

USEFUL COMPUTER SOFTWARE FOR PHYSICAL ANALYSIS OF PROCESSES

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Abstract: This paper gives a short account about the role of multimedia in developing the student imagination and thinking. Using information and communication technologies (ICT) in physics education can help to increase the effectivity of the teaching process. The real life situations are analyzed as physical problems. Some computer programs help to simplify studying and to calculate some physical quantities. For students, the physical analysis using computer programs is more demonstrative, learning physical equations is quicker, understanding of the physical laws is easier. The control of some programs isn't demanding – it is suitable for pupils at the primary and grammar schools, too.

Key words: e-learning, ICT, physical education, strengthening key competencies

1 INTRODUCTION

Students like to use and to work with computers and the modern information and communication technologies (ICT). If we connect the work on computers with studying physics, this form of education will become very attractive for students and we can suppose that their knowledge in physics will be better [1]. Utilizing of ICT in physics education helps the students to work more actively and supports developing of their creative thinking [2].

Multimedia technologies have shown their potential in the teaching of scientific subjects. New techniques attract student's attention, enabling an easier and rapid process of learning. Physics and technology are often considered to be difficult subjects. Interactive multimedia tools with computer presentations, simulations, animations and movies, are particularly effective in teaching physics [3]. It is very important to use these tools in other subjects, including basic education, to make science and technology more appealing and to address the scientific apathy crisis of young people [4].

2 PHYSICAL ANALYSIS USING COMPUTER PROGRAMS

2.1 VideoPoint

VideoPoint [5] is software that allows to analyze situations which have been captured on digital video. It can be used in physics, math, science, and other fields to help to teach concepts, to improve students' understanding of graphs and to get students involved with their education in fun way. Every motion in one or two dimensions we can analyze using VideoPoint. We can plot position, velocity, acceleration, and much more. VideoPoint has been used to analyze situations ranging from a dropped ball to determining position, velocity and acceleration (Fig. 1) using demo version. As the authors say, careful movie taking and analysis can easily provide results within 5% of the theoretical values. Students can record what is important to them, from basketball shots on the playground, to jumping and other favorite activities. The ease of using this program can encourage students to experiment and to analyze their own videos. This program develops students' creativity and some students can find new ideas for analyzing real situations. R. Beichner shows [6] that increased usage of a Video Analysis tool improves students understanding of kinematics graphs.

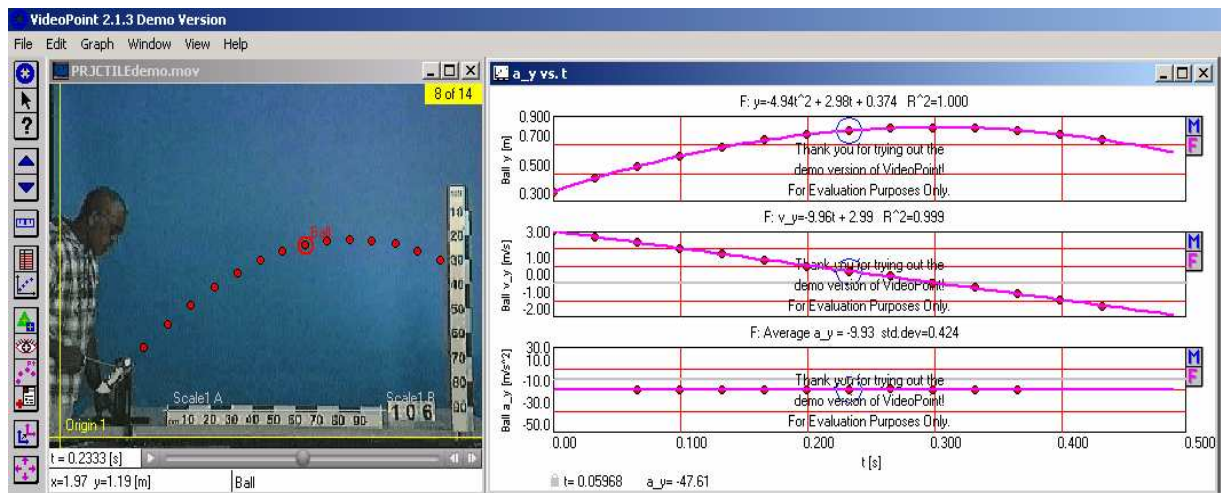


Fig. 1. Analyzing the motion of a ball launched from a canon using demo version of VideoPoint

