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UNIVERSITY OF LISBON
INTERDISCIPLINARY STUDIES
ON SUSTAINABLE ENVIRONMENT AND SEAS

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Unmanned Aerial Vehicles for Environmental Monitoring

Alexandra Moutinho
Control, Automation and Industrial Informatics
Mechanical Engineering Department
Instituto Superior Técnico, Universidade de Lisboa

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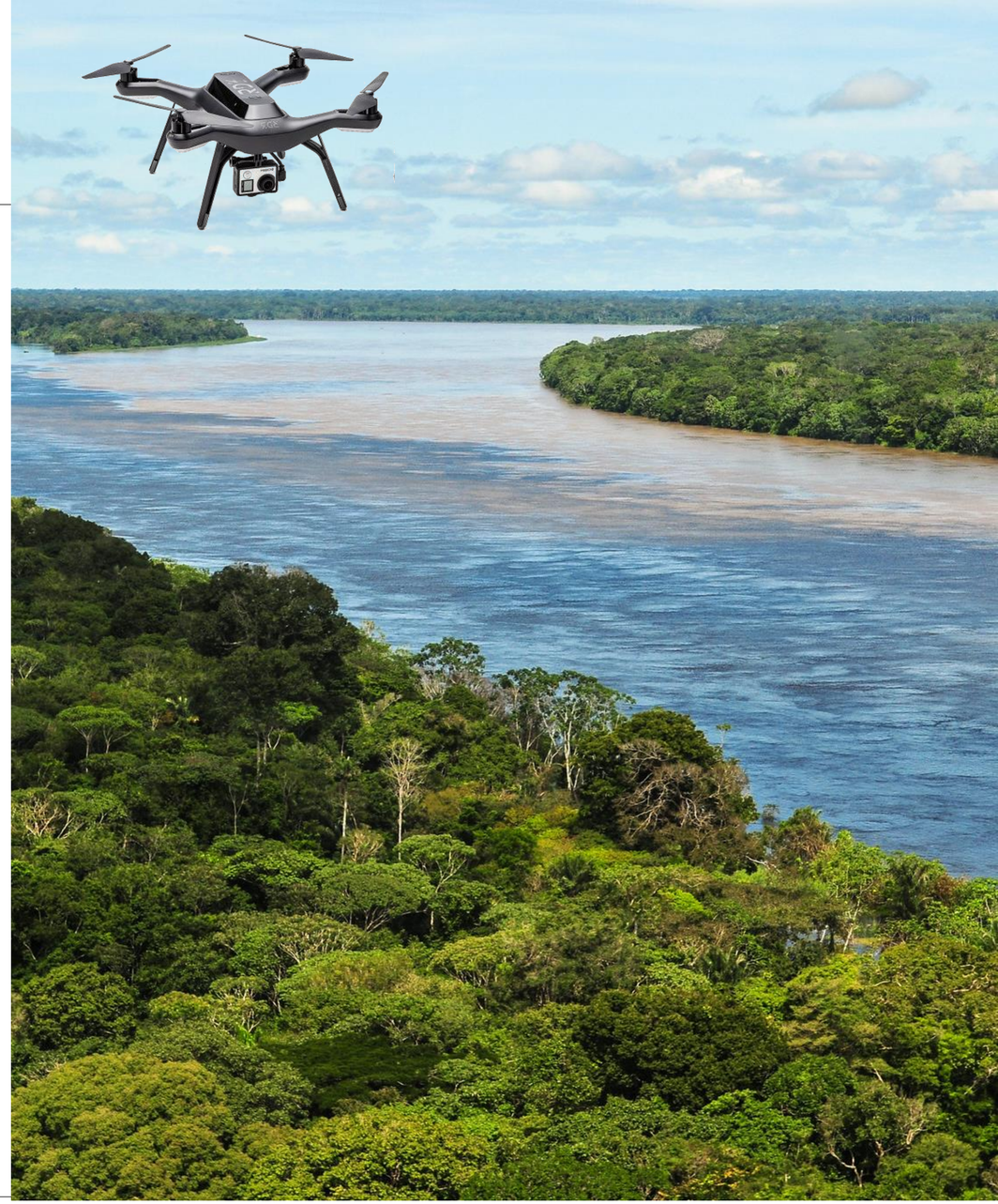
Module contents

