TEACHING GPSS IN E-LEARNING ENVIRONMENT

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Abstract

This paper describes specific implementation of GPSS (General Purpose Simulation System) for teaching discrete event simulation in e-learning environment. Primary goal of the research is to develop interactive and user-friendly web based environment for creating, testing and analyzing discrete event system models and integrate it in existing e-learning system. We introduce a new solution for learning simulation over web - FONWebGPSS. Architecture and key components of FONWebGPSS application are described in the paper, as well as integration with e-learning management system Moodle. In addition, we provide an example of applying FONWebGPSS in solving a typical problem of discrete event simulation.

Keywords: GPSS, FONWebGPSS, discrete event simulation, e-learning, web based learning.

Presenting Author's biography

Marijana Despotović was born in 1977, in Ruma, Serbia. She received her BS degree at the Faculty of Organizational Sciences, University of Belgrade in 2001, and MSc degree in 2003. She received her PhD degree with thesis "Design of methods for postgraduate e-education based on internet technologies" in 2006. Since fall 1995 till present she has been with the University of Belgrade, Faculty of Organizational Sciences, Department of Information Systems, currently as a professor of computer sciences. Since 2001 she has been teaching several courses at the Faculty of Organizational Sciences: E-business, Simulation and simulation languages, Internet technologies, Risk management in information systems. Her current professional and scientific interests include computer simulation, simulation languages, information systems, software project management, internet technologies, distance education. She can be reached at maja@myelab.net.

1 Introduction

Courses that teach discrete event simulation are usually realized by using a specific simulation language. Key issue is to find the appropriate language for simulation. It is necessary for a language to be enough flexible and dynamic, so that it can support analyzing and solving different types of problems. Simulation language should be able to adapt to the up-to-date directions in science of simulation and to enable efficient simulation execution on modern computers [9].

GPSS (General Purpose Simulation System) is language for learning discrete event system simulation. It is oriented to processes. GPSS defines model's structure based on language commands [1]. Program in GPSS is composed as collection of processes descriptions, which specifies sequences of activities and operations that will be executed on the attribute of object model. GPSS presents language interpreter for executing simulation of discrete, stochastic systems. The most known versions of GPSS language for personal computers are: GPSS/PC [5], GPSS/H [6], GPSS World [7].

GPSS/FON [2] was created in Laboratory for simulation, at Faculty of organizational sciences, University of Belgrade, during 90s. GPSS/FON presents the extended version of GPSS. Because of its simplicity and accessibility, quick and easy model debugging, GPSS/FON language has been successfully used for teaching course computer simulation at University of Belgrade [3].

1.1 Defining problems and research goals

GPSS/FON language has been studied within the scope of course Simulation and simulation languages. Course is organized for undergraduate students in the area of information systems and internet technologies. Course is realized by using learning management system – Moodle [10]. Moodle is web-oriented, open source platform for managing online courses. We use blended learning concept. Teaching materials are presented through online lessons, tutorials, multimedia presentations, examples, etc.

The course lasts for three months. It includes three different areas of simulation: continuous simulation, discrete event simulation, 3D simulation. All the topics are explored by using appropriate simulation language (CSMP, GPSS, X3D, respectively). The course content is organized through tutorials with many examples and problems. Focus is on solving real-life problems with simulation models. Specific cases and problems related to the areas of discrete event and continuous simulation are discussed in the scope of practical exercises. Students are obliged to implement their own models and solutions for different problems in simulation of complex, real systems. In the scope of the course, area of discrete event simulation is being studied for five weeks.

During the period of exploitation, we have noticed some of GPSS/FON's disadvantages. Today, key problem is how to perform GPSS/FON integration in e-learning system. Old version of environment for this language doesn't have ability to integrate in Moodle system. Due to the big number of students that will create their works and send request over web for execution of simulation, problems related to scalability and security are to appear.

Primary goal of the research is to develop interactive, integrated and user-friendly environment for creating, testing and analyzing of discrete event system model.

Specific aims are related to:

- Improving performance of the teaching activities
- Integration of all the activities in teaching process.
- Enabling students to study simulation by variety of real models and learn how to apply knowledge about simulation
- Simple way of learning simulation that is accessible to all students in every moment.
- Language syntax with strictly divided specification of the model database, model structure and control of the simulation process
- Interactive environment with resident editor, processor and result analyzer
- Fast and easy model debugging
- Enable different views and analysis of simulation results.

