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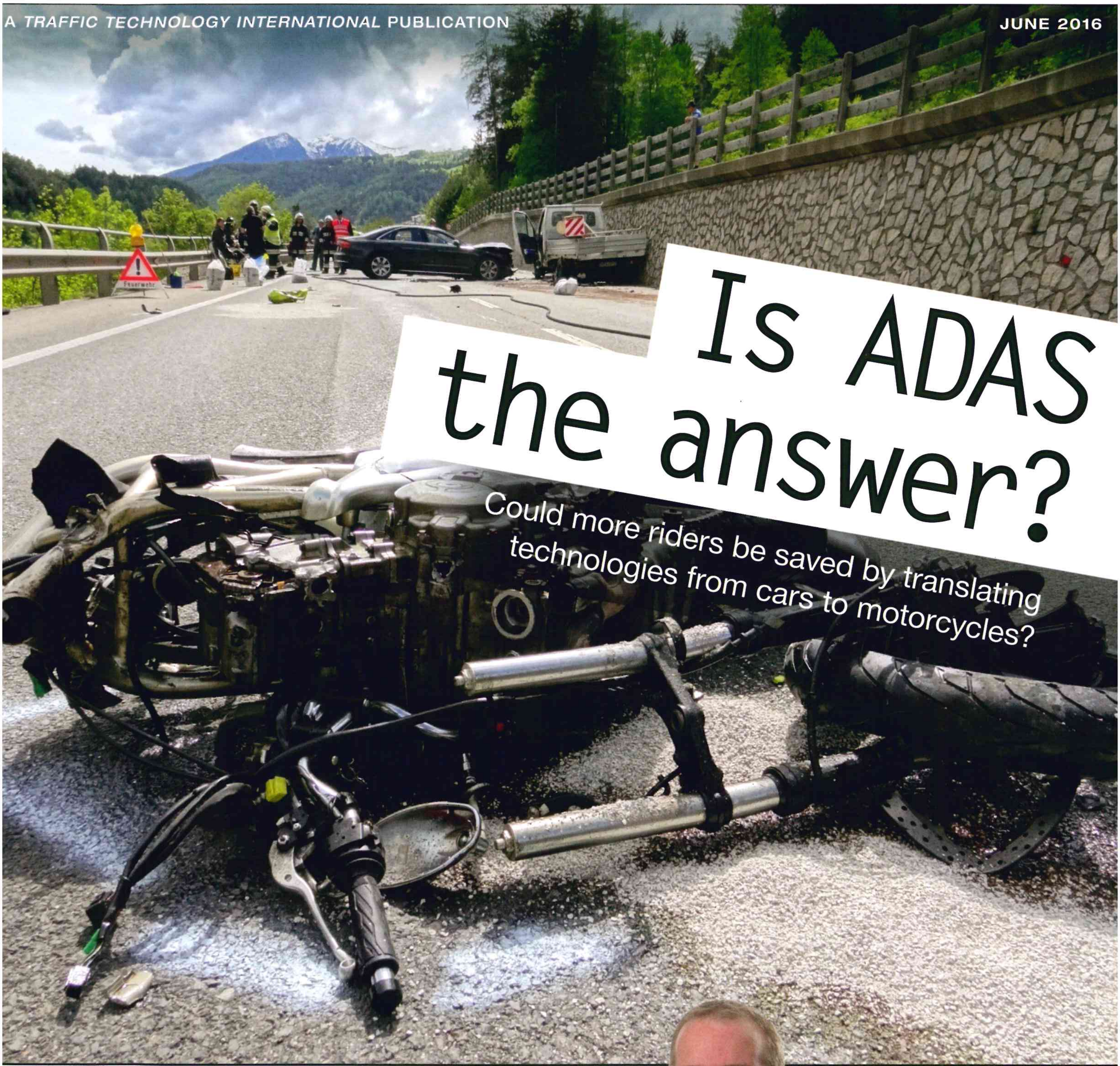

Is ADAS the answer?

Could more riders be saved by translating technologies from cars to motorcycles?

