Pavement assisted vehicle lane keeping with passive material sensing

Vehicles with advanced driver assist systems (ADAS) and automated vehicles (AV) offer a number of safety benefits. However, in adverse conditions, their lane keeping ability is compromised as current sensors fail to perceive lane markings. Pavement assisted vehicle lateral position determination method is proposed in this study to help vehicles stay in the lane during normal and snow covered conditions. Prismatic concrete blocks of cross-section 3 inch x 3 inch were reinforced with steel fibers or metglas (metal with high magnetic permeability) to create an electromagnetic (EM) signature. Such concrete blocks were placed at the center of a 150 ft. long and 12 ft. wide lane on the pavement surface. A custom sensor array with magnetometers in gradiometer form was mounted on the bumper of the car at 6 inches above the concrete surface (which corresponds to 9 inches above the pavement surface). In addition, a front-facing camera and two side mirror cameras were mounted on the vehicle. The vehicle's position was determined using videos from the camera by applying computer vision algorithms. The average of two side cameras was considered as ground truth (the true vehicle position) and compared with the position estimated from the front camera and magnetometer. The vehicle was driven in straight and meandering motion within the lane in normal condition (dry/wet surface with visible lane markings) and with the lane covered by more than 2 inches of snow. Statistical analysis was performed for the lateral path error of 42 runs, which corresponds to driving approximately 6300 ft. The overall error of the camera and magnetometer in normal conditions was 1.3 inch and 1.6 inch, respectively. However, with more than 2 inches of snow on the lane, the camera system failed to perceive the lane marking. The magnetometer had an overall error of 1.8 inches, which is statistically similar to the normal condition error. The results showed that the proposed EM method applied to a roadway section could reliably determine the vehicle's lateral position even in adverse weather.

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