Omron's high-speed robot tests the reliability of black boxes A non-destructive alternative to crash tests

Generali Jeniot, a company wholly owned subsidiary of Generali Italia and devoted to developing innovative Connected Insurance and IoT services, has developed a non-destructive application to test the key parameters of black boxes that are due to be installed in cars. The test is based around the high-speed movements of an Omron Delta Quattro robot.

For some years, black boxes have been installed in cars to record and transmit a range of data, including their location, speed, acceleration etc. Insurance companies benefit as the black box provides them with more detailed information relating to thefts and accidents and helps to reduce fraud and encourage better driving. However, policyholders can also benefit, as better driving can lead to rewards in the form of discounts on their policies.

Black boxes need to be small, easy to install and above all, reliable. Their built-in capabilities must offer a very good representation of the dynamics of an impact and also of driver behaviour. This is why manufacturers and insurance companies conduct real crash tests, similar to those carried out for the safety of passengers, but with the aim of improving, for insurance purposes, the estimate of actual damage recorded by the black box.

Generali Jeniot decided to find a non-destructive, more efficient and more economical alternative to a crash test that would provide reliable information. It has therefore patented and developed a new testing method in conjunction with Viasat, a telematics systems and IoT solutions company. The solution uses Omron's Delta

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Quattro robot, which is programmed to subject the black boxes to the same acceleration and deceleration that would be recorded on a car during a crash test, as well as other simulated road traffic situations. The application was developed in collaboration with the University of Padua and was presented at international insurance company conferences and at the SPS automation fair in Parma. It has since been used successfully for testing the black boxes of the Generali Group's policyholders, as well as those produced and distributed by third parties.

Using the robot to simulate an accident

The engineering and architecture element of the new software solution, developed in collaboration with Omron and R4P, is called JADA. In conjunction with the Delta Quattro robot, it can replicate, on three axes, the effect of speed, acceleration and deceleration on the movement of a black box installed in a car. Valerio Matarrese, Head of Research, Design and Testing at Generali Jeniot, explains: „To put it simply, the test is carried out by a robot that moves the black box as if it was installed in a vehicle during a collision. It isn't a computer simulation but something real - an alternative way of replicating the impact on a car involved in a road accident."

JADA wasn't only designed to replicate accidents but also to automate the entire evaluation part of the test, starting with an accelerometric curve that is fed into the robot. The acceleration signal resulting from the movement is recorded and compared with that of a highly accurate reference accelerometer. This comparison detects any differences in the accelerometric peak and any variations in speed. The final data includes a report with graphs and the accelerometric and speed data, including the deviations from the reference sensor.

Refining the test

Unlike traditional crash tests, in which the impact speed can vary considerably, JADA also allows an intervention on the accelerometric curve. The robot is instructed to replicate a previous impact whose real dynamics are known. Valerio Matarrese explains: „Replicating an accident isn't easy, but past experiences enable us to have a large database of information from crash tests, so we can develop customised protocols based on customer needs."

Anything is possible - for example, minimising any errors on all three or on one of the axes; for instance, the one considered most important in terms of the crash dynamics. For instance, an algorithm can be developed that enables

the robot to learn the differences between the movement performed and the one requested and to repeat it until it falls within pre-defined tolerance limits. „This is a method based on the minimisation of the root mean square error," says Eng. Luca Slavazza, R4P Robotics Manager. „The robot is taught to follow a trajectory starting from a target, and the software automatically measures the error and adjusts it until it falls within a predetermined range."

Minimising errors with Omron's robot

To minimise the error, the black box is housed in a very light but very rigid aluminium and carbon fibre support which cancels all vibrations that could affect the detection of the signal. Similarly, the robot is confined inside a very heavy support cell with a mass of approximately 1.3 tons.

The on-board robot programming is based on a Linux system, with a real-time kernel that allows the signal from the accelerometer to be read to a tenth of a millisecond. This ensures the reception of a very accurate signal without losing the high frequency dynamics. Everything else is configurable. The robot can be instructed to perform a series of predefined tasks with a differing number of executions and accelerometric curves: the operator can modify the peaks by increasing, reducing or filtering them.

In these stable conditions, Omron's robot is more accurate and more versatile than other similar solutions, as it can work at speeds that allow interpolations per millisecond that can replicate very strong accelerometric variations and peaks that exceed even 15G. „Usually, a Cartesian trajectory is performed and then with the inverse kinematics we have to go back to the joints to move the robot," explains Luca Slavazza. "With Omron's Delta Quattro robot, however, we no longer need to do this: we can just set a Cartesian trajectory with its accelerometric curves and speeds and transfer them to the robot. The robot will interpolate the points almost instantaneously, thanks to a command mode that can assimilate a position every three milliseconds."

