Abstract

In order to ensure a safe driving in the dark a large lighting range of the headlamps of a vehicle is desirable. However the lighting range of the headlamps has to be limited to avoid dazzling oncoming traffic. The height of the cut-off line indicates the height of the light beam produced by the headlamp. Therefore the cut-off line of a headlamp has to be adjusted so that the largest possible lighting range is reached, without dazzling oncoming traffic. Due to the loading of the vehicle or due to dynamic pitching movements the cut-off line of the headlamp shifts. To avoid dazzling oncoming traffic, the cut-off line has to be adapted by means of a manual or automatic headlight leveling system to the load condition of the vehicle. For headlamps whose bulbs exceed a luminous flux of 2000 lumen, an automatic headlight leveling system is prescribed by law. For such a system the angle between the body of the vehicle and the surface of the road hast to be determined.

In this thesis a method is presented for determining the angle between the body of a vehicle and the road surface by means of two acceleration vectors. One acceleration vector is measured using a 3-axis microelectromechanical (MEMS) acceleration sensor and represents the superposition of the gravity vector and acceleration vector of the vehicle. The second acceleration vector is the acceleration vector of the vehicle. This can be determined by deviating the vehicle speed measured by wheel speed sensors. Using these vectors it is possible to determine the vehicle inclination. In particular, it is possible to distinguish between the vehicle and the road inclination. In addition to the mathematical derivation of the method an implementation is presented in this thesis.

Furthermore, a sensitivity analysis and the results of an extensive patent research are shown. The high number of filed patents shows that there is a high interest in the pitch angle determination by means of acceleration sensors. The approach presented here, however, is not represented in the examined patents.

Since MEMS acceleration sensors typically have a relatively large offset error, it is shown in the sensitivity analysis, that the use of non-calibrated sensors is unsuitable for use in the described method.

However, it is shown that by using calibrated sensors, the dynamic pitching movements of the vehicle could be detected during a test drive with an accuracy of $\pm 0.2865°$. This complies with legal requirements.