OMS Race Application Report 2025

Formula Student Team Delft

1 Background

Formula Student is an international engineering competition where university teams design, build, and race single-seater, formula-style cars. It gives students the chance to apply their engineering knowledge while also developing skills in project management, business, marketing, and fundraising. The competition includes both static events, which assess the car's design, manufacturing, cost and business plan, and dynamic events, which test its on-track performance.

Our team brings together passionate and driven students from across 22 countries and a range of academic backgrounds. Since 1999, we've been competing in Formula Student, designing and building high-performance race cars each year. We work together to push the limits of innovation and performance on the international stage.

Part of what makes Formula Student cars agile and fast is the independent torque control at each wheel, enabled by four powerful electric motors, and advanced control algorithms. The Controls department is responsible for computing the optimal torque distribution for each wheel to go around the track as fast as possible. To do so, it continuously estimates important information about the car's state such as velocity, acceleration, roll, pitch, yaw, and much more. This information is then used by numerous subsystems. Our traction control system manages wheel slip during acceleration, maintaining optimal traction and stability to maximize performance across varying track conditions. Our Torque Vectoring system optimizes cornering performance by controlling wheel torque to track a target yaw rate based on the current velocity and steering input. To unlock the full potential of these systems, precise state estimation is needed, which requires highly accurate sensors such as the OMS Race.

2 Use cases of OMS Race Data

2.1 Velocity Estimates

One very important aspect of our control system is our velocity estimation. Previously, the estimations were based on data from our wheel speed sensors and acceleration sensors, combined in a Kalman filter. However, deviations of up to 4 m/s were observed during moments where slip is more likely to occur, like quick acceleration from low speeds and heavy braking. Most notably, the velocity estimate is significantly compromised if the wheel slip reaches higher magnitudes. Coincidentally, it is especially important to have accurate velocity information in situations with higher wheel slip. This is because the traction control, that is crucial in these situations, requires accurate velocity information to function properly. With the data from the OMS Race, these discrepancies can be accounted for, improving our estimations.

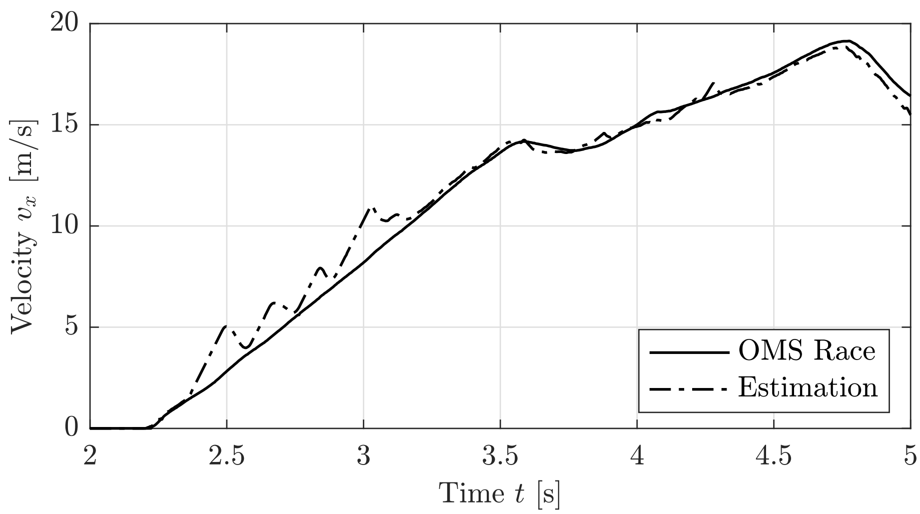

Figure 1: Vehicle velocity measured by the OMS Race compared to our previous velocity estimation during the acceleration event.

For example, a comparison of the velocity data obtained from the OMS

Race and our previous separate velocity estimation is shown in Figure 1. This data was recorded at a race track in Strijen in August 2025.

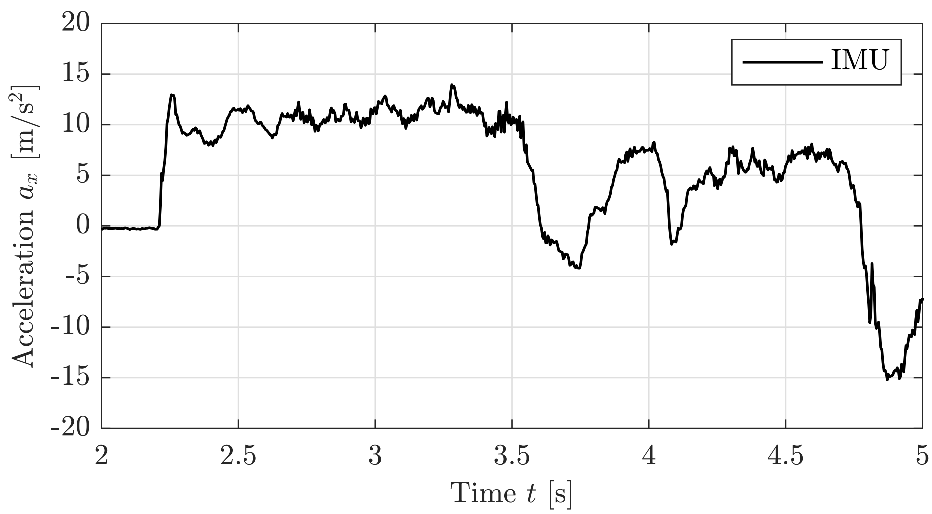

Figure 2: Acceleration data measured by the IMU during the acceleration event

An independent inertial measurement unit (IMU) indicates consistently positive longitudinal acceleration during the relevant period, found in (Figure 2). This contradicts the oscillatory velocity behavior of the estimates by our previous estimation method, as such oscillations would imply alternating acceleration and deceleration. In contrast, the OMS Race measures vehicle velocity independently of wheel slip effects, and is consistent with the data of our IMU. Thus, more reliable velocity estimations enable more consistent traction control behaviour, particularly in grip-limited conditions. By improving the consistency of traction control behaviour, wheel slip can be reduced, resulting in improved longitudinal acceleration.

