European Commission Joint Research Centre

RPAS Applications With Societal Benefits - JRC's RPAS-Related Activities

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This article describes some of the work of the JRC and its Institutes involved with Remotely Piloted Aircraft Systems (RPAS). With the dawn of contemporary knowledge-based societies emerging developments in science and technology impinge on all aspects of our society today, creating new opportunities and challenges. The Joint Research Centre (JRC)[1] is a Directorate-General of the European Commission, and strives to act as a reference centre for research-based policy support in the EU. Its main remit is to provide customer-driven independent scientific and technical support for the conception, development, implementation and monitoring of EU policies. As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national. The JRC coordinates and contributes to numerous EU-wide networks linking industry,


Sky-Y - Alenia Aeronautica, Italy

universities and Member State institutes, and also carries out studies and experiments in its own laboratories on behalf of its customers and stakeholders. Its main goal is to help create a safer, cleaner, healthier and more competitive Europe. The JRC comprises seven institutes located in five member states. Over the years, the JRC has developed special skills and unique tools to use science for providing and assessing policy options. Its activities range from the risk assessment of chemicals to the measurement of natural disasters impact, from evaluating product safety standards to providing assistance to humanitarian crises and security research.

The main JRC institutes involved with RPAS are IPSC and IES. The Institute for the Protection and Security of the Citizen (IPSC)[2] in Ispra, Italy, provides scientific and technical support on EU security policies, particularly in the areas of global security and stability, border management, transport and energy security, and nuclear safeguards. IPSC also works in the fields of risk prevention and management, antifraud and econometrics. The Institute for Environment and Sustainability (IES)[3], in Ispra, Italy, supports policies aimed at the protection and sustainable development of the European and global environment. It covers all environmental sciences, with particular competences in the fields of remote sensing and Earth observation.

EC-JRC Past, Ongoing and Upcoming RPAS-Related Activities

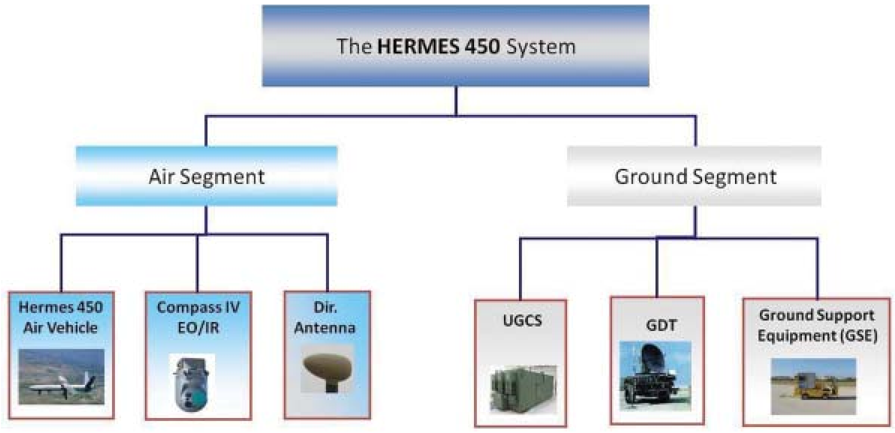
In recent years, the EC-JRC has carried out several RPAS experiments and research work to assess the potential of RPAS for several applications, in particular for maritime surveillance and post-disaster mapping in the IPSC, and for monitoring of agricultural resources and management practices in the IES.

The main maritime experiments involving RPAS carried out by the IPSC, comprise an experiment in collaboration with Alenia Aeronautica, Italy[4] in Sardinia, Italy (Oct. 2010), a small boat detection trial with Elbit Systems, Israel[5] in Haifa, Israel (Dec. 2010), a small boat detection experiment in Rotterdam, The Netherlands (Feb.2011) with Metasensing, The Netherlands[6] and a maritime surveillance campaign within the framework of the EC research competitive project WIMA2S (Wide Maritime Area Airborne Surveillance)[7] in Huelva-Spain (Jul. 2011). A brief description of each experiment is given next.

