

Kari M. Sormunen, Vladimir A. Tarasov, and
Sergey R. Bogdanov (Eds.)

**Mathematics and Science Education in the
North-East of Europe: History, Traditions
& Contemporary Issues**

Proceedings of the Sixth Inter-Karelian Conference
Sortavala, Russia
11-14 September, 2003

Host of the conference:
**North — Ladoga branch of
Karelian State Pedagogical University**

Publisher of the proceedings:
**Department of Applied Education
University of Joensuu**

This conference was supported by:
Russian Humanitarian Scientific Foundation (project 03-06-00425 r/C),
Government of the Republic of Karelia (contract № 37-03, 15 April 2003),
**University of Joensuu, and
Karelian State Pedagogical University**

**THE ELABORATION OF INTERACTIVE COMPUTER MODELS
IN SUPPORT FOR A DISTANCE COURSE OF PHYSICS BY MEANS
OF FLASH - ANIMATION**

A. Kyurshunov, N. Leonova

Karelian State Pedagogical University

Abstract. At present the problem of the elaboration of distance learning courses of physics becomes urgent. One of its aspects is the use of computer models, the article describes a model example that examines basic principles and approaches to the elaboration of interactive computer models with the help of Flash - animation in detail.

Introduction

Recently the elaboration of distance learning courses in physics has become urgent in connection with the development of distance learning (DL). Physics in its basis is an experimental science therefore the course of physics traditionally includes the conducting of laboratory classes but in conditions of DL there is no access to labs in educational institutions. The exclusion of laboratory practice from the DL course of physics will lower the quality of education. Therefore, one faces the necessity of using educational means, which with the minimum losses of the quality of education enable to pass on to DL, the basis for which is computer and Internet technologies. Interactive computer models (ICM) can be considered to be such means. They are elaborated to be used in the net and are independent of on operational platform.

At present time there are different ICM in support for the course of physics. But the majority of them is impossible to apply to DL of physics, because they do not take into consideration the peculiarities of DL. Among the variety of the means of ICM elaboration special attention should be paid to Flash-animation. Macromedia Flash enables to create movie clips meant for the use in the Internet. It uses the vector format of graphics which allows to create small in size files of movie clips. Flash-clips can be inculcated into Web-documents and played in the majority of modern browsers of different operational systems. In comparison with other editors of movie clips the basic advantage of Macromedia Flash is its embedded object-oriented programming language ActionScript. This language enables to operate objects, which gives the developers of ICM the tool kit for creating interactive movie clips.

The article gives an example of the use of a Macromedia Flash clip that realizes the model of the electron motion in homogeneous electric field.

The example of using Flash-animation

The modeled situation consists in the following. An electron flies between the plates of an air capacitor; the task is to investigate the influence of the initial velocity and field intensity of the capacitor over the nature of the electron motion. The following equation system underlies the computer model:

$$x(t) = x_0 + v_{0x}t; \quad y(t) = y_0 + v_{0y}t + \frac{at^2}{2} \quad \text{the equations of the electron motion;}$$

$$v_{0x} = v_0 \cos(\alpha_0); \quad v_{0y} = v_0 \sin(\alpha_0);$$

$$v_x(t) = v_{0x}; \quad v_y(t) = v_{0y} + at; \quad v^2 = v_x^2 + v_y^2; \quad \alpha = a \tan \frac{v_y}{v_x}$$

the equations describing the motion velocity vector of the electron; $a = \frac{qE}{m}$ - the acceleration of the electron motion, where x - the coordinate of the electron relative to the axis OX (this axis is directed along the condenser plates), y - the electron coordinate relative to axis OY, v - the module of the velocity vector, α - the angle of the velocity vector inclination to the axis OX, v_x - the projection of the velocity vector on the axis OX, v_y - the projection of the velocity vector on the axis OY, q - the electron charge, m - the electron mass, E - the intensity of the capacitor electric field, t - the time.

The Flash-clip realizing this model consist of the following movie clips:

- 1) "electron" - with the picture of the electron
- 2) "vector" - depicting the velocity vector

- 3) "plate 1", "plate2" - depicting capacitor plates
- 4) "wall" - faceplates image
- 5) "control" - the movie clip that controls the electron motion; containing text fields which, the initial parameters of the model (the velocity vector module, the angle of the speed vector inclination, the electric intensity of the capacitor field) and the starting button and the button of the halt of the motion.

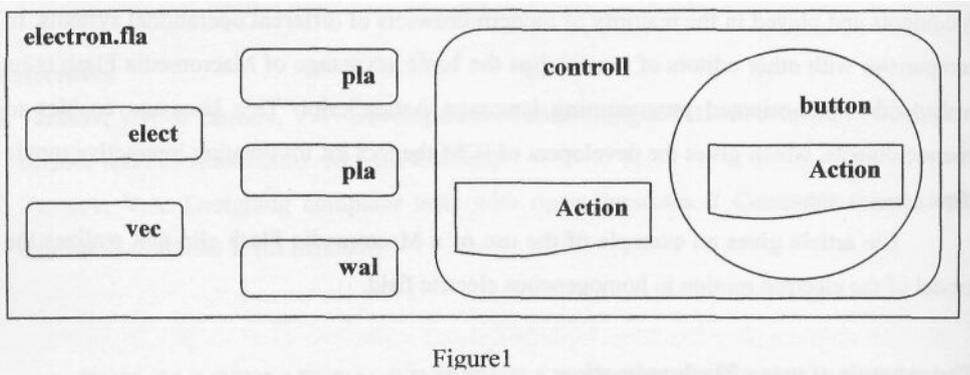


Figure 1

The structural scheme of the Flash-clip (electron.fla) is presented on figure 1.

