Application of Java Applet in Physics Experiment Network Teaching

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Abstract A Java applet is a small application which is written in Java, and the user launches it from a web page. It has the function of realistic interface design, powerful graphics and computing functions and a serial of events interaction and response mechanism. This article analyzes the present situation of physics experiment network teaching, and then points out that the virtual simulation experiment in network teaching will involve some obvious drawbacks such as the Internet bandwidth and system security, etc. Relative to this, the Java applet shows its own unique advantages, including powerful capacity, multithreading, free installation, strong compatibility, high security, and so on. So if we apply the advantages of Java applet to physics experiment network teaching, such as restoring physical process, simulating physical phenomena, processing experimental data, etc., we can do better to promote physics teaching reform, enhance quality of physics experiment teaching, improve physics experiment teaching resources construction, and so on.

Keywords: *physics experiment, java applet, network teaching, virtual experiment*

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1. Introduction

The rapid development of information technology has brought profound influence to the reform and development of school education. Network is everywhere, every aspect of human activities largely depends on the network, and education is no exception. As an important part of physics education, physics experiment teaching also must change due to the emergence of the Internet.

Physics is a natural science based on the experiment. In the scientific method, an experiment is an empirical procedure that arbitrates between competing models or hypotheses. [1,2] Researchers also use experimentation to test existing theories or new hypotheses to support or disprove them [3,4].

In physics teaching, experiments can raise test scores and help a student become more engaged and interested in the material they are learning, especially when used over time. [5] So, the experiment teaching occupies an important position in the physics teaching.

Using advantage of information technology, study of computer assisted physics experiment teaching can solve some difficulties in traditional experiment teaching, and it's an important way to realize the optimization of experiment teaching.

2. Present Situation of Physics Experiment Network Teaching

In recent years, along with the deepening reform of education, computer assisted physics experiment has made some progress. Combining pictures, chart, video, animation, physical projection and others in practice simulation and content processing, it has formed a kind of effective teaching method and generated unique teaching effect. Computer assisted physics experiment teaching includes the following several forms, such as using CAI (Computer Assisted Instruction) courseware for experimental preview and review, controlling experimental process, collecting and processing experimental data, simulating virtual experiment and so on, many of which are carried out in the form of network teaching.

However, from the present situation of physics experiment network teaching in China, we can see some limitations, which can roughly be shown in two aspects. On the one hand, normally, we just move experimental preview from books to network, but it makes no difference to the traditional teaching, because we only have changed a medium form. If there is BBS (Bulletin Board System) in which teachers and students can discuss, that will be better, we can breakthrough the limitation of time and space and realize resources sharing and communication, but it's largely one-way communication teaching mode. On the other hand, we can realize network teaching of simulating virtual experiment. Using interactive courseware, the network teaching covers online feedback, online FAQ (Frequently Asked Question), online evaluation, and other forms of real-time interaction, in this way students can learn more independently and get timely feedback. Due to its advantage of interactive and

authenticity, the simulating virtual physics experiments is now a focus of teaching reform.

But it also has a very obvious drawbacks, interactive network courseware used in the virtual simulation experiment teaching generally occupy a larger storage space. Take the "College Physics Simulation Experiment" [6] for example, each experiment courseware is of 26 MB, on average.

As following, there are several screenshots of program interface of "Raman spectra experiment": (e.g. Figure 1 - Figure 4).

