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Intelligent Virtual Systems in Learning

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Abstract - **Computer Assisted Learning (CAL) in it's wide range of methods, successfully merges with many new fields of research. One is the field of Artificial Intelligence which strongly supports development of Intelligent Computer Assisted Learning (ICAL). We have developed our approach to intelligent tutoring implemented as ICAL. Approach can be described as intelligent computerized speaking tutor that supports learning based on experiments with virtual dynamic systems. Approach is suitable for learning the behavior of any dynamic system, especially in the field of complex, live, bio-medical systems. We are now implementing this approach in the field of bio-medicine. Two important systems are our virtual system GLUCOMAT - homeostatic glucose regulation in human, and ECOLOG - population growth in natural eco-system.**

Key words - **Virtual systems, Virtual experiment, Artificial speech, AI, ICAL**

I. INTRODUCTION

Among various methods and approaches that are present in computerized learning, especially in today's Internet based distance learning, virtual experiment is of fundamental role. The possibility to learn by self paced experimenting with virtual, simulated systems, opens new horizons.

Virtual experiment is primarily of interest when we have to support learning in the field of dynamic systems with higher degree of complexity. This is the case with almost all dynamic systems in biology, but also with many other systems that should be understood along the process of education.

Virtual experiment is simply experiment with the mathematical model of the system, not with the real system itself. In that way we eliminate the real laboratory, but have to develop precise mathematical model and appropriate software platform for experimenting with that model.

Many virtual objects (mathematical models of dynamic systems) make virtual laboratory for learning. When this is placed on the Internet, the widespread use makes it even more useful.

One of the main arguments for virtual experiment approach is that the learning process is organized as guided discovery at individual pace. On the contrary, high development cost, and very sophisticated multidisciplinary knowledge needed in the development team, are some of the drawbacks of virtual experiment as a method.

II. SYSTEM DESIGN

The main components of typical ICAL system are *problem solving expertise* (the knowledge that the system tries to transfer to the learner), the *student model* (model which in a formal way track what the learner does and does not know), and *tutoring strategy* (module which decides how the system presents material to the learner).

In our case, main aim is to present (teach) the behavior of a complex dynamic system. For that purpose, we put the virtual object (mathematical model of the dynamic system) in the center of the system. This is the *knowledge in the form of virtual object* that is expressed in the form of mathematical model.

Due to the dynamic nature of the object, we have to include dynamic tracking modules in our system. These modules should *monitor the virtual object and the learner*.

Implementation of our tutoring strategy is based on guided discovery where the learner is "softly" guided, but, at the same time, has the full freedom for virtual experiment at his own pace. Generated speech communication with the learner is the central method of tutoring guidance.

In Fig.1. we present the structure of our Intelligent Virtual Tutoring System with all the modules it contains and all the necessary connections between the modules.

In order to specify the function of the whole system more precisely, we describe each module via corresponding function and implementation.

III. DESCRIPTION OF MODULE FUNCTIONS AND IMPLEMENTATION

Module for self-monitoring of the virtual system:

Function: Monitoring of the behavior of the virtual system in terms of internal state (variables and parameters), input and output.

