Effective Interaction With The Computer: Observations And Models From An Eight-Year Experience

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Contents

1. Summary

Asynchronous and web-based learning networks heavily rely on human interaction with computers. This includes use of computer modules for concept development, tutorials, and simulation. The present paper introduces examples of computer modules designed and created for maximum learning effectiveness. The smallest unit of interaction is defined as a mini-run. A mini-run results in an action bite. Cost and utility functions are suggested for action bites based on total computer response time, burden on the sensory-motor system of the user, and effectiveness of the action bite in learning. It is suggested that for maximum interaction and minimum effort the modules i) be specialized for the desired capability as opposed to carrying extensive flexibility, ii) have interaction speed close to the real-time operation of the physical system, and iii) use open-loop movement of finger and hand as opposed to closed sensory-motor loops. Three examples of exploratory electric circuit computer modules, in which basic elements of interaction loops are structured for maximum learning effectiveness, are presented.

2. Introduction

In asynchronous learning and web-based environments computer modules play an important role in helping students to develop concepts, practice, simulate and design. Efficient interaction with the computer plays a critical role in learning effectiveness. In this paper we discuss a user's interaction with the computer in a simulation environment. The conclusions apply to other cases such as presentations, tutorials, design projects and laboratory supplements.

Digital simulators are familiar tools in the undergraduate teaching and learning environments. In both inanimate and live forms, simulators are used as tools for design, concept development, demonstrations, and as supplements to laboratory experiments. In a laboratory environment their speed of operation and input-output capability place them on a par with analog simulators and their programming flexibility gives them an advantage.

A previous paper[1] discussed some basic aspects of the dynamics of interaction between the student and the computer with emphasis on the sensory-motor, decision, and computational processes involved. The man-machine interaction is modeled by the diagram of Figure 1. The user changes parameters of simulation by hand, fingers, voice, etc. and picks up the output through auditory, visual, or other sensory channels. The human side of the loop involves noticing computer display, processing and decision, and sensory-motor coordination for providing input to the computer. The time needed by the computer to process the model and display the results introduces delay in the loop. Two important factors which influence the effectiveness of interaction with the computer are: i) sequences of motor acts by the user and ii) presentation of the response by the computer[1]. For further insight into man-computer interaction, see References 4 and 5.

Briefly, to minimize the burden on the user, motor acts should be open-loop as much as possible, computer response time should be as close to real-time operation of the physical system as possible, and the display of the results should be as simultaneous and parallel as possible.

3. Examples

During the past eight years we have developed, used, and evaluated computer-based modules and software packages for the undergraduate electrical engineering curriculum. The work has been carried out in close collaboration with several institutions, among which are the members of a consortium of four institutions (Cal Poly State University, Rose-Hulman Institute, Worcester Polytechnic Institute and University of Alabama at Birmingham) and Synthesis, a coalition of eight universities (Cal Poly State University, Cornell University, Hampton University, Iowa State University, Southern University, Stanford University, Tuskegee University and University of California at Berkeley), and Vanderbilt University [2, 3].

Cal Poly modules are designed and developed with the aim of satisfying the optimality criteria listed above. They cover the three categories of circuits, signals, and dynamical systems. The circuit modules cover the concepts of amplifiers, resistive circuits, RC-RL-RLC circuits, and electric power.

Figure 2 displays an example of the RC module. The module gives the user the choice of five circuits and nine signals and the ability to rapidly modify element values and initial states. Voltages and currents are displayed on the monitor. Figures 3 and 4 display examples taken from RL and RLC modules. Further details and examples may be found on the author's webpage.

4. Conclusion

Students approach learning in many different ways. For each approach there is a tool more suitable than others. The class of modules discussed in this paper can be used as tools for exploration, tutorials, structured lectures, presentations, testing, and design. They reinforce both analytical and laboratory approaches to the teaching and learning of the fundamentals of engineering. In addition, these modules react with a response time which can approximate the real-time operation of engineering systems. Because of this property and the flexibility of parameter manipulation, the modules provide the student with a broad spectrum of observations and examinations not easily available in the laboratory or by analytical approaches.

5. References

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Figure Legends

Fig. 1 Basic Elements of Man-Machine Interaction.
Fig. 2 Examples of RC-Module Outputs.
Fig. 3 Examples of RL-Module Outputs.
Fig. 4 Examples of RLC-Module Outputs.