Figure 1. Main Scene Graph
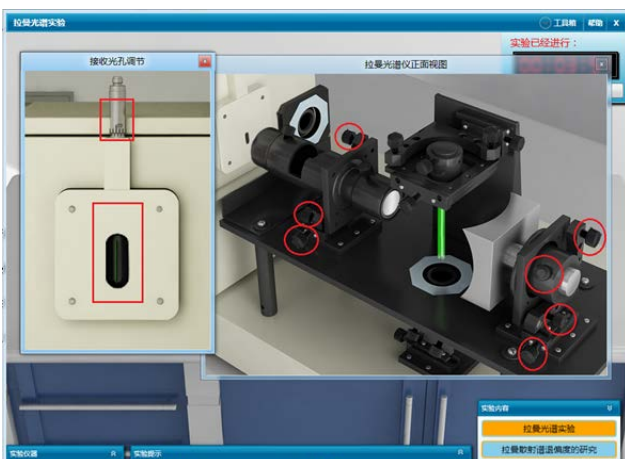

Figure 2. Select Experimental Samples

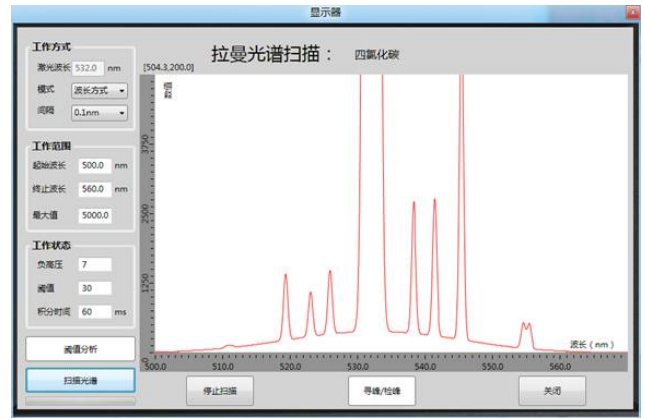**Figure 3.** Adjust Light and Slit Position

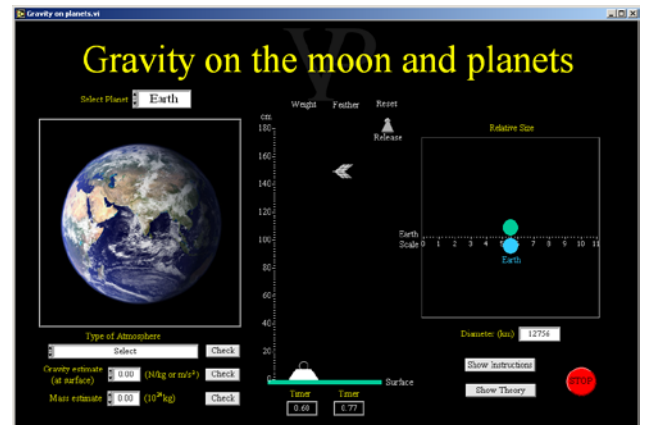**Figure 4.** Display Adjustment Form View

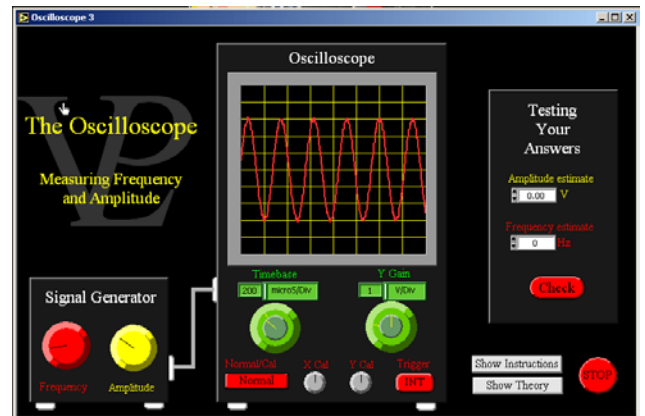**Figure 5.** Gravity on the Moon and Planets