Defined goals are realized through developing web application for learning discrete event system simulation. Further, the application has been integrated in existing e-learning system.

2 FONWebGPSS application architecture

FONWebGPSS is built in our Laboratory for simulation. This application is the newest improvement of GPSS/FON. It enables students to configure simulation models, execute simulation and analyze results in a web page.

Structure and key components of FONWebGPSS application are presented in figure 1:

- user interface,
- application logic,
- simulator.

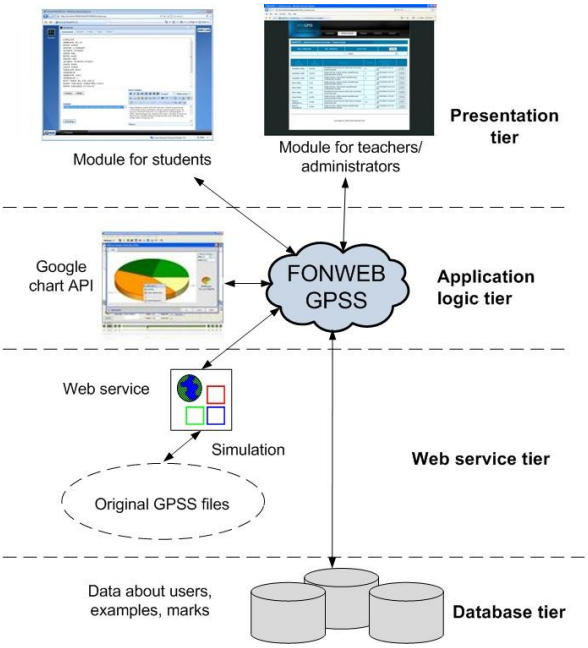

Figure 1. FONWebGPSS application structure

In the text that follows we provide detailed description of FONWebGPSS architecture and key components.

User interface

User interface includes a module for teachers and a module for students.

Module for teachers enables them to create, update, test and manage cases and problems in discrete event simulation; assess students' work and create different types of reports. Teachers can also perform basic system administration tasks such as managing user accounts, grades, etc.

Part of the module for teachers is shown in Figure 2. There is list of students, with their assignments and option for assessment. Teacher can perform simulation and check results by simple click on student's simulation model.

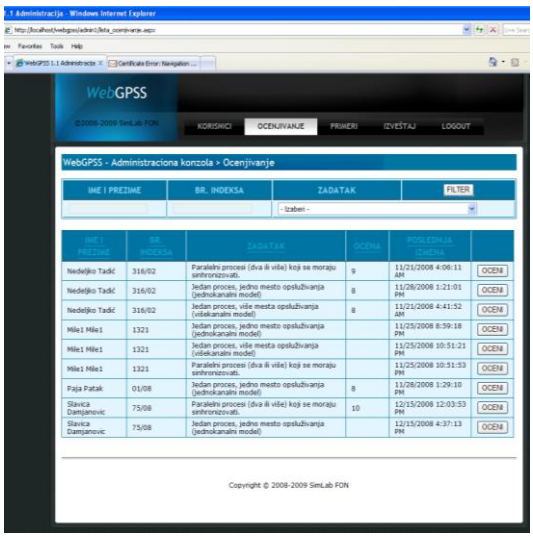

Figure 2. Module for teachers

Module for students enables them to create and test simulation models, perform simulation for created models, adjust graphical environment and analyze simulation results. Students can also submit solutions for discrete event simulation cases and view grades. Module for students is shown later in the text, in figures 5 and 6.

Presentation tier is realized by using technologies such as: HTML, XML, JavaScript and ExtJS JavaScript Framework. Dynamic user interface enables easy and quick exploring of application for both students and teachers.

Application logic and web service tier

Users' requests are created on web page and submitted to application logic tier.

Key part of the application is component marked as FONWebGPSS (Figure 1). This component accepts and handles requests, provides and implements all the applications' features:

- Receiving users' requests
- Communication with data base
- Managing application's features
- Invoking web service
- Receiving simulation results
- Sending data to the component that draws simulation statistics.

Web service tier receives data sent from application logic tier and calls the method that executes simulation. This method calls a legacy method from GPSS/FON application written in Pascal and Delphi. Results are sent back to application logic tier. Communication between components is realized using XML technology.