2.2 Pitch and Roll Data

Furthermore, the OMS Race allows us to get accurate information of pitch and roll angles. Tyre deflection accounts for a significant portion of the roll and pitch angle, which is why we cannot rely solely on damper travel sensors used in our suspension.

With the OMS Race however, tyre deflection effects are also measured, in addition to suspension motion and setup changes. With this data, we can improve our vehicle dynamics models, to more accurately represent the behaviour of our car. Additionally, it is very difficult to estimate lateral velocity or sideslip angle robustly using onboard sensors. Up until now this has prevented the team from using this information for the control system of the car. With the OMS Race, this now becomes possible, and the stability and performance of the car can be further improved.

3 Mounting and assembly of the OMS Race

The sensor required a mounting method that was not disruptive of the aerodynamics of the chassis, was protected from frontal impact, and did not adversely impact the integrity of the chassis by drilling through critical areas. Initial considerations were to mount it within the critical structure of the chassis through a transparent panel, but it was deemed too risky to do so on the chassis' load path. Therefore, an exterior location was chosen.

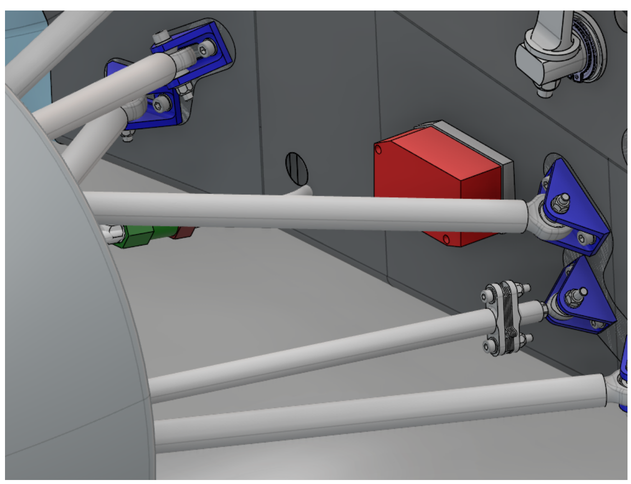

Figure 3: Location of the OMS Race on the DUT 25

The OMS Race was placed between the rear suspension linkages, on the right side of the car. This position was chosen for the following reasons.

- The already existing electrical components and suspension links meant the OMS Race will have a minimal effect on the aerodynamics compared to a clean area.
- The place was easily accessible, so maintenance was not difficult.
- The position was close to a wiring hole in the chassis, so it was easy to connect the sensor to our main CAN bus.

With the location selected, the mounting method needed to be decided. To do so without making permanent holes or impacting critical chassis zones, we used composite adhesives and a metal bracket with helicoil threads. Appropriate load cases such as frontal impact with a cone were applied to find the minimum bonding area for the bracket. A knockdown factor of 0.5 was applied, as required in the Formula Student rules. This was then glued onto the chassis using 3M's 2K adhesive EC-9323. This rigid attachment ensured a stable location within the car's reference frame and allowed the OMS Race to reliably give the car's dynamic data.

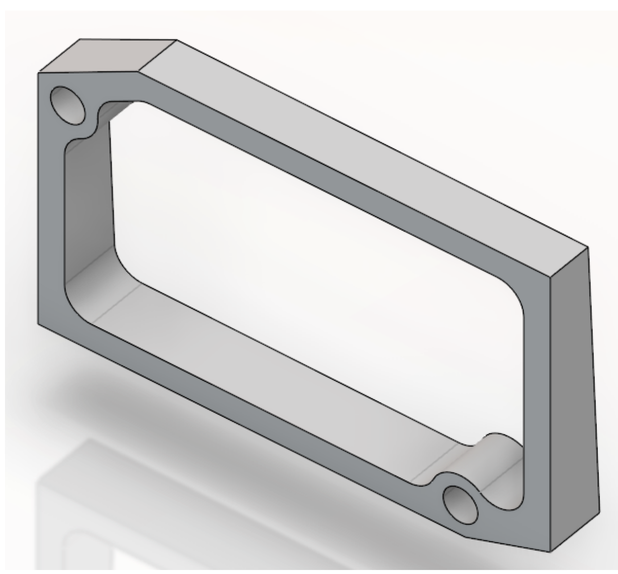

Figure 4: Bracket used for the OMS Race

4 Conclusion

Since integrating the OMS Race, the performance of our controls system, especially our velocity estimates, has improved significantly. The slip-independent velocity measurements allowed for more accurate estimations in our control system, resulting in more consistent traction control behavior in grip-limited situations. This allows us to make more use of the available tyre grip when we most need it.

In addition to its impact on our performance, the OMS Race was a valuable development tool. The availability of accurate attitude and sideslip-related data allowed for validation and refinement of our vehicle dynamics models, which previously relied on indirect or incomplete measurements and assumptions. We have yet to use this data to its full potential, and we plan to further exploit this data in the coming seasons.

The sensor was successfully integrated into the vehicle using a rigid, rule-compliant mounting solution without compromising on aerodynamics or chassis integrity. Ultimately, the OMS Race contributed to improved vehicle performance during the season, including our podium finish at Formula Student Germany

Based on our experience, we would strongly recommend the OMS Race for applications requiring accurate, slip-independent vehicle state estimation, particularly in high-performance motorsport and autonomous vehicle development, where robust sensing is critical for both control and model-based design.