Rotational Motion About a Fixed Axis*

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This task is similar to the experiment "Sliding Friction" where we used video tracking to investigate the friction between the surfaces of a linearly sliding body and a static surface. In this task, we will investigate friction accompanying rotational motion. A disc will be attached to a shaft and manually rotated. Friction will decelerate the rotating disc. We will record this motion on a high speed camera and investigate some interesting aspects of angular kinematics.

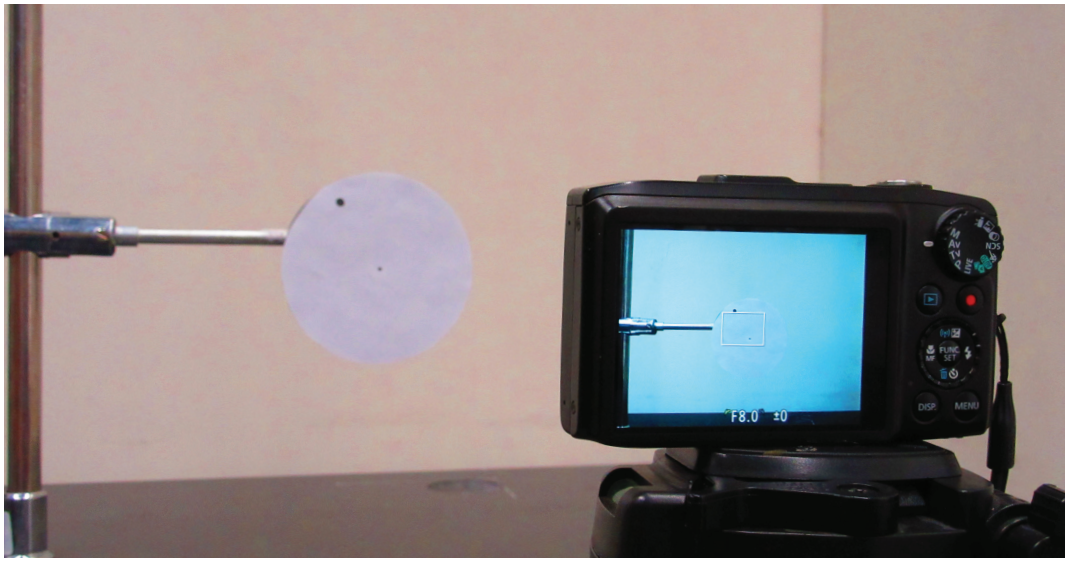

Figure 1: Set up for the rotational friction activity.

Setup the apparatus as shown in Figure 1 and set the camera mode to high speed video recording at $240 fps$. There will already exist a small tracking dot on the disc. Manually rotate the disc and let it rotate for some time. The disc will eventually decelerate to rest. Record this motion simultaneously on the camera. Transfer the recorded video file to an appropriate location on the PC.

In Matlab, browse to the PhysTrack root directory and run the script

`analyzeRotationOnAFixedPivot`. Similar to the "Sliding Friction" experiment, use the GUI tool presented by the script to trim and crop the video. In the object selection window, click the `Manually mark an object` button to draw a tight rectangle around the track pointer marked on the disc. The script will now track the marked point and present the coordinate system tool afterwards. You can move the coordinate system anywhere on the scene but as a suggestion, the script will automatically move the center to the visual center of rotation of the rotating marker. This point is actually the center of the circle defined by fitting the trajectory of the track point. For distance calibration, mark the known diameter of the disc.

The script will also perform some sample analysis on the acquired data and save some variables in the base workspace. Use these variable for further investigation of the motion. View Table 1 for the details of these variables. It is understood that you've already read our primer on video motion tracking which describes useful techniques that can be used in the analysis.

Physical Quantity	Variable Names
`xdata` of the trajectory	`dx`
`ydata` of the trajectory	`dy`
Center of the circle fit	`circCenter`
Angular displacement of the trajectory about the center of the coordinate system	`w`
Time stamps	`t`

Table 1: Base workspace variables generated by the script.

Q 1. Plot the angular displacement, angular speed and angular velocity as a function of time.

Q 2. How would you mathematically model the effect of friction?

Q 3. Is the decay exponential, linear or any other function?