Acknowledgments

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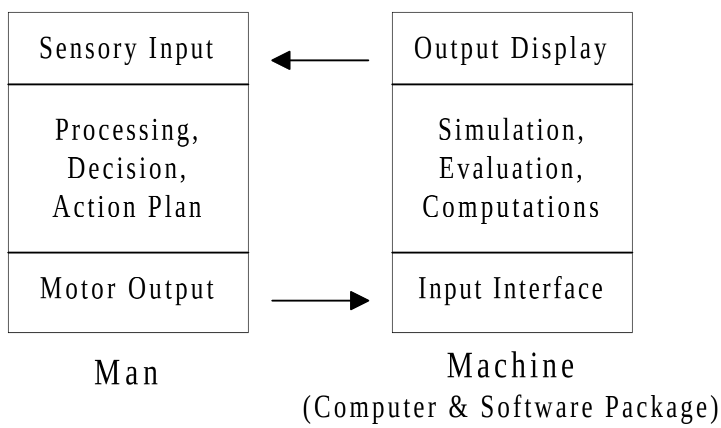
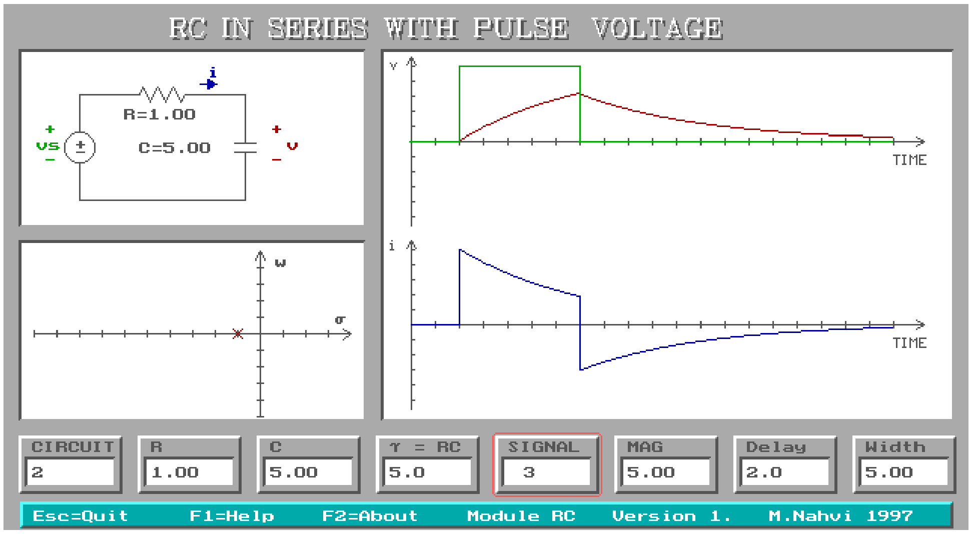

Sensory Input
Processing,
Decision,
Action Plan
Motor Output
Output Display
Simulation,
Evaluation,
Computations
Input Interface
Man
Machine
(Computer & Software Package)

Figure 1



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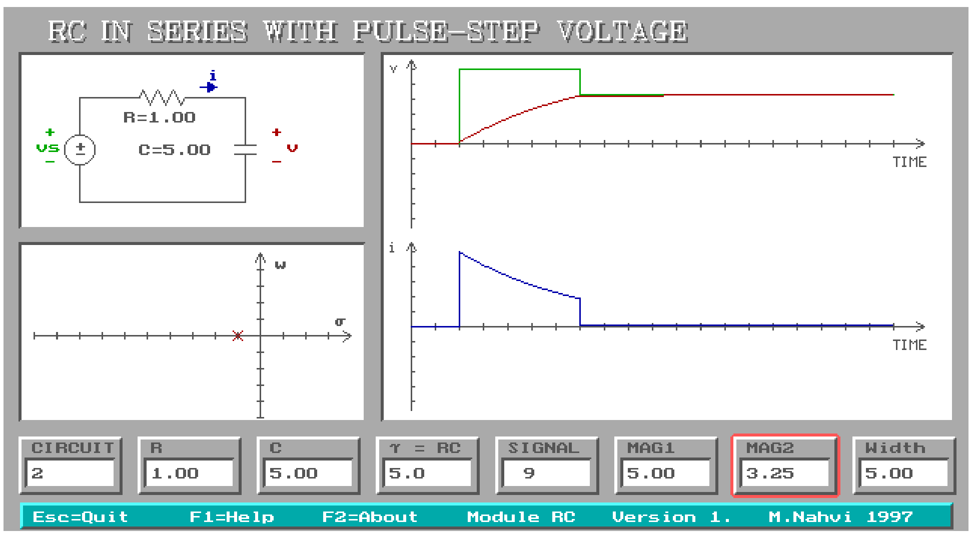

