al., 2009; Moridpour, 2010a; Moridpour, 2010b; Moridpour et al., 2012). Understanding heavy vehicle drivers' lane changing behaviour is important due to its implications for the models employed in traffic and transportation policies.

To improve freeway capacity and traffic safety, previous research has examined various lane restriction strategies for heavy vehicles (Al-Kaisy & Hall, 2003; Lord et al., 2005; Siuhi & Mussa, 2007; Adelakun & Cherry, 2009; El-Tantawy, 2009; Yang & Regan, 2009). Due to the large size of heavy vehicles, restricting heavy vehicles to certain lanes can potentially bring psychological benefits for passenger car drivers. To evaluate different lane restriction strategies, previous studies have primarily used microscopic traffic simulations. Although heavy vehicles and their driving behaviour have been the main focus of those studies, microscopic traffic simulation packages are mostly using a general lane changing model to estimate lane changing behaviour of heavy vehicle and passenger car drivers. The parameters of the general lane changing model are calibrated for heavy vehicles and passenger cars, separately (Moridpour, 2010). However, heavy vehicle and passenger car drivers may have fundamentally different lane changing behaviour. Therefore, a lane changing model for heavy vehicle drivers may increase the accuracy of microscopic traffic simulation models in estimating heavy vehicle drivers' lane changing behaviour and enhance the performance of microscopic traffic simulation models.

The broad aim of this chapter is to advance microscopic traffic flow modelling by developing a fuzzy lane changing model for heavy vehicles and analysing the performance of that fuzzy lane changing model using data mining. Consistent with that broad aim, the following objectives have been established.

- Develop a fuzzy lane changing model for heavy vehicle drivers on freeways,
- Validate the heavy vehicle lane changing model and assess its accuracy,
- Evaluate different lane restriction strategies for heavy vehicles using data mining.

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