III. On Training Young Teachers

The importance of the question is determined by that future of any institute depends on how young teachers are being trained, in particular during their study at post-graduate course. Namely on this reason, questions of training skilled workers must be based on the clear and well thought-out system. The system, in spite of the obvious things – preparation to post-graduate examinations and scientific work in the field of the own dissertation theme – should encompass the following:

- the increase by post-graduate students of their level in mathematical and engineering learning;
- an active participation of post-graduate students in scientific-research and methodological work of the department;
- attendance by post-graduate students of lectures of skilled teachers giving basic courses;
- gaining by post-graduate students of a certain pedagogical experience.

When fulfilling all the points, it is needed, on one hand, to provide the necessary help for a post-graduate student, and on another hand, a strong control of his work.

All this is a copybook truth, but it is not done in due way anywhere and ever. And this noticeably worsens quality of training young teachers.

Conclusions

In my paper, I paid main attention to how engineering high school education should be built, and correspondingly in what direction efforts of leading and teaching personnel of high school should be directed. The main thing is preservation and even strengthening of fundamental basic background of students. Namely this was a glory of the best higher education of the USSR. Everything must be done in order these traditions to be saved.

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ABOUT THE EXPERIENCE OF DEVELOPING INTERACTIVE DYNAMIC ILLUSTRATIONS FOR EDUCATIONAL E-MATERIALS

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Abstract: Publication describes the author's experience in the development of illustrative dynamic materials for eLearning courses. The presented illustrations offer multiply interactive possibilities for a student and powerful flexibility in creating theoretical or control pages for a teacher. Both specialized and universal ways for illuminating of educational materials are discussed. All interactive dynamic illustrations are realized as Java applets, although it is emphasized, that basic ideas are helpful for any other similar technology.

Keywords: education, eLearning, interactive illustration, dynamic illustration, electronic educational materials, Java applet.

ACM Classification Keywords: K.3.2 Computers and education - computer and information science education; I.6.3 Simulation and modeling - applications

Introduction

Although distance learning originally arose from conventional «paper» materials, now this process cannot be envisioned without computer technologies [1–5]. Educational materials in an electronic form (e-materials) became an essential element of modern education even in its intramural forms. The amount of computer educational

resources is growing with constant acceleration, but the simple types are prevailing as yet: hypertexts with static pictures, linear presentations or short video clips. Nobody doubts the utility of these instrumentations, but it is also evident that they do not completely realize the powerful teaching capabilities of modern computers, often enforcing pupils to achieve passive familiarization with information on the screen.

The most accepted (at least in our country) way to induce students' activity while working with e-materials is quizzes and tests that control the digestion of information. The results of testing also give teachers or better to computer software some potential for the choice of further materials to study. A more «creative» pedagogical tool is interactive computer models, which are directly handled by pupils. In particular, such models are common in the natural science courses like physics [6–10]. Interactive computer models became one of the basic tools in CBT-courses (Computer-Based Training) on CD-disks [6–8]. Models based on Java applets are mainly spread as large libraries (see [9] for example), but some successful attempts to make them an important part of WBT-course (Web-Based Training) can be also found in the Internet [10].

The reply to the strategic challenges of modern education requires essential increasing of students' activities during the process of obtaining knowledge. This important problem objectively leads to the development of the interactive presentation methods for educational material with variability of behavior according to some built-in internal logic. This paper describes the experience of the successful, from this point of view, development of dynamic Java applets that can be put to use in educational materials for informatics course. These applets can be included into any frame with theoretical explanations and may be used as an instrument provided to students for doing practical exercises as well. Such multipurpose technology can be helpful in the development of educational e-materials. As a result teacher can construct unusual «live» and interacting with pupil pages that cannot be gained by any other conventional method. Java applets are not the only way to realize the examples which are described in this publication – booming Flash-technologies, with their rapidly increasing power, are suitable for this purpose too.

Illustrations based on applets and their values

It is known that applet is the software, written in Java programming language and designed for the execution inside Web-page in a browser window. According to fundamental Internet principles, information for browser must be platform independent; hence applets can be imaged on computers with different architectures without any incompatibility problems. Applet's most important advantages in illustrating of educational e-materials directly result from its nature:

- applet is a dynamic illustration unlike static pictures and snapshots;
- applet is an interactive dynamic illustration and this essentially differentiates it from video clips.

We evidently see that applets are the tool for visualization of the learning content that increases the activity of the students; many distant learning courses lack this feature.

The use of programming language for creating applet illustrations has several values. For instance, it provides high veracity of a dynamic image: we see a virtual process that not just looks like original one, but completely accurate picture that is fully adequate to laws of nature we study. Due to existing mechanisms of parameters' input, we may generate new variants of illustration, let us say, adding or hiding particular objects. The potential to affect the applet's functioning from the outside is the main advantage over educational film. Let us note, that the possibility to stop watching a process and watch it repeatedly is proper to both means (to film and to the applet as well).

