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Shuqi Xue, Bin Jia, Rui Jiang, Xingang Li, Jingjing Shan

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An improved Burgers cellular automaton model for bicycle flow

2 Shuqi Xue, Bin Jia*, Rui Jiang, Xingang, Li, Jingjing Shan

MOE Key Laboratory for Urban Transportation Complex Systems Theory and Technology, Beijing Jiaotong University, Beijing, China

Abstract

As an energy-efficient and healthy transport mode, bicycling has recently attracted the attention of governments, transport planners, and researchers. The dynamic characteristics of the bicycle flow must be investigated to improve the facility design and traffic operation of bicycling. We model the bicycle flow by using an improved Burgers cellular automaton model. Through a following move mechanism, the modified model enables bicycles to move smoothly and increase the critical density to a more rational level than the original model. The model is calibrated and validated by using experimental data and field data. The results show that the improved model can effectively simulate the bicycle flow. The performance of the model under different parameters is investigated and discussed. Strengths and limitations of the improved model are suggested for future work.

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Keywords: Bicycle flow, Burgers cellular automaton, Initiative move, Following move,

Fundamental diagrams

1. Introduction

Bicycling, as an energy-efficient, non-polluting, and healthy transport mode, was previously recognized as the major transport mode in many cities of China. In the 1990s, more than 50% of all trips in Beijing were made through bicycles, and less than 0.3 million motor vehicles were used at that time. However, with China's rapid economic boom, the car ownership soared and led to a continuing decline in bicycle use. The bicycle mode share fell by nearly 30% in Beijing over the period 1986 to 2007 while the number of motor vehicles increased from 1.51 million to 3.07 million; in Guangzhou, the number of bicycle trips dropped rapidly from 34.1% in 1984 to 10.4% in 2005; in Shenzhen, from 1995 to 2007, the bicycle mode share plummeted from 30% to 4.7% [1, 2]. Some European countries such as the Netherlands, Denmark, and Germany also experienced such a sharp fall in bicycle use during the 1950s and 1960s. But due to the policy reform that was meant to promote cycling and restrict car use, a bicycling renaissance turned up in these countries since the mid-1970s [3]. At present, the governments of many large cities in China have begun to rethink the car-oriented policy and shift the focus to the use of new-energy vehicles and shared bicycles [4], to ease the suffering from the rapid increase of motorized vehicles, such as traffic congestion, traffic-related air pollution, and traffic accidents. Consequently, bicycle traffic has also attracted academic attention.

Bicycle traffic researchers can be primarily divided into three groups: (i) Researchers who centered their attention on how bicycling could be promoted. They tried to explore the potential effects of various interventions on bicycling promotion through case studies and survey [5-10]. (ii) Researchers who were devoted to bicycle safety. They tried to investigate how cyclist behavior along with environmental

E-mail address: bjia@bjtu.edu.cn (B. Jia)

^{*} Corresponding author.

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