1. Introduction to Unmanned Aerial Systems
2. UAVs payload: sensors for environmental monitoring
3. UAVs operation
4. Examples of application of UAVs for environmental monitoring



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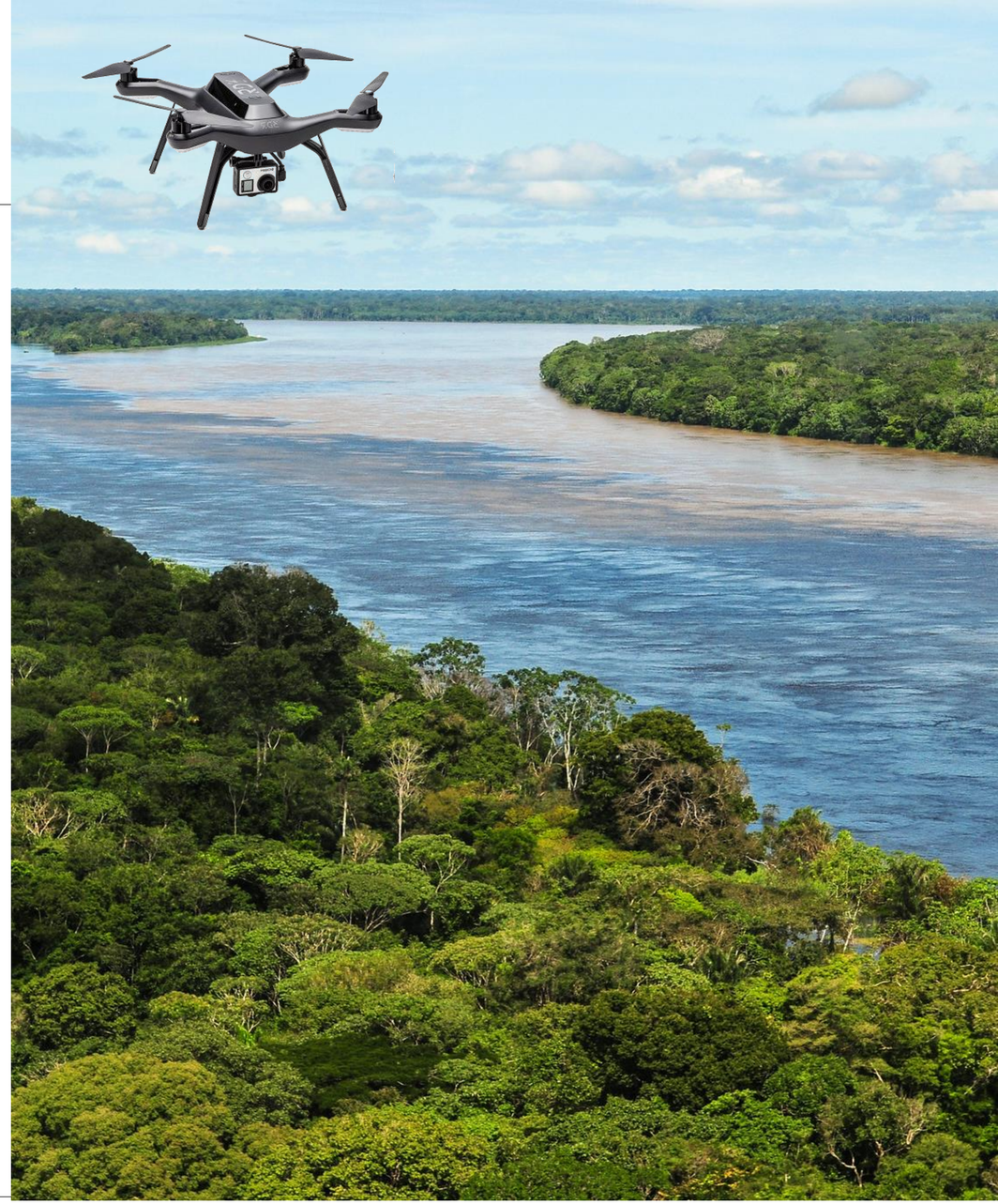

