



A flying robot finds its own way

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A labyrinthine mine, dimly lit and a dusty environment – the researchers at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) chose a particularly difficult location to test their flying robot. The task – given a defined destination, the multicopter was to automatically create a map of the site using an on-board stereo camera and sensors, and then navigate autonomously to its target. The airborne system confidently found its way through the mine's passageways, demonstrating for the first time the principle of autonomous flight under difficult environmental conditions and without external navigation aids, such as GPS. In future, flying robots equipped with this navigation system could also fly into buildings in disaster-stricken areas or map changes in mines over a long period.

"We deliberately selected a location in which the challenges faced by the navigation system were particularly demanding," explains Korbinian Schmid from the DLR Robotics and Mechatronics Center. The researchers found precisely the challenges they needed at a coalmine in Recklinghausen. Facing difficult lighting conditions, the flying robot was asked to overcome air turbulence in the narrow passages, swirling dust, an uneven floor, slanted walls and obstacles such as machines and generators – while still arriving safely at the destination that its operator had commanded over a wireless network. "These adverse conditions could all be present during a search and rescue mission following a disaster."

Planning with its own map of the location

To navigate safely, the flying robot's on-board computer combines measurements of acceleration and rotation rates it receives from the sensors with the relative orientation and position measurement data that the stereo camera provides. The estimated positions are then put to further use in combination with the images provided by the airborne system's stereo camera to continuously create a map of the surroundings. The flying robot always knows its position, its orientation and the speed at which it is travelling, and is therefore able to autonomously plan the trajectory it must take to reach its defined destination. Once created, the map is sent to the operator over a wireless network for mission planning. If the wireless connection between the multicopter and the operator fails, the system has a choice to continue along its independent flight towards its destination or return to a previously defined point, for instance the mine entrance. The apparatus remains hovering in the air if it is unable to reach a destination due to the presence of obstacles, while it waits until it receives new commands. The DLR team has already garnered a Best Paper Award at one of the world's largest robotics conferences, the International Conference on Intelligent Robots and Systems held last year in Japan, for the publication of its research work.

The plan is to continue developing the autonomous navigation. Carrying along its own source of illumination in the form of LED spotlights, the stereo camera currently covers a field of view of around 60 degrees. "What we would really like to do is enlarge this field to make it truly panoramic," says Schmid. "Additionally, we want to be able to consider the altitude and the dynamic properties of the system when planning a trajectory." The system currently maintains a constant height whenever possible. A combination of a rover and a flight system would be possible to explore disaster areas. Also fitted with a stereo camera and autonomous navigation, the rover would move over the ground, operating as a carrier to transport the multicopter to the outer edge of impassable terrain, where it would hand over operational duties to the flying robot explorer. "One thing is crucial in all missions – the navigation system must ensure that the robots can function as autonomously as possible," emphasises Schmid.

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Video: Multicopter with autonomous navigation system



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