

Unmanned aircraft in civil security

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So far, unmanned aircraft have been mainly used by the military for observation and reconnaissance purposes. Their advantages are obvious: flying under remote control by pilots on the ground, such uncrewed planes are usually smaller than conventional aircraft, produce less noise and can be manoeuvred much more flexibly. Moreover, they are capable of operating over prolonged periods and in hazardous circumstances – for example to analyse nuclear, chemical, or biological clouds. This makes them interesting for civilian missions, too.

For quite some time, the German Aerospace Center (DLR) has been actively involved in the development of unmanned aircraft systems (UAS). DLR is one of the founding members of the international UAVNet initiative that was established with the support of the European Commission in 2001. Its aim is to develop and promote the use of UAS in civilian applications.

Two of DLR's main research areas, aeronautics and space, are involved in the UAS projects. Participating scientists come from the Institutes of Flight Guidance, Flight Systems, Communication and Navigation, and Robotics and Mechatronics. At the same time, the activities dealing with unmanned aircraft for civil security form part of security research, DLR's cross departmental programme under which defence- and security-related research and development activities are being planned and controlled.

Even at present, DLR's experts hold key competencies in fields that are important for developing and operating unmanned aircraft:

- Navigation and flight control, the basis for carrying out sophisticated missions with precision.
- Decision-making systems and maximum pilot support through maximum autonomy (both of sensors and data processing) increase the independence of a UAS from human interference.
- Environment recognition with the aid of cameras, which liberates a UAS from waypoint-based flight plans.
- Mechanical path planning, which enables a UAS to move entirely autonomously even over unknown terrain.
- Flight management systems, which permit a UAS to integrate with other airspace users.
- Optical and hyperspectral on-board sensors, which ensure that police or disaster response forces are provided with the information required to fight organised crime and terrorism, or, respectively, manage a crisis or a disaster.

The Institute of Flight Systems is testing unmanned aircraft in realistic simulations as well as in real-life flight tests. The systems used by researchers in field tests include not only small ARTIS helicopters (0.5 to 3 metres rotor diameter) but also the Prometheus rigid-wing aircraft. Plans for a solar-powered aircraft of prolonged flight endurance called Solitair are currently on the drawing board.

Among other things, scientists are focusing on finding solutions that enable unmanned flying objects to react automatically to other airspace users so as to avoid collisions (sense & avoid). Another field of research is the operation of manned and unmanned aircraft together in the same airspace (manned-unmanned teaming), which opens up new fields of application such as search and rescue missions.

Operation in buildings

The Institute of Communication and Navigation studies and develops systems comprised of particularly small aircraft called micro aerial vehicles (MAVs). What is special about these systems is that a multitude of MAVs flying simultaneously may be combined into a multi-agent system. With their decentralised organisation, these systems are very agile and robust, which makes them perfect for civil-security and disaster control missions, where they may serve to explore situations or set up communication relays. Because of their small dimensions, MAVs may be deployed in cities and even buildings.

The challenges confronting the developers are many and varied. Ideally, MAVs should be capable of operating for several days in a multi-agent system. To provide themselves with energy during that period, they must be capable of flying to a recharging station autonomously. And although a multitude of MAVs are employed in a system, it is not desirable to increase the number of operators. Simultaneous interaction between an operator and a large number of highly dynamic MAVs calls for new concepts of interaction between humans and multi-agent systems.

The Institute of Communication and Navigation operates a fleet of MAVs with which it runs operational tests of MAV-based multi-agent systems under controlled laboratory conditions. In addition, the institute has extensive experience in the implementation of outdoor experiments with MAV swarms. In this field, DLR has been cooperating with international civil-protection organisations for years.

Remote sensing in real time

Unmanned multi-rotor systems offer new remote-sensing applications to the police and disaster response forces. Scientists of the DLR Institute of Robotics and Mechatronics are currently testing various types of sensors against a variety of operational scenarios at the institute's Sensor Concepts and Applications department.

Research activities focus on innovative ways of evaluating aerial images and automatically generating digital terrain models. Since the maximum payload any of these aircraft can carry is about one kilogram, developers find themselves confronted by novel constraints regarding the design of the sensor systems being used. The department's expertise covers integrating and georeferencing cameras that are highly sensitive in the visible, thermal, and short-wave infrared spectra as well as evaluating and validating experimental sensor configurations.

