Video Analysis Workshop: Representing Motion

Goals: Improve communication and teamwork capacities**;** Improve ability to record notes; Improve confidence using computers; Start learning to use analysis tool LoggerPro; Start learning to perform video analysis; Use video analysis to produce motion diagrams and position vs. time graphs; Apply video analysis to constant velocity and constant acceleration motion along a straight line; For constant velocity situations, use the slope of the position vs. time graph to determine the velocity; For constant acceleration situations, use the slope of the velocity vs. time graph to determine the acceleration.

Equipment & Groups: Your primary tool today will be the computer; you'll need to use one of the classroom computers as we will be working with specialized software. If you'd like it, you can obtain a copy of the LoggerPro software we will be using today, located in the program Orca share, under Handouts, Software. If you choose to install LoggerPro on your own computer, you can find the password in the same place as the download file.

The videos for today's video analysis are located in the program Orca share, under Handouts, and then in the Video Analysis Workshop folder.

For today's activity, you will work in groups of 2 at a shared computer (it's ok if you work alone, but it's not ok to have more than 2 in a group since that's too many at a single computer).

References:

- LoggerPro tutorials 01 Getting Started, 07 Viewing Graphs, and 12 Video Analysis, available under LoggerPro, File: Open: Tutorials.
- 00 Video Analysis for LoggerPro, available in the program file share, under Handouts: Video Analysis Workshop.

PART 1: VIDEO ANALYSIS, MOTION DIAGRAMS, POSITION VS. TIME AND VELOCITY VS. TIME GRAPHS
As a class, you will be introduced to video analysis. By the end of this introduction, you will be shown how to do the following. On completion of this workshop, you should individually be able to do all the things on the following list. One person should follow along on the computer, while the other person takes careful notes.

- ☐ Find and launch LoggerPro, Insert a Movie, and Play the video
- ☐ Turn on the Video Analysis tools
- ☐ Set the scale to convert screen coordinates to world coordinates
- ☐ Add points to make a Motion Diagram, toggle trails to show or hide points, and delete a point
- ☐ Use Movie Options to set the frame advance
- ☐ Set the Active Point to track more than one object
- ☐ Make a Position vs. Time graph and a Velocity vs. Time graph
- ☐ Find and show best fit lines on graphs
- ☐ Copy motion diagrams and graphs into a separate document for later printing
- ☐ Save LoggerPro files to your Cubbie or Workspace

a) Together, we will analyze the video One Buggy (source: J.A. Bryan, Ball State University). All videos are available in the program file share, in Handouts: Video Analysis Workshop. In LoggerPro, make sure to use Insert: Movie to open the video from within LoggerPro (don't use File: Open).
b) We'll produce a motion diagram.
c) We'll produce a position vs. time graph. Since the motion is in the x direction, this is an X vs. time graph; remove the Y data since it is not important in this case.
d) Analyze the position vs. time graph for the buggy to determine its velocity by finding a best-fit line to the X vs. time graph and recording the slope.
e) Analyze the velocity vs. time graph for the buggy to determine its velocity by using the Statistics tool. Compare the velocity found this way to the velocity found in part d).
f) Save the (usefully named) LoggerPro file to your Cubbie or Workspace folder. Close LoggerPro.

PART 2: SLOWING DOWN (source: J.A. Bryan)
Here, we will again perform video analysis together. This time switch who is on the computer, so that the other partner performs the video analysis at the computer. The person who previously used the computer should take careful notes. As we'll discuss, this is a situation with non-constant velocity.

a) Re-launch LoggerPro, and use Insert: Movie to insert the video Slowing Down. Watch the video a few times (straight through and using the scroll bar at the bottom of the video player screen). How do we know this must be non-constant velocity?
b) Produce a motion diagram.
c) Produce/examine the position vs. time graph (since the motion is in the x direction, this is an X vs. time graph; remove the Y data since it is not important in this case).
d) Produce/examine the velocity vs. time graph (since the motion is in the x direction, this is an X velocity vs. time graph; remove the Y data since it is not important in this case).
e) Analyze the velocity vs. time graph to determine its acceleration.
f) Save the (usefully named) LoggerPro file. Close LoggerPro.

For the remaining parts, work with your partner. Use your experience and your notes to solidify how to carry out video analysis.

PART 3: TWO BUGGIES

a) Re-launch LoggerPro, and use Insert: Movie to insert the video Two Buggies. Reproduce the steps demonstrated in class to create motion diagrams for the two buggies.
b) What do you notice about the spacing between the dots in the motion diagram? What does this indicate?
c) Analyze the position vs. time graphs for the two buggies to determine their velocities. Comment on the signs of the slopes.
d) Save, etc.

PART 4: SPEEDING UP (source: P.Bohacek)

a) Re-launch LoggerPro, and use Insert: Movie to insert the video Speeding Up. Note the non-standard frame rate for this video, indicated in the first frame. You can adjust for this using Movie Options (right click on the movie) and then look for Override frame rate to: .
b) Produce a motion diagram and examine the position vs. time (just X) and velocity vs. time (again, just X velocity) graphs. Is the toy bus moving with (nearly) constant velocity? With (nearly) constant acceleration? If so, determine the velocity or acceleration.
c) Save, etc.

PART 5: BALL TOSS (source: J.A. Bryan)

a) Produce a motion diagram. What occurs here that hasn't occurred in your previous motion diagrams? You may find it convenient to turn off the toggle trail while clicking so as not to be distracted by the points but then turn them on again when done to produce the motion diagram.
b) Reproduce the rest of the analysis as in Part 4, noting that this time the motion is in the Y direction.

ANALYSIS

1. Consider your results from Two Buggies. What evidence on the position vs. time graph supports the claim that the buggies moved at (nearly) constant speed? Which buggy moved faster? How does that show up in your position vs. time graph? How does the fact that the buggies are moving in opposite directions show up in your position vs. time graph?
2. Consider your results from Speeding Up. What graphical evidence supports the claim that the truck moved with (nearly) constant acceleration?
3. Consider your results from Ball Toss. What graphical evidence supports the claim that the ball moved with (nearly) constant acceleration? What value is this suggestive of?

CHALLENGE PROBLEM: WILL THEY COLLIDE? (attempt if you have time, interest)
View the video Will They Collide. Use the video analysis techniques you have learned today to start to analyze this situation. Note the complications compared to earlier analysis. You will have to use problem-solving strategies not directly addressed in lab, so you get the chance to practice being creative problem-solvers. Discuss your ideas with your partner and others. Come to a conclusion about whether the buggies will collide. Produce a clear, concise, complete summary supported by evidence, based on mathematical and physics principles, and grounded in reason that tells your story (in other words, be able to explain how you came to your conclusion).