## Unicycle and Bicycle Model for Car Collision Avoidance

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This project’s goal is to formally verify safety regions of a car avoiding an obstacle while braking and turning. This system is represented in two separate models, the Unicycle Model and the Bicycle Model. The Unicycle Model features a single point located at the center of the rear axle of the car. The car’s physical dimensions, length and width, are still accounted for in the safety regions however the motion is modeled with the rear axle point. In order to sophisticate the system, uncertainty was introduced by adding upper and lower limits to the input controls to allow a range of possible trajectories. The Bicycle Model builds upon the Unicycle Model by changing the rear axle point to a fixed wheel and adding a second, turning wheel to the center of the front axle. The motion of the car is model in accordance with both these wheels. The significance of the Bicycle Model is that it changes the input controls to more realistic parameters. Instead of using turn radius and heading angle which is not feasibly directly regulated by a driver/controller, it uses turning angle (steering wheel) and velocity (pedals). The safety regions for both models have been derived by hand and simulated in MATLAB. Using differential dynamic logic, the Unicycle Model without uncertainty has been specified and verified with the KeYmaera X tactical theorem prover. The verification for the uncertain Unicycle Model and Bicycle Model, both rear-wheel-drive and front-wheel-drive, is still underway using the same method.