The motion of a ball ejected from a PASCO projectile launcher is measured using VideoPoint. Position, velocity, and acceleration are plotted and fit to see the correlation between the real data and the kinematic equations. Applying mathematical fit we can find the theoretical value of the free-fall acceleration $g = 9.96 \text{ m.s}^{-2}$. Using this program, the teacher can easily demonstrate the relationships between functions and the real world. Many of the motions of interest can be described by analytic functions.

2.2 COACH

Another program for mathematical analysis of physical action is Coach [7]. In a Data-Video Activity of Coach the position and the time data can be collected from digital video clips of formats: avi, mpg or mov. From the number of frames per second the time information is deduced, while position information can be measured in the two dimensions of the video image after calibration (the same principle as in previous program).

The basketball shot is a motion which is another example of the projectile motion. The motion can be divided into two parts: the horizontal component and the vertical component. These two components can be calculated independently of each other and then the results can be combined to describe the total motion. The only forces acting on the ball are the forces of gravity and the air resistance. From measured ball's trajectory and the next mathematical description using function-fit and process of derivative we found the value of the free-fall acceleration $g = 9.41 \text{ m.s}^{-2}$.

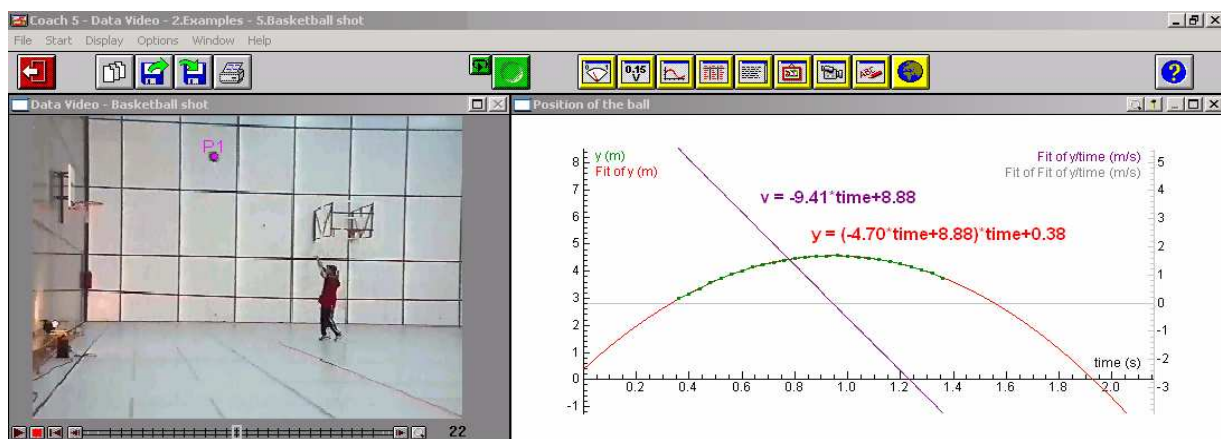


Fig. 2. Analyzing a basketball shot using Coach5 program

2.3 VIRTUALDUB AND E-RULER

VirtualDub [8] and e-Ruler [9] are free programs. These programs allow us to make an easier analysis of physical actions than the commercial programs. The time information can be found using the VirtualDub, while the position information can be calculated using the e-Ruler after its calibration from the similarity to the real dimensions of some object recorded in a video playing in the VirtualDub.

