Vehicle Rollover Prevention Through Dynamic Shifting of Center of Mass

Hui, Vivian (School: Albemarle High School)

Car rollovers are common accidents on the road, resulting in 39,000 fatalities and numerous injuries every year. This research project proposes an original method of dynamically shifting the center of mass (COM) of a vehicle laterally to drastically reduce vehicle rollovers. In this research, a scaled prototype SUV with an Arduino microcontroller system was built to shift a mobile weight, such that the movement of the weight shifts the vehicle's COM. This mechanism is programmed to integrate an algorithm to process raw values read from an accelerometer into the current tilt of the vehicle. A PID loop is then implemented to logically command a stepper motor to move the mobile weight. A testing platform with slopes to simulate vehicle rollovers was constructed. Testing was performed to measure how different COM locations affect a vehicle's rollover impact energy threshold. The COM was varied by altering the location of the mobile weight, The locations of COM were calculated first and then validated through balance tests. Testing demonstrated that an 11.8% of the vehicle's total weight shift to the opposite side increased the rollover impact energy threshold by 4.00 times. Furthermore, through mathematical analysis, this research reveals that this design is more effective on vehicles with higher COMs. With the increased popularity of electric vehicles, this COM shifting method can be achieved by mobilizing an electric battery instead of adding a "dead" weight that would decrease fuel efficiency by 4.5%. A typical car battery is 450 kg, about 23% of the vehicle's total weight, much heavier and thus more effective than the 11.8% of vehicle weight used in this research. This innovation provides a cost and weight effective solution to combat vehicle rollovers.

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