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FIZIČKI MODEL UPRAVLJANJA PROMETOM U ŽELJEZNIČKOJ POSTAJI KAO MULTIMEDIJSKA APLIKACIJA

SAŽETAK

U sklopu proučavanja prometnih znanosti željeznički promet predstavlja primjer složenog sustava, a upravljanje tehnološkim procesom prometa kroz željezničku postaju njegov značajan podsustav. Profesionalni pristup informatizaciji upravljanja željezničkim prometom zahtijeva od stručnjaka koji se bave tehnologijom i tehnikom željezničkog prometa odgovarajuću informatičku naobrazbu. U radu se prikazuje multimedijska edukacijska jedinica za upravljanje prometom vlakova kroz željezničku postaju.

1. MULTIMEDIJSKI OKOLIŠ ZA UPRAVLJANJE FIZIČKIM MODELOM

Edukacija upravljanja prometom u željezničkoj postaji, uz ostala edukacijska pomagala, uključuje i fizički model objekata postaje: željezničke prometnice, vozila i signalno-sigurnosne uređaje (Gold i dr., 1992.). Upravljanje i nadzor fizičkog modela kao i kod realnih sustava zahtijeva module:

- upravljanja vožnjom lokomotive
- upravljanja radom signalno-sigurnosnih uređaja
- povratnih informacija iz željezničkog sustava.

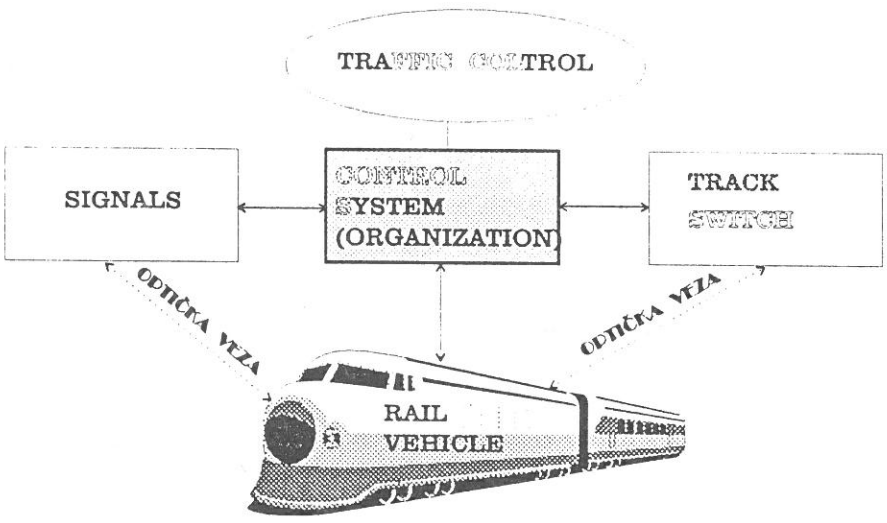
A PHYSICAL MULTIMEDIA APPLICATION MODEL OF TRAIN CONTROL IN THE RAILWAY STATION

SUMMARY

In the study field of transport and traffic engineering, the railway transport represents an example of the complex control system in which the control of technological process of train passing through the railway station becomes its subsystem. Professional approaches to informatization of railway transport control require expertise in the field of technology and technique of railway transport, but also particular education in the field of informatics. In this paper, a multimedia educational module for the control of train passing through a railway station is presented.

1. MULTIMEDIA ENVIRONMENT FOR CONTROL OF A PHYSICAL MODEL

Education in the domain of control of train passing through a railway station is provided, among other educational means, by help of a physical model of railway station including railway tracks, rail vehicles and signaling equipment (Gold et al., 1992). The control and monitoring of the physical model, as well as a real system, need modules for control of trains and control of signalling and safety equipment.



