The Stability and Control of the Single Track Vehicles

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Bicycles, motorcycles and scooters are all examples of the single track vehicles. The dynamics of the single track vehicle involve many degrees of freedom and various modes which govern its performance, making a complicated and interesting research topic. Motorcycle in motion can roll, yaw, and steer about the steering axis. It has three main modes which determine the motion and stability of it, they are weave, capsize, and wobble. The motorcycle performance is limited by the behavior of its modes, and if even one of the modes becomes unstable, the vehicle will roll over, and crash. The goal of this research is to analyze these modes and determine what parameters affect them the most, and by redesigning the vehicle, improve the performance of it. This research uses a basic bicycle/motorcycle model developed by Whipple and adds more realistic effects such as tire side slip, lateral force delays and steering damper into mathematical model. The vehicle motion is simulated in the real time with a steering torque input from the joystick to analyze the human control ability. Some of the results are expected and intuitive, some are not. Additional work is required. It is necessary to include frame flexibility and body lean input effects to get accurate results at higher speeds. The multi-body simulation code is required to obtain a non-linear model which takes into account aerodynamics, nonlinear behavior of the tires, and other features.