Design and Simulation of Indigenous Roll-over Sensor for Four-Wheeler Automobiles

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Abstract

In India, more than 150,000 people are killed each year in traffic accidents, according to the Ministry of Road Transport and Highways 2016 report. That's about 400 fatalities a day, which is far higher than in developed auto markets like the US which, in 2016, logged about 40,000 a year. Taking note of this, the government has tightened regulations, and, from April 2019, it will be mandatory for all four wheelers to have airbags. Given the population, it shouldn't be surprising that India is among the largest car manufacturers in the world. However, the sensors employed in these vehicles are mostly imported. In this paper, we propose a design for a MEMS Gyroscope, which measures the angular velocity. Integrating the angular velocity gives us the value of the rotated angle and these two values are used to make a judgment for deployment of the airbag. A 2-DOF vibrating system is used in the drive direction which is capacitively actuated and a 2-DOF system is used in the sense direction with an interdigitated capacitor for sensing. The benefit of the system is that it gives a reasonable Q-value without jeopardizing the bandwidth, and the Q-value stays the same over large temperature and environmental (damping and noise) variations. The design and simulations of the MEMS gyroscope have been carried out in COMSOL Multiphysics using the Solid Mechanics and Electrostatics Module. The Solid Mechanics module has been used to study oscillatory motion because of sinusoidal capacitive actuation. In the sense direction, Coriolis force is calculated and then applied to study sense direction motion. The amplitude data is taken from Solid Mechanics module and then the gap in interdigitate capacitor is changed accordingly in electrostatics module to find the change in capacitance. This capacitance change can be used to calculate the angular velocity and the total angle rotated. We get change in capacitance in orders of femto-Farad which can be detected using on-chip detection mechanism. This data is fed to the ESU which takes the required action. The ease of fabrication has also been kept in mind while designing.

Figures used in the abstract

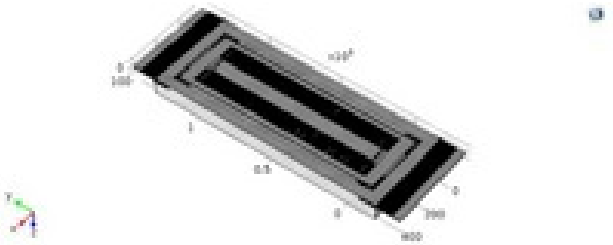

Figure 1: COMSOL Multiphysics design of 4-DOF MEMS Vibrating Gyroscope