Decoupled Dynamic Control of Unicycle Robot Using Integral Linear Quadratic Regulator and Sliding Mode Controller

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Abstract : This paper focuses on the dynamic modelling of unicycle robot. Two main concepts used for balancing unicycle robot are: reaction wheel pendulum and inverted pendulum. The pitch axis is modelled as inverted pendulum and roll axis is modelled as reaction wheel pendulum. The unicycle yaw dynamics is not considered which makes the derivation of dynamics relatively simple. For the roll controller, sliding-mode controller has been adopted and optimal methods are used to minimize switching-function chattering. For pitch controller, an LQR controller has been implemented to drive the unicycle robot to follow the desired velocity trajectory. The pitching and rolling balance could be achieved by two DC motors. Unicycle robot is a non-holonomic, non-linear, static unbalance system that has the minimal number of point contact to the ground, therefore, it is a perfect platform for researchers to study motion and balance control. These real-time solutions will be a viable solution for advanced robotic systems and controls.