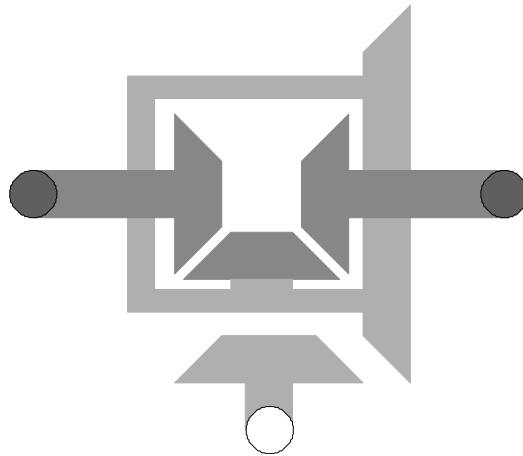# Virtual Physics

12.11.2013

Exercise 6: 1D-Mechanics: Differential

The engine of our future car model will drive the two rear wheels. These two wheels share the same axis but may rotate at different angular velocity (e.g. while driving in a curve). In order to transmit the torque to both wheels, we need a differential (gear). The task of this exercise is to model this differential.

Task A: Develop a component for a differential.

A differential is not included in the Rotational Standard Library. Hence, we have to add this missing component by ourselves. Create a 1D-rotational component with three rotational flanges and add the missing component equations.

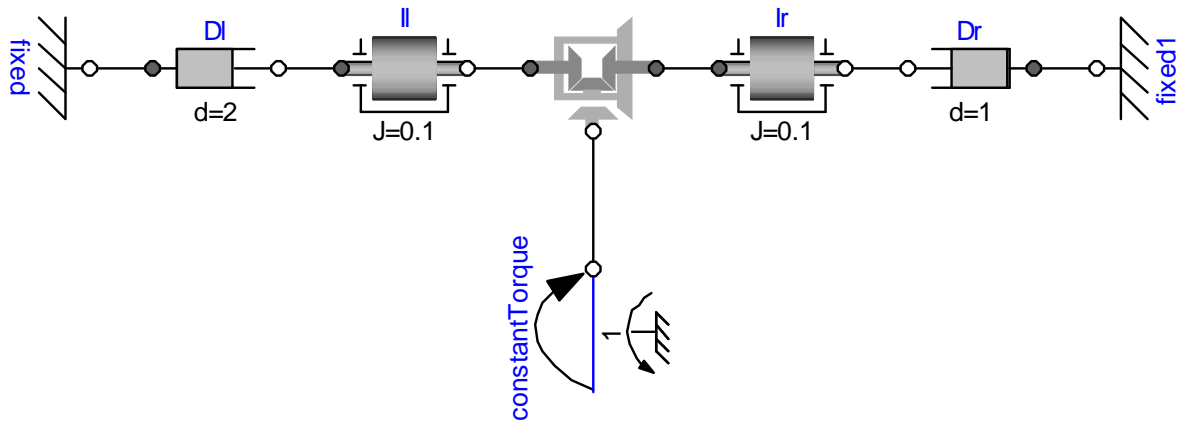For a differential the following equation holds:

$$2 \cdot \omega_{drive} = \omega_{left} + \omega_{right}$$

Since this component represents a transformer, it conservers energy.

Also the torque at left side will equal the torque at the right side.

You may either model this component from scratch or take use of already existing components in the Rotational library.

Task B: Test your component.

In order to test your component, you may build up a virtual test rig as sketched above. Examine the velocity of the inertias when the systems move towards steady-state.

Task B: (from Exam WS 2010/2011)

Let us model a film reel that is being used in a movie projector. The film reel transforms rotational motion into translational motion. However, the radius is changing while the film is being reeled. The radius is thereby dependent on the rotation angle `phi`. This is approximated by the following law:

`r = r0 + phi*d/(2*pi)`

where `d` is the width of the film.

Hint: the cable reel can be regarded as an ideal rolling wheel with dynamic radius. You do not have to use holonomic constraints. It is ok to use a non-holonomic constraints (i.e. make a statement about the velocity)

The Modelica model already contains the two connectors and the parameters. Provide the missing variables (if any) and the missing equations.

```
import SI = Modelica.SIunits;

connector TranslationalFlange
  SI.Position s;
  flow SI.Force f;
end Flange_a;


connector RotationalFlange
  SI.Angle phi;
  flow SI.Torque tau;
end Flange_b;
```

```modelica
model FilmReel

  TranslationalFlange flangeT;

  RotationalFlange flangeR;


  constant Real pi = 3.14159;

  parameter Real r0 = 0.1;

  parameter Real d = 0.0004;


equation
```