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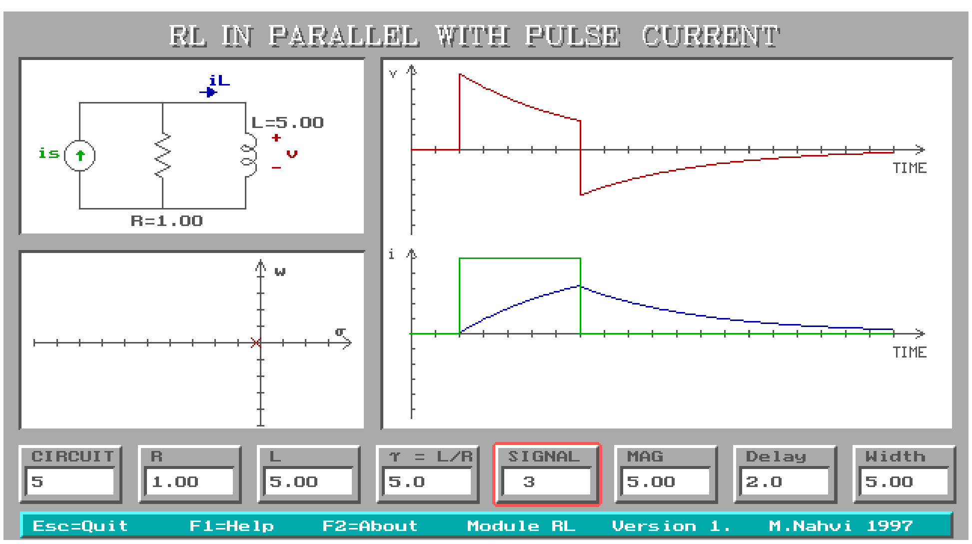

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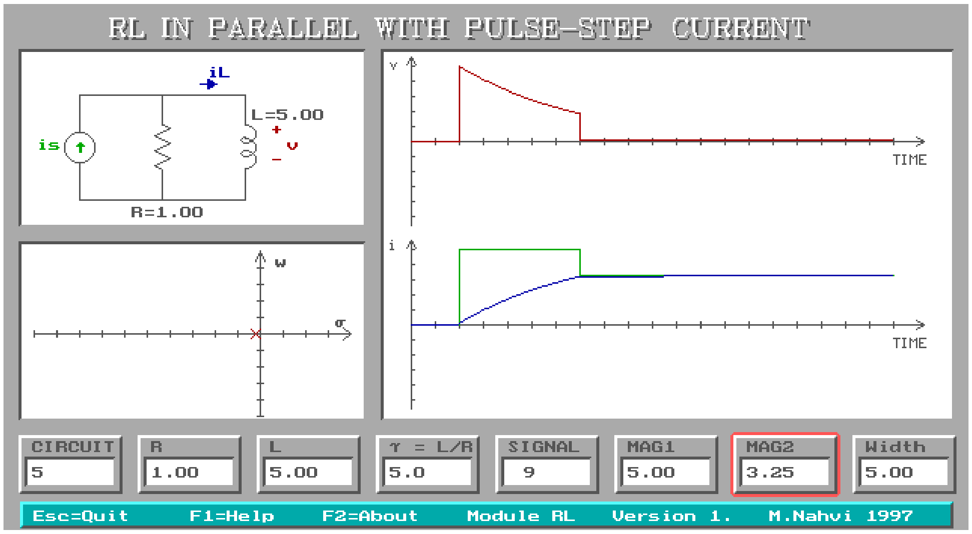

