

JAVA-BASED SIMULATION FOR DEVS¹

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ABSTRACT

There are many excellent characters of Java-based simulation compared with existing ones in the respect of running on the Internet/Web, reuse , integration and etc.. In this paper, the main idea of design and realization of Java-based modeling and simulation software for DEVS will be discussed in detail.

KEYWORDS

Java, Modeling and Simulation, Internet/Web, Object-oriented, component

1 INTRODUCTION

Discrete event system(DEVS) has been widely used in FMS, CIMS, computer network, traffic and many other fields. And there have been many general simulation languages such as GPSS-PC, SIMSCRIPT, etc.. These existing simulation languages have great importance to the use and spread of DEVS simulation technology, but they have also exposed three main shortages: lack of portability, lack of interoperability and lack of capability to execute on the Internet/Web, which hinder the simulation technology from applying widely on some degree.

With the development of Internet/Web and Java, there will be lots of advantages of the new simulation software that is designed and coded in Java and that

can run on Browse/Server compared with the existing ones. In this paper, the main idea of design and realization of Java-based modeling and simulation software for DEVS will be discussed in detail.

2 JAVA-BASED DEVS SIMULATION

2.1 Character of Java-based DEVS Simulation

Java is an object-oriented, architecture-neutral programming language that emphasizes the central ideas of simplicity, portability, flexibility, dynamism and security. A Java program has the ability of "write once and run everywhere". Java Applet or ActiveX can be embedded in a HTML document to provide interactive, executable content on the Web.

With the help of Java, the software of DEVS is analyzed and designed by the technology of object-oriented and component, which has broken the traditional conception of simulation method. According to the objects and their relationship of the aimed actual system, the simulation model is constructed and it's objects denote the corresponding entities of the aimed actual system, by which it would narrow the gap between the actual system and the model. So the simulation model is much more direct, more understandable and has the distinguishing capabilities of reuse and integration, which would provides a more convenient way to construct and

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research larger, complex system.

Simultaneously, the user does not need the whole software package any longer, but only downloads the modeling tool and the analysis tool (designed as Applet or ActiveX control). Moreover, when the simulation software needs upgrading, what must be done is to maintain the uniform user interface. And it would increase the running speed of the simulation by distributing the simulation tool on different servers and/or by the multithreading technology of Java.

2.2 Framework of Java-based Simulation Software for DEVS

The designed simulation software is composed of three main components, which are modeling tool, simulation tool and analysis tool, shown as figure 1.

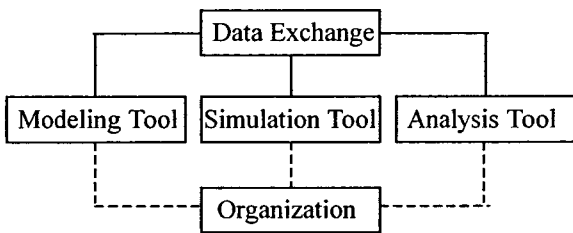


Figure1 Framework of DEVS Simulation software

The modeling tool and the analysis tool are downloaded to run on the side of browser, while the simulation tool runs on the side of server. These three

main components communicate each other by the protocol of HTTP and the exchange data are the format of ASCII. All of components' functions and their operation logic of this software are completed by means of hypertext linking or function keys that can activate some specific method.

3 DESIGN AND REALIZATION OF SIMULATION SOFTWARE FOR DEVS

3.1 Design and Realization of Modeling Tool

The designed simulation software for DEVS is aimed at the system of the multiple servers on the multiple levels with the multiple queues, which is under the condition of optional simulation time-limit and optional simulation test times, such as the machining and assembling system, social serving system and so on.

In the object-oriented analysis of simulation model, the aimed question space is the specific DEVS that has been described just now. So the basic entities of this DEVS are the server, the queue and the customer that will be served by some server or wait for being served in some queue at some time. These entities are all not only independent but also related. The composed objects and their properties of the DEVS simulation model are shown as figure 2.

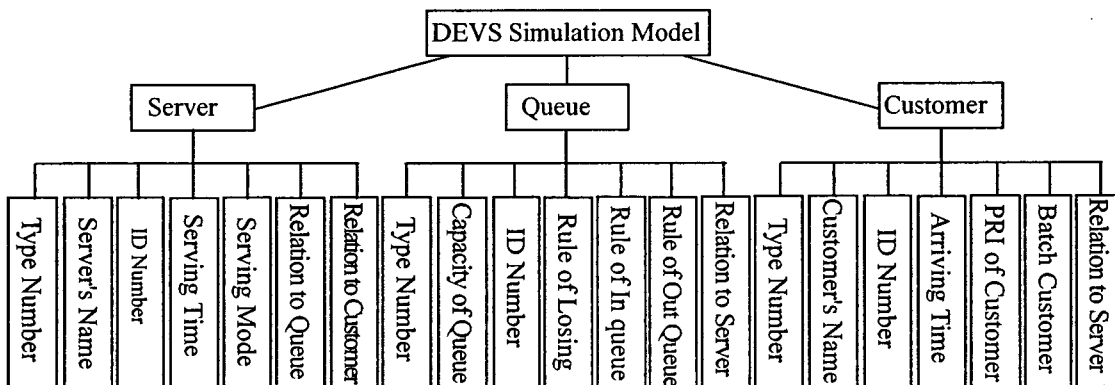


Figure2 Object and its Properties of DEVS Simulation Model

From figure 2, it can be concluded that each object has two kinds of properties. One is the character property, which reflects the nature and status of the object itself. Another is the relative property, which reflects the topological relationship among objects. In this software, two kinds of system modeling modes are designed for user interface, which are wizard modeling and graph modeling. By defining every object's properties, a simulation model of the aimed DEVS is constructed and described. Modeling tool is designed as an ActiveX control that runs on the side of client and is realized by the ASP technology.

