Laboratory 4: High Speed Video

To: R&D Team
From: James W. Bales
Date: 7 October 2009
Re: Evaluation of High-Speed Video.
IM4-JWB

I've been asked if we need to purchase a High-Speed Video (HSV) system to expand our motion analysis capability. As these systems cost in the $20k to $80k range, I've arranged to have Vision Research loan us their Phantom 7.1 HSV system so that we can evaluate it. I need a head-to-head comparison of the HSV against our standard multi-flash technique, as well as a sense of how the HSV compares to synch and delay.

Assignment
Use the HSV to image a falling object and calculate *g* from your results. Compare these results to your work with the multiflash system. Next, use the HSV to look at the milkdrop experiment. Compare its ease of use and image quality to what you might expect from using a film camera and the synch and delay technique. Finally, take time to look at something interesting with the HSV. (As usual, discuss your proposal beforehand with the Lab Manager, who has final say in what experiments are performed.) Write up your results in a memo. Your memo should:

1. Provide a quantitative assessment of the accuracy of multi-flash and HSV for determining *g*. Discuss the benefits and drawbacks of each method.
2. Present HSV images of the splash of a milkdrop, and discuss the benefits and drawbacks of HSV vs. Synch and Delay.
3. Present any additional images you obtained.
4. Describe your procedures in sufficient detail that we can reproduce your results.
5. Recommend if we should consider purchasing an HSV system. If you recommend that we consider the purchase, tell us how you think it will save us money, improve our productivity, or allow us to do what we cannot accomplish with film and strobes. If you recommend that we not consider the purchase, tell us what would have to change to make it worth considering.

Laboratory 4 -- HIGH SPEED VIDEO

In this lab you will work with a High Speed Video system. Items in **bold** should be prepared in advance of lab and handed in to your TA. **Have your equipment list and work plan written in your notebook when you arrive for lab. Estimate the time you will spend on each part of the lab.**

1. Measure the acceleration of a falling object. Set up the experiment so that you are able to observe the acceleration over a height range of approximately 1 meter. You may use a 28 mm, 50 mm, or 90 mm focal length lens. Assume that the electronic image sensor (800 x 600 pixels) measures 17.6 mm wide by 13.2 mm high. Pick a lens and set up the camera to maximize your resolution. **What is the magnification? What will be the approximate lens-to-subject distance?**

   Think in advance about the characteristics that an object should or should not have to give you good data. **Plan how you will calibrate the image.**

   How long will it take the object to fall? Use the cursor built into the Phantom software to acquire position information as a function of time. Use at least 10 measurements spaced over the course of the fall.

   Analyze and plot your data during the lab session so that you are assured of getting reasonable results and can correct any experimental problems as they arise. *Include a plot of velocity versus time in your lab report*. On the same plot show the relationship between velocity and time you expect on the basis of theory. What value do you find for *g*? What are the inaccuracies in the process and how might you improve the experiment? Compare your results with HSV to your results from the multiflash experiment.

2. Use high-speed video to examine the splash of a milk drop.

   In advance of lab plan what lens you will use. You want good magnification, but you do not want to be so close that the splash might actually reach the lens. Assume that you wish to image an area 2" wide. Assume that the electronic image sensor (800 x 600 pixels) measures 17.6 mm wide by 13.2 mm high. Your Lenses are:

   Lens 1: 28 mm focal length; minimum working distance of 0.85 meters.
   Lens 2: 50 mm focal length; minimum working distance of 0.45 m.
   Lens 3: 90 mm focal length; minimum working distance of 0.40 m.
   Lens 3: 200 mm focal length; minimum working distance of 0.71 m.

   Which lens do you choose, and what are the appropriate object and subject distances?

   Copy your files to your team's hard drive. You may download the Cine Viewer player from the subject web page (under "Resources"). Generate printouts to include in your report. Include a sequence of at least five (5) images to characterize the splash sequence.

3. Time permitting, study something that interests you. **Email 6.163-staff@mit.edu with your ideas at least 48 hours in advance of your lab! When you arrive in lab, your equipment list and work plan must cover this part of your experiment.**