Slika 1. Sustav upravljanja pokretnim sredstvima u željezničkom prometu
Figure 1. Control system for rail vehicles in railway transport

Multimedijski pristup edukaciji pojačava reprezentaciju realnih procesa. Konvencionalne multimedijske aplikacije integriraju tekst, grafiku, zvuk i video. Za taj oblik aplikacija osnovna sklopovska i programska oprema računala proširuje se odgovarajućim zvučnim i videomodulima. Premda se konvencionalni multimedijski sustavi uvelike koriste u edukaciji, oni ne uključuju module za upravljanje fizičkim modelima. Multimedijsku opremu, proširenu modulima za nadzor i upravljanje fizičkim modelom regulacije prometom željezničke postaje, pokazuje slika 1.

Sa stajališta programske podrške, multimedijska aplikacija uključuje analizu usmjerenu objektu i projektiranje aplikacije, grafičko okruženje i interakciju čovjeka i stroja. Upravljanje fizičkim modelom upravljanja prometom u željezničkoj postaji dodatno zahtijeva integraciju pogonskih programa, poruka i protokola za objekte modela u multimedijskom okruženju.

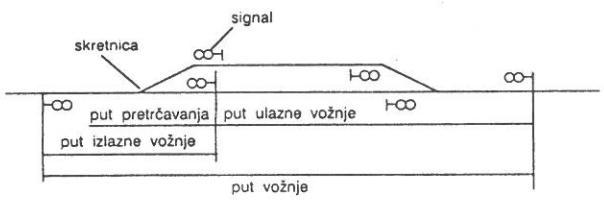
2. MODEL UPRAVLJANJA PROMETOM U ŽELJEZNIČKOJ POSTAJI

Općenito gledano, sustav upravljanja je sastavljen od dvaju osnovnih dijelova - upravljačkog i upravljanog sustava. Na temelju određenih pravila, informacija iz upravljanog sustava upravljački sustav upravlja podređenim sustavom pomoću odgovarajućih tehničkih elemenata.

Željeznički promet ima za cilj, kao i ostale vrste prometa, pokretanje prometnih sredstava preko prometnog puta prema poznatom cilju. Specifičnost željezničkog prometa prepoznaje se po prijevoznom putu, koji, za razliku od ostalih oblika prometa, ograničuje slobodu kretanja. Prometnica za odvijanje željezničkog prometa je složen tehnički sustav koji nazivamo željezničkim kolosijekom. Promet željezničkim kolosijekom onemogućuje slobodno kretanje željezničkih vozila u svim smjerovima. Ona se mogu kretati samo po fiksno postavljenom kolosijeku, a skretanje s jednoga kolosijeka na drugi obavlja se u željezničkoj postaji preko skretnica.

S obzirom na specifičnosti željezničkog prometa, upravljanje pokretnim sredstvima je ograničeno, a obavlja se uporabom signalnih uređaja. Signalni uređaji imaju zadaću optičkim putem prenijeti osoblju koje upravlja prometnim sredstvom naredbu o načinu kretanja. U cilju što sigurnijeg odvijanja željezničkog prometa potrebno ga je regulirati određenim pravilima, koja obuhvaćaju tehničke elemente za upravljanje prometom, kao i organizaciju upravljanja prometom.

Izvor opasnog stanja u željezničkoj postaji pojavljuje se unutar puta vožnje kroz nju (sl. 2.). Put vožnje kroz željezničku postaju obično započinje na određenom mjestu ispred ulazne skretnice, gdje se postavlja ulazni signal, a završava na istome takvome mjestu s druge strane postaje. Unutar puta vožnje mogu se promatrati tri različita elementa: put ulazne vožnje, put izlazne vožnje i put pretrčavanja.



Slika 2. Elementi puta vožnje kroz željezničku postaju

Multimedia approach to education makes possible direct presentation of real processes. Conventional multimedia application integrates text, graphics, sound and video in one system. For such an application, the basic hardware and software configuration of computer is expanded with suitable sound and video mudules. Although broadly used in education, conventional multimedia equipment does not include hardware and software modules for the control of physical models. The elements of the physical model that must be included in the model of train passing through a railway station are shown in Fig. 1.