Important characteristic of the interactive applet's realization is the presence of *two ways* to control it. First, the parameters of the applet may be inputted with the help of conventional visual controls like text fields, lists, buttons an so on (Java language provides a special library called AWT – Abstract Window Toolkit, which contains all controls of familiar graphic interface). Second, any applet is able to read parameters directly from the text of the Web-page where it is installed. This power of two-way handling is rarely important from the didactic point of view: the first way is meant for a student, interacting with an illustration during learning a course, and the second one – for a teacher, developing the contents of a lesson and preparing suitable illustrations for it. These flexible features diversify the applets potential educational usage.

And one more additional feature of dynamic illustrations based on applets: they can be constructed as specialized or universal. Every specialized applet supports only one illustration, whereas universal one is suitable to attend complete series of exemplifications without any internal changes. It is evident that specialized

applets are easier to write, but universal ones approve themselves more usable, especially during complex review of cognized material, when teachers need to combine tasks from different themes. Of course the choice of applet's realization depends on concrete educational content.

Several examples of educational dynamic interactive applets, developed by the author, will be described in the next sections of the paper. Although their subject is devoted to learning of the fundamental principles of modern computers functioning, it is not essential condition. The adaptability of considered technology to other educational disciplines will be discussed after the description of examples.

Example of specialized applets

As an example of specialized dynamic illustrations we shall discuss the series of Java applets, developed by the author [11], which were designed for learning of the governing instructions of a modern RISC processor. The suitable educational base for teaching this topic is MMIX model, proposed by the classic of computer literature D. Knuth [12–14].

Two typical examples from the series of applets under consideration are presented on fig. 1: first (left) allows the user to study the work of instructions, which determines the contents of microprocessor registers, and the second demonstrates the principles of how of processor's arithmetic operations work. Let us examine the selected applets in a more detailed way.

Generally, learning of the instructions that set data into processor registers does not lead to serious difficulties. Nevertheless, MMIX, being 64-bit processor with 32-digit binary RISC instructions, has some specific for such architecture peculiar properties. It is evident, that it is impossible to determine all bits of the register by means of one instruction which has smaller digit capacity. As a result, in MMIX and in real processors of similar architecture programmer can fill register's bits only by parts: all 8-byte register is divided into 4 equal parts, marked H, MH, ML and L; special command from the processor's instruction set is used for every part. Therefore 4 such instructions are required for full setting of a register value in the case of arbitrary binary code. To make easier and shorter the programming of registers' initialization in the most often and simple situations, one of these instructions (SET) not only writes constant into specified part of the register, but also clears the rest three parts.

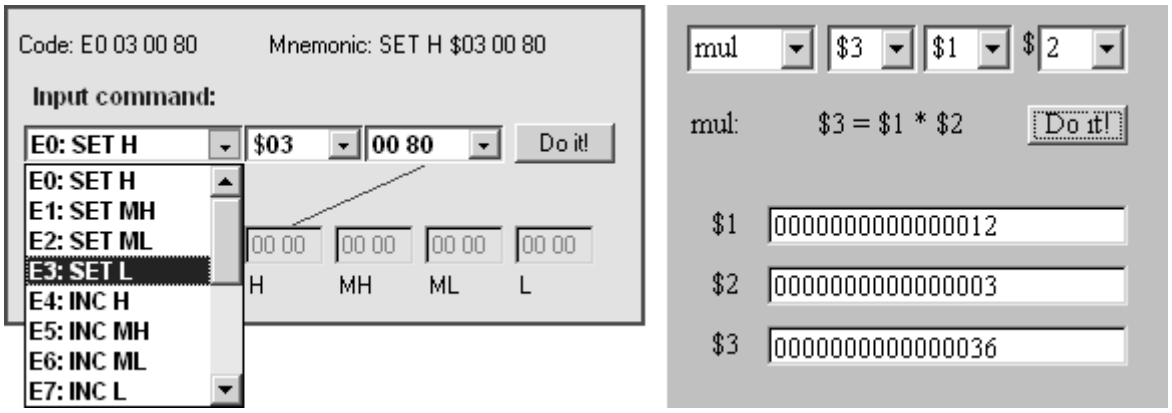

Fig. 1

Presented above brief description is enough to understand the helpfulness of the offered dynamic interactive model (fig. 1, left), which allows to study all the details of determining value in a register of large length. It gives possibility to test any instruction: SET, INC, OR, ANDN (shortcut from AND-NOT) for every quarter of the register. Furthermore, any *sequence* of such instructions can be simulated, that is even more important from practical point of view. Note that not only operation can be selected from the dropdown list; arguments of the instruction (register's number and value to set) also can be changed the same way.

We must emphasize that described illustration gives student possibility not only to learn the theoretical description of all MMIX instructions from this class, but also to do many exercises with its help, watching visualization of the results immediately.

The second example (fig. 1, right) demonstrates the execution of all arithmetic operations in MMIX RISC processor. This dynamic illustration is also able to form any required arithmetic instruction, define original

numbers for it and then check the result of the operation. As in the previous case, applet can execute any arbitrary sequence of supported commands.

