Simple Mobile Inverted Pendulum (MiP) Sketch

A close up of a clock

Description automatically generated

1. These are the final equations of motion of a simplified MiP.

(1)

(2)

: Wheel inertia

: MiP body inertia

: Wheel mass

: MiP body mass

: Wheel radius

: Distance from MiP center of mass to wheel axis

: Gravitational acceleration

: MiP body angle

: Wheel angle

: Torque

1. The current equations of motion are nonlinear and thus difficult to integrate. The equations can become linear by linearizing around the MiP’s upright state.

(1)

(2)

1. Equations (1) and (2) still have torque, which can be described in voltage. In addition, the MiP body and wheel angles share a relationship. Furthermore, a wheel’s inertia is described below.

(3)

(4)

(5)

: Motor stall torque

: Motor constant

: Wheel speed

: Motor armature speed

: Gearbox ratio

: Normalized motor duty cycle (from -1 to 1)

1. Equations (1) – (5) can be combined to form 2 models. which describes normalized motor duty cycle to MiP body angle. which describes MiP body angle to wheel angle.