A brief introduction to video analysis

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A Brief Introduction to Video-Analysis

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Video Analysis (VA) represents a general class of techniques used to extract physical data from digitally recorded images that has recently become a valuable tool in teaching introductory physics.[1,2] Originally used for the study of kinematics, nowadays its application has been extended to the study of any phenomenon wherever visible changes in the setup or in the device reading takes place [3]. VA can be used effectively for both in-class and home-work activities, becoming a feasible, cost effective alternative to live experiments when the equipment is unavailable, the motion is too fast to observe with the naked eye or the phenomena under study take place outside of the classroom. Based on our experience with VA, it has enormous potential to captivate and engage the students.

In VA of motion, the staged experiments or real-life events such as roller-coaster rides, car races, objects falling, etc., are video recorded, uploaded on a computer and analyzed using commonly available software packages such as Logger Pro [4], Tracker [5], or other similar open source or commercial software. A camcorder or a webcam connected directly to the computer captures the event in real time. In addition to photographs, most modern digital cameras allow the recording of short video clips that can be later inserted in the program. Cell phones with video recording capabilities can be used as well. The software allows you to obtain motion data (time and position) from each time frame (30 frames per second for a typical camera). This recording speed is usually sufficient to capture most of the popular classroom experiments. Webcams can exhibit some delays in displaying the movie being recorded, but even webcams works well enough for slower events. Faster events like explosions and collisions might require more expensive high-speed recording equipment. Once the video clip is inserted in the program, it can be advanced by one frame at time, and the positions of objects in each video frame can be measured by pointing a mouse and clicking. The dots representing a motion diagram appear in the movie window, and the numerical data table, along with the graphs of motion, is generated by the program. The data generated can be graphed, analyzed using spreadsheets, fitted and compared to theoretical models.

An example of VA of a free falling object is shown in Figure 1. In this example a ball is dropped and allowed to fall freely while a video of its descent is recorded and then entered into, in this case, the Logger Pro software package. The graphs on the right show vertical displacement and vertical velocity of the ball as functions of time. Logger Pro software used in this analysis allowed us to fit the data to obtain the values of instantaneous velocity values of the ball and its acceleration. This example can be used to link students'
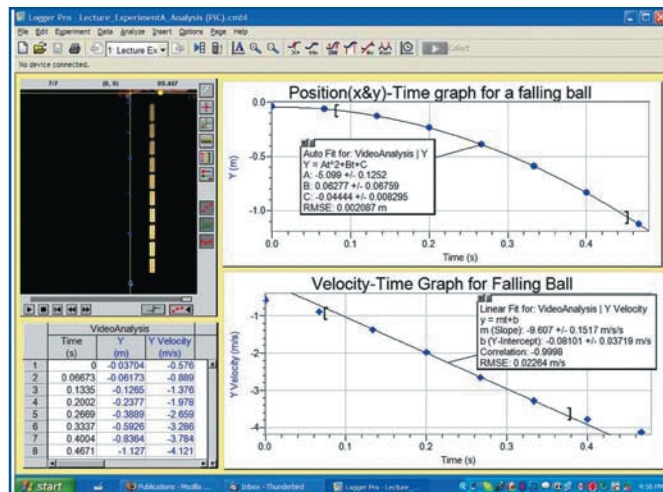

Fig.1: Video Analysis of a free falling object

mathematics and physics knowledge: the raw data contains the position-time information, while the velocity and acceleration values can be obtained from it either using calculus or graphically. We use this activity to help the students to overcome persistent difficulties with interpreting graphs of motion [6] and linking different representations of motion such as motion diagrams, kinematics graphs and numerical values.

There is a wealth of online resources on VA. LivePhoto Project at Rochester Institute of Technology has a large collection of very short video clips [7] and a collection of links to other relevant resources. Patrick Cooney's website [8] has a section that covers all aspects of making movies for VA. His hands-on advice ranges from the choice of recording equipment to the discussion of potential problems and pitfalls. Another great resources, mentioned earlier, is a free Java Video Analysis tool developed by the Open Source Physics Project called Tracker.5

If you are planning to attend CAP 2009 Congress in Moncton, you will have a chance to participate in a hands-on introductory work-shop that will help you get started using Video Analysis for class-room and homework assignments. The examples of recording and analyzing of short video clips will be demonstrated.

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