

## ITERATIVE LEARNING CONTROL BASED FREEWAY RAMP METERING WITH ITERATION-VARYING PARAMETER

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**ABSTRACT.** *In this work, a revised iterative learning control based ramp metering algorithm with compensation for the iteration-depended traffic free speed is proposed. This control method works well when free speed is iteration-varying, which is the most common situation for the freeway traffic system. With rigorous analysis, the proposed control scheme guarantees the asymptotic convergences along the iteration axis. In order to make the strategy practical, estimation methods of compensation coefficient are proposed as well. Intensive simulations show the effectiveness and superiority of the proposed strategy with iteration-varying free speed, as compared with the pure iterative learning control method.*

**Keywords:** Iterative learning control, Freeway ramp metering, Iteration-varying

1. **Introduction.** Among numerous freeway traffic control methods, ramp metering, which based on monitoring the freeway on-ramps and preventing traffic volume from exceeding freeway capacity, is the major one. Ramp metering, when properly applied, is an effective way to ease freeway congestion and improve freeway utilization [1]. It can be implemented by using traffic lights to meter the number of entering vehicles. Numerous ramp metering methods have been exploited, e.g., mathematics programming [2], fuzzy logic [3], PID-like controller [4,5], function approximation based on neural network [6], optimization and optimal control theory [7], etc. These methods, according to [1], can be further classified into three strategies: fixed-time strategy, locally actuated control strategy and system control strategy. The fixed-time strategy is the simplest to be carried out, but the effect can not be guaranteed. It was reported that the local control strategy is far easy to design and implement, and proven to be noninferior to coordinated approaches under recurrent traffic congestion conditions [1].

Traffic flow patterns are in general repeated every day. Based on this observation, the iterative learning control (ILC) based freeway local ramp metering system was proposed by [8] for the first time. It makes use of the repeatability of the macroscopic traffic flow patterns, so it has learning function, which means the controller performance getting better and better with the number of cycle increasing. In [9], the ILC based ramp metering strategy is further complimented by combining with existing feedback controller, such as ALINEA, in an "add-on" pattern in order to make the strategy robust to external disturbance. In [10], the ILC approach is extended to the speed signalling case.

However, from the assumptions of [8,9,10], we can see that the strict repeatability of the traffic flow model is a crucial condition for the ILC-based control. In reality, the strict repeatability of the traffic flow model may not hold. The free speed, which is the most