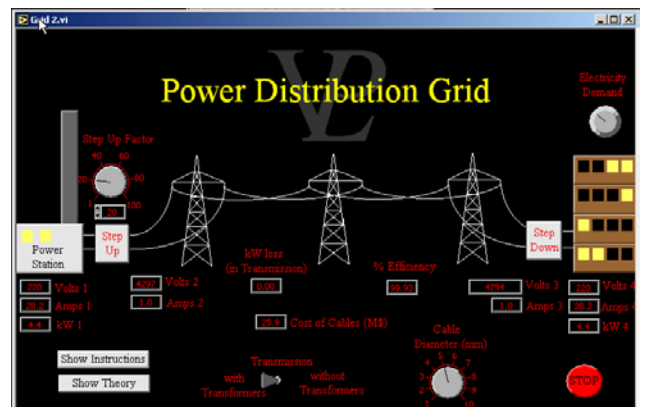**Figure 6.** The Oscilloscope

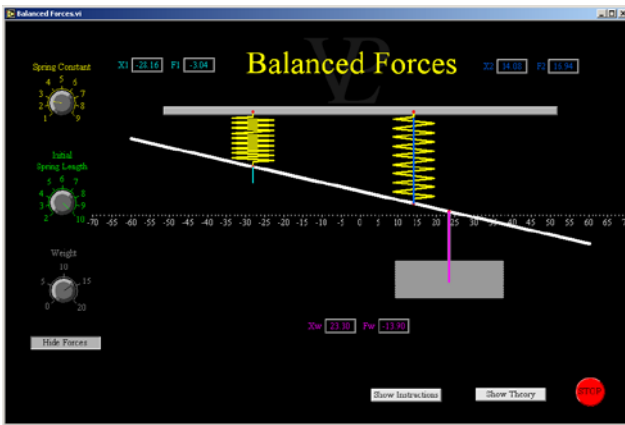**Figure 7.** Power Distribution Grid

Figure 8. Balanced Forces

Abroad, there are more resources and platforms about virtual physics experiments, the function is more complete and the application scope is much wider. For example, The VPLab (Virtual Physical Laboratory) [7] is a suite of over 300 interactive physics simulations. Below are several screenshots from a range of different simulations available in the VPLab software. (e.g. Figure 5 – Figure 8) They are only 0.013% of the full content. Thus it can be seen that the resource is versatile and flexible, but of course you have to pay it.

That would be fine if it's connected to LAN, but once connected to the Internet, there would be major problems.

1) The Internet bandwidth

For real-time transmission of such large courseware, time delay is very obvious, and that the network facilities may vary considerably in different area, so it is difficult to implement virtual effect.

2) System security

Range of the system application and expansion of the number of users make the security environment significantly worse. Huge server loading capacity will be a real problem.

In order to solve these two problems, we can use the program to develop interactive contents such as virtual environments and instruments of experiment. After that we store them locally in the form of CD media, and then teaching management and interaction between teachers and students can be realized online, in this way we can solve the problem of the Internet bandwidth. On the other hand, we can upgrade software and hardware to improve system security. But it is bound to increase the cost for producing and publishing CD media and upgrading hardware and software. As a result, we limit the rapid development of physics experiment network teaching. So we can apply Java applet in physics experiment network teaching to solve these problems in a better way.

3. Advantages of Java Applet

A Java applet is a small application which is written in Java, and the user launches it from a web page. Java applets run at very fast speeds and until 2011, they were many times faster than JavaScript. [8] The Applets are used to provide interactive features to web applications that cannot be provided by HTML alone. They can capture mouse input and also have controls like buttons or check boxes. In response to user actions, an applet can change

the provided graphic content. This makes applets well-suited for demonstration, visualization, and teaching. There are online applet collections for studying various subjects, from physics to heart physiology. [9] A Java applet can show all of the following advantages:

1) Powerful capacity

Java is a mature and fully object-oriented programming language. For Java, there is no limit to the capacity and complexity of the Java applet, it has great processing power of graphics and network, but due to the limitation of communication speed, capacity of most applets is not very big.

2) Multithreading

With the multithreading function provided by Java, a applet can perform multiple small tasks at the same time. Compared with C and C++, multi-thread technology of Java makes it have better interaction and real time control performance, etc.

3) Free installation

As long as the loading of a web page, the Java applet embedded in it will be loaded at the same time. Unlike general program or software needing be installed, Java applet is of free installation.

4) Strong compatibility

Java applet can run on most platforms (such as the current Windows, Macros, Unix and Linux) and get the same results.

5) High security

Compared with other techniques, Java applet is very safe, and it is hard to destroy the system. An untrusted applet has no access to the local machine and can only access the server it came from. The security of Java can be guaranteed from two aspects. First, In the Java language, functions such as pointers and freeing memory of C++ are deleted, that avoid the illegal memory operations; Second, When Java is used to create browser content, functions of language and provided by browser itself together make it more security.