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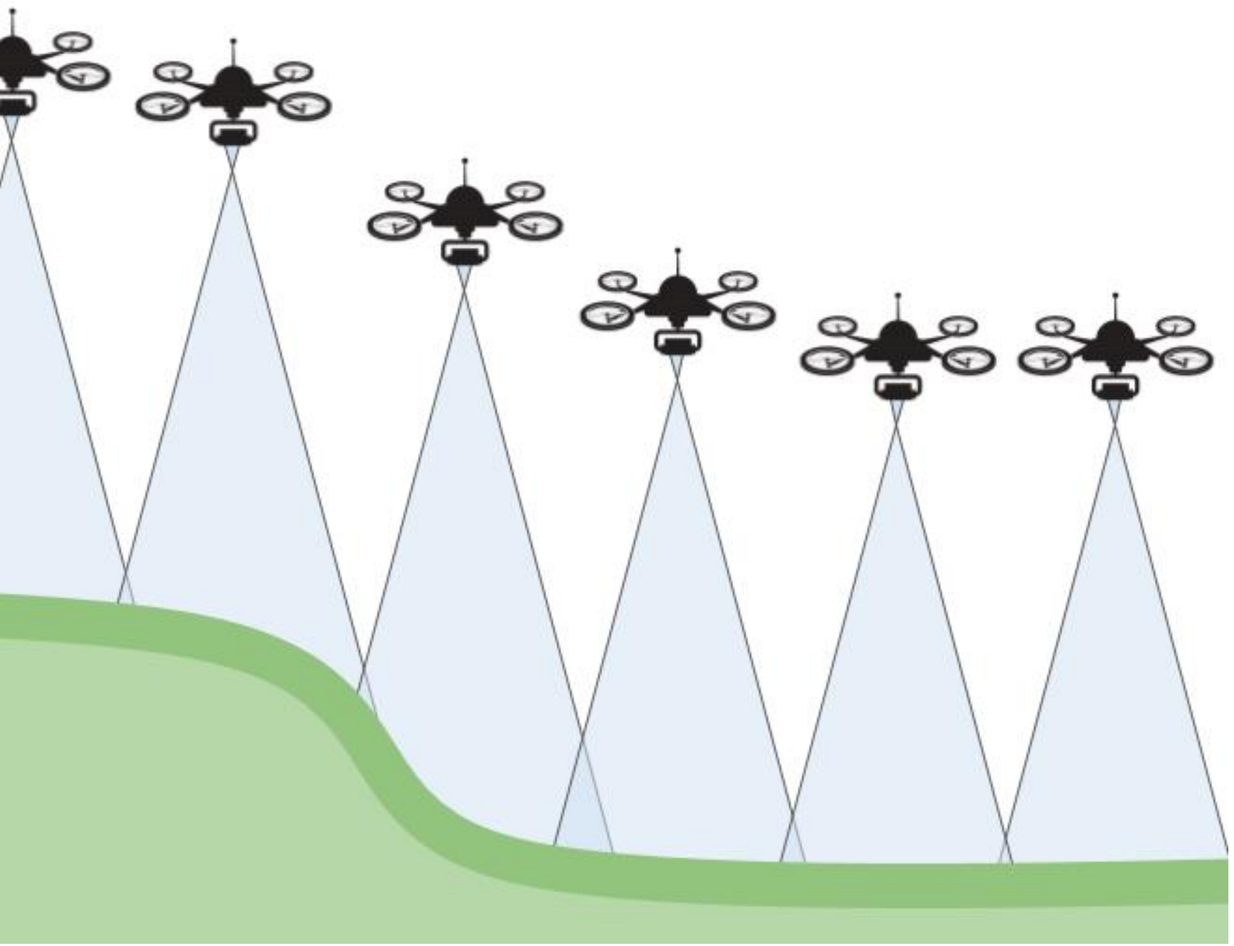
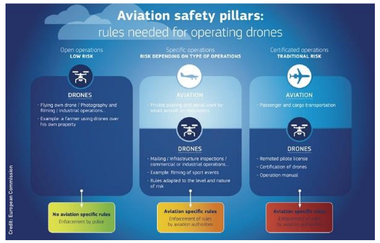
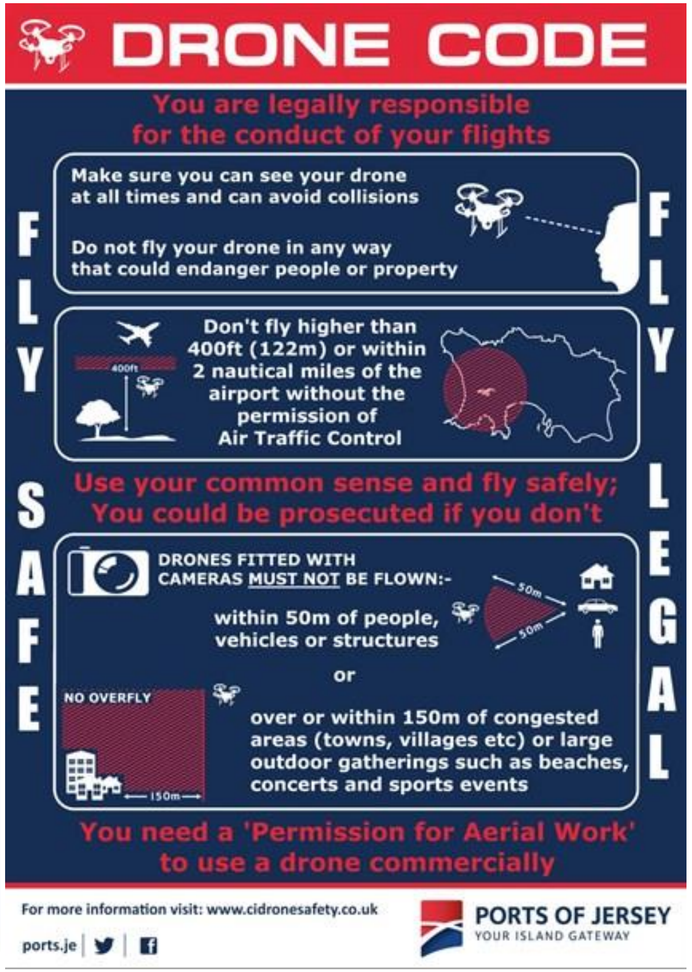
UAVs operation