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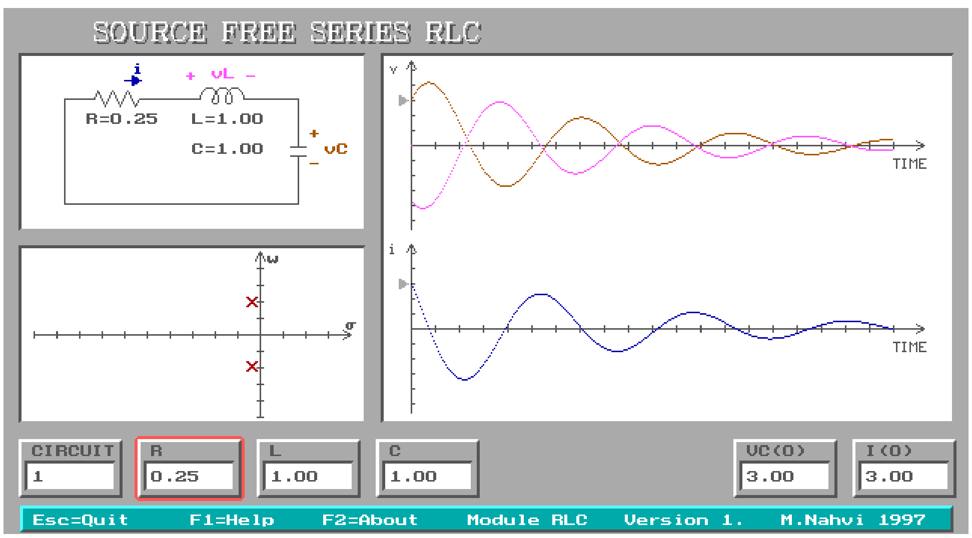

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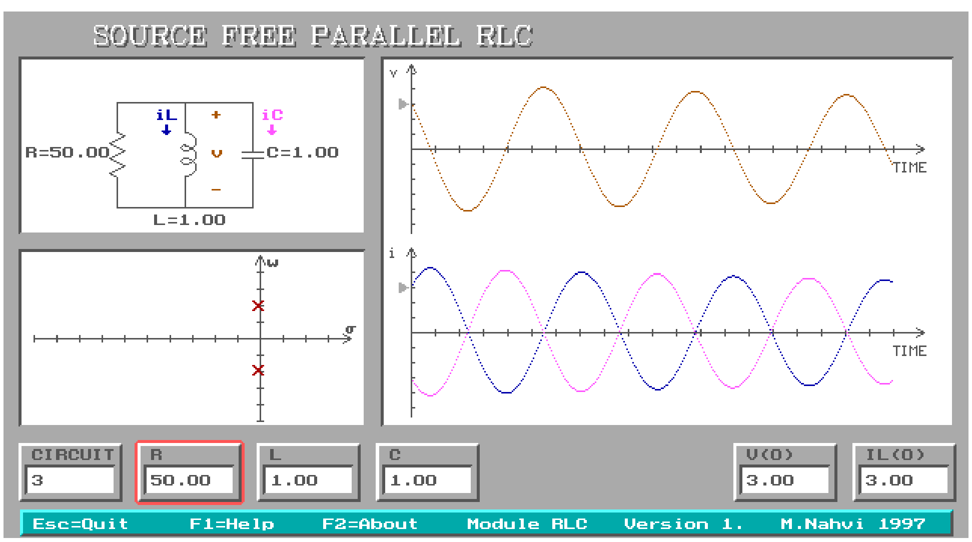

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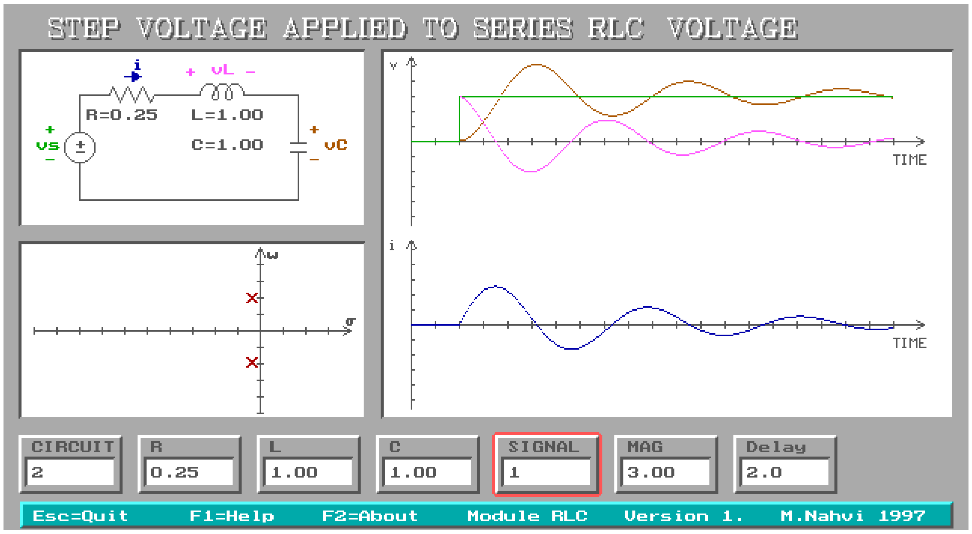