Passive safety

New equipment and tests could be needed to bring designers' visions of autonomous vehicle interiors to fruition

Glass innovations

From head-up displays to automatic dimming, anti-fogging and improvements in strength

Andrew Miller

The president and chairman of the board at Euro NCAP discusses how autonomous cars could be tested

On track

In the development of highly automated driving functions it will be necessary to verify a massive amount of test data using GNSS/INS solutions – but there are cost and accuracy challenges to overcome

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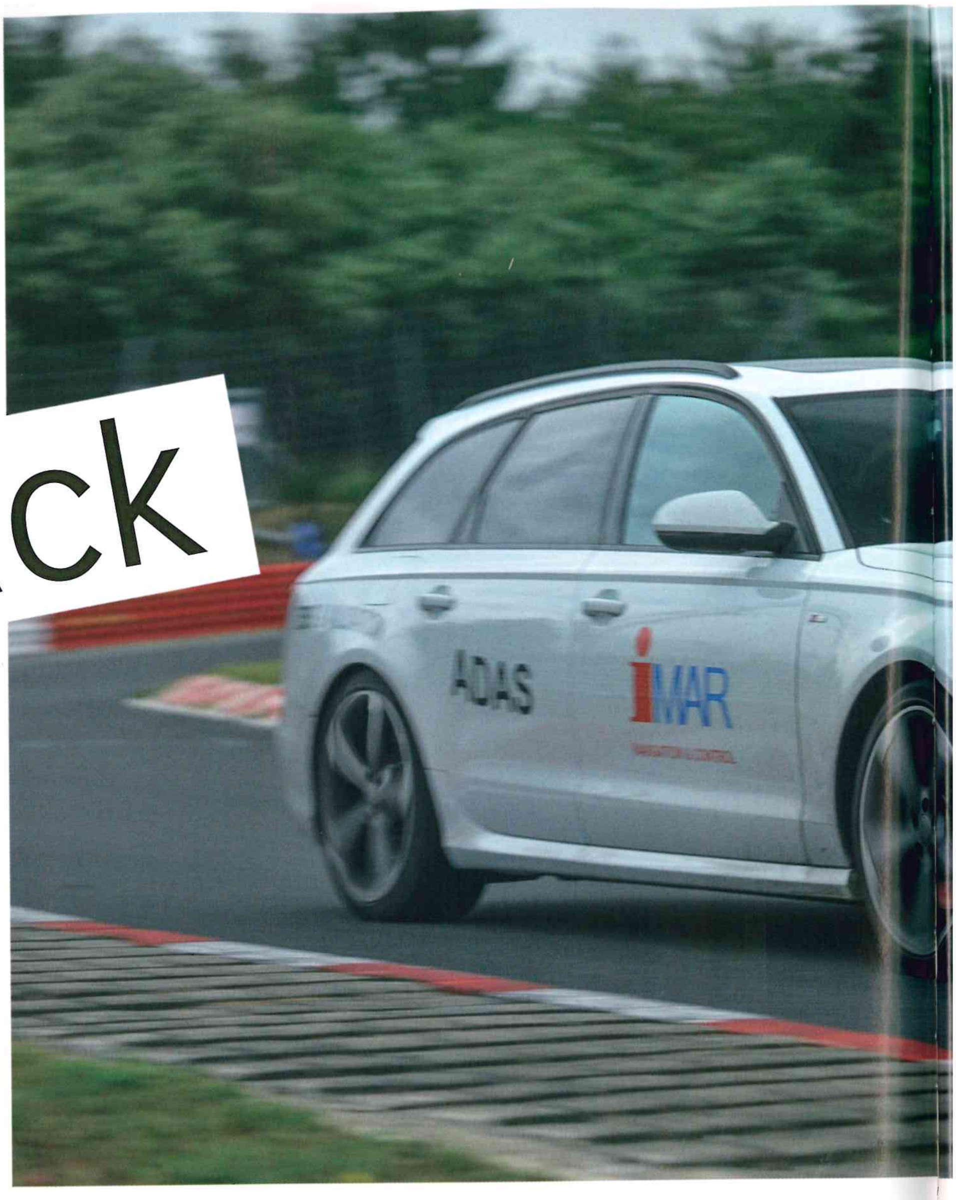

(Main) An iMAR demonstration of GNSS/INS performance at the Nürburgring, the racing circuit nicknamed The Green Hell

Developers of highly automated driving functions will need to pinpoint the vehicle's position during a test, and particularly when certain events or failures occur. The accuracy required will vary: to the meter (for E-Call), the decimeter (for collision avoidance), or the centimeter and below (for automated parking). To gather this data, engineers will need to use a high-accuracy global navigation satellite system (GNSS) with real-time-kinematic (RTK) functionality.

