ONLINE SIMULATION WITH SIMUL_R

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ABSTRACT

This paper presents the main application fields and needs of online simulation. Interfaces to the simulation user and to machines must be available in a simulation language, which supports online simulation. The simulation language SIMUL_R is presented, which offers two interfaces for these purposes. Three examples - industrial applications - show, how these interfaces are used, with the help of Transputers and MS-Windows.

INTRODUCTION

Online simulation is one of the most important subjects in today's simulation work. It includes all areas, where simulation interacts with its environment, like the human being, or machines.

Interactive working with the model and during a simulation run (like production planning in a factory) on one hand and functionality testing systems (as in hardware in the loop simulation) on the other show the main problem in online simulation: finding useful interfaces between simulation and its environments (see Fig. 1).

Interfaces

The man-simulation interface must be userfriendly.

Today's computation standards show, that this can be reached only by graphical and menu driven desktops for simulation. Therefore graphical interfaces must be available for the building of models as well as the input of parameters, examinations (like starting of simulation runs), interactive input during simulation, presentation of results.

The simulation-machine interface needs special arrangements for controling, measurement, visualization of machine data. In most cases this demands for the capability of realtime simulation in the simulation system.

SIMUL_R

The simulation language SIMUL_R (Ruzicka 1988, 1989), which has been developed by SIMUTECH, offers all necessary features, needed with online simulation.

SIMUL_R - a short overview

SIMUL_R is a compiling simulation language for continuous and discrete systems based on C. The system offers graphical and textual modelling, using one or more models in one simulation program. Examinations are done by using menus and/or a strong runtime interpreter.

The interpreter allows the usage of loops, command files (recursive, too) and arbitrary expressions with assignments and displaying. A special feature are userdefined functions, which enable the user to add new commands to the system (commands for steady state, zero search, continuous and discrete optimization, statistical evaluations are available as well).

A huge graphical library supports among others moving plots, 3D-plots, niveau lines, cross plots (for displaying solutions of PDEs), animation for both, continuous and discrete systems (SIMUTECH 1990).

Online capabilities of SIMUL_R

SIMUL_R offers a graphical, menu driven user interface under MS-Windows and X-Windows.

It is an open system, what is one of the most important features for matching the needs of its environments: adding of new commands, software interfaces.

The Transputer version SIMUL_TR allows realtime simulation, too.

SIMUL_R'S SOFTWARE INTERFACES

SIMUL_R contains two software interfaces, which support online simulation: the user-communications and the menu interface.

The user-communications interface

consists of a freely defineable C-function, which is called at each communications point (time step) of a simulation run.

As shown in Fig. 2, simulation in general consists of an initialization part, a loop with computations, and a termination part. SIMUL_R breaks this loop up by calling the user_comm()-function.

This interface is used for example to allow user interaction during simulation runs: a sample user_comm()-function checkes for keypresses or mouse cursor clicks onto objects of an animation screen (see Example 2) and then changes values or screen information according to the user's commands.

In another application this interface is used to read and write controller I/O-data values (see Example 1).

The menu interface

consists of a freely defineable C-function, which is called at the beginning of each command line input.

Fig. 3 shows the program scheme of a typical runtime interpreter:
it in general consists of an initialization part, a loop with user-input and the command interpretation, and a termination part. SIMUL_R additionally calls the menu()-function, which filters the user's input and builds up commands for the interpreter according to the input.

A typical menu()-function is implemented in the SIMMENU block graphics desktop for SIMUL_R. This environment allows the specification of simple menues (choseable by a keypress) and windows for input and output. Here it is not necessary for the application user to know specific simulation commands. He (maybe an industry-worker or a pupil/student) works in an environment restricted to his needs, once built up by a menu-writer.

This interface has been used as well during the development of the MS-Windows or X-Windows versions of SIMUL_R, which are full graphic, menu driven, multiwindowing environments for simulation.

EXAMPLES

The following three examples show industrial applications, which use SIMUL_R's interfaces.

Example 1:

The first example describes a functionality testing system, currently used in car industry in Europe. Fig. 4 gives an overview of the system, which basically consists of a simulation model in SIMUL_TR, used to test an electronical controlling system (the test object).

User input can be done by keyboard or mouse connected to a PC, which is also used as curve and data display and for data storing. Simulation itself is performed on a Transputer (with 4 milli seconds time steps). It simulates the car and its behaviour and sends data (using the user-communications interface) to the test object or the function generator SIMIO (the lower gray square), which produces fast signals (16 digital I/Os, 16 analogous 12 bit-I/Os) with a 15 micro seconds cicle.

The system contains a special fast data logging system (SIMLOG) and a fast animation system (the upper gray square), which also allows user-interaction by mouse, too.

Example 2:

This is an example (Schriber 1974), which shows a typical problem in industry: job schedule.

Fig. 5 (the animation screen) shows a casting factory with 6 types of machines, queues in front of them, 3 kinds of jobs (0 to 2), and some displays.

SIMUL_R allows the usage of several animation screens. The user-communications interface is used to support input per mouse: if a machine is clicked, another screen is displayed, which shows the utilization of the machine's group and some other informations;
by clicking the queue in front of a machine, the machine can be stopped and restarted. Clicking other objects allows the input of values by keyboard.

Example 3:

This example uses the same model as Example 2, but under MS-Windows (using the menu-interface). SIMUL_R is used as tool, which assists the spreadsheet program MS-Excel.

Fig. 6 shows the Windows screen. The user (e.g. the foreman in a factory, who uses simulation as a helping tool for his scheduling problems) works in the spreadsheet.

He changes values (in this case the capacities of the machines) and simulation delivers the numbers of produced entities during the next shift (written automatically to the right fields of the spreadsheet). The costs and returns and a graphic window are updated, too.

The connection between SIMUL_R and MS-Excel is built up by using DDE (Dynamic Data Exchange) and the corresponding features of the two programs. Other programs like scheduling tools (Niwinski 1990), replacing MS-Excel, can be used in other applications.

CONCLUSIONS

Online simulation is one of the most important subjects in the field of simulation, especially for industrial applications. SIMUL_R offers a lot of features to support online simulation. Example 3 shows a useful way to use a simulation tool in an AI environment, using standard desktops like MS-Windows on a PC.

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