- **Study design**
  - Drones regulations & legislation
  - Platform & sensors choice
  - Sensor settings and drone control software
- **Pre-flight fieldwork**
  - Reconnaissance of surveyed area
  - Field data collection
  - Sensors calibration
- **Flight mission**
  - Weather conditions
  - Mission definition
- **Data processing**
  - Data correction
  - Data synchronization
  - Data fusion
- **Quality assurance**
  - Benchmarking

Drones regulations and legislation





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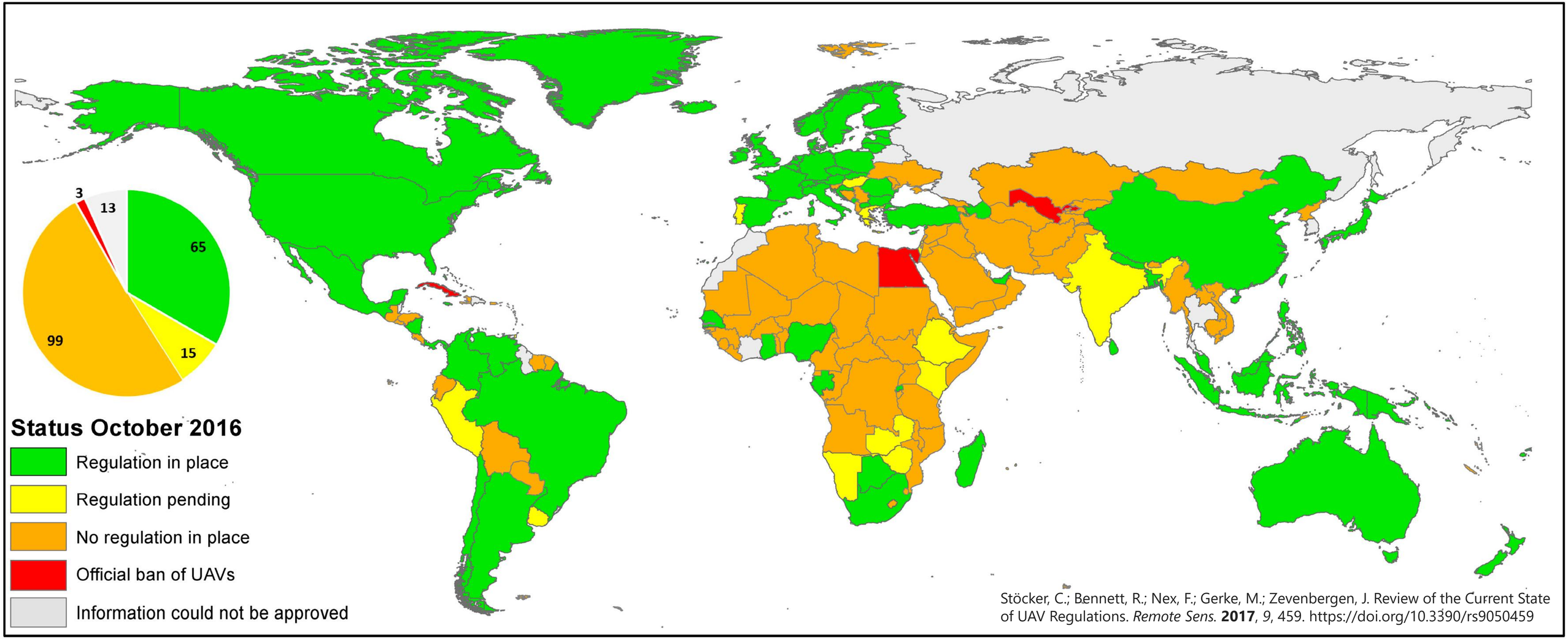
Drones regulations and legislation



