Applications

Introduction
Driving Assistance Systems combine a variety of sensors with vehicle display, control and handling capabilities to improve driver performance and safety. As part of a project to evaluate new driving assistance systems using environmental sensors, engineers at Renault needed to measure the exact car speed in real time with better than 0.1 km/h accuracy. Common existing solutions are based on either GPS (Global Positioning System), the use of CAN (Controller Area Network) data, or optical sensors.

System Comparison
Differential GPS uses a network of fixed ground based reference stations to broadcast the difference between the positions indicated by satellite systems and the known fixed positions. GPS based speed measurement systems have sampling frequencies below 100 Hz and the achievable accuracies no better than 0.1 km/h. Occasional signal dropouts are a significant disadvantage of this system.

Controller Area Network (CAN) is a shared serial bus standard for connecting electronic control units. When using CAN data for velocity measurements, the maximum sampling frequency is 40 Hz and the best available accuracy is only 0.2 km/h. Besides the lower sampling frequency and accuracy, CAN data filtering may cause a time delay of up to 60 ms. Another measurement approach is to use the Correvit optical velocity sensor. It is a non-contact solution similar to Polytec’s Laser Surface Velocimeter; but, it has a significant disadvantage in that it fails to work on wet ground.

Successful Tests
Desiring to find a better speed measurement solution, the LSV came to the attention of the Renault engineers at the end of 2004.

High-Precision Real Time Measurement of Car Speed Using Laser Surface Velocimetry

A novel application of Laser Surface Velocimeter (LSV) technology is being investigated at Renault for Driving Assistance System evaluation and test. While LSVs are traditionally used for precision measurement of surface speed and integrated length on moving materials used in manufacturing, Renault is incorporating the LSV as an on-board reference sensor to measure real-time vehicle ground speed with better than 0.1 km/h accuracy. This accuracy is found to be better than other methods commonly used for ground speed measurement including GPS.

Precision Speed Measurement by Light

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They took the opportunity to measure LSV accuracy and repeatability on a roller test bench with a velocity precision of 0.1 km/h. The results were very encouraging and a Series 6000 Velocimeter System was ordered at the beginning of 2005.

Polytec’s LSV systems combine a sensor head, a controller and software into a rugged industrial package. These systems are very accurate, making measurements from standstill to speeds of more than 7200 m/min (430 km/h) in either direction. The Series 6000 Laser Surface Velocimeter consists of a compact, IP-65 protected LSV-065 Sensor Head and a 19” rack-mountable LSV-6200 Velocimeter Controller. The Sensor Head (Figure 1) is available with various stand-off distances up to 2.5 m (maximum depth-of-field of ±0.1 m). The Controller powers the sensor head, manages signal demodulation and communicates the data to external process control systems.

To implement a field test with the LSV, a special challenge was to find the best place to mount the sensor on the car. If the sensor head were mounted outside the car, its function would be affected by vibrations and environmental conditions. The optimum position turned out to be inside the car, above the passenger front-seat (Figure 2). Once the test car had been equipped with the LSV, test runs were performed on a test track with various acceleration and braking cycles.

A GPS-based measurement system was used for comparison. From an analysis of the results, the LSV proved to be the superior measurement instrument, providing more stable and precise data. In Figure 3, velocity vs. time is plotted when braking from 80 km/h to nearly standstill. The GPS data were very noisy in comparison to the LSV data which showed a very smooth progression.

Conclusion
The LSV Laser Surface Velocimeter directly measures surface speed, thus providing an accurate, repeatable, and reliable method of car velocity measurement. When mounted in test cars, it provides very stable and precise data, even when measuring on wet ground. Further investigations are necessary to clarify details of the test installation, portability to other types of vehicles, remote power supply and data processing.

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