From the software point of view, multimedia application includes object-oriented analysis and design of application, interactivity and graphical user interface. The control of physical model of the railway station additionally requires integration of drivers, messages and protocols for objects of the model in a multimedia environment.

2. THE MODEL OF RAIL VEHICLE CONTROL IN THE RAILWAY STATION

In general, the control system comprises two basic parts: the master control system and the controlled system. On the basis of information and strictly specified rules from the control system, the master system controls subsystems using related technical elements.

As the other types of transportation, railway transport, has as its objective moving of a rail vehicle on the railway tracks to a known destination. Moving of the railway vehicle, in contrast to other means of transportation, is constrained to one dimensional path.

The paths for the completition of railway traffic represent a complex technical system named the railway track. Drive on the established railway track in the railway station constrains free moving of rail vehicles in all directions. Thus the crossing of rail vehicles from one track to another is only feasible using the switches.

Control of rail vehicles is constrained and completed using the signalling equipment. The signalling equipment has the task to transmit in the optical form driving instructions to persons directly responsible for the control of rail vehicle. For a more secure rail traffic it is necessary to regulate it with standardized rules, encompassing the technical elements and organizational issues of traffic control.

The sources of dangerous state for the moving of a vehicle through the railway station appear in its driving path, Fig. 2.

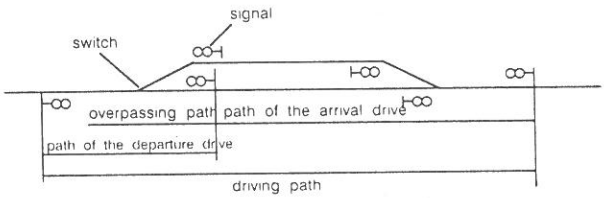


Figure 2. Elements of driving path through the railway station

Driving path through the railway station usually begins at a particular position on the track, in front of the rail station, where the arriving signal is set. The driving path is finished in

Sigurno odvijanje prometa kroz željezničku postaju omogućuje signalno-sigurnosni uređaj. To je tehnički sustav koji na temelju stanja zauzetosti kolosijeka, položaja skretnica i ovisnosti između predviđenih putova vožnje i stanja signala omogućuje sigurno i racionalno odvijanje željezničkog prometa kroz željezničku postaju. Osnovica za određivanje pravila prometa kroz željezničku postaju ili kolodvor čine tablica ovisnosti i vozni red, koji propisuju dopuštena i zabranjena stanja u prometnom procesu te određuju putove vožnje.

Postavljanje, analiza i realizacija tablice ovisnosti i voznog reda jedan je od osnovnih zadataka izobrazbe stručnjaka iz područja tehnologije odvijanja željezničkog prometa. S tim ciljem razvijena je simulacija upravljanja prometom kroz željezničku postaju na fizičkom modelu.

3. RAZVOJ MULTIMEDIJSKE APLIKACIJE UPRAVLJANJA PROMETOM NA POSTAJI

Aplikacija upravljanja fizičkim modelom razvijena je metodom analize ponašanja objekata (Goldberg, 1990) u željezničkoj postaji.

Iz analize građe i načina odvijanja tehnološkog procesa u željezničkoj postaji identificiraju se sljedeće komponente modela:

- sustav za upravljanje prometom u željezničkoj postaji
- podsustav za praćenje položaja vlaka, uključivanje signalno-sigurnosnih uređaja
- korisničko sučelje koje prikazuje stanje pojedinog podsustava.

Pojednostavnjeni model pokazan je na slici 3.