Research aims at developing a method of processing, in real time, georeferenced live image data from various optical sensors into live image mosaics and digital terrain models. In the future, such systems will be used mainly to survey and document accident and disaster scenarios promptly. For this purpose, further fine-tuning of the aircraft, its optical sensors, and the data processing system will be required.

Challenges of the future

DLR systems such as ARTIS or Prometheus are even now being used experimentally to generate terrain and obstacle maps, 3-D versions included. New components and the quality of live CCTV transmissions to ground stations are being tested regularly. The new Solitair aircraft will add high-altitude observations and long-range missions to this portfolio. Another UAS issue is the surveillance of maritime areas, for instance to detect illegal pollution by shipping, and, in the more distant future, to secure the EU's external borders. Because the UAS may also be employed in matters of internal security, the Federal Ministry of the Interior is cooperating with DLR on a variety of projects.

However, several challenges will have to be mastered before unmanned aircraft can become a part of our daily life. They are still banned from civilian airspace, and special permits are issued only under strict conditions and/or for very light aircraft. So far, the dependability of the aircraft and their automated flight-control systems has failed to measure up to the standards set by manned aircraft and human pilots.

The DLR Institute of Flight Guidance in Braunschweig deals with integrating unmanned aircraft with public airspace users, investigating all methods that are essential to ensure operational safety: flying a route in conformance with instrument flight regulations, approaching alternative airports, flying around bad weather, and emergency procedures. The tests are run with DLR's experimental aircraft playing the part of quasi-UAS, controlled by trained pilots working in a special ground control station but carrying backup pilots on board. The tests include a full simulation of the air space and are carried out with the participation of air traffic controllers.

Contacts

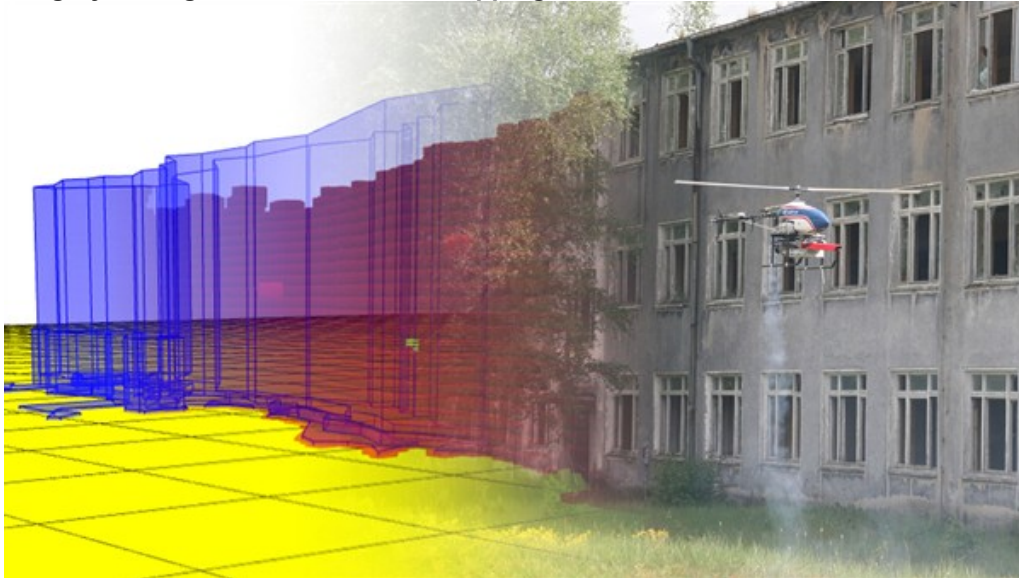
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Imagery intelligence and real-time mapping



Imagery intelligence and real-time mapping delivered by fully automated flight into unknown terrain.

Credit: DLR (CC-BY 3.0).

Digital surface model



Digital surface model of a building site.

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Octocopter



Octocopter fitted with thermal and daylight sensors.

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Remote-piloting a UAV



Remote-piloting a UAV outside a ground control station during ESA study "Satellites for the Integration in Nonsegregated Airspace of UAS in Europe"

Credit: Image: AT-One EEIG..

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