Stöcker, C.; Bennett, R.; Nex, F.; Gerke, M.; Zevenbergen, J. Review of the Current State of UAV Regulations. *Remote Sens.* **2017**, *9*, 459. https://doi.org/10.3390/rs9050459

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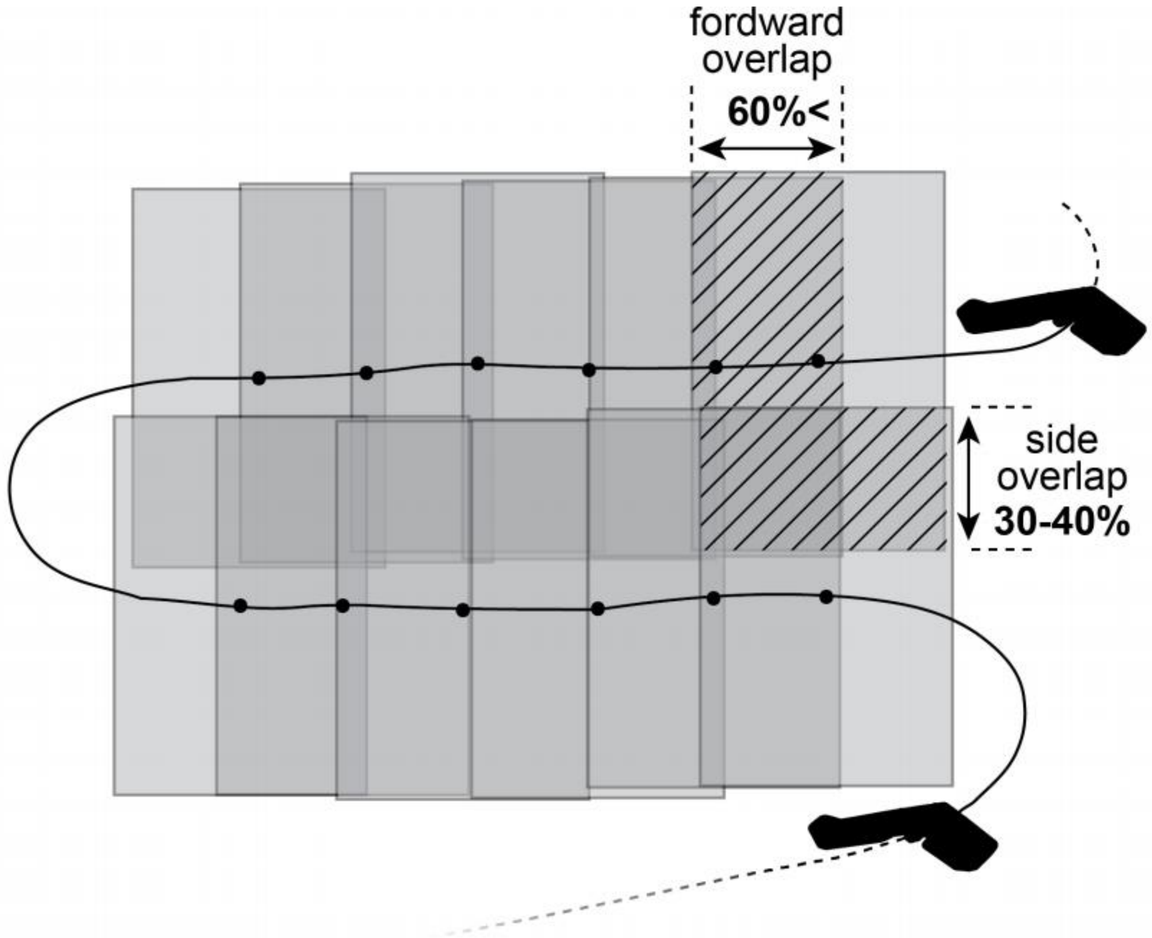
Mission planning