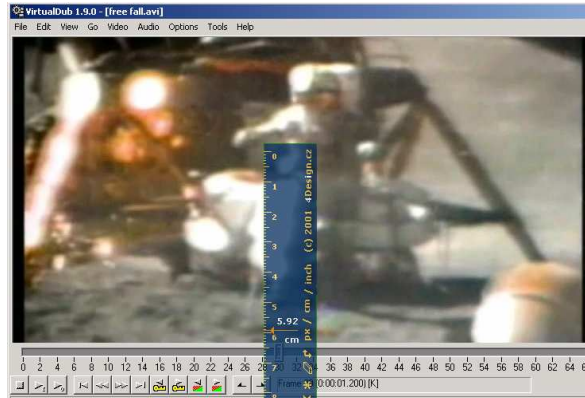


Fig. 3. The analysis of the motion of a hammer on the Moon using the VirtualDub and the e-Ruler programs

From the estimate of the height of an astronaut we calculated the distance of the free fall of a hammer on the Moon. Applying the well known equation for the distance traveled by an object in the free fall and the time information deduced from the VirtualDub we found the value of the free-fall acceleration on the Moon $g_M = 1.82 \text{ m}\cdot\text{s}^{-2}$.

2.4 AUDACITY

Audacity is free, open source software for recording and editing sounds. We can use Audacity to record live audio through a microphone or a mixer, to edit sound files, to cut, to splice, to copy or to mix the sounds together, to change the speed or the pitch of the recording, and more [10]. We used Audacity for the sound recording of the bounds of a ping-pong ball, for finding the duration of the upward and downward motion. The height we can find using video camera or measurement. (If we drop the ball from about 1 meter distance above the table, after bound the ball achieves the maximum height 0.63 meter in our measurements). The time of the free-fall drop is one half of the time between two bounds.

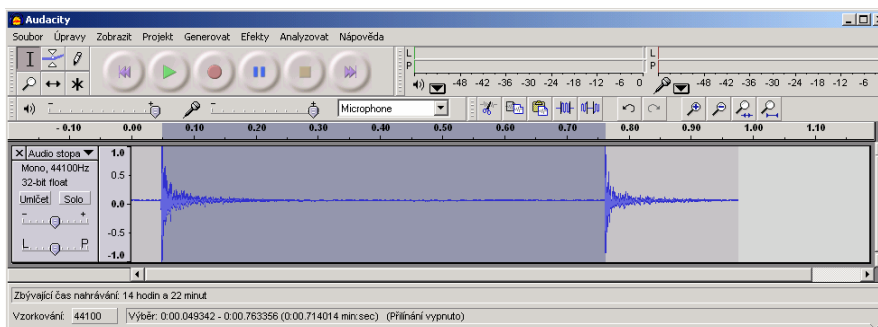


Fig. 4. Amplitude wave form – oscillogram, recording of two bounds of the ping-pong ball

In the oscillogram the x-axis represents the time, the y-axis indicates the relative amplitude. Using this program we calculated the time between two following bounds of the ball ($t =$

0.714s = twofold time of free fall) and using the measured value of the maximum height (the maximum distance of the freely falling ball from the ground) we found the value of the free-fall acceleration $g = 9.88 \text{ m.s}^{-2}$.

Some of these programs are successfully utilized by the school attending children in the Children's University of Žilina, too. For example, Audacity enables one to record, to replay and to analyze the various sounds [11].

3 CONCLUSION

Studying using computer (e-learning) compels the students to work in an independent and imaginative way. New techniques and technologies attract students' attention. Interactive programs develop students' creativity and their creative thinking, encourage them to experiment, and to analyze their own movies and videos. Using this computer software, teachers can easily demonstrate the relationships between mathematical functions and the real world described by physics. Utilizing useful computer programs in physical analysis of real processes is one of the ways how we can strengthen the key competencies for students.

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