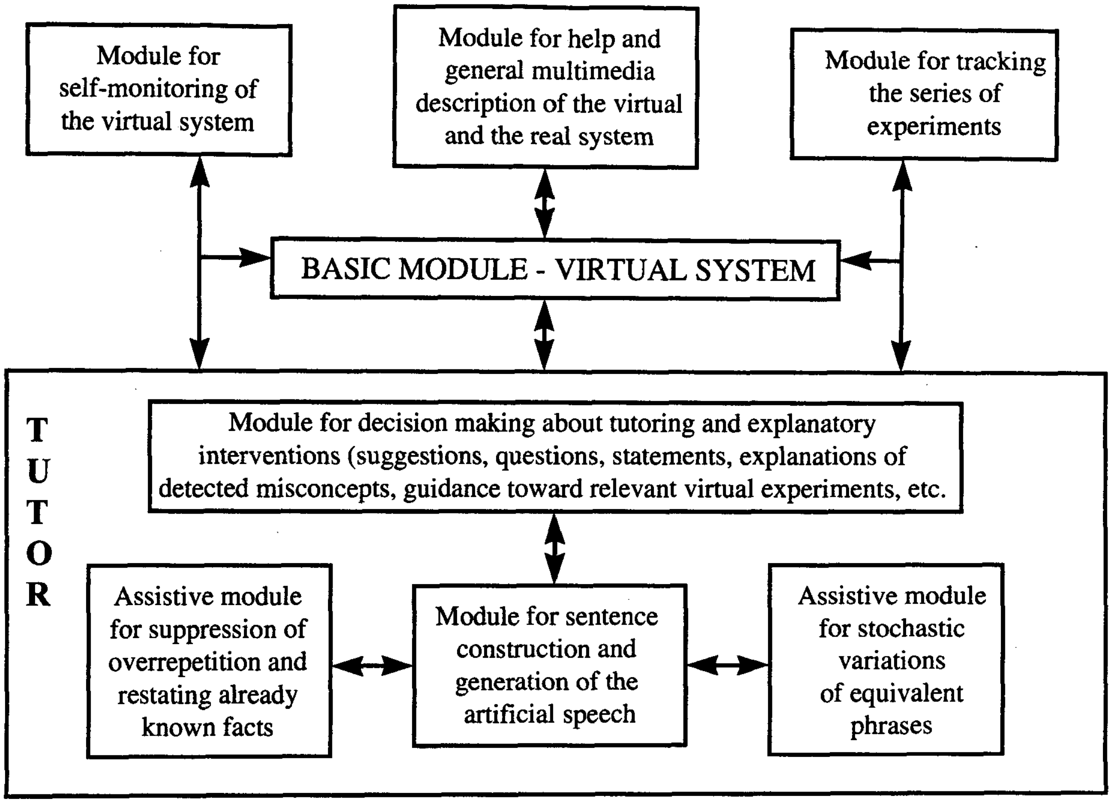

Figure 1. Structure of the system

Implementation: Row monitoring in the form of state array in discrete time. Important more complex states detection is based on the row monitoring in the form suitable for sentence construction.

Module for help and general multimedia description of the virtual and the real system:

Function: Description of the real system, virtual system, system dynamics, etc. Multimedia supports better explanation.

Implementation: Intro video or text sequences, HELP video or audio associated with screens. Animated system presentation.

Module for tracking the series of experiments:

Function: Tracking of the series of experiments via memorizing the successive experiment definitions made by the learner.

Implementation: Vector of input data in successive experiments.

Basic module - virtual system:

Function: Main module for obtaining the virtual system.

Implementation: Formalism of various kind (most likely mathematical model).

Module for decision making about tutoring and explanatory interventions (suggestions, questions, statements, explanations of detected misconcepts, guidance toward relevant virtual experiments, etc):

Function: Decision making on when and what to say using artificial speech.

Implementation: Production rules and interface with all other modules.

Module for sentence construction and generation of the artificial speech:

Function: To form appropriate guidance sentence (message, suggestion, explanation,...) and to say it.

Implementation: 1. Of the shelf digitized sentence retrieval. 2. Rule based construction of sentences from "subsentence" elements that sufficiently cover relevant language subdomain.

Assistive module for suppression of overrepetition and restating already known facts:

Function: Suppression of the most frequent unnecessary language attributes.

Implementation: Comparison with the already spoken sentences.

Assistive module for stochastic variations of equivalent phrases:

Function: Achievement of better language elegance based on introduction of different phrases with the same meaning.

Implementation: Random generation of equivalent phrases

The structure, function and implementation of the Intelligent Virtual System is specially designed for dynamic systems and for artificial speach guided discovery based on free virtual experiment. We are now in the final stage of several implementations. Briefly, we mention the two.

First is based on our model GLUCOMAT which is the mathematical model for human glucose homeostatic regulation system. Model is described elsewhere (Spasic, 1989a, Spasic, 1989b) together with the testing results that support model validity.

Virtual experiment covers four hours of system time. At the beginning (zero time), the system is in the steady state as if during previous eight hours there has not been any food intake or other external disturbances. The step is one minute that is sufficient for system dynamics and inherent time delays.

Learner can define all the parameters and all the system input. Results of the virtual experiment are represented as four simultaneous time graphs for concentrations of glucose, insulin, glucagon and adrenalin over four hours.

Although the virtual experiment executes smoothly and user friendly, the model itself is somewhat complicated and was difficult to develop. We published the book, dedicated to mathematical problems connected with the model, and with the detailed description of the system and the model.

GLUCOMAT is in a widespread use, but the new intelligent platform which generates artificial speech communication, will enhance it significantly.

Second system is based on our model ECOLOG which is a model for population growth in natural eco-system with internal and external influences. Details are published elsewhere (Spasic, 1989a, Spasic, 1989b).

Virtual system has the structure of deterministic-stochastic model and exhibits the realistic behavior. Speech guided discovery of the system is especially useful for explaining and understanding of the complex interactions within the eco-system.

IV. Conclusion

We have developed Intelligent Virtual System for the main purpose of presenting (teaching) the behavior of a complex dynamic systems.

Using advanced methods of AI and artificial computerized speech we are succesfully implementing our approach for several virtual dynamic objects in the field of bio-medicine.

V. References

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