A Discrete Event Model for Freeway Systems

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Discrete Event Dynamic Systems (DEDS) are a research subject of growing interest. This class essentially includes man-made systems that consist of a finite number of resources shared by several users which all contribute to the achievement of some common goal. The coordination of the user access to these resources requires complex control mechanisms which usually make it impossible to describe the dynamic behaviour of such systems in terms of differential equations, as in physical phenomena. Past and current research on DEDS have resulted in a number of representation and analysis methods among which one cannot forget the max-plus algebra approach [1],[2], the logical approach to automata [3], and the perturbation analysis of trajectories [4]. Simulation is still commonly used.

In this paper, it will be shown how a freeway can be modelled as a DEDS. The term *freeway* is used to characterize a road traffic system with the following characteristics [5]: i) a long road; ii) unilateral flow; iii) more than one lane (so that overtaking is possible); iv) no amber lights along the mainstream; v) interactions with adjacent roads limited to particular on-ramps and off-ramps. The term freeway is often used as a generic term for all traffic systems of the defined class. Highways (USA), motorways (UK), autobahnen (Germany), autostrade (Italy) and autoroutes (France) are examples of traffic systems belonging to this class. Here particular reference will be made to Italian freeways (autostrade), which are toll roads.

Freeways present characteristics that require dedicated control systems and methods. Speed and density are quite high. As a result, disruptions in the traffic flow can rapidly

propagate and increase in severity. On the other hand, when imposing traffic measures, care should be taken not to provoke dangerous reactions by drivers.

In the final paper, in order to refer theoretical issues to a practical case, a simple freeway system will be considered. Such a system is constituted by the portion of road included between three subsequent on-ramp/off-ramp couples. The road is divided into three lanes and the traffic flow can be modelled by taking into account the fact that it consists of different classes of vehicles.

With each class particular speed profiles and arrival distributions are associated on the basis of real-world average data. A certain number of possible perturbations to normal traffic flow are considered. These perturbations, in a DEDS model, are regarded as "events" and give rise to precise effects which need to be taken into account during simulation or whenever certain control strategies are meant to be applied to the system in question, as will be detailed in the paper.

References

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