Simulation Complex for Training and Supporting the Decision Maker in Subway Train Traffic Control Systems

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Abstract: The control of subway trains traffic is a complex and poorly formalized task, that has to be resolved by train dispatchers within a very tight timeframe. The subways of major cities impose very serious requirements to the quality of subway traffic control, the principal criterion of which is either accomplishment of the planned traffic schedule when disturbances to the traffic schedule can be compensated or providing the maximum degree of comfort to the subway passengers if such disturbances can not be compensated.
The soft-hardware complex is built around a subway line model that allows for imitating the operation of the main underground line subsystems with regard to the train traffic. Besides that, the model can represent different conditions of the environment and the actions of the subway personnel and technical equipment in response to the controlling commands of the train dispatcher.
The current levels of the computer means development make it possible this day to successfully resolve the task of making control process of subway trains traffic automated. This report gives proper consideration to the basic principles of building the simulation software and hardware for training and supporting of decision-maker (dispatcher) at control of subway trains traffic.

Key Words: control; subway; dispatcher; simulation

1 Introduction

The management and control of subway trains traffic is a complex and poorly formalized task, that has to be resolved by train dispatchers within a very tight timeframe. The subways of major cities impose very serious requirements to the quality of subway traffic control, the principal criterion of which is either accomplishment of the planned traffic schedule when disturbances to the traffic schedule can be compensated or providing the maximum degree of comfort to the subway passengers if such disturbances can not be compensated. Requirements that high can be satisfied only by providing the best level of subway train dispatcher qualification.

These requirements can be met only if two major tasks are solved:

- Raising the level of train dispatchers' skill by means of implementing up to date training features, particularly, train dispatcher's training simulator;

- Improving train dispatchers' operating conditions by means of implementing automation and decision making support features.

This report gives proper consideration to the basic principles of building the simulation software and hardware for training and supporting of decision-maker (dispatcher) at control of subway trains traffic.

2 Lines of development of underground line control automation facilities

Automation of train operation controlled by a train dispatcher along the underground line is being introduced at present [6]; the following has been already created (Figure 1):

- operator's automated workstation on which the operator directly controls turnouts and traffic lights on the line in order to effect the dispatcher's commands; normally, the direct line control should be carried out by two operators;

- joint use panel intended to provide the most complete data display of the line objects' status;

- automated workstation of actual traffic schedule performs the analysis of the data received from the line model as well as comparative evaluation of the actual traffic against the planned traffic schedule. On the basis of the obtained data the actual traffic schedule is drawn up that should be referred to as the principal document by which the quality level of the traffic control on the line should be estimated [7];

- train dispatcher's simulator created in the Moscow State University of Communication Lines. The employment of the data exchange protocols similar to those incorporated in the actual automated systems of subway traffic control allows one to use the simulator as a means of testing new automated equipment developed for subway traffic control [3].

