MODELLING AND PERFORMANCE ANALYSIS OF URBAN TRANSPORTATION NETWORKS

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A discrete event approach is proposed to evaluate the performance and develop control strategies for a urban intermodal transportation network. The discrete event model presented integrates public and private means of transport. Some disturbances are included to model the stochastic nature of the system. Based on such a model, a urban traffic simulator (INTRANET) has been designed on purpose. INTRANET includes two major modules. The first one, the Traffic Simulation Kernel, allows to study the dynamic behaviour of the transportation system, analyzing its performances and applying control strategies to optimize them. The second one, the Passenger Information Service, gives the system users at any time updated information about the different intermodal paths between any pair of origin/destination nodes. A case study relevant to the transportation network of an Italian city is dealt with. Related experimental results, showing the effectiveness of the proposed control strategy, are presented and discussed.

1. Introduction

In recent years, the integration between public and private transport services, with the aim of increasing the 'attractiveness' of public means of transport with respect to private ones, has become a research topic of great interest. Such an integration results in realizing intermodal transportation. Intermodal transportation can be defined as the serial use of different modes of transport to move passengers and/or freight from a place to another [1], [2], [3], [4]. In this paper, the problem of integrating passenger transport services in a urban area is dealt with. The realization of efficient intermodal transportation systems is especially intended to lead people not to use their cars to move in the cities, which would result in both an optimization of the travelling times and a decrease in air pollution.
A transportation system consists essentially of two major components: the demand system, which represents the needs and the behaviour of the users, and the supply system, which includes all what concerns the service production from the infrastructures to the planning rules of the system [5]. Some demand aspects usually depend on supply characteristics and vice versa. Then, a model of a transportation system can be seen as the integration of the models of demand and supply, and their interaction [6], [7]. This paper deals with a supply model relevant to an intermodal transportation network, proposed with the aim of analyzing the performances of the system and designing control strategies to optimize them. The network realizes the integration among urban public transport services themselves and private traffic. The proposed model can be viewed as an extension of the one presented in [8]. The system is represented as an oriented graph, in which the nodes are stations where it is possible to switch from a mode of transport to another one.

For the peculiar characteristics that an intermodal transportation network presents, it seems suitable to model it as a discrete event dynamic system. In fact, discrete event modelling is suitable for those systems in which significant changes in their state only occur at discrete time instants. Discrete event systems are asynchronous and modular, and often include control strategies and communication systems. Ruling communication and control strategies, it is possible to make the event flow satisfy the project requirements [9], [10]. For the transportation system under study, a peculiar discrete event model is proposed. Due to the stochastic characteristics of the transportation system considered, some disturbances are also included. The behaviour of the discrete event system modelling the transportation network is studied by means of a simulation tool on purpose designed, which is the kernel of the urban traffic simulation program INTRANET (INtegrated TRANsportation NETwork).

INTRANET is designed to perform two major functions, almost independent of each other. The first objective is the validation of integrated timetables for the different modes of transport, so as to consider the various transport services to be parts of a whole