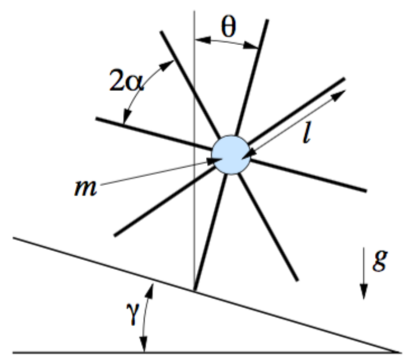
Homework 9 - BIOEN 440 / ME 445 - Spring 2016

1. Rimless Wheel Walking Model

In this problem you will explore the rimless wheel walking model in detail. The goal is to develop the equations of motion, including collision dynamics.

Do/answer the following:



Tedrake, 2009

1. Recall that we can the rimless wheel can be considered an inverted pendulum during the stance phase. Derive expressions for the kinetic and potential energy of the inverted pendulum (we did this in class!).
2. Use Lagrange's equation to derive the equations of motion:

   $$L = T - U \qquad \frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}_i}\right) - \frac{\partial L}{\partial q_i} = 0$$

   where T is kinetic energy and U is the potential energy. Use $q = \theta$. You should have one equation in the form $\ddot{\theta} = f(\theta)$.
3. Now you will derive the collision dynamics. In order to to this you must consider two points in time: t^- is the point in time immediately before collision of the next spoke and t^+ is the point in time immediately after collision. Draw two spokes of the rimless wheel at the instants of collision, Draw there respective velocity vectors v^- and v^+ (recall for pure rotation the velocity vector is tangent to the circular motion).
4. Derive the expressions for angular momentum about collision point at both t^+ and t^- instances of time. Angular momentum is defined as:

   $$H = r \times mv$$

   Show that if angular momentum is conserved then: $\dot{\theta}(t^+) = \dot{\theta}(t^-)\cos(2\alpha)$.
5. Discuss how to simulate this system (e.g., in MATLAB).

2. Paper Review

Read the *compliant leg model* paper posted on the website. Give a brief one paragraph summary. Address the following:

1. What are the experimenters trying to test?
2. How did they test this?
3. Describe the difference test conditions.
4. What were the results?
5. What are the limitations of the study?