Using Video Analysis Software to Enhance Traditional Physics Experiments

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Introduction

Computer technology has for a number of years provided new methods to assist science teachers. However this technology has often been beyond the reach of science budgets. With inexpensive computers now on the market and a syllabus that requires the use of computer technology science teachers are increasingly having to adapt to what at times appears to be complex software and hardware. In this workshop I examine a small sample of inexpensive software that can be used to support the Physics Stage 6 Syllabus.

Workshop Content

Demonstration 1: Video Analysis Software

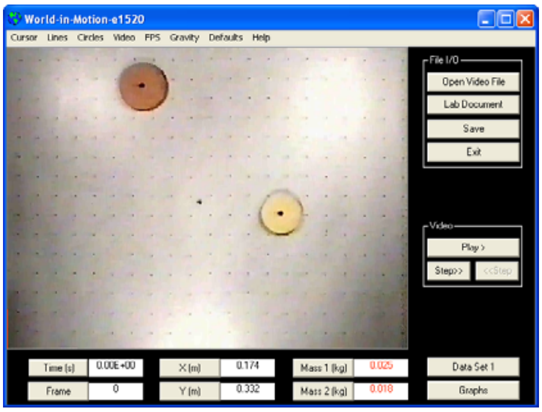
World in Motion is a program designed to analyse video footage and produce a range of graphs from position vs time to momentum vs time. A large number of videos are included on the CD, which illustrate both one and two dimensional motion. They range from objects rolling along horizontal and inclined planes to projectile motion and collisions. In addition you can analyse your own video, if you have a video camera and a video capture card.

In this workshop we use this software to perform two experiments -

i) a collision relating to Stage 6 Syllabus Content 8.4 Moving About and
ii) projectile motion relating to Stage 6 Syllabus Content 9.2 Space.

These experiments are discussed below

Exercise 1: A Two Dimensional Collision



The figure at right shows two pucks colliding on an air table. An air table provides a cushion of air and reduces friction. Both the x and y directions, in this video, are real world horizontal. The video was taken using a tripod with the camera pointed down at the air table.

In this example we step through the video marking the position of both pucks as instructed.

Measurements taken directly from a screen can be difficult so in practice this experiment is best done using a display system and white board, or clear plastic overlay and marking pen.

Using the overlay provided mark the dots for both pucks and produce position vs time graphs for the motion before and after the collision. From these graphs determine the velocities before and after the collision. Compare your graphs with that produced by the software.

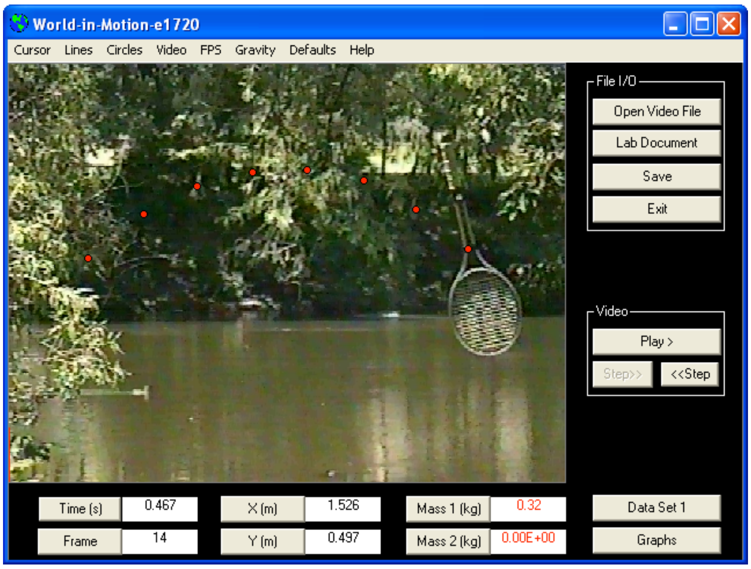
Optional: Verify that momentum was conserved in this collision by determining the total momentum before and after the collision. All data including puck masses is provided.

Exercise 2: Projectile Motion

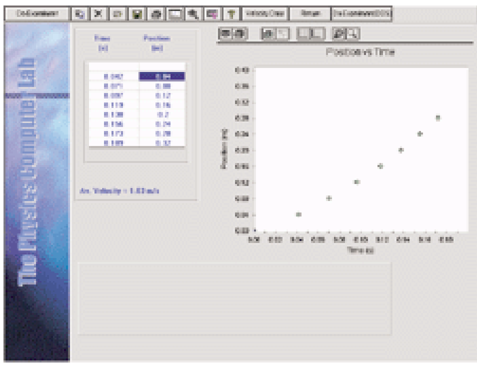
The figure below shows a picture of a tennis racket traveling across the video. As it travels, it also rotates. In this example we can show that the centre of mass of the racket undergoes projectile motion. A black tape indicates the centre of mass.

By stepping through the video and placing dots on the centre of mass for each frame produce position vs time graphs for this motion in the horizontal and vertical directions. Compare your graphs with those generated by the computer.

Optional: Produce velocity vs time graphs for both directions.

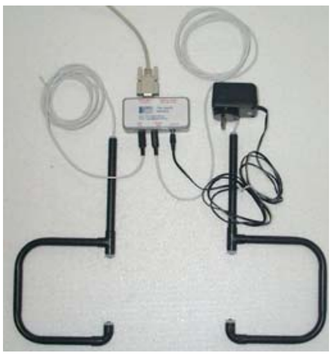


Exercise 3: Using a data logger to analyse motion



In this demonstration I will use both distance sensors and photo gates (with picket fence) to analyse motion and compare this technique with video analysis techniques.

