

VIRTUAL LABORATORY WORK: PRINCIPLES OF DEVELOPMENT

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Annotation: The paper presents new principles of building virtual laboratory work, the relevance of which has become apparent in recent years. Didactic, hardware (instrumental), modeling, communication with the program and other principles are presented.

Keywords: Virtual laboratory work, principles of construction and visualization, development of a scenario, user reaction, presentation of results, scaling in time and space.

INTRODUCTION

As is known, among the natural phenomena studied in the university course of physics, there are processes, the direct observation of which within the framework of the workshop is difficult or requires special equipment. Traditionally, a real experiment involves the use of a variety of physical devices and installations. With the development of computer technology and multimedia software, a real alternative has emerged: the use of computers for virtual demonstrations, i.e., the simulation of physical phenomena and processes on a computer.

Today, due to advances in computer speed, visual representation of such phenomena can be achieved through the use of animation techniques during the solution of mathematical model equations, where the "observed" parameters of the phenomenon are fully determined by the "natural" values of the initial data. This is implemented in virtual laboratory exercises conducted in a dialogical mode on a computer [1-3].

MATERIALS AND METHODS

From the above, the use of computers in the educational process is preferable (or is the only one) in the following cases:

➤ when the physical phenomenon under consideration is too fleeting (for example, the occurrence of a shock wave during the flight of a bullet) or, on the contrary, too long-lasting (for example, the process of crystal growth) for direct observation;

- when the spatial scales of the phenomenon are too small or too large for direct observation;
- when the physical phenomenon is not observable in principle (for example, the movement of electrons);
- When a virtual experiment is more economically advantageous, which is particularly important.
- There are two main methods for creating computer demonstrations of virtual experiments:
- Modeling physical processes using programming.
- Creating computer-based video clips.

Computer modeling is an effective method for studying systems. Computer models are often easier and more convenient to explore, and they allow for computational experiments that are difficult or unpredictable to conduct in real life. When modeling physical processes using programming, traditional programming languages such as Pascal, C++, Delphi, and Basic are commonly used, and graphics can be pre-processed using packages such as 3D Studio MAX, Photoshop, and CorelDraw. This method emphasizes the use of animation to represent physical phenomena, which is a promising approach as it offers virtually unlimited possibilities for demonstrating complex systems. However, there are challenges associated with the fact that not every complex system can be implemented on conventional personal computers, as there are limitations in terms of both processing speed and memory capacity. An alternative to this is the development of demonstrations made in the form of animated graphs on MachCAD (running sine wave, distribution of sine wave taking into account the dissipation of wave energy, standing wave). First, such developments are simpler than similar ones made in Delphi or C++. Second, and most importantly, animated graphs are a natural bridge between lecture demonstrations, in the traditional sense of the word, and simple graphs that are so abundant in physics lectures. Therefore, in order not to lose a large number of positive qualities of graphs, by going to a more difficult path, it is possible to implement a module for working with graphs in the Delphi programming language in addition to the module for three-dimensional imaging of experiments.

The use of computer technology has significantly expanded the possibilities of a conventional experiment, allowing the simulation of various physical objects and phenomena, the natural demonstration of which in laboratory conditions is technically very difficult or simply impossible. For example, a computer is used to simulate the motion of charged particles in electric and magnetic fields, the scattering of beta particles on the nuclei of atoms of other substances, the motion of bodies in gravitational fields, the motion of bodies with variable mass, the passage of light beams through various optical systems, the configuration of various force fields, and many other physical phenomena. When studying the motion of charged particles in a uniform magnetic field, the trajectory

of a particle entering a constant magnetic field at a certain angle is simulated, and the influence of the particle's specific charge, velocity, and the magnitude and direction of the magnetic field's induction on the particle's trajectory is investigated.

Using a computer, the processes accompanying the change in the electrical resistance of a sample during its transition from the normal state to the superconducting state and back, and the effect of such parameters as magnetic field strength and temperature on superconductivity, are simulated.

The computer model is widely used in laboratory practice, allowing for calculations of the measured value based on the obtained experimental data, finding measurement errors, and controlling the course of the experiment.

Computer models are often easier and more convenient to study, and they allow for computational experiments that are difficult or unpredictable to perform in real life. Computer modeling of experiments in physics provides great opportunities, allowing you to obtain more complete information about the studied phenomenon, expand your understanding of the invisible processes occurring in the depths of experience, and also allows you to visually compare the results obtained through various experimental studies.

RESULTS

Thus, we can formulate (in the first approximation, without claiming generality in general):

Virtual Laboratory Work: Principles of Development

1. Didactic

- Visual representation of phenomena in the micro- and macro-world:
- The motion of a satellite around the Earth in a gravitational field
- The scattering of γ -photons on free electrons
- A visual representation of ultra-fast and slow processes:
- The motion of an electron in a vacuum tube
- The distribution of molecules in a gravitational field
- Variability
- Initial conditions
- Situations in the development of
- Individualization (list number, date of birth, etc.)
- Interactive content
- Game content
- ?

2. Hardware (instrumental)

- Scaling
- Time-based
- Space-based (pixel-based)
- ?
- Presentation of experimental results
- Vector-based
- numerical (tabular)
- graphical
- ?

3. modeling

- functional animation
- solving algebraic equations
- solving differential equations
- parametric modeling (methods of similarity and dimensionality)
- ?
- semantic animation
- ?

4. communications with the program

- □ manual response
- □ voice interface
- □ parametric effect
- □ ?

Solving organizational problems

Of course, in addition to methodological problems, there are also organizational problems in the use of virtual laboratory work and simulators in the practice of technical (primarily) universities. The solution to these problems is as follows:

1. To develop a sufficient number of computer laboratory work, with a complete visualization of the phenomenon, with functional interactive content and a variety of situations (what is called an "additional task" in the generally accepted methodology, which goes beyond the standard procedure).
2. Such work should be organized in university computer classrooms, for full-time students, and at home for distance learning (in the latter case, this type of work can serve quite well a competitive replacement for the so-called control works, which are more than 99% compilatory in nature today).

3. It is clear that developing any serious virtual works is a complex and large task, so it is necessary to organize a group within the Methodological Council to develop and implement such works.

It is also necessary to attract (on a contractual basis) specialists in the methodology of such work (teachers), subject specialists (as experts and scenario developers), and software specialists, of course, on a competitive (tender) basis.

CONCLUSIONS

In general, the development and implementation of such work can not only radically change the results of student training, but also serve as a source of additional income for the university: if the issue of intellectual property for the developed software product (registration in the relevant institutions) and marketing for its promotion in related universities is properly addressed.

LITERATURE

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