Accepted Manuscript

New control strategy for the lattice hydrodynamic model of traffic flow

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PII:	\$0378-4371(16)30784-1
DOI:	http://dx.doi.org/10.1016/j.physa.2016.10.080
Reference:	PHYSA 17638
To appear in:	Physica A
Received date:	23 June 2016
Revised date:	23 August 2016

Volume 282, Item	x 22, 15 November 2013 (55% 6378-4371
PHYSICA	A STATISTICAL MECHANICS AND ITS APPLICATIONS
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Please cite this article as: C. Zhu, S. Zhong, G. Li, S. Ma, New control strategy for the lattice hydrodynamic model of traffic flow, *Physica A* (2016), http://dx.doi.org/10.1016/j.physa.2016.10.080

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1 New control strategy for the lattice hydrodynamic model of traffic flow

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5 The new delayed-feedback control strategy is applied for lattice hydrodynamic model of traffic 6 flow by considering the control signal of the variation rate of the optimal velocity. The linear 7 stability condition is derived in the frequency-domain with control theory. Then, different 8 feedback gains under the periodic boundary scenery and on-ramp scenery are simulated. The 9 periodic boundary scenery provides an initial small disturbance situation on the circle road, while 10 the on-ramp scenery reproduces the disturbance triggered by the on-ramp on the open road. Both the theoretical analysis and simulations show that this new control signal has a positive effect to 11 12 suppress traffic jams.

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Key words: Lattice hydrodynamic model; Variation rate of the optimal velocity; Delayed-feedback control; Stability analysis

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17 **1. Introduction**

In order to understand the mechanism of traffic congestion, many traffic flow models have been proposed in recently years, such as the microscopic and macroscopic models. Microscopic models, including cellular automata [1-5] and car following models [6-10], focus on the dynamics of individual vehicles, while macroscopic models, including gas-kinetic-based models [11-15], continuum models [16-20] and lattice hydrodynamic models [21-41], regard the whole traffic flow as a flow of continuous medium composed of vehicles.

Lattice hydrodynamic models are firstly proposed by Nagatani [21] in 1998, which can describe the real traffic flow properly, especially the jamming transitions. The jamming transitions of traffic flow are always described by the kink-antikink soliton density waves derived by mKdV equation near the critical point through nonlinear stability analysis [23-30, 32-41]. Besides, the lattice hydrodynamic models can reproduce various congested patterns induced by the on-ramp system well [22, 23], and the lattice models also can reproduced the spatiotemporal evolution of all the traffic states described in phase diagram [23].

Due to the good performance of describing the real traffic, and deep connection with the continuum models and car-following model, the lattice model received great attention [22-35]. Ge, Wang, Tian, Zhu, Sun et al. [24-30] proposed the lattice models by considering the sites ahead or behind in vehicle motion. Li, Zhu, Peng [31-35] have taken the optimal velocity, driver's dely, driver's forecast effects and driver's memory into account. Besides, some two-lane lattice models were also proposed [36-41].

However, up to now the suppression of traffic congestion especially in the bottleneck systems is rarely considered in those models [42-45], but which was studied intensively for car following models [46-53]. Ge et al. [46, 47], Nakayama et al. [48], Konishi et al. [49, 50], Zhao and Gao[51], Shen et al. [52] and Li et al. [53] have utilized

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