Video Modeling with Tracker

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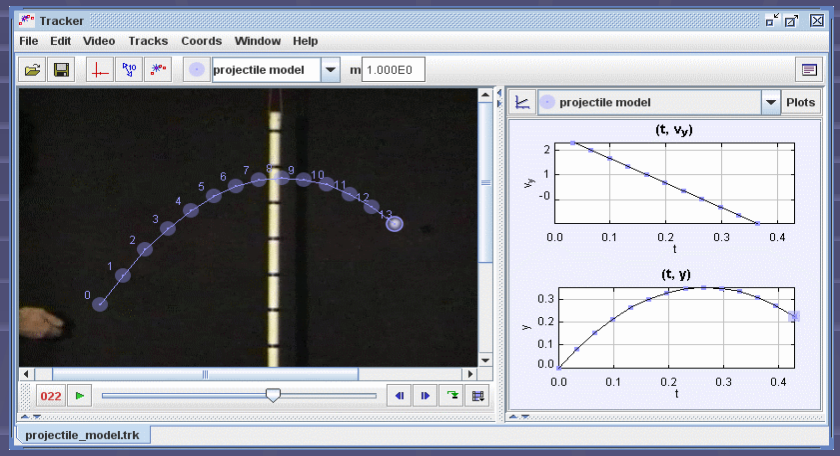
Tracker is a free Java video analysis and modeling tool from Open Source Physics.

What is Video Modeling?

- Compare videos of the real world to animations of theoretical models.
- Students define force expressions, parameters and initial conditions for dynamic particle model simulations based on Newton's Second Law.
- Model simulations synchronize with and draw themselves right on the video.

Example: Freefall



- *Objective*: test constant force model, find g.
- *Experiment*: capture video of a tossed ball.
- *Model*: Fy = -mg.
- *Comparison*: adjust model for visual fit.
- *Conclusion:* the model works well.

Traditional Experiment

- *Objective*: test constant force model, find g.
- *Experiment*: drop a ball, measure position-time data (spark tape, motion detector, etc).
- *Model*: Fy = -mg, so ay = Fy/m = -g (constant), therefore vy = vy0 – gt.
- *Comparison*: Plot vy *vs* t, fit straight line, determine slope to find -g.
- *Conclusion*: anything from “human errors” to “correlation coefficient = 0.998”

Video Modeling Advantages

- Students build the model.
- Model testing is visual, not mathematical.
- Focus is on how forces affect motion.
- Interactive process, instant feedback.
- Intuitive interpretation of results.
- Discrepancies lead to exploration.
- ODE solver handles all force possibilities.

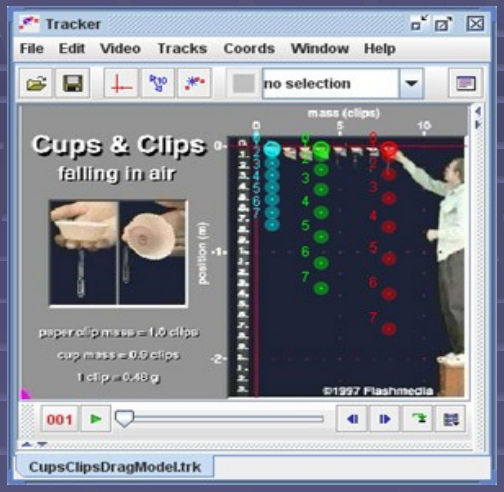
What About Analysis Skills?

- Model particles generate data, so analysis is easily included.
- Students can analyze model data alone.
- Students can compare model data with experimental data.
- Students can compare one model with another.
- BUT much can be learned without analysis.

Video Modeling: Beyond Basics

- Available expressions and constants
- Using expressions for initial conditions
- Discontinuous forces: “if” statement
- Support functions to simplify expressions
- Polar coordinates

Air Resistance Models

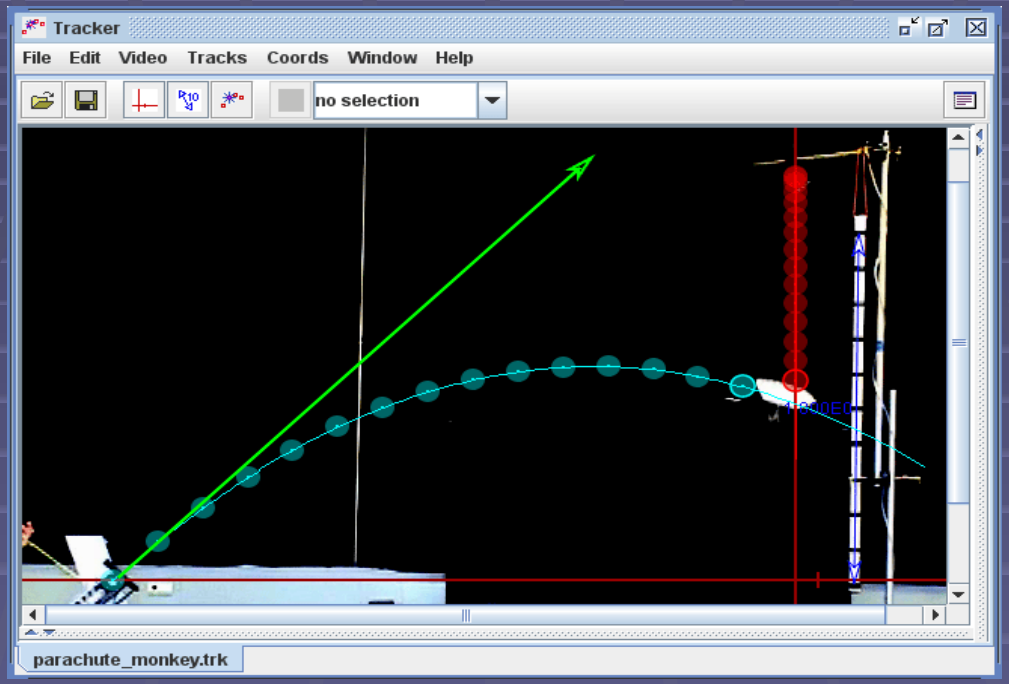


- Video: falling cupcake cups
- Viscous and drag force models
- Brown & Cox, "Innovative Uses of Video Analysis," *The Physics Teacher* **47**, 145-150 (March 2009)