Results gained in the process of simulation are usually presented using charts and histograms. For creating charts in web interface we have used Google Chart API. Upon simulation results, tables are filled with data from data source. After that, application shows all required statistics.

Application logic tier is implemented using dynamic web technologies (ASP.NET, ADO.NET). Code behind pages is written in C#.

Simulator

FONWebGPSS simulator is derived from older version of GPSS/FON simulator [2]. Simulator is integrated in web service. Web service implements three-phase simulation, presented in figure 3

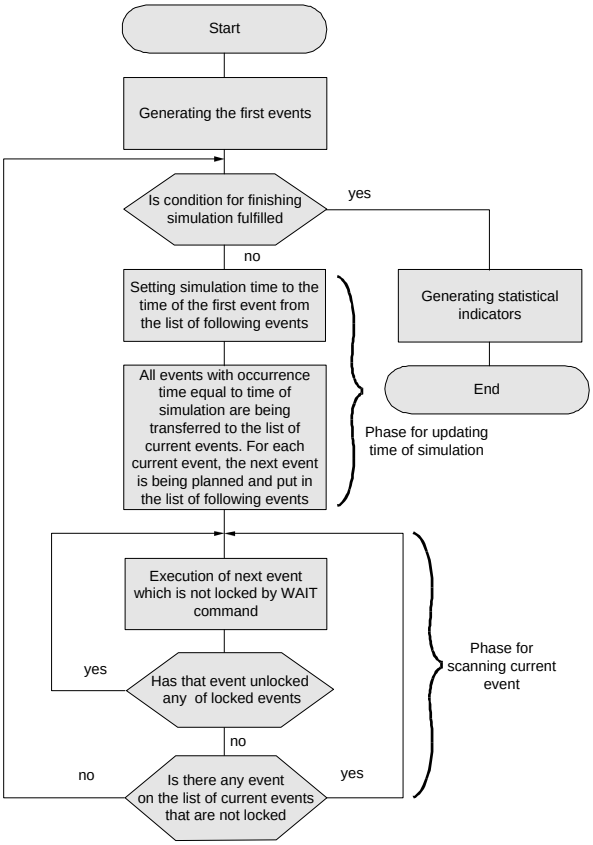

Figure 3. Algorithm that describes how simulator works

Key advantages of FONWebGPSS applications include [11]:

- New and efficient environment for learning discrete event simulation
- Effective integration with e-learning system
- Discrete event system simulation over web
- Clearly defined roles in system
- Simple and intelligible interface provided with variety of options for each type of user users' authorization
- Improving application scalability and interoperability by using web service technology

The web application uses all advantages of GPPS/FON language, but adds new features. Dynamic interface provides effective work and adapts learning to students' needs and requests.

The application FONWebGPSS is currently available at: http://maestro.myelab.net/webgpss

2.1 Integration with Moodle LMS

Next step in developing FONWebGPSS was its integration in the existing e-leaning system – Moodle LMS. Essential idea was to improve our e-learning courses in the area of computer simulation by providing students with possibility to learn simulation over web. This application is placed on the main page of Moodle course Simulation and simulation languages, as additional module (Figure 4.). It is available for all students that attend our courses. By clicking on the FONWebGPSS link, students and teachers are being redirected to the start page of FONWebGPSS

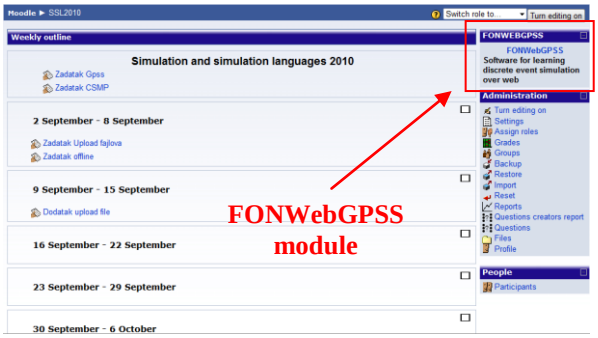

Figure 4. Home page of course Simulation and simulation languages 2010

Students learn discrete event simulation and do their assignments by using FONWebGPSS application. Teachers can create examples and assess students through FONWebGPSS

