

Technologies for aerial robotic industrial inspection, maintenance and transportation

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Aerial Robotics Topic Group**
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Overview

- **Aerial Robotic Manipulation for Inspection and Maintenance**
- **Aerial Robotic Transportation for Industrial Logistics**
- **Conclusions and future work**

Aerial manipulation for inspection and maintenance

AEROARMS: Aerial RObotic system integrating multiple ARMS and advanced manipulation for inspection and maintenance

Objective 1: Aerial manipulation methods and technologies for industrial inspection and maintenance

- Dual arm aerial manipulation
- Aerial manipulators with **fully actuated platforms**
- New **control, perception, planning and teleoperation** methods for aerial manipulation



Objective 2: Validation in industrial inspection and maintenance

- Contact inspection while flying
- Deploying and maintaining a mobile robotic system
- Installation and maintenance of permanent sensors



Aerial manipulation for inspection and maintenance

New Univ. Sevilla AEROARMS results

- New dual arm autonomous aerial manipulators
 - Compliant arms
 - Visual servoing
- New long-reach aerial manipulator
 - Long reach to maximize access
 - Local re-planning



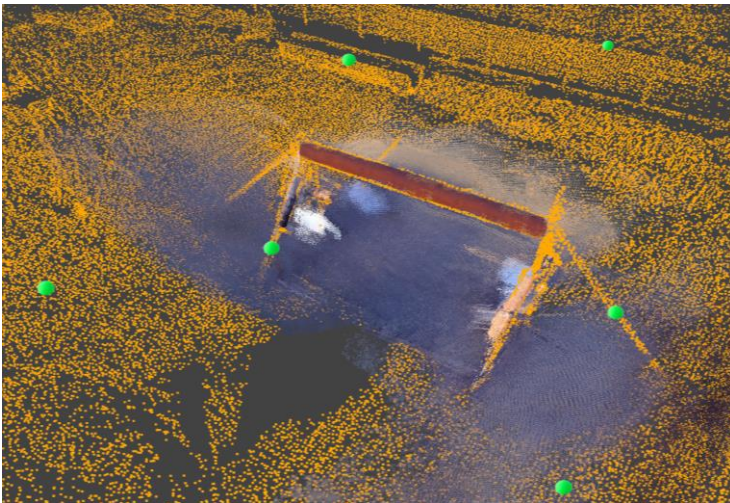
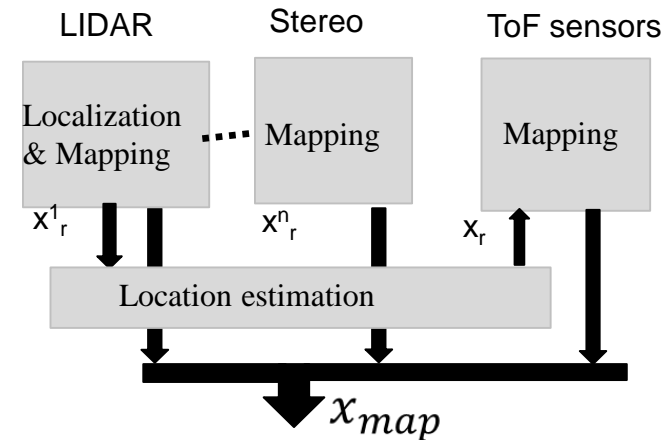
Aerial manipulation for inspection and maintenance

New Univ. Sevilla AEROARMS results

New Multi-sensor (3D LIDAR, stereo and ToF sensors) simultaneous localization and mapping



Velodyne HDL-32E
ZED stereo camera
ToF range sensors
UWB ToF sensors



Aerial manipulation for inspection and maintenance

New AEROARMS results: industrial inspection platform

Overall winner of the ICT innovation radar prize 2017



<http://www.euronews.com/2017/12/04/new-drone-technology-wins-innovation-radar-prize-2017>

Bridges contact inspection: AEROBI project



Univ. Sevilla

Aerial robotic transportation for industrial logistic

EUROC Challenge 3: ARCOW (Aerial Robot Co-Worker in Plant Servicing)

- Implementation of aerial robotics technologies in aircraft manufacturing plants.
 - Logistic of light goods
 - FOD detection
- Indoor navigation in man-made GPS-denied environments without beacons



Aerial robotic transportation for industrial logistic

Tuning and set up in the factory

- Reduce risk of an accident between a worker and the MAV
- A number of threat barriers are considered
 - Flying at several meters from the ground (space free of major obstacles)
 - Use of a net to avoid a crash with workers or manufacturing elements in case of a failure on the aerial platform
 - Use of a hopper to maximize the distance between the aerial robot and the worker when performing delivery of small tools and goods
- Increase reliability
 - Platform: DJI F550 with Pixhawk (PX4 firmware), onboard PC, LIDAR 2D Hokuyo UTM-30LX with mirrors, UWB sensors for FOD
 - Fully autonomous localization algorithms based on LIDAR, new altitude estimation method

Implementation in regular conditions

Aerial robotic transportation for industrial logistic

EUROC ARCOW (Aerial Robot Co-Worker in Plant Servicing)



**Special Innovative Prize 1st EU
Drones Award
European Parliament (January
2017)**

Project presentations in Airbus



Airbus D&S CEO Dirk Hoke (May 2017)



**HO Operations Andre-Hubert Roussel and HO
Plants & AIT Spacecraft Jörg Brill in Nov'17**

Conclusions and Future Work

- AEROARMS: Development of new aerial manipulation technologies
- Validation and demonstration of AEROARMS technologies
 - Validation in indoor testbeds
 - Outdoor validation in relevant environments
- EUROOC-ARCOW: Development validation of fully autonomous beaconless industrial transportation
- Demonstration in industrial environments
- Future work:
 - Integration and validation of AEROARMS technologies
 - Industrial demonstration of Aerial Manipulation for contact inspection
 - Increase reliability of aerial platforms for fully autonomous beaconless long time navigation
 - New platforms.