Student Modeling Project

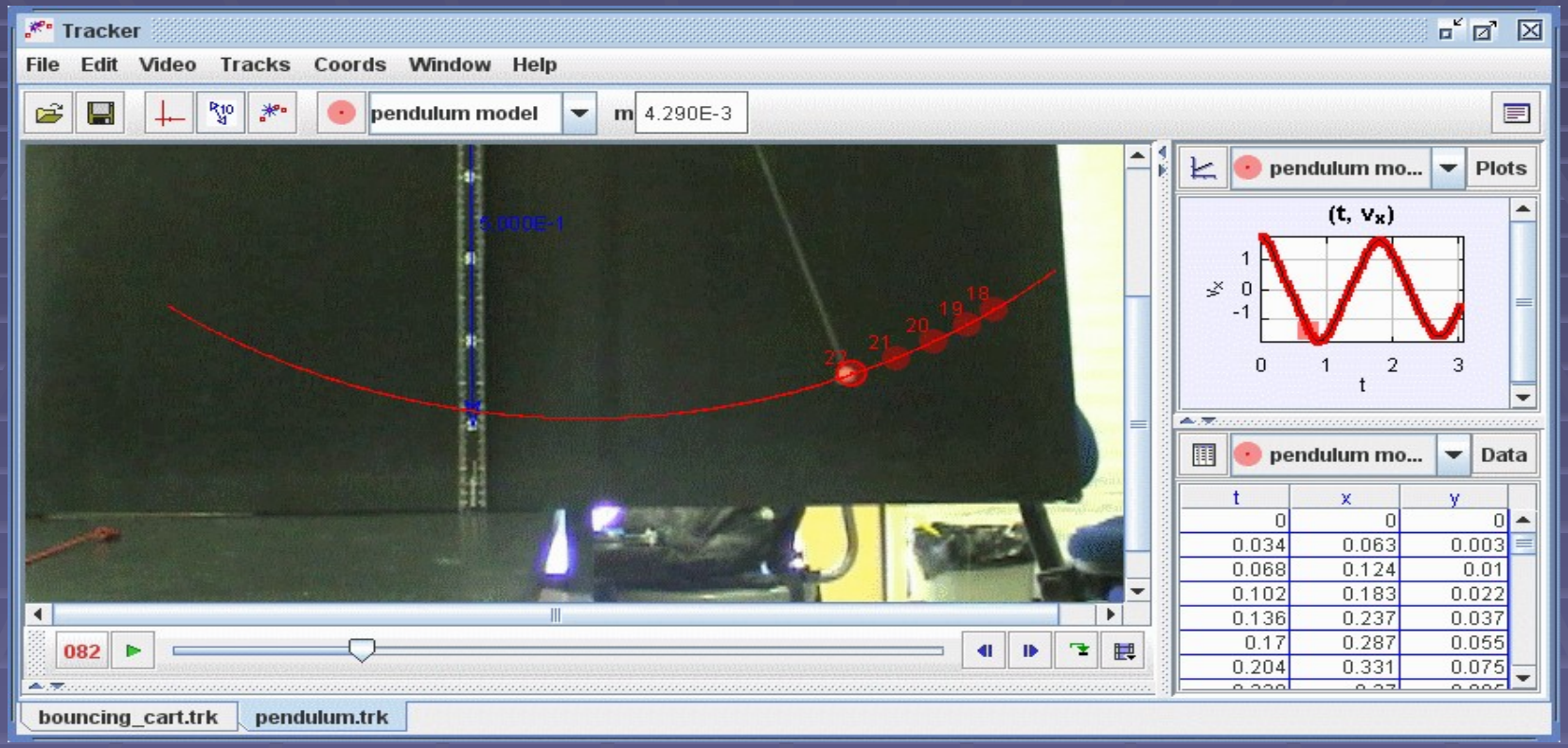
- First semester calculus-based mechanics
- Open-ended assignment
- Groups of 2-4
- 3 weeks at end of semester
- Worked on projects in both lab and drop-in learning community
- Formal presentations of results

Monkey with a Parachute



- How should you aim to hit a coffee filter?
- Use models to make a prediction.
- Hit it on the first try!

Pendulum



- Large amplitude oscillations with drag.
- Use polar coordinates.

Other Examples

- “Spring Wars”: cart pulled by opposing springs and slowed by friction.
- Accelerating cart pendulum.
- Bouncing cart on an air track.
- Mass/spring in oil.

Conclusion

- Video modeling is an attractive way to introduce students to dynamic particle modeling and Newton's Second Law.
- Tracker is freely available from Tracker's home page <http://www.cabrillo.edu/~dbrown/tracker/> or the comPADRE Open Source Physics collection <http://www.compadre.org/OSP/>
- Contact Douglas Brown at dobrown@cabrillo.edu
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Tracker

OSP open source physics

comPADRE Digital Resources for Physics & Astronomy Education