At the same time, roles in Moodle and roles in FONWebGPSS are synchronized. When one role (student, administrator, teacher) is assigned to someone in Moodle, they get the same role in FONWebGPSS, and vice versa. Thus, user management is being performed in Moodle LMS

Assignments that students do and upload via FONWebGPSS are stored in Moodle, too. Teachers can choose, whether they want to assess student's assignments in Moodle course or directly in FONWebGPSS

All data about students' results in the scope of the course are stored in the Moodle's database. At the same time, teachers can use Moodle to announce news in the same way they do for other areas within the course. Thus, FONWebGPSS supports blended learning concept. It enables realization and coordination of all activities in teaching.

Figure 5. shows integration between Moodle LMS and FONWebGPSS application. These two software applications are connected through MySQL database. The database stores data about users and tasks within the course in Moodle LMS, but at the same time, data about users' activities in FONWebGPSS are stored there. Applications share common data: data about users' activities, marks, assignments, etc.

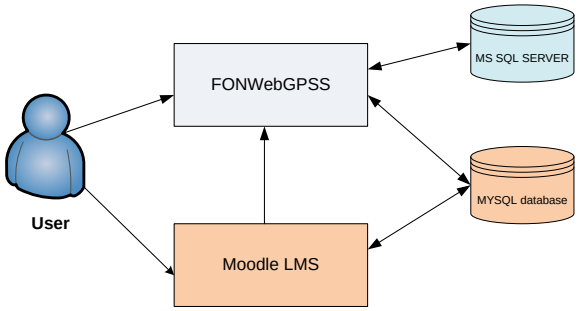

Figure 5. Integration between Moodle LMS and FONWebGPSS

In addition, we present a FONWebGPSS application in simulation of a typical discrete event system.

3 Applying FONWebGPSS in solving typical problem of discrete event simulation

GPSS has been successfully applied in analysis of complex systems with discrete changes of the system's state, such as airports, hospitals, factories, etc.

In the scope of our course Simulation and simulation languages students learn about three types of problems in discrete event simulation: one process and one serving place, one process and many serving places, many processes and many serving places.

When creating their works and solving simulation cases in FONWebGPSS application, students need to choose type of the case. After that, students are obliged to enter case description and GPSS commands.

In the paper, we discuss a typical problem in area of organizing and optimization of public transportation, particularly busses. In this example we observe passengers that wait for the bus, process of bus entering the station, passengers getting off and on the bus. Main goal of the example is to illustrate how FONWebGPSS could be used in teaching and solving discrete event simulation.

Figure 6 shows user interface of the FONWebGPSS web application. The window is separated in three areas: case (problem) description, case type choice and editor for writing GPSS code. After entering all the required data, by selecting option (button) *simulate*, simulation is being executed.

After simulation has been executed, user gets a notice whether the simulation succeeded or failed. If there are any syntax errors, student will get an error message.