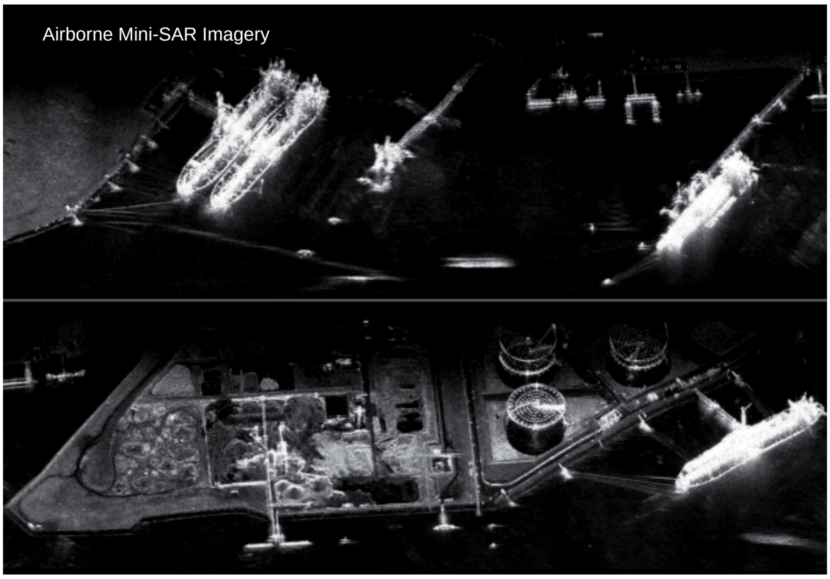
The first RPAS experiment took place on 29 Oct. 2010 in Porto Corallo, Sardinia-Italy and it was a coupled RPAS/Satellite maritime surveillance trial planned, set up and carried out in collaboration with Alenia Aeronautica. This trial was aimed at assessing the potential of RPAS for maritime surveillance and small boat detection. Two vessels were deployed on sea about 2 nautical miles East of Porto Corallo, namely an 8-meter long rubber boat and a 16-meter fishing vessel. This deployment took place at the time of an overpass of the TerraSAR-X satellite SAR (Synthetic Aperture Radar). The Remotely Piloted Aircraft (RPA) (Sky-Y[8]) took off from Decimomanu airbase in Sardinia-Italy and flew about 75 km East to the experiment area, Porto Corallo. The payload used comprised an EOIR sensor suit. The Sky-Y performed detection and tracking of several maritime targets moving at different speeds.

The second RPAS maritime surveillance experiment was organised in collaboration with Elbit Systems, and took place on 8 December 2010 a few miles southeast of Haifa, Israel over sea. It involved a simultaneous RPAS flight and the acquisition of a space-borne SAR image (Radarsat-2) and the deployment of a small (12 meter) boat. The Hermes 450[9] took off from Haifa and flew a couple of miles east towards the experiment area. The payload was an EO/IR sensor suit.

The third maritime RPAS trial was organised with Metasensing and took place near the port of Rotterdam in the Netherlands on 28 Feb. 2011. This trial was initially planned to be carried



out using an RPAS with a payload comprising the Mini-SAR developed by Metasensing, but due to an RPAS problem, the Mini-SAR was flown in a manned aircraft. Still, the manned flight illustrated the potential of the Mini-SAR for maritime surveillance using RPAS.
Finally, the fourth maritime surveillance experiment was carried out within the framework of the WIMA2S project in Huelva-


Airborne Mini-SAR Imagery

Spain on 6 July 2011. The JRC was involved in WiMA²S, a collaborative R&D project related to RPAS funded under the EC´s FP7 program. WiMA²S (Wide Maritime Area Airborne Surveillance) aimed to provide the key airborne “Building Block” (including RPAS) of a maritime surveillance “System of Systems” to be defined in Europe. WiMA²S aimed in particular at developing key technologies to prepare the future for the operational use of RPAS and innovative mission aircraft. WiMA²S addressed primarily the urgent need to control illegal immigration and human trafficking by sea, in the context of the Integrated Border Management. In line with the EU Maritime Policy, it also contributed to other public service missions, namely: shipping safety, search and rescue, protection of the marine environment, fisheries monitoring, interception of illegal trade and smuggling arriving by sea.

Within the framework of the WiMA²S project, an RPA flight, comprising several missions, took place on 6 July 2011 at El Arenosillo base in Huelva, Spain in collaboration with the Spanish authorities, in particular the Guardia Civil, and also ISDEFE (Ingeniería de Sistemas para la Defensa de España, S.A.), and INTA (Instituto Nacional de Técnica Aeroespacial). An RPAS, the Fulmar[10] from Aerovision[11], was used. The main objectives of the WiMA2S experiment were to demonstrate the WiMA2S concept and how an RPAS could be integrated into a maritime surveillance system of systems[12].

During the flight the Fulmar performed several missions aimed at testing different maritime surveillance concepts of operations (CONOPS), such as detection-classification-identification, interoperability, surface operations support, always as line of sight (LOS) operations. It also tested different flight control modes, such as scheduled flight, waypoints definition, manual control, emergency flight (in case of command link loss) and automated flight towards a detected target. Interaction mechanisms with both national and regional command and control centres, as well as interoperability with surface surveillance units were also tested. Two satellite communications terminals, Thrane E500 & Thrane Explorer E700, were used to transmit the real time RPAS video and images from the RPAS Ground Control Station to the remotely located Command and Control Centre through Inmarsat.

All four maritime experiments have served to demonstrate the feasibility of using RPAS for civilian maritime surveillance, and have contributed on one hand to build up the trust in the technology, and on the other hand to show weaknesses that still need improvement. Of course, many more experiments under different scenarios and circumstances are needed to fully test


Hermes 450 - Elbit Systems, Israel


Fulmar - Aerovision, Spain

Fulmar - Aerovision, Spain

and quantify the potential of RPAS for maritime surveillance.

