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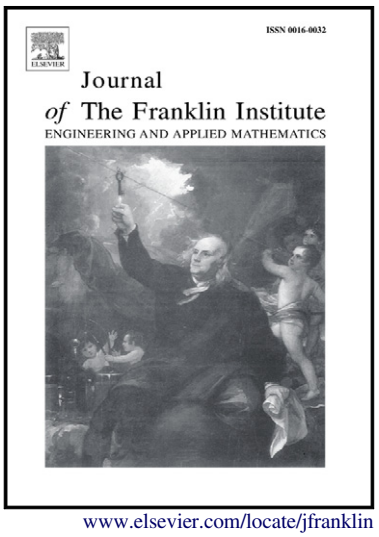

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A novel hybrid petri net model for urban intersection and its application in signal control strategy

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Abstract

A signal control strategy based on model reference adaptive control is investigated with a new hybrid petri net model for urban intersection in artery. The hybrid petri net intersection model is simplified via the token transition. The new model can be more in touch with facts through the waiting zones and addition phases. The hybrid petri net is innovatively used as the reference model in the model reference adaptive control method. The predicted traffic flow is precisely computed by the support vector machine. Finally, a series of simulation results with the practical data verify the feasibility of the novel arterial petri net model and the effectiveness of the control strategy.

Keywords: Intersection modeling; Hybrid petri net; Model reference adaptive control; Support vector machine

1. Introduction

With the increasing need for vehicles in the urban, the congestion problem has been serious. Traffic-jam usually occurs in the urban artery, especially during the rush hour [1]. When the layout of cities have been fixed, it is hard to broaden the road. In this case, the solution for easing the traffic congestion will be quested in the signal control strategy in recent research [2].

Webster and Akcelik proposed the Webster model [3] and ARRB model [4], respectively. Both the two model can be applied well in the low density traffic flow. Yet, the two models cannot be used precisely in the high density traffic flow. An Arrival-Based model proposed by Rahim F. Benekohal and Yoassry M.El-Zohairy[5] can be applied well in the urban traffic signal optimization. The platoon arriving types are considered in the delay time function of Arrival-Based model, increasing the accuracy for computing the delay time of the vehicles. However, the delay time models are based on the statistical method and cannot accurately describe the random feature for vehicles passing the intersection. Recently, The petri net theory [6,7] is used in modeling the intersection. A hybrid petri nets model for urban transportation is proposed by Angela Di Febbraro and Nicola Sacco[8]. This petri model can reflect the real artery system from the two parts: the macroscopic continuous road model and the microcosmic discrete intersection model. Considering the more factors of the real system, the petri model for intersection is becoming more complex and hard to be understood. To simplify the expression of the Petri net model, the conception of token transition is illustrated in this paper. [9,10].

The tradition signal optimization methods are the decision-making process without the feedback signal[11-15]. The generalized hill climbing algorithms[16-18], ant colony algorithm[19-21] and particle swarm algorithm [22-23] are widely used in the signal optimization process. In paper[24], the state transition matrix and control strategy have been given out for two phases

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