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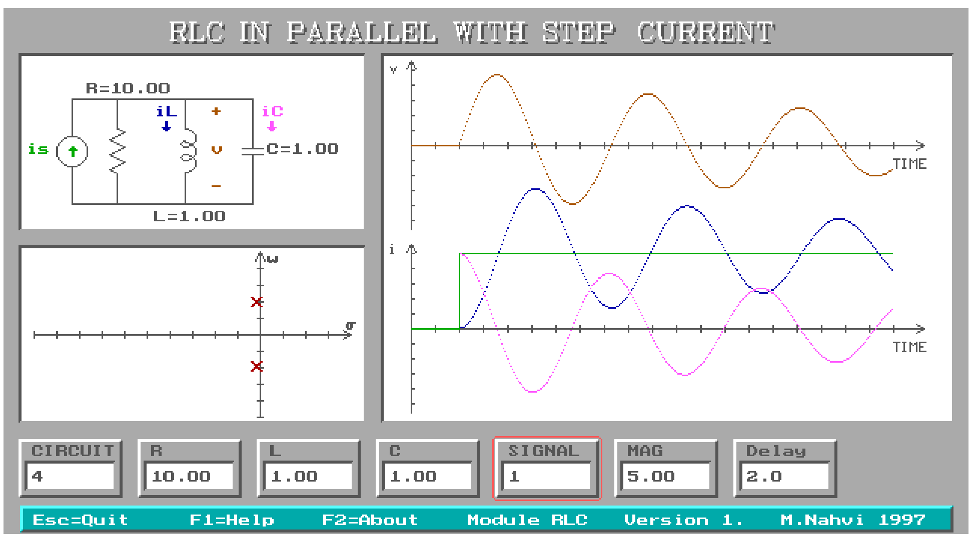

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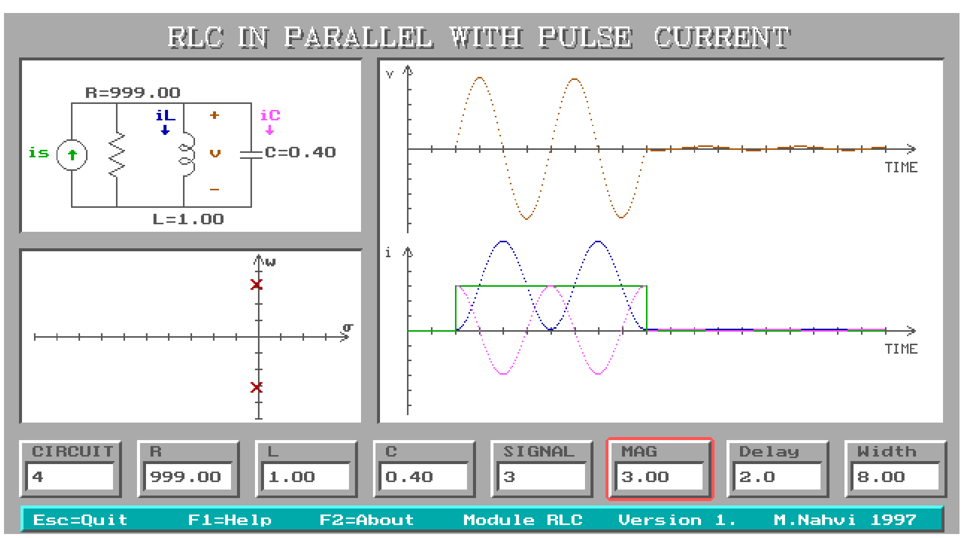

Figure 4e