The benefits of non-destructive testing

The advantages of the new solution are obvious: it eliminates the costs involved in the purchase, repair and disposal of cars used in traditional crash tests. Fewer people are needed for the test (one operator instead of three workers); the test times are shortened; but above all the accelerometric curves can be chosen to replicate various types of impact, and always with a consistent level of reliability. „With traditional methods, it took a full day to

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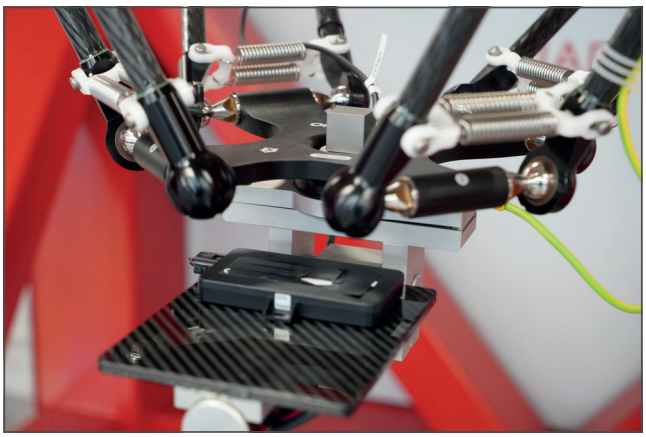
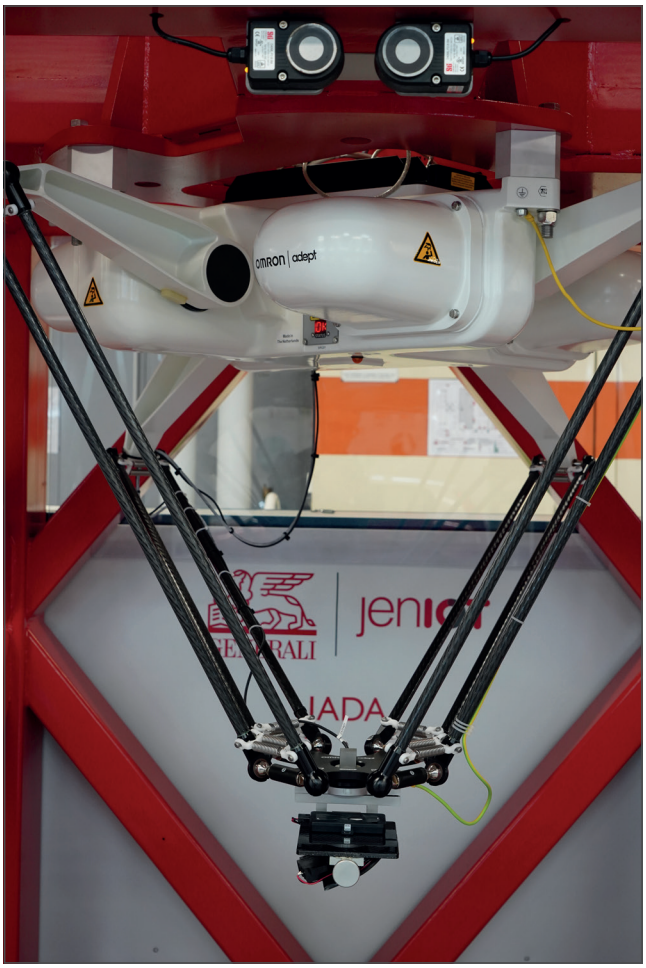
The solution can replicate, on three axes, the effect of speed, acceleration and deceleration on the movement of a black box installed in a car.



perform 12 real crash tests, but with Omron's Delta Quattro robot there are no limits: we can carry out 12 tests in 45 seconds," says Marco Marello, Director of the Innovation and Experimentation Center at Generali Jeniot. This project underlines the growing importance of accelerometers, GPS and other sensors within the automotive industry.

A significant part of the time and cost savings comes from the automation of comparison procedures. Accelerometric comparison usually takes a long time, due to the comparison and alignment between the signals recorded in the black box and those recorded by the reference sensor. This comparison is carried out entirely by the algorithms developed within the JADA software.

„These capabilities enable us to conduct various types of tests based on the final destination of the black box," concludes Marco Marello. „We can limit ourselves to identifying the impact for simple rescue needs, for example. Alternatively, we can reconstruct the extent of the impact more accurately, both in terms of the accelerometric peak and the direction and quantity of impacts in the event of multiple crashes. This is a valuable tool that will improve the services offered by insurance companies and reduce costs for policyholders. "



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About Generali Jeniot

Generali Jeniot is a new company, wholly owned subsidiary of Generali Italia and devoted to developing innovative Connected Insurance and IoT services in the fields of urban mobility, smart home, health and the world of connected working. The Innovation and Experimentation Center of Generali Jeniot is devoted to research and development, prototype design and cooperation with other firms, research institutes, universities and start-ups. For more details, visit http://jeniot.it/.

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R4P provides the industrial, medical, civil and research sectors with services that support the innovation of high technology products and processes. These include advanced feasibility studies and prototyping; the design, implementation and management of turnkey solutions; project management; advanced technical training; on-site/remote assistance; and software and algorithms. The company is based in Milan and has a range of engineers, physical mathematicians and researchers from different disciplinary fields. For more details, visit the website at https://www.r4p.it/.