Connecting autonomous aerial and surface vehicles

PORT INSPECTION The RAPID (risk-aware automated port inspection drones) project aims to integrate the benefits of unmanned aerial vehicle (UAV) services into port environment applications by combining research results and technologies requested by the maritime industry. Here, Nils Hagemeister and Vincent Schneider highlight the objectives of the RAPID project and how Fraunhofer CML's unmanned surface vehicles (USVs) and monitoring software will be enhanced in order to improve condition monitoring of maritime infrastructures in ports.

The SeaML is a development by Fraunhofer to test and verify promising technologies for maritime services. Within RAPID, the current setup will be modified and equipped with a landing platform and a battery hot swap system for UAVs. Source: CML

Unmanned aerial vehicles (UAV) or drones are becoming increasingly popular for inspection and monitoring tasks across many sectors. Aerial drones can be equipped with a variety of payloads ranging from stabilised photo and video cameras, light detection and ranging (LiDAR), to meteorological sensors or combinations thereof to adapt quickly to different missions.

The RAPID (risk-aware automated port inspection drones) project aims to integrate the benefits of UAV services into the port environment while developing new technologies to fit the individual needs of the maritime industry. The RAPID consortium consists of nine European partners, connecting experts from different domains such as image recognition and situational awareness, autonomous navigation, energy systems, port operations, legislation and communications.

Fraunhofer CML is represented by its Maritime Technologies and Biomimetics team and adds expertise in the area of integrated hardware and software development and rapid prototyping. The three-year project is funded through the European Commission's Horizon 2020 programme with the aim of developing an early warning system that detects deterioration in critical transport system infrastructure and minimises downtime caused by maintenance and inspection (MI) activities.

RAPID targets four use cases for real world applications by combining latest research results and technologies requested by the industry. The first use case is emission monitoring within a complex port environment from the air. With many European ports located close to densely populated areas and emission regulations being continuously tightened, monitoring compliance and identifying breaches in an economic and timely manner is of growing importance.

The bridge inspection use case targets detection of cracks and tracking of crack propagation. This is vital to determine the state of critical infrastructure, which today requires on-site engineers and expensive equipment. RAPID will employ automated drone inspections with crack detection and classification capability based on neural networks and machine learning, therefore drastically reducing the time, equipment and personnel needed for bridge inspections.

The third use case focuses on ship hull inspections, where an array of cameras fitted to drones can give a fast overview or detailed analysis of areas of interest defined by the customer.

The fourth use case is collision accident response for which an aerial overview of the situation can be provided to support towage operations, firefighting or oil spill containment.

To achieve the ambitious goals set in the use cases, the RAPID consortium will develop a fully automated maintenance inspection service. One of the system's unique features will be the integration of drone swarms with unmanned surface vehicles (USV) that will enable long-range inspections and increase the efficiency of MI in ports. This will be implemented and tested using Fraunhofer CML's USV SeaML (Figure 1). The SeaML is a multi-purpose demonstration platform developed and successfully tested in the MarTeRa and RoboVaaS projects. In the RAPID project, SeaML will be equipped with a landing platform and a battery hot-swap system to extend the UAV energy autonomy and enable execution of longer and multiple missions in close succession, without human involvement. Further gains are expected from the validation of safety assured beyond visual line-of-sight UAV flights. This will permit operation of the system to be overseen from a remote command and control centre.

Besides developing the battery hot-swap system, for which its rapid prototyping capabilities will be leveraged, and providing the USV with the landing platform,

Fraunhofer CML will develop a human interface for the operation of RAPID. It will be based on the institute's proprietary, web-based command and control software for unmanned vehicles which allows real-time mission planning, monitoring and assessment from anywhere in the world. Fraunhofer researchers will also build upon the experience from previous and concurrent projects to develop a lightweight and low-cost UAV sensor payload for measuring emissions.

In RAPID, a typical mission is executed in the following sequence. A customer, which can be any stakeholder in the harbour like a terminal operator, shipowner or port authority, orders a service at a specific location. A detailed plan for the mission is generated, specifying waypoints and sensor activation commands on which a pre-flight risk assessment is performed in a digital twin environment to define a safety portfolio for the flight. This information is forwarded to unmanned traffic management, which checks if the mission can be executed safely within the marine and air traffic spaces. .

Upon approval, the mission plan is sent to the unmanned vehicles. The USV then carries the drone to its take-off location from where it performs its tasks before returning to the USV. If a mission requires longer flight time, the drone automatically suspends the mission to swap its batteries on the USV before resuming its assignment. Depending on the type of mission, data is streamed in real time to the customer via the web interface, or the acquired data is thoroughly analysed and compiled into a report.

The innovative autonomous service technology developed in RAPID is posing the challenge of integrating 'beyond visual line-of-sight' flight in complicated environments such as ports. Developing the legal frameworks to make the RAPID services a reality is a crucial part of the project. The results and integration approaches into air traffic control are combined with extensive tests and demonstrations. This includes simulations in a digital twin environment as well as experiments of individual components and mission types in closed air spaces. At the end of the project, each case will be demonstrated in the port of Hamburg.

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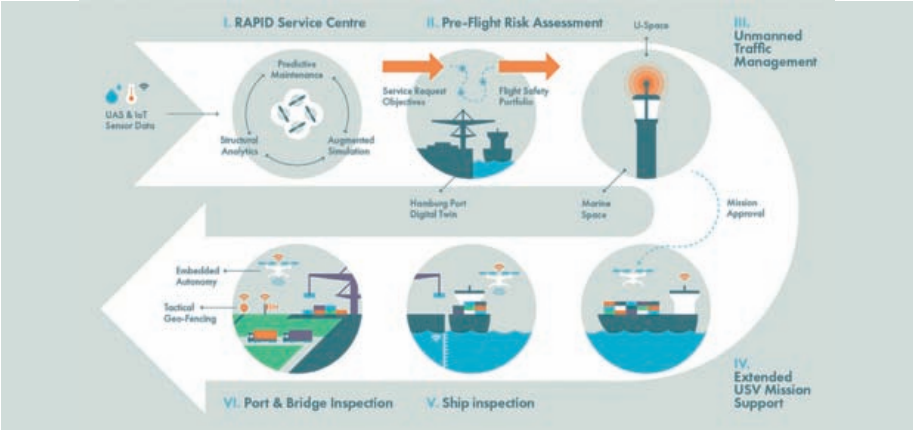

The RAPID service pipeline with its six core steps will provide the technological basis to perform fully autonomous inspections of critical infrastructure while fulfilling air traffic safety regulations

Source: Revolve Media