These advantages mentioned above make the Java applet very suitable for application in the physics experiment network teaching. With its powerful processing capacity of graphics and network and multithreading, we can carry out simulation and demonstration of complex physical phenomenon, make the network classroom active, and provide the process of interaction. With its free installation and strong compatibility, we can publish it in the Internet much more easily. With its small capacity, we can realize fast real-time transmission in the network and reduce the server load. With its high security, we can ensure the stability of the running system.

Compared with the previous solution, the main difference is that the interactive contents realized by program are still loaded in the server when we use the Java applet, but the load capacity doesn't increase a lot, students can learn anytime, anywhere by the online client without carrying variety media and resources.

4. Java Applet Applications in Physics Experiment Network Teaching

4.1. Source of Java Applet

Where is the Java applet? Of course, make it by our own, thus it will match with our mind. Java is based on C/C++, so for programmers who are familiar with learning C/C++, they will be familiar with learning Java and make Java applet with high proficiency. On the other way, there are many websites about Java applet, we can download it or use it through links directly, and it's a kind of method to save time and effort.

4.2. Examples of Java Applet

Here are two examples of Java applet applied in physics experiment network teaching [10]. You can see the interface and function of the two programs.

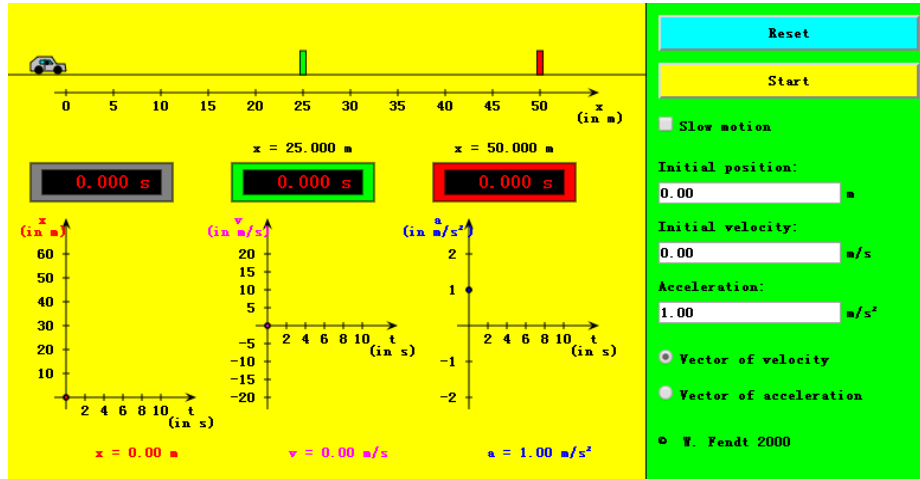1) Motion with Constant Acceleration (e.g. Figure 9)

Figure 9. Motion with Constant Acceleration

This Java applet shows a car moving with constant acceleration. The green control panel contains text fields where you can vary the values of initial position, initial velocity and acceleration (don't forget to press the "Enter" key!). By using the buttons at the top right you can bring back the car to its initial position or stop and resume the simulation. If you choose the option "Slow motion", the movement will be ten times slower.

Three digital clocks indicate the time elapsed since the start. As soon as the car has reached the green respectively red light barrier with its front bumper, the corresponding clock will stop. Both light barriers are adjustable by dragging the mouse with pressed mouse button.