3.2 Design and Realization of Simulation Tool

According to the essential factors of DEVS simulation and the simulation strategy of event dispatching, the classes and objects of the simulation tool are analyzed and designed by the technology of object-oriented with the analysis result of modeling tool considered.

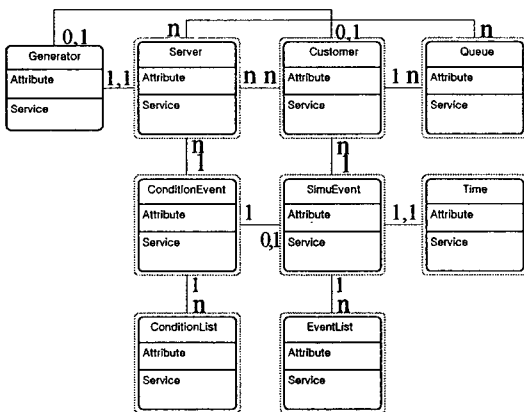


Figure3 Class/Object of DEVS Simulation Tool

The question domain of the simulation tool for DEVS is composed of such entities as the server, the queue, the customer, the event, the event list, the simulation clock, the random number generation, the conditional event and the conditional event list. Correspondingly in it's solving domain, every entity is represented by a

class of the abstract objects that encapsulates relevant properties and methods. Class/object of DEVS simulation tool is shown as figure 3. The lines in this figure stand for the relationship between two classes. For example, the line between the class of Server and the class of Customer means that one server could serve multiple customers and one customer could also accept multiple servers' serving.

Having limited space, only class of Queue and it's parts of properties are defined as such:

```
import java.util.Vector;
public class Queue extends Vector
{
    /*properties*/
    int m_type; // Type number of queue
    int m_ID; // ID number of queue
    int m_QC; // Capacity of queue
    int[] m_OutofSer; // array of the server's ID number
    int m_IORule; // Rule of in and out of the queue
    boolean m_Lose; // Rule of losing of queue
    .....
    /*methods*/
    public Queue(int ID, int type, int capacity, int iorule,
boolean lose, int[] out){.....} // method of constructor
    public void InQue(Customer c){.....} // method of in
the queue
    public Customer OutOfQueue(){.....} // method of
out of the queue
    .....
}
```

The main program for simulation is a loop structure of do-while, where a branch instruction of switch-case is embedded. The loop structure mainly determines whether the simulation test times is arriving at the demand of the user. The branch instruction deals with different kinds of events by calling the relevant event functions until the ending event happens.

4 SIMULATION EXAMPLE

In order to test the designed system modeling and simulation software, a machining and assembling system is experimented. The tested system has three machines on two levels and each machine has one queue for parts waiting. On the first level, there are two different machines(i.e. Server) that are used to process two different kinds of parts(i.e. Customer). On the second level, one assembling machine(i.e. Server) is used to assemble two kinds of parts that are delivered from the first level. The modeling mode of wizard is adopted and the test results are in the statistical table, shown as figure 4.

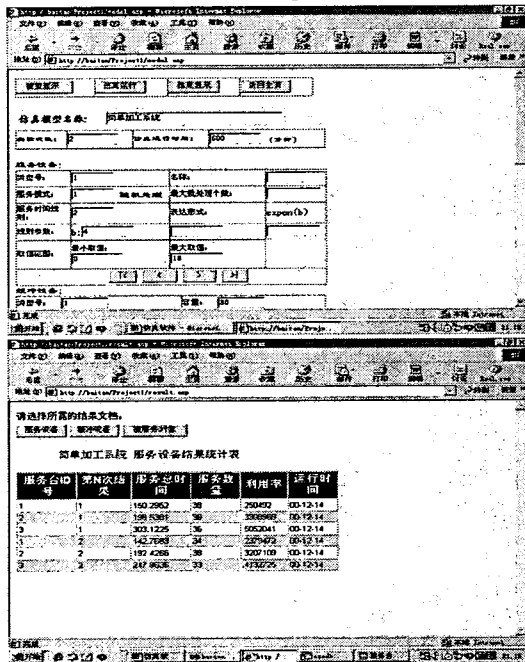


Figure4 User Interface

From the result of simulation, it could be concluded that the arriving ratio of customers directly hold up the productivity of the machines on the first level and the processing machines' efficiency will affect the assembling number of the assembling machine on the second level.

5 CONCLUSION

This paper has introduced the main idea of design and realization way of Java-based modeling and simulation software for DEVS. This software can run on the Internet/Web and the object-oriented idea of system modeling and simulation is very simple, direct and understandable. So it can provide the user a convenient, rapid evaluation tool for system performance.

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