ActionScript is assigned to the movie clip "control" and realizes the process of the electron motion, here is the text of the programme:

```

onClipEvent (load) { //variables initialization
var t = 0; //time
var playback = false; //the variable determining the state of the motion
var m = 3; //relative electron mass; var q = 1.6; // relative electron charge
var E; //the intensity of the capacitor electric field
var Vo; //the initial velocity; var V; //the velocity of the electron motion
//the position of the electron movie clip at the initial moment of time
//relative to the axis OX and OY
var Xog = _root.electron._x; var Yog = _root.electron._y;
var alpha; //the angle of the deviation of the initial electron velocity relative to the axis OX
var alpha 1; // the angle of the inclination in radial
var Voy; // the projection of the initial electron velocity on the axis OY
var Vy; // the projection of the electron velocity at the moment of time t on the axis OY
var Y; //the coordinate of electron on the axis OY
var Vox; // the projection of the initial electron velocity on the axis OX
var X; // the coordinate of electron on the axis OX
var a; //the electron acceleration

```

```

var L = 0.02; //relative plate length; var K = 360/L; // the coefficient of the transition from
//the model coordinate system to graphics context
var ho = _root.arrow._width; // the initial length of the movie clip velocity vector
var h = ho; } // the current length of the movie clip velocity vector
onClipEvent (enterFrame) {
if (playback) {
Y = Voy*t+a*t*t/2; X = Vox*t; //the change of relative electron position coordinates
Vy = Voy+a*t; V = Math.sqrt(Vy*Vy+Vox*Vox); //the computation of the velocity
alpha = Math.atan(Vy/Vox); // the computation of the angle of the velocity vector inclination
t = t+5e-6; //the change of time
if(X>380){a = 0;} //if the electron leaves the range of the condenser, it moves uniformly
//the change of movie clips "electron" and "vector"
setProperty (_root.electron, _x, Xog+K*X); setProperty (_root.electron, _y, Yog-K*Y);
setProperty (_root.vector, _x, _root.electron._x);
setProperty (_root.vector, _y, _root.electron._y);
setProperty (_root.vector, _width, ho/Vo*V);
setProperty (_root.vector, _rotation, -alpha* 180/Math.PI);
//the verification if the electron collides with the capacitor plates and the faceplate
if ((_root.plat1.hitTest(_root.electron)) || (_root.plat2.hitTest(j-oot.electron)) ||
(_root.wall.hitTest(^root.electron))) {playback = false;}}

```

The following ActionScript is assigned to the start and stop button (that is in the movie clip "control"),

```

on (release) {
if (playback) //the setting of the initial parameters
alpha = alphas*Math.PI/180;
Voy = Vo*Math.sin(alpha); Vox = Vo*Mam.cos(alpha);
setProperty (^root.vector, _rotation, 0); setProperty (_root.vector, width, ho);
a = q*E*1e4/m;t = 0;}
playback = Iplayback;}

```

There is an elaborated ICM on figure 2.

This model enables the user to input the initial values of the velocity vector of the electron motion and electric capacitor intensity using a keyboard. To press the Start/Stop button is to set the electron in motion and to stop it. At the moment when the electron comes into collision with the surface of the capacitor plates or with the faceplate, it stops.

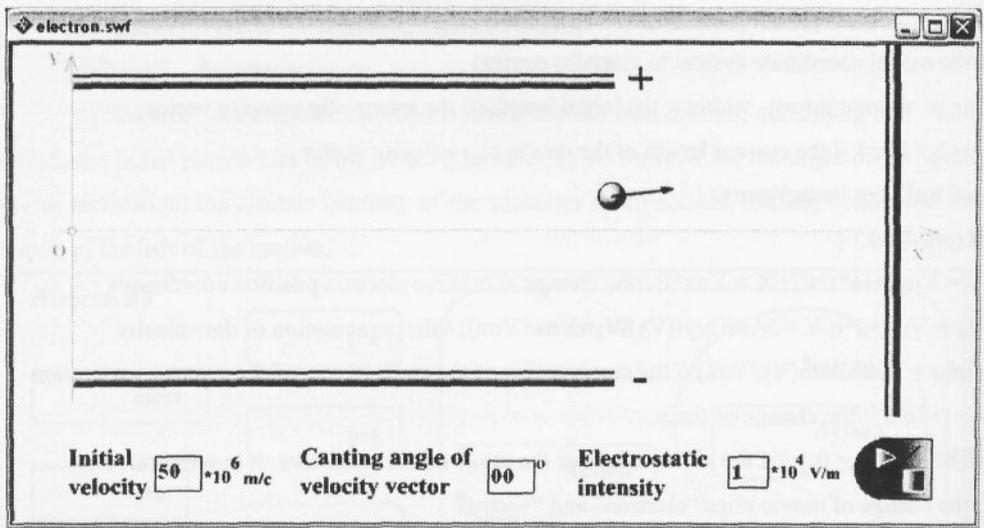


Figure 2

Overall results

While elaborating the ICM it was found out that Flash-animation is unable to depict graphics of functional relations. However this problem can be solved through the use of "path tracing" movie clips, placed on the trajectory of the motion of the inquired object at equal intervals of time. The principle of creating interactive, dynamic computer models with the help of Flash-animation examined in the article can be applied to many tasks in physics that provide the motion of objects in time. The working version of the examined ICM is available on <http://aks.dem.ru>. besides, there is a model of the electron-beam tube elaborated on the basis of this pilot model.

References

1. Kyurshunov, A. (2002). Computer laboratory work in the conditions of distance learning. Informatics and Education, 3, 81-84 (in Russian).
2. Tutorials, Math-Physics. <http://www.flashkit.com/tutorials/Math-Physics/>
3. David M. Harrison, Flash Animations for Physics. <http://www.upscale.utoronto.ca/GeneralInterest/Harrison/Flash/>