Three diagrams illustrate the motion of the vehicle:
- Position x versus time t
- Velocity v versus time t
- Acceleration a versus time t

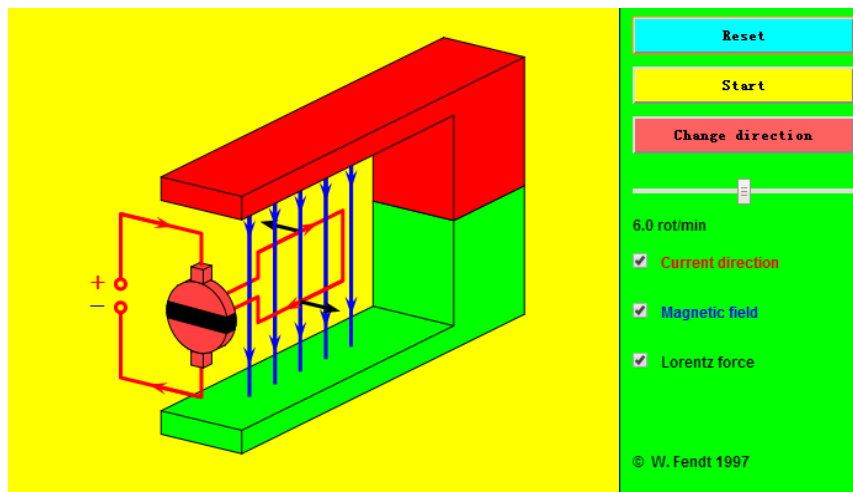2) Direct Current Electrical Motor (e.g. Figure 10)

Figure 10. Direct Current Electrical Motor

This Java applet shows a direct current electrical motor which is reduced to the most important parts for clarity. Instead of an armature with many windings and iron nucleus there is only a single rectangular conductor loop; the axis the loop rotates on is omitted.

The red arrows indicate the conventional direction of current (from plus to minus). You can recognize the magnetic field lines (directed from the red painted north pole to the green painted south pole) by the blue color.

The black arrows represent the Lorentz force which is exerted on a current-carrying conductor in the magnetic field.

The mentioned Lorentz force is perpendicular to the direction of current and to the magnetic field lines. The orientation of this force results from the well-known three finger rule (for the right hand!):
- Thumb: Conventional direction of current
- Forefinger: Magnetic field

- Middle finger: Lorentz force

On average, the source program is only of 26.8KB. As you can see, its size is not big, but the function you can realize is very powerful, and it operates much faster just like opening a picture on a web page.

Through the examples above, we can preliminarily understand the role of Java applet applying in the network teaching. With the development of computer hardware and software and further improvement of network transmission conditions, the advantages of Java applet applying in physics experiment network teaching will be further reflected.

4.3. Application of Java Applet

The use of Java applet is very simple, we can embed it in a web page with general web page creating tools such as Dreamweaver, it's as easy as inserting a picture in a web page. HTML authors can transmit initial parameters to Java applet to make it more diversiform, and even can directly use it through links of the existing web site.

To be more specific, the Java applet can be used in a variety of different ways to liven up the physics experiment network teaching [7]:

1) As a curriculum support resource.

2) As a demonstration of how to conduct an experiment prior to letting the students operate the real physical equipment in the laboratory.

3) As a tool to enhance the subject knowledge and deepen the understanding of pupils as well as teachers.

4) As a virtual experiment to generate typical measurement data.

5) As a low cost data-logging package (using the sound card microphone input and or the mouse as position/angle sensor).

6) As an animated blackboard.

7) As a qualitative exploration tool.

8) As a platform to help students in an extension project.

The Java applet resources are intuitive in its operation. Once installed on a school server, a class of students in a computer network classroom can work simultaneously on any number of simulations. Also, Students can prepare before class, learn in class, and consolidate after class. Absolutely, the Java applet can play a very important role in physics experiment network teaching.

5. Conclusion

In recent years, the Java language is widely used in enterprise management, design of training software, production of electronic commerce system, development of mobile communications and games software, etc. It is an innovation trend to apply java in education, especially in course teaching. In physics experiment network teaching, the simulating virtual physics experiment is now a focus of teaching reform because of its advantages of interactivity and authenticity. But it also has some obvious drawbacks with enormous storage space, and that is easy to cause problems such as the Internet bandwidth and system security. Relative to this, the Java applet has its own unique advantages, including powerful capacity, multithreading, free installation, strong compatibility, high security, and so on. So if we apply the advantages of Java applet to physics experiment network teaching, such as restoring physical process, simulating physical phenomena, processing experimental data, it will be very good to promote the development of physics experiments network teaching.

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