Goran Tmušic, Salvatore Manfreda, Helge Aasen, et al., Current Practices in UAS-based Environmental Monitoring, Remote Sensing, 2020, 12, 1001; doi:10.3390/rs12061001

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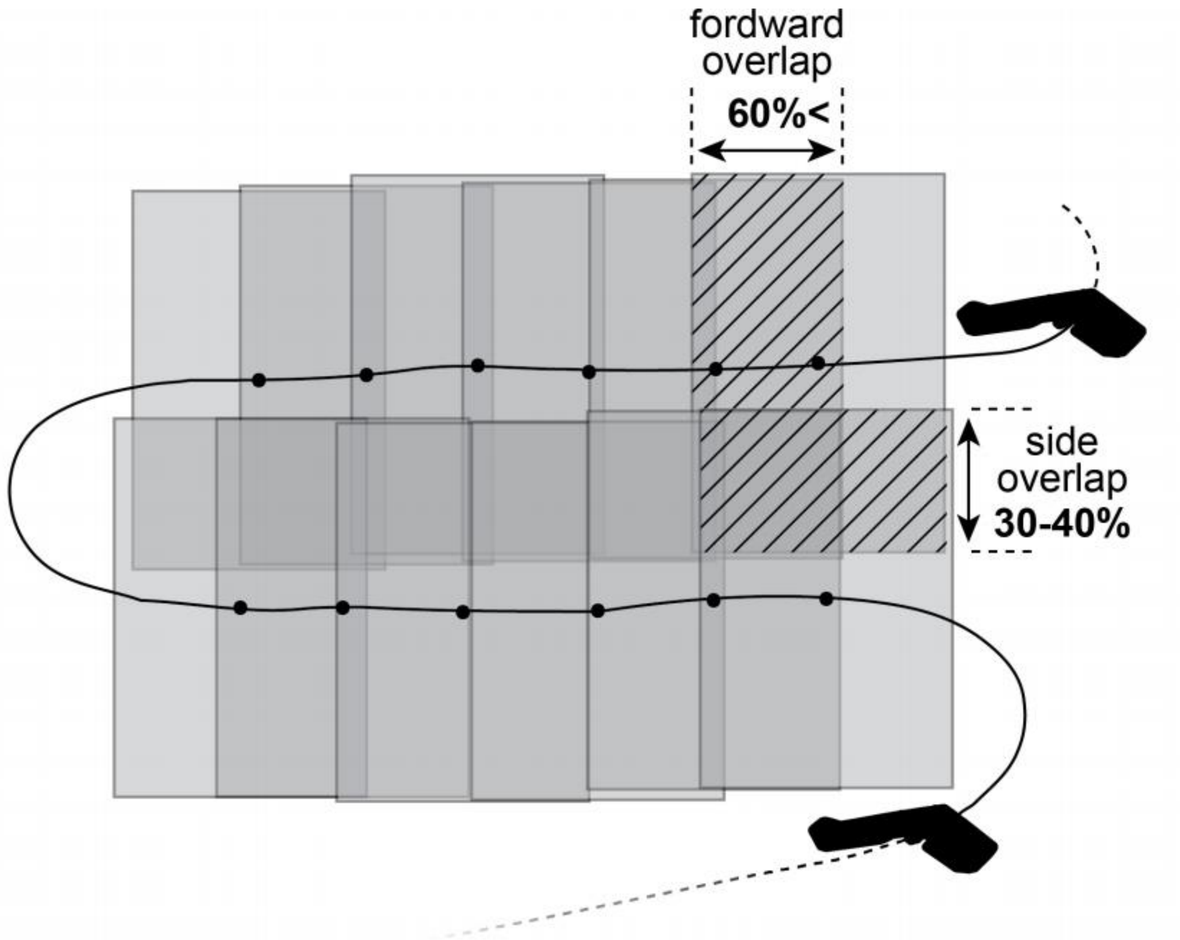