On another front, the IPSC is testing the use of small, rapidly deployable RPAS for post-disaster mapping. In 2008-2009, an exploratory research aimed at developing a low-cost portable kit for gathering near real-time information in post disaster scenarios was run. The research project objective was to perform a feasibility study of a portable kit for data collection and analysis to be used directly in field campaigns, in order to support decision making and relief operations. The RPAS was built, a trial registration was performed, data processing was half automatic, but the final mosaic has to be corrected manually to remove distortion[13].

In addition, the JRC's IES institute carried out an experiment involving an RPAS. In the summer of 2011 two areas in Maussane les Alpilles (France) were flown by a RPA carrying a high resolution RGB camera, yielding 5 cm resolution at 200 m AGL. The RPAS consisted of a 5 m wingspan fixed-wing RPA capable of 3 hour endurance at 13.5 kg take-off weight (TOW), enabling the acquisition of both monitoring crop sites in one single flight each. The RPA was controlled by an autopilot to follow a plan using waypoints, comprising a dual CPU controlling an integrated Attitude Heading Reference System (AHRS) based on a L1 GPS board, 3-axis accelerometers, gyros and a 3-axis magnetometer. The ground control station and the RPA were radio linked, transmitting position, attitude and status data at 20 Hz frequency; this tunneling transmission link was also useful for communication purposes for the operation of the remote sensing camera on board the RPA. The camera was geometrically calibrated using photogrammetric methods to determine the internal orientation of the camera, which enabled the automatic generation of the mosaics from the single images acquired by the RPA. Standard quality assessment procedures were conducted at IES to evaluate the quality of the mosaics in comparison to satellite-based products currently used. Two sets of images have been produced with 10 cm and 20 cm pixel resolution.

Finally, JRC is also actively involved, together with other parts of the European Commission and EU Agencies, in other RPAS related activities, namely following the efforts for the insertion of RPAS into the European airspace. To that end, JRC is participating in workshops, conferences and meetings.

Future for RPAS

Maritime surveillance plays an important role in maritime security and safety. A significant part of the world's economy relies directly or indirectly on maritime areas. It is not just the shipping or fisheries industries and their related activities. It is also shipbuilding and ports, marine equipment and offshore energy, maritime and coastal tourism, aquaculture, submarine, telecommunications, blue biotech and the protection of the marine environment. A significant part of the world's maritime areas face risks and threats posed by unlawful activities, such as drugs trafficking, smuggling, illegal immigration, organised crime, piracy and terrorism. Small boat detection capability is an essential asset for maritime surveillance, since a significant number of sea-based major threats involve small craft. Currently used maritime surveillance assets, such as coastal radars, ship-based radars and manned aircraft only allow (small) boat detection in limited areas and/or for limited periods. In many cases, the surveillance needs to be persistent for adequate early warning allowing timely intervention to mitigate the above mentioned maritime threats. Satellites in low earth orbit provide global coverage, but can only make a limited number of observations per day on a give site, while geostationary satellites - that could provide persistence - do not yet have sufficient resolution. Persistent surveillance is currently one of the most sought characteristics in any surveillance system. RPAS have the potential to improve persistent surveillance.

Future actions, as part of the IES objectives, will focus on the retrieval of landcover / landuse information from multispectral cameras onboard RPA using capabilities currently out of reach for satellite sensors, such as: i) off-nadir viewing angle acquisition along with very high resolution (VHR) imagery to identify elevations of man-made parcel boundaries; ii) digital elevation model (DEM) reconstruction from stereoscopic methods using miniaturized multispectral cameras; iii) retrieval of landcover / landuse attributes with cm resolution, enabling the detection of landcover objects of interest; iv) developing methods for monitoring the greening requirements under the new Common Agricultural Policy of the EU.

In addition to maritime surveillance and the retrieval of landcover / landuse information from multispectral cameras, RPAS may find potential useful applications in several fields of European relevance, including post-disaster relief operations, fisheries control, security of critical infrastructures blue and green border surveillance and agriculture just to mention a few. However, before that potential can materialise, further testing and validation of RPAS is required, namely concerning CONUSE, CONOPS, security and safety issues, as well as the insertion into the airspace and the financial aspects. CONUSE and CONOPS are being consolidated in different fields. Unsolved security and safety issues include, but are not limited to, communications command and control systems, the transition between Line of Sight (LOS) and Beyond Line of Sight (BLOS) operations and interoperability issues, such as the change over between control stations, as well as autonomous collision and sense and avoid technology. The insertion into the airspace is a very challenging process, which involves the collaboration of several national and international civil aviation authorities, other institutions and the industry. Last, but not the least, it is essential that the financial cost of using RPAS is lower than the cost of alternative technologies.

Future JRC RPAS-related activities, among others, will also likely include the continuous fostering, together with stakeholders, of the RPAS insertion into European airspace and the investigation of the potential benefits of its use in relevant fields of the JRC remit. Other potential lines of research include the study of security-related issues, such as communications interference, both cooperative and unintentional (jamming, spoofing, etc.) and major threats to the security and safety of using RPAS.

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