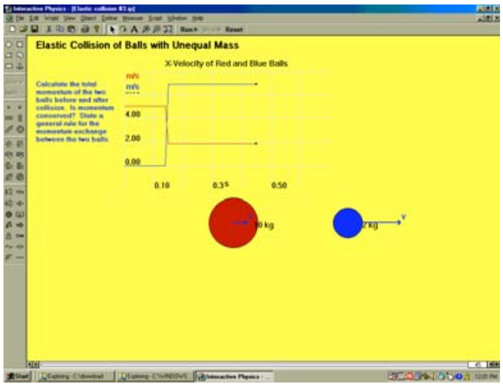
Position vs time and velocity vs time graphs will be produced and the direct techniques compared with those used by video analysis.



Optional Demonstration 2: Simulations you Create Yourself: Interactive Physics

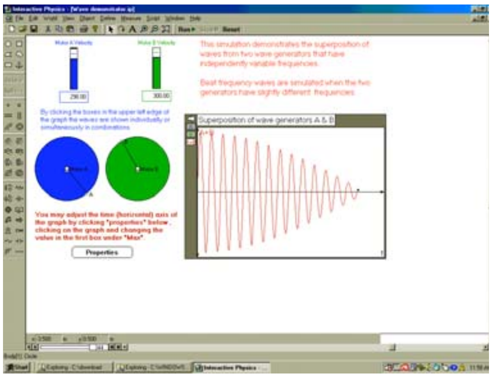
Interactive Physics makes it easy to integrate modeling and simulation into your physics classes.

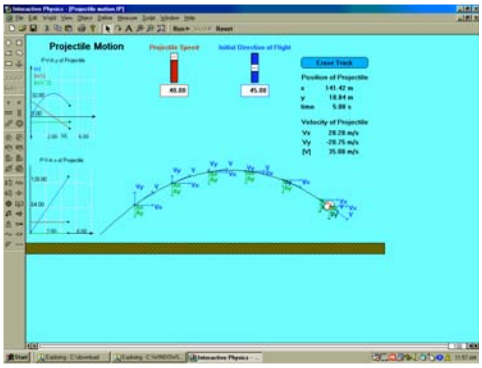
It contains a range of predefined solutions including dynamics, mechanics, electrostatics and magnetism, or alternatively you can create and save your own by drawing onscreen with a powerful and easy-to-use graphic interface.



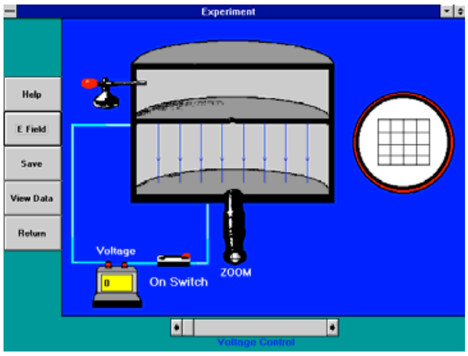
You can add objects such as springs, dampers, ropes, and joints. Measure attributes of your objects like velocity, acceleration, momentum, and energy. You can also display these measurements as numbers, graphs, or animated vector displays. Then interact with your model in real time by changing parameters as the simulation runs.

In this part of the workshop you can examine a number of predefined solutions and create a simple one ourselves.



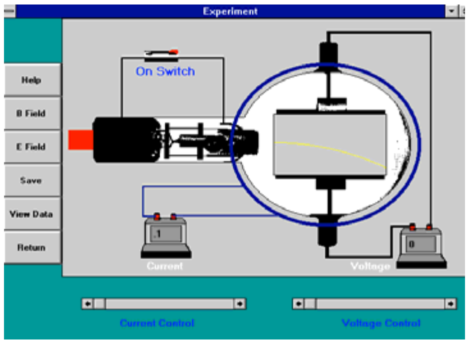


Optional Demonstration 3: Simulation Software

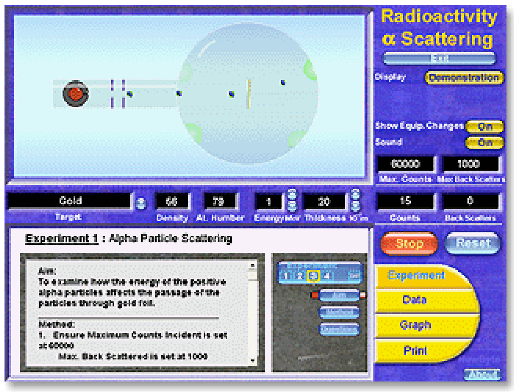


Simulation software provides a means to perform experiments that are either dangerous or difficult to conduct in the school laboratory.   In this demonstration we look at three examples of simulation software for use with the Stage 6 Syllabus.

1. Millikan Oildrop Experiment: This software package simulates the famous oil drop experiments conducted by R.A. Millikan between 1909 and 1913. From these experiments Millikan was able to successfully determine the charge on the electron.



2. Thomson's Charge to Mass Ratio Experiment In 1897, the British Physicist J.J. Thomson succeeded in finding the charge to mass ratio (e/m) of the electron. His famous experiment used an evacuated tube to enable a beam of electrons (Cathode Rays) to pass through without collisions occurring with gas molecules. This software package simulates this experiment.



3. Rutherford's Alpha Scattering Experiment This software package simulates Rutherford's famous experiment It is a comprehnsive package allowing students to investigate the relationship between metal thickness, particle energy, target atomic number and alpha particle back scatter.