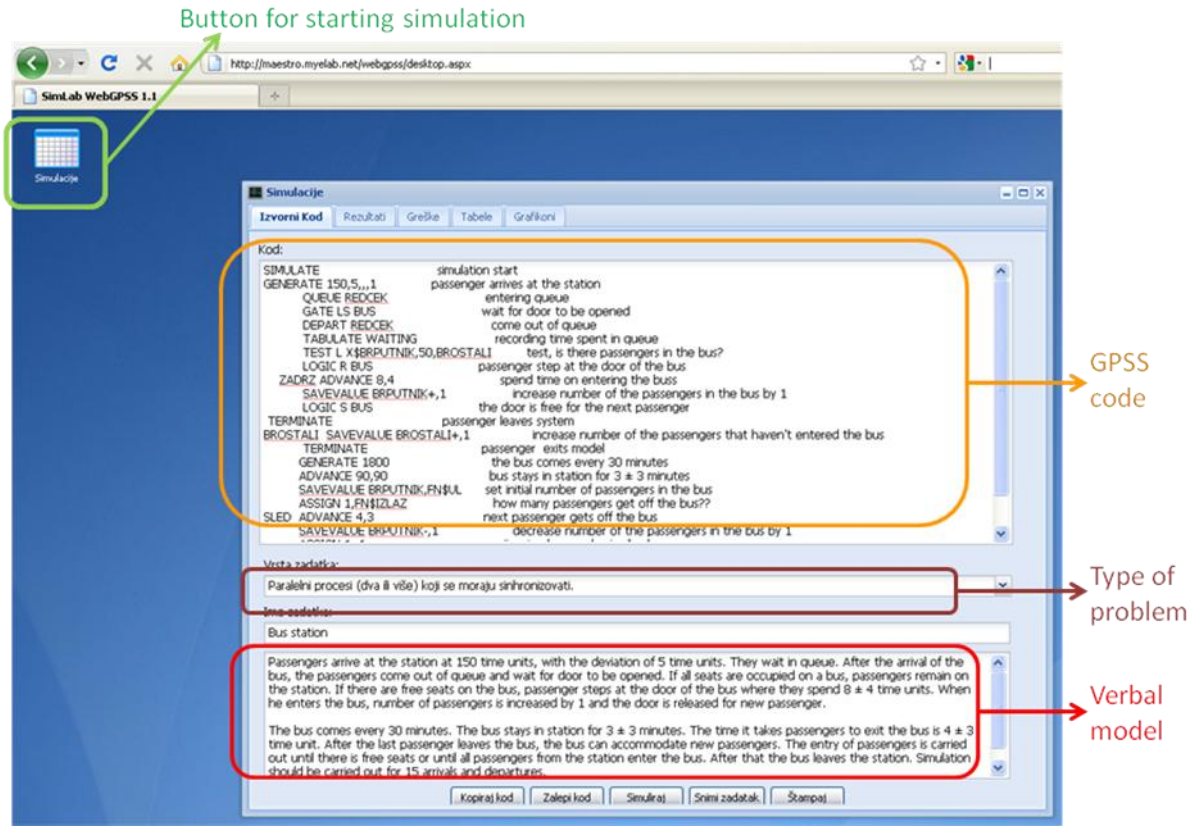

Figure 6. Window with case description and GPSS code editor

Figure 7 shows simulation results. It is possible to create a chart for each queue or table in the model.

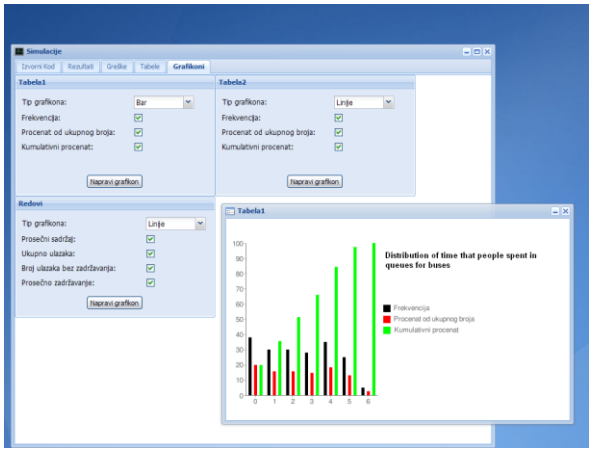

Figure 7. Simulation results[1]

In this example, total number of passengers that came to the bus station during the simulation period is 191. During the simulation, 15 buses entered the station. Overall number of passengers that got on the buses is 170. Because of the crowd in a bus, 21 passengers had to wait for the next bus. Total number of passengers that got off the bus on the observed station is 84. Average time a passenger spent waiting for the bus was approximately 15 minutes.

We can conclude that usage of buses is good, but the number of buses should be extended. At the same time, passengers wait too long for a bus.

4 Conclusion

Learning discrete event system simulation in traditional way and by using existing simulation languages is complex task. Researchers are focused toward finding new approaches and environments that can make learning simulation easier.

In this paper the following has been done:

- New and efficient web based environment for learning discrete event simulation has been developed
- Architecture of FONWebGPSS application was presented, as well as technologies used for developing the application
- Key features of FONWebGPSS application were described with emphasis on user interface
- Integration of FONWebGPSS application and existing e-learning system was explained
- An example of a typical discrete event system is solved using FONWebGPSS application integrated in Moodle

Future researches will be related to extending application of FONWebGPSS in teaching simulation at Faculty of organizational sciences. It would be very useful to analyze and evaluate new approach to teaching discrete event system simulation. At the same time, it is necessary to develop additional features and provide full integration of FONWebGPSS with the existing e-learning system.

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[1] Application is in Serbian language at the moment of writing this paper.