Slika 3. Pojednostavnjeni model upravljanja prometom kroz željezničku postaju

Slijede primjeri uloga i odgovornosti nekih objekata unutar modela, izvedeni korištenjem metode analize ponašanja objekata:

Objekt::Naziv: NadzornaKonzola

Odgovornosti: Prikazuje položaj vlaka, stanje signalno-sigurnosnih uređaja

Veze: Vlak. Signal dolaska vlaka.

Objekt::Naziv: InfoDolaskaVlaka

Odgovornosti: Detektira dolazak vlaka. Predaje poruku o dolasku vlaka upravljačkom sustavu.

Veze: Vlak. Ulazna izolacija.

Promatrani u okviru multimedijskog okruženja posebno su značajni objekti vezani uz zvučne i vidne efekte na postaji. Tako se, npr., objekti signalizacije opisuju na ovaj način:

the same position on the other side of the rail station. Inside the driving path we can define three different elements: path of the arrival drive, path of the departure drive and overpassing path.

For the protection of safety traffic flow through a railway station the signalling safety equipment is used. The signalling safety equipment offers a safe and logical rail traffic flow depending on the state on the track, the position of the switch and dependency of the planned driving paths and states of signals. Definitions of driving rules for transport of rail vehicles through a railway station are expressed in dependency tables and train schedules prescribing allowable and not allowable states. The dependency table is defined by driving paths through a railway station.

Construction, analysis and completion of dependency tables and train schedules represent one of the primary tasks in the field of rail traffic education. With this goal in mind the model of driving control is developed.

3. MULTIMEDIA APPLICATION OF TRAFFIC CONTROL THROUGH A RAILWAY STATION

In the development phase of the model building the methodology of object behavior analysis was used (Goldberg, 1990). In the implementation phase the object oriented programming methods were used (Pinson; Wiener, 1988). Based on the analysis of the structure and behavior of the transport process inside a railway station and on the basis of a derived dependency table, the following components of the model were identified:

- system for control of traffic in the railway station,
- subsystem for tracking train position, monitoring signalling and safety equipment, and
- user interface showing the state of each subsystem.

The simplified model is shown in Fig. 3.

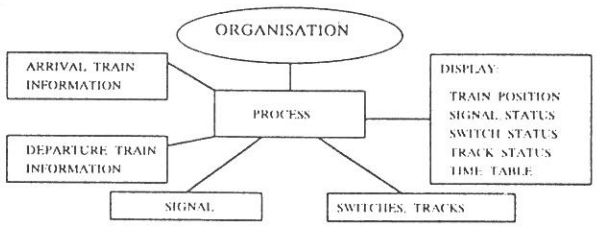


Figure 3. Simplified model of train control through the railway station

Each component of the model is defined with its role and responsibility in the model. In the process of building the educational module for representation of train control the components for which the behavior can be expressed with sound and picture is specially worthy. For that reason in the process of implementation of the model, a multimedia technology is used. The components of the model restrained to optical signalling are represented with competent video information, symbols, still and motion pictures. Not allowable states or situations of the traffic flow inside the model are represented with sound signals and effects, with the objective to emphasise the safety factors.

Objekt::Naziv: ZvučniSignal

Odgovornosti: Zvukom signalizira dolazak vlaka.

Veze: Vlak. Zvučna kartica.