The similar illustrations are developed for several other kinds of instructions [11]. Their complement gives possibility to make the learning of RISC processor's instruction set easier and more demonstrative.

Example of the universal applet

The logical evolution of the complement from the separate interactive dynamic illustrations, described above, naturally leads to creation of one unified applet, which is able to execute any instruction, comprised into instruction set. Actually we get a virtual working model of a processor as a result, which can be built into any educational e-material. The complexity of writing of such applet will be requited by the new appearing feature: the universal model is able to execute arbitrary sequence of commands that means absolutely all linear, brunching or cyclic programs. The specialized applets permit to learn only separate groups of instructions of the same kind, just as the universal one may additionally become a base for learning processor codes programming.

The example of such universal interactive illustration for e-course is presented on fig. 2 (variants of its usage in educational e-materials can be find on the author's site [15]).

Applet realizes the computer educational model «E97» [16–19]. As we can see from the screenshot on fig. 2, educational model consists of the following parts (fig. 2):

- block of registers, which contents can be edited;
- memory, the contents of its cells can also be changed;
- virtual display screen for output of the results and echoing of keyboard input process;
- controls of the model.

If such illustration is included into Web-page, student after reading its text can input into model's memory required program and run it. As an example, on fig. 2 you can see the result of execution of the program that prints Latin alphabet on virtual computer's display.

An important feature of discussing universal applet is its ability to extract program from HTML page text and store this program into model's memory. So, as an alternative variant, a teacher can prepare examples of programs for the educational course in advance (various on different pages), and then a student just analyze given examples and run them.

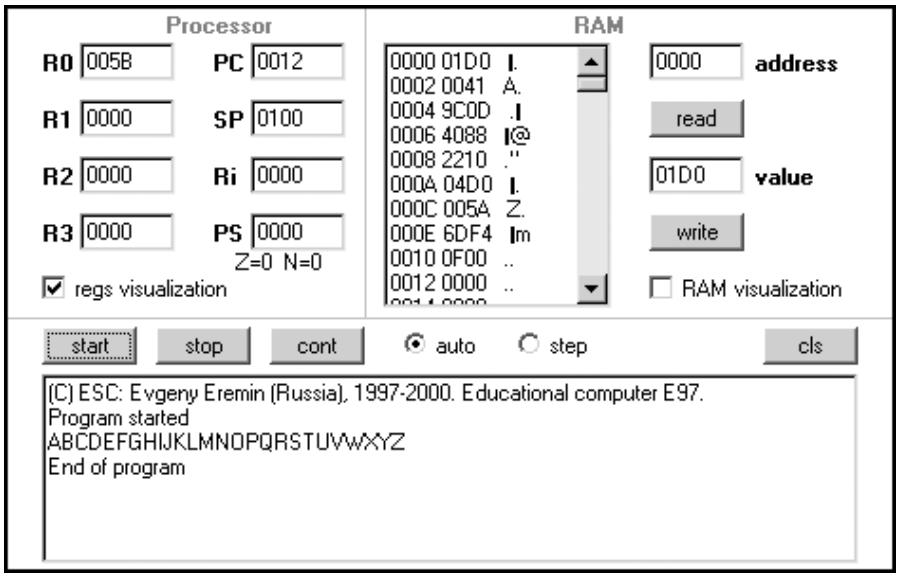

Fig. 2

As it was emphasize earlier, an applet model can play a role of some kind of empty «blank», which pupils fill with their solutions of the task, given on the page, and then verify the results by watching displayed results.

Thus, the value of universal illustration technology is confirmed in the following way: one applet is enough for all learning material, and it is easy for changes according to the contents of any educational page.

Conclusion

Thus the technology of development of the learning materials with interactive dynamic illustrations, described in this publication, demonstrates essential values of the electronic form in comparison with conventional «paper» one.

It is necessary to emphasize that the subjects of the selected examples were determined exceptionally by the schedule of disciplines taught by the author. At the same time the described technology itself is easily applicable to many other (although may be not absolutely to all) educational courses. In the informatics area we may without special afterthought enumerate such questions like programming language constructions, number system notations, rules of queries composition for data bases or search engines, learning of the operating system commands (including OS with a graphic interface) and so on. The use of considered technology for illustrating e-materials seems to be quite real for other educational disciplines, for instance visualization of planets' moving in astronomy, demonstration of some objects' interaction in physics, realization of interactive electronic maps in geography and so on. In all cases the question is in illustrations which have dynamic character and require the dialog with a student.

As it was noted above, the choice of Java applets by way of realization interactive dynamic illustrations is not the only possibility. Graphic images, implemented with the help of Flash technology, also become more and more popular. It is important to accent that maximal effect we shall have not for simple Flash clips or screened comics, made up on basis of pictures that are changing by means of «Next» button, but for really interactive applications. In other words, the main idea of the publication is not just propagandize of including dynamic graphics into educational e-materials – the question is in its essential interactivity, when the pupil gets a chance to have an influence on illustration's behavior according to the given task or makes some experiments aimed at familiarization of the new educational material.

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