



Pilot training on a robotic arm

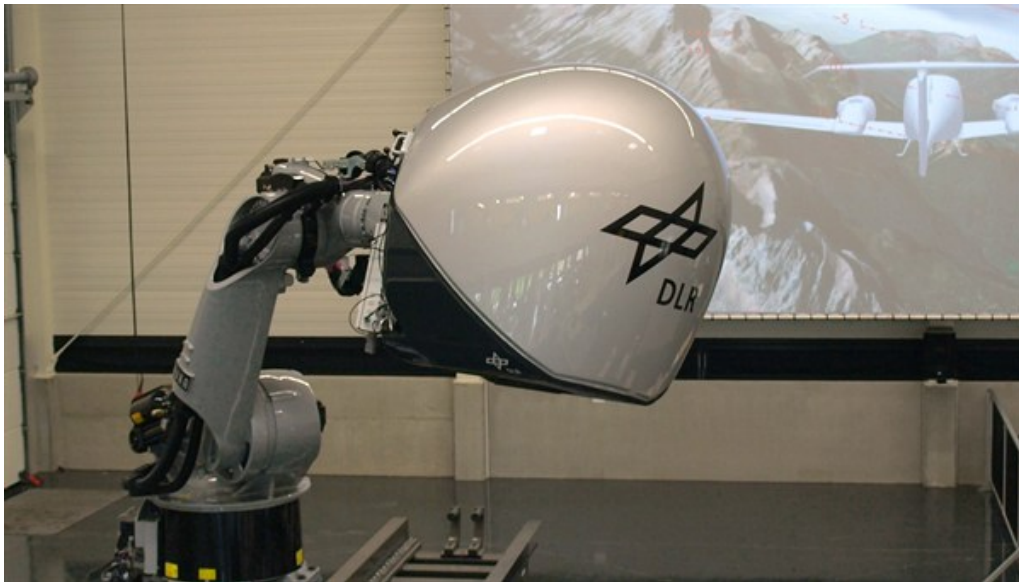
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From the outside it looks like just a large industrial robotic arm with a cockpit, but to the pilot inside the simulator, it feels like a real aircraft. The pilot sits at the controls, and the flight commands are converted into corresponding movements of the robotic arm in real time. This is the first robot-based flight simulator in the world, and it will be used for training pilots. For its development, two researchers from the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) and their partners Grenzebach Maschinenbau and KUKA have been awarded the euRobotics Technology Transfer Award. The prize is awarded annually to projects that combine research findings with commercial applications. To achieve this, the two DLR engineers have, among other things, exposed dummies to numerous acceleration tests, designed the structure of the system and worked on tricky flight path planning – all to create the perfect illusion of flying.

Pilots are usually taught and trained on hexapod systems before undertaking real training flights. Here, student pilots sit in a cockpit that is mounted on a six-axis movable platform. The disadvantage of these systems is their price, ranging between seven and 25 million euros, making them too expensive for smaller flying schools. "A simulator mounted on an industrial robot would take these costs down to about one million euros," explains DLR researcher Tobias Bellmann, who received the award along with DLR engineer Johann Heindl and Olaf Gühring from Grenzebach Maschinenbau.

From car to helicopter

The researchers at the DLR Robotics and Mechatronics Center have been working on a simulator based on industrial robots since 2004. In 2010 they succeeded in interactively implementing flight on the robotic arm. The passengers no longer flew on predefined flight paths – they could control the capsule themselves. "For us, this means that the movements of the robotic arm have to be computed in real time – in other words really quickly – because they cannot be planned in advance," explains Bellmann. In 2011 the robotic arm received a new 'cockpit', inside which instruments could be swapped over as necessary: an aircraft control yoke, a steering wheel for a car, or helicopter flight controls. By refitting the cabin, the simulator was at times converted into the interior of a car, an aircraft or a helicopter – although the robotic arm and dome always stood in the test hall at the DLR facility in Oberpfaffenhofen.



DLR simulator

The research results have now been incorporated into the design of the Grenzebach DA42 pilot training simulator. "In this simulator, pilots can, for example, be trained for critical situations over and over again," says Bellmann. "In a training aircraft, this would not only be expensive but also dangerous." From the simulated cockpit of the Diamond DA42 aircraft, the pilot's view always remains completely faithful to the one he would have on a real flight – regardless of the movements of the robotic arm. Experienced pilots from various airlines and aircraft companies have put the simulator to the test on numerous occasions. "This feedback was very important for us, so that we could make the simulation as realistic as possible," continues Bellmann. In the near future, aviation authorities are expected to certify the Grenzebach DA42 simulator as a Level D flight simulator – the highest category of qualification.

This means that pilots in the robot-based simulator will be able to experience situations that will save them in real life. "Our simulator enables extreme rolling and pitching movements, because there is plenty of room for the movements of the robotic arm," explains Bellmann. For pilots, this means that even inverted flight is effortlessly possible.

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Video: First robot-based flight simulator



Pilot training in the world's first robot-based flight simulator - developed by DLR in cooperation with Grenzebach Maschinenbau and KUKA.

Credit: Grenzebach/DLR.

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