4. IMPLEMENTACIJA MODELA UPRAVLJANJA PROMETOM NA POSTAJI AUTORSKIM SOFTVEROM

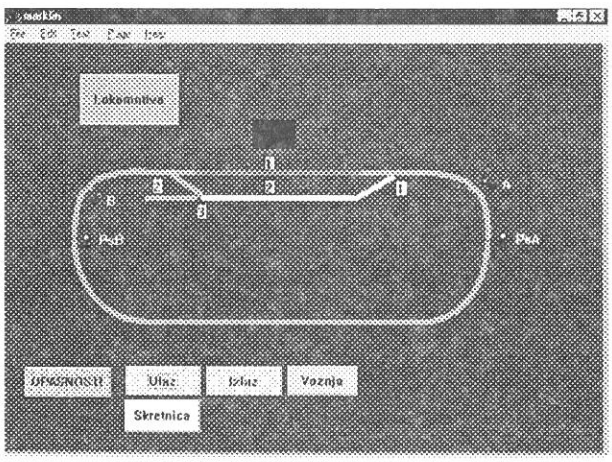
Budući da je postavljeni cilj razvoja multimedijskog upravljanja fizičkim modelom željeznice edukacija studenata, dodatni zahtjev na softver predstavlja mogućnost navigacije, korištenjem metaveza između multimedijskih elemenata, kao i mogućnost relativno jednostavnog i brzog razvoja aplikacije od strane nastavnika. Prikladne softverske produkte koji zadovoljavaju navedene zahtjeve, a uz to ne zahtijevaju dugotrajno učenje za korištenje, predstavlja autorska programska podrška.

Kod tradicionalno realiziranih aplikacija, inicijativa upravljanja komunikacijom između programa i korisnika je na strani programa. Program zahtijeva ulazne podatke i predaje rezultate bez mogućnosti intervencije korisnika na taj postupak. Također je i razvoj same aplikacije vezan uz složeni postupak editiranja, prevođenja i povezivanja programskih elemenata.

Aplikacije realizirane u okruženju usmjerenom objektu pružaju korisniku mogućnost da sam upravlja programom. Uz pojedini objekt vezan je pridruženi program - skript, čije aktiviranje ovisi o prijamu prikladne poruke, npr. signal pritiska na tipku "miša" ili signal prelaska lokomotive preko ulazne izolacije.

Razvoj aplikacije autorskim softverom kreće na autorskoj razini izgradnjom korisničkog sučelja. Uz pomoć pomagala za grafički prikaz objekata na ekranu se crtaju i raspoređuju potrebni objekti. Objektima uključenima u aplikaciju pridružuju se skripti koji izražavaju ponašanje objekata. Za razliku od tradicionalnoga linearnoga razvoja programa, razvoj aplikacije usmjerene objektu omogućuje trenutačne promjene na objektima i skriptima. Prelaskom na razinu korisnika/učenika moguće je istovremeno ispitati pravilnost izvođenja aplikacije.

Korištenjem pristupa programiranja usmjerenog objektu razvijen je model upravljanja signalno-sigurnosnim uređajem



Slika 4. Grafički prikaz fizičkog modela upravljanja prometom na željezničkoj postaji s dva kolosijeka
Figure 4. Graphical presentation of the physical model of train control on a railway station with two tracks

The examples of roles and responsibilities of some objects in the model developed using the object behavior analysis are shown:

Object::Name: ControlDisplay

Responsibilities: Display position of a train, status of signaling and safety equipment.

Associations/Collaborators: Train. InfoTrainArrival.

Object::Name: InfoTrainArrival.

Responsibilities: Detect train arrival. Send message of train arrival to the control system.

Associations/Collaborators: Train. Contact.

Regarding the multimedia environment, the significant objects related to sound and video effects are of particular interest. The objects of signaling are described as follows:

Object::Name: SoundSignal.

Responsibilities: Signalling the train arrival.

Associations/Collaborators: Train. Audio board.

4. IMPLEMENTATION OF THE TRAIN CONTROL MODEL IN THE STATION WITH AUTHORING SOFTWARE

Because the goal of the multimedia control of a physical model of railway is education, among other multimedia elements, computer learning software must incorporate navigation using hyperlinks and means with which the author can relatively easily and rapidly learn how to use the tool and develop educational modules. Authoring software is such a programming tool.

In traditional applications, the initiative of controlling communication between the program and the user is on the side of the program. The program requests input data and delivers results with no possibilities of intervention on the part of the user. Also, the development of the application is connected with the long lasting processes of editing, compiling, linking and executing.