GNSS works perfectly under open skies, but is susceptible to multipath signal reflections and signal blockages, and can even fail completely when the vehicle drives through a tunnel or into a parking lot. Unfortunately, all these scenarios will need to be tested to enable unrestricted use of highly automated driving functions.

GNSS/INS solutions

The limitations of pure GNSS can be overcome by coupling it with an inertial navigation system (INS). GNSS/INS is already used by most of the companies working in this area to test, evaluate and demonstrate performance. For example, GNSS/INS was used for Audi's Piloted Driving project, which involved piloting a driverless vehicle at race speed around the Hockenheimring in Germany during a break at a major touring car race, in front of thousands of spectators. Daimler has also used a GNSS/INS setup for its F 015 concept car, and iMAR has demonstrated GNSS/INS performance on Germany's Nürburgring circuit.

(Below) The top-of-the-line iTraceRT-R300 GNSS/INS unit

iMAR can provide various GNSS/INS solutions, with varying levels of accuracy, mainly defined by the grade of inertial measurement unit (IMU) used. The top of the range is the iTraceRT-R300, which uses a navigational-grade laser gyro IMU, and is used where the highest possible accuracy and reliability is needed and where there are longer GNSS outages. This equipment can also be used in a purely inertial mode in GNSS-denied areas.

Then there is the iTraceRT-F402, which uses a tactical-grade fiber gyro IMU. It is suitable for ADAS testing and the development of highly automated vehicles under real-world conditions in almost all scenarios.

For cost-sensitive applications, iMAR offers the iTraceRT-M200. This equipment has a MEMS IMU and is useful for testing in locations with minor GNSS blockages, for mass data collection, and for fleet tests.

Finally, the iDriveRT-M200 enables driverless testing using the car's actuators. It has a drive-by-wire interface using onboard diagnostics or customer-specific interfaces.

All these systems use multifrequency GNSS, mostly L1/L2 GPS/GLONASS, and will also be capable of use with

(Below) The iTraceRT-F402 is iMAR's workhorse GNSS/INS unit, used by car manufacturers wordwide in their testing activities

System	IMU	Positional accuracy	Angles	Velocity
iTrace RT-R300	Navigational-grade laser gyro IMU	2cm	0.003° RP, 0.008° Y	0.005m/s
iTrace RT-F402	Tactical-grade fiber gyro IMU	2cm	0.01° RP, 0.025° Y	0.01m/s
iTrace RT-M200	MEMS IMU	2cm	0.02° RP, 0.06° Y	0.05m/s
iDrive RT-M200	MEMS IMU	2cm	0.02° RP, 0.06° Y	0.05m/s

additional satellite navigation systems, including Galileo and Beidou.

GNSS/INS is a reliable solution for many automotive testing applications, but it is also known to be too expensive for the mass market. Customers are asking for a way to bring the cost of these technologies down for the instrumentation of future vehicles.

Highly automated vehicles will rely on a mix of camera, radar and lidar sensors to operate, and will also use additional information – for example, maps and traffic reports – to aid navigation. Despite being able to navigate with this information, a GNSS/INS-based position will still be important at the starting point of the vehicle's journey, and also if the failure of the other technologies results in the vehicle having to come to a standstill in a safe position.

The question of accuracy

The accuracy required of this system – whether it needs to be to the meter, the decimeter, or less; and in what timeframe this accuracy has to be guaranteed – is still under discussion. The accuracy required will have a major influence on which IMU and GNSS are the most suitable.

The L1 GPS and L1 GPS/GLONASS receivers currently used will not fulfill these requirements. To achieve greater accuracy, we'll need to focus on more accurate GNSS measurements, using an RTK technique. This requires a correction data service and a new broadcast format, State Space Representation (SSR). RTCM is now developing a standard for SSR, and Japan is already transmitting the signal via satellite. Other areas are running test installations.

With SSR in service, it will be possible to achieve the initial accuracy needed for highly automated vehicles. But how will we solve the problem of the high cost of IMUs? In the past, the design goal for automotive IMUs (gyros, accelerometers) was more about cutting costs than improving performance. Today, car manufacturers and Tier 1 suppliers are trying to improve performance at a reasonable cost. To achieve this, while integrating GNSS/INS into a working subsystem, with performance still to be defined in detail, will require specialist skills. A secure way to make progress in that challenging environment is to look for a solution provider with knowledge in all of those areas – this will help prevent time- and cost-consuming errors along the way. ‹

• *Hans Scheyer is manager of automotive applications, and Patrik Vockenberg is an application engineer in the same field at iMAR Navigation*