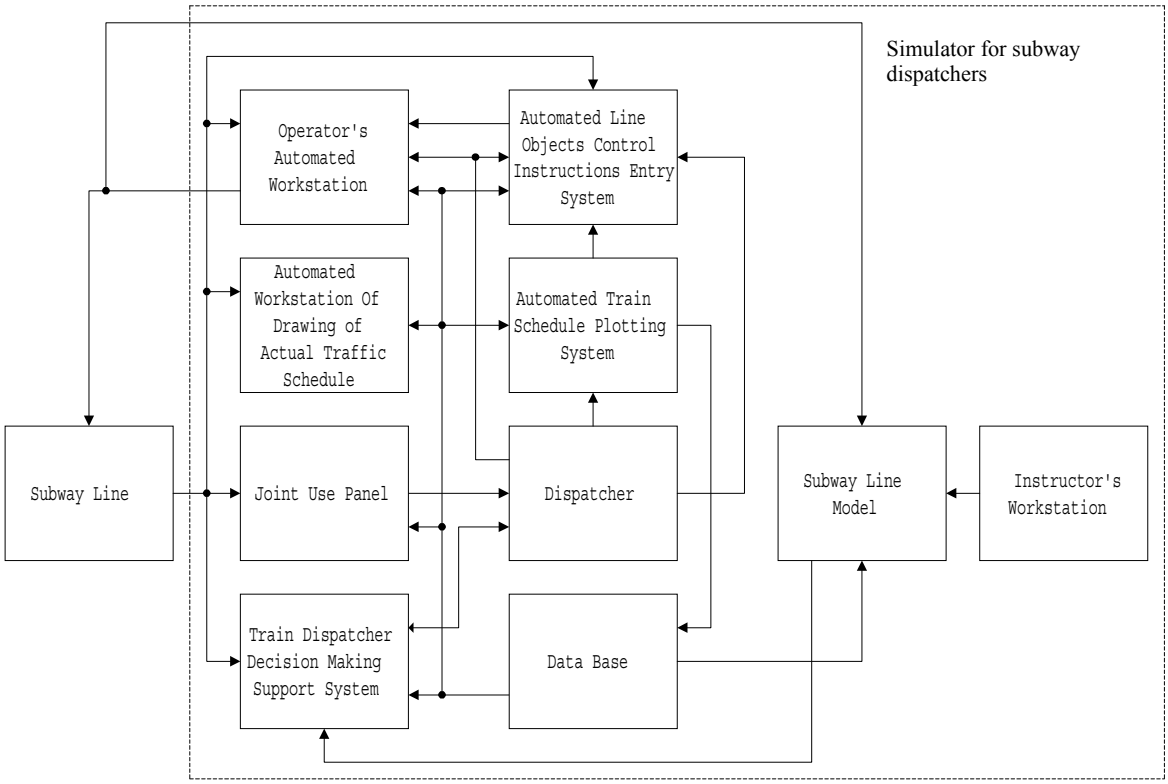

Fig. 1. Structure of underground line control automation facilities

The following are created at present:

- automated train schedule plotting system supposed to implement man-machine procedure of train schedule plotting and adjustment subject to prime requirement of paired operation, service and maintenance conditions of rolling stock and individual features of the line (line geography, hold-yard and night car spotting locations, depot location) [1];

- automated line objects control instructions entry system that will enable to transmit line objects control instructions under automated operating conditions subject to the schedule and authorization of the operator [8];

- train dispatcher decision making support system [5].

All above mentioned train operation control automation facilities use the same information space structure, namely, uniform input/output data transmission format and protocol as well as data base. Remote signaling signals from the underground line objects directly related to the train operation control (track circuits, traffic lights, rail relays, etc) and remote control signals transmitting control actions from the train dispatcher to the line objects provide a basis of uniform information space comprising introduced and prospective automation facilities complex [6].

Different criteria may be used for the evaluation of the train dispatcher's actions. As a rule, such criteria should be the similar to those used by dispatchers for planning the control strategy, that is:

- normal accomplishing of the planned traffic schedule;
- managing to keep correct traffic intervals;
- controlling trains with passengers stopping between stations;
- correct performance of turnarounds at intermediate stations;
- etc.

3 Principal Layout of Subway Train Dispatcher Simulator

A simulator is a technical device built in order to provide for the professional training of operators' personnel. The main purpose of such a device is to shape up and enhance appropriate professional skills and techniques of the trainees necessary to adequately control the service object under command. This training should be done in the manner of numerous repetitions by the trainees of those activities that are normally performed in the field [4].

Let us give consideration to the structural layout of such a simulator (Figure 1). The arrows represent the information exchange between the personnel employed on the automated workstations and the technical devices of the simulator.

The simulator is built around a subway line model that allows for imitating the operation of the main underground line subsystems with regard to the train traffic. Besides that, the model can represent different conditions of the environment and the actions of the subway personnel and technical equipment in response to the controlling commands of the train dispatcher [2].

In contrast to the ordinary underground line control system the simulator comprises Instructor's Workstation. The instructor at his automated workstation imitates the actions of other participants to the subway line control process, such as: power line dispatcher's actions on controlling the power system and actions of train operators on providing the appropriate

intervals of train holding at stations, changing direction and the rate of traffic. The instructor at his workstation also forms an initial training situation on the line and introduces faulty conditions into the model (such as equipment failures).

4 Tasks of Train Dispatcher Decision Making Support System

The train dispatcher decision making support system must solve following tasks [5]:

- forecasting of error conditions;
- diagnostics of malfunctioning underground line devices and the cause of failure;
- notification of all persons concerned of existing line status;
- development of possible line operation scenario under fault conditions;
- development of fault conditions elimination proposals;
- development of possible line error condition elimination scenario;
- development of specific trains and stations control proposals;
- arrangements for underground line scheduled train operation recovery;
- actions record keeping.

5 Summary and Outlook

The article describes general principles of construction and structure of underground line dispatcher support and training simulated hardware and software complex. Further research is related to formalization and machine implementation of dispatcher control logic using up-to-date control theory, namely, neural networks, fuzzy logic and etc. Some complex‘s components may be regarded as an artificial intelligence system that at the initial stages may form part of the train dispatcher training facilities and subsequently, as operational experience is obtained, of the real control loop.

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