Development of application in authoring environment offers to the user more control of the program. Each object is associated with a small program - script. The behavior of the object, expressed by the procedures of the script, depends on receiving an appropriate message, i.e. touch signal on the mouse button or signal of train passing the entry isolation.

Development of the application with authoring software starts on the author's level by building the graphical user interface. With the help of graphical tools objects are drawn and arranged on the display. To the objects included in the application, scripts that express the behavior of the object are associated. In contrast to the traditional linear way of programming, the development of object oriented applications permits, during the development of application, instantaneous changes on objects and scripts. Changing the author/user levels it is possible to check the execution of the application.

Using the object oriented approach of programming, the model of signalling-safety equipment on the simple railway station with two tracks is developed. The real model is presented by the picture on the screen of the computer monitor, Fig. 4.

Graphical presentation is divided into two levels: control and supervising level. Particular signs on the computer screen

na jednostavnoj željezničkoj postaji s dva kolosijeka. Aplikacija je grafički orijentirana, tako što je prikaz realnog modela slikom predstavljen na zaslonu monitora računala (sl. 4.). Grafički prikaz je podijeljen u dvije razine - upravljačku i kontrolnu. Pojedini znakovi prikaza simboliziraju komandne funkcije te zajedno s komandnim modulima računala upravljaju elementima modela. Tako je, na primjer, grafički prikaz tipkala upravljanja skretnicom implementiran tipkalom "miša", te je funkcija pravog tipkala zamijenjena prikazom na zaslonu monitora koji ima stvarnu funkciju upravljanja fizičkim modelom skretnice.

Model je implementiran (Gold i dr., 1993) korištenjem autorskog programa "Multimedia ToolBook" tvrtke Asymetrix (Pierce, 1990).

5. ZAKLJUČAK

Multimedijska tehnologija i programiranje usmjereno objektu u edukacijskom procesu omogućuju lakše odvajanje konstrukcije modela od načina njegove primjene. Tu odvojenost osigurava podjela prikaza na autorskoj i korisničkoj razini. Koristeći autorsku razinu, korisnici/studenti mogu samostalno, koristeći pravila tehnologije željezničkog prometa na postaji razvijati vlastite modele i provoditi simulacije. Važna značajka multimedijskih modula razvijenih ovim pristupom je mogućnost njihova korištenja u procesu izgradnje modela drugih sustava upravljanja u željezničkom prometu.

Objektu usmjerena metodologija modeliranja i programiranja te implementacija edukacijskih modula pomoću autorskih programskih pomagala doprinosi stručnijoj i kvalitetnijoj edukaciji, a time i povećanju sigurnosti odvijanja željezničkog prometa.

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symbolize command functions and together with the command modules of a computer govern the elements of the model. So the graphical presentation of the button for switch control is implemented by the mouse button. In this case the function of the real button is changed with the presentation on the computer screen that has the real function of controlling the physical model of the switch.

Described model is implemented using the authoring software "Multimedia ToolBook" by Asymetrix.

5. CONCLUSION

Use of the multimedia technology and object oriented programming in the educational process gives rise to introduction of authoring software creating the possibility of separation of the production of an application on the author level from using an application on the user level. The author level is used in the process of model construction and the user level is used in the execution of the model. With the aid of rules of the rail traffic technology students can on the author level develop models and execute simulations. Object oriented programming methods give to the user the control of the simulation inside the control system. The remarkable characteristic of the multimedia modules developed with this approach represent the possibility of use in the process of building models of other control systems in railway transport.

Design of software products for real time control based on dependency tables that evolve from rapid prototyping using multimedia technology can be applied more directly. As the example we can empasize the situation in which the video control of passengers entering a rail vehicle using closed TV system can be relatively simply replaced with a video presentation on the screen of the control computer (Kos et al., 1988).

Object oriented methodology of modeling and programming, and implementation of the educational module with authoring software contribute to a more expert and qualitative education, and with this, to the increase of safety in the field of the railway transport.

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