Open Source Physics in the Amusement Park

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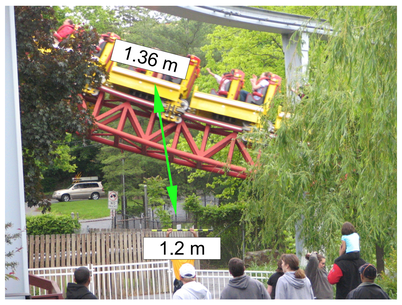
Abstract

There are a variety of tools from the Open Source Physics project in typical amusement park physics activities. The Tracker Video Analysis tool can be used to extract data from video clips that can be taken with almost any modern digital camera. We present some examples of the use of Tracker to analyze motion of amusement park rides and discuss some of the issues with camera set up and video calibration. We also present some simple simulations created with the Easy Java Simulations tool.

www.opensourcephysics.org	Open Source Physics
www.um.es/fem/Ejs/	Easy Java Simulations
www.cabrillo.edu/~dbrown/tracker/	Tracker Video Analysis and Modeling Tool

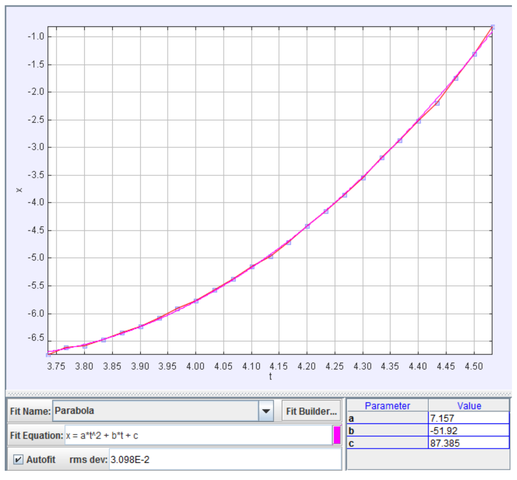
Video Analysis with Tracker

- Tracker video analysis program (free)
- Digital Camera with video mode
- Video clips from moderately priced digital camera
- Tripod recommended
- Distance + telephoto = reduced perspective distortion
- visual element to set length scale
- Example: Storm Runner launched coaster



First Stage of Calibration with Photo

Video Track with Second Stage Calibration



acceleration = 2×7.2 m/s^2 = 14 m/s^2

Hershey claims storm runner goes 0 - 72 mph in 2 seconds

72 mph = 32 m/s

$a = \Delta v / \Delta t$ = 16 m/s^2

Other videos

Pirate Swing Ride (pendulum, simulation)

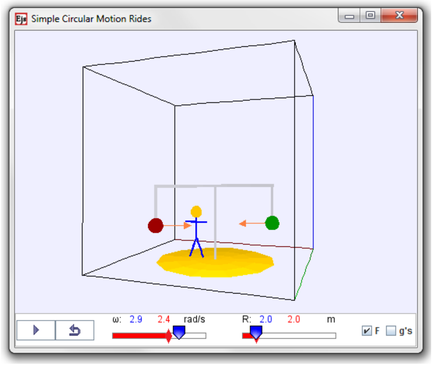
Swing Rides (centripetal acceleration)

Coaster with Vertical Drop (acceleration)

Log Flume (motion on a ramp, but ...)

including some high speed video (125, 250 fps) with Casio EX-ZR100

Amusement Park Simulations With EJS



Simple Circular Motion Rides

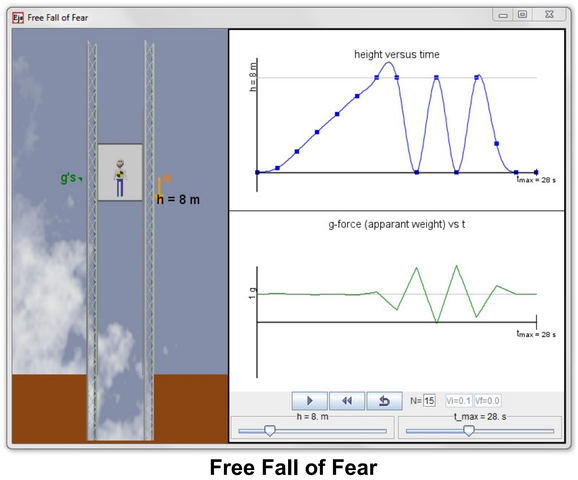
- Exploration of the physics of the simplest type of ride
- Experimental "lagged" controls to prevent unrealistic thrashing of virtual riders
- Worksheet Questions:

  How does the rotational speed ω affect the force felt by the riders?

  How does the radius R affect the force felt by the riders?

  What is the greatest force you can get out of this ride? Discuss the ramifications in terms of the physiological impact of g-forces.

  List some rides that are at least approximately simple circular motion. Which, if any, of these rides would be "extreme"?
- Similar Merry Mixer/ Scrambler Simulation

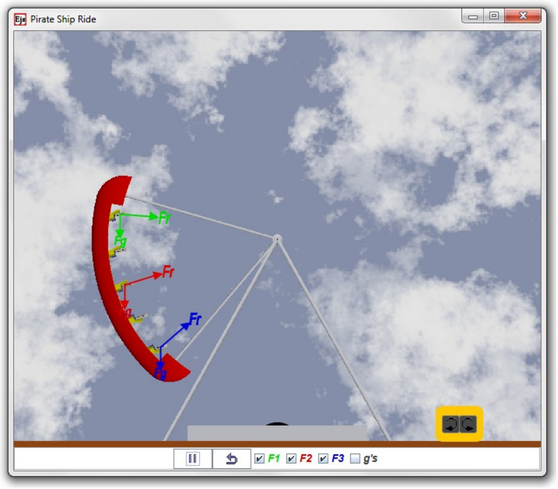


Free Fall of Fear

- Elevator Rides as an introduction to kinematics +
- Students design ride experience
- Contrast acceleration and apparent weight
- Worksheet Questions:

  For more dramatic rides that stay within our ride requirements of starting and ending velocity, what is the greatest g-force you can get out of the simulation? Is this a safe ride? Include a sketch of your height versus time and g-force versus t graphs.

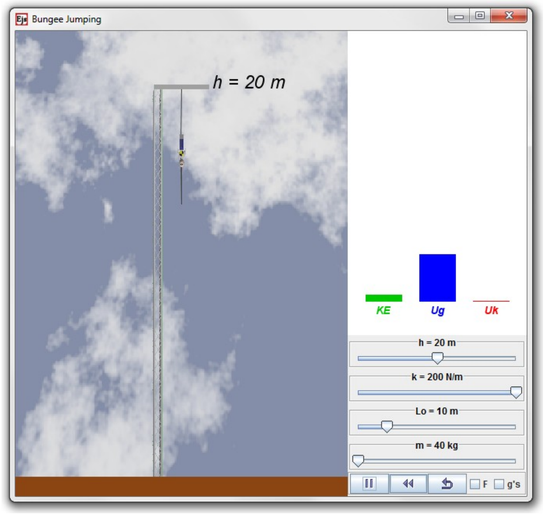
  What is the greatest time you can get the rider to be at or near zero g's? Include a sketch of your height versus time and g-force versus t graphs.



Ship Swing Rides

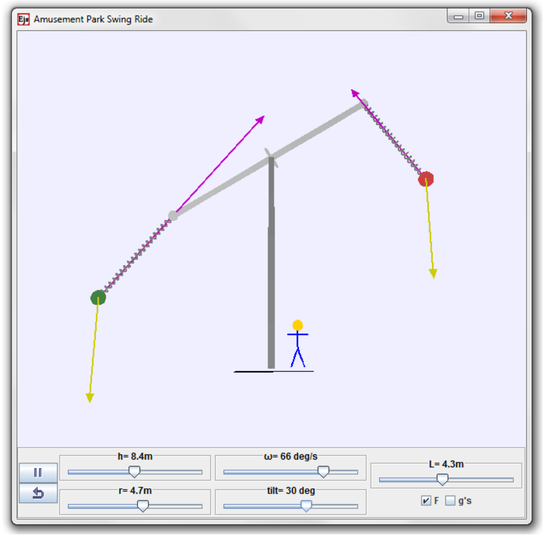
- Students "drive" the ride controls, physically reasonable parameters
  - Torque only while ride is in contact with driver
  - Drive on in either direction or off
  - physical parameters in simulation estimated, not researched
- Exploration of physical pendulum
  - Period
  - Amplitude dependence of period
  - work/energy concepts

    (drive torque+angle+swing height)
- Does the rider's seat affect the rider's experience?



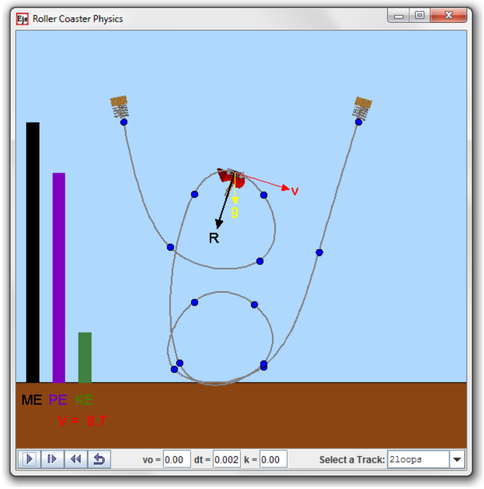
Bungee Jumping

- Multiple types of potential energy
- Safety (impact and G forces)
- More sophisticated physics coming soon (friction, more realistic elastic model)



Swing Rides

- Physical model drives dynamics
  - Rigid structure rotates about a tilt-able axis
  - Swings connect to structure with damped springs
  - Air Resistance



Roller Coaster

- Exploration of conservation of energy and friction as well as reaction forces
- Editable Track
- Sophisticated Dynamics (includes notes on Lagrangian dynamics)
- Available in OSP repository

Parting Comments

- Open Source Physics has tools appropriate for Amusement Park Physics:
  - Tracker Video Analysis
  - Applets (OSP repository)
  - Tools to make your own (EJS)
  - Curricular materials (OSP repository)

The EJS applets created for this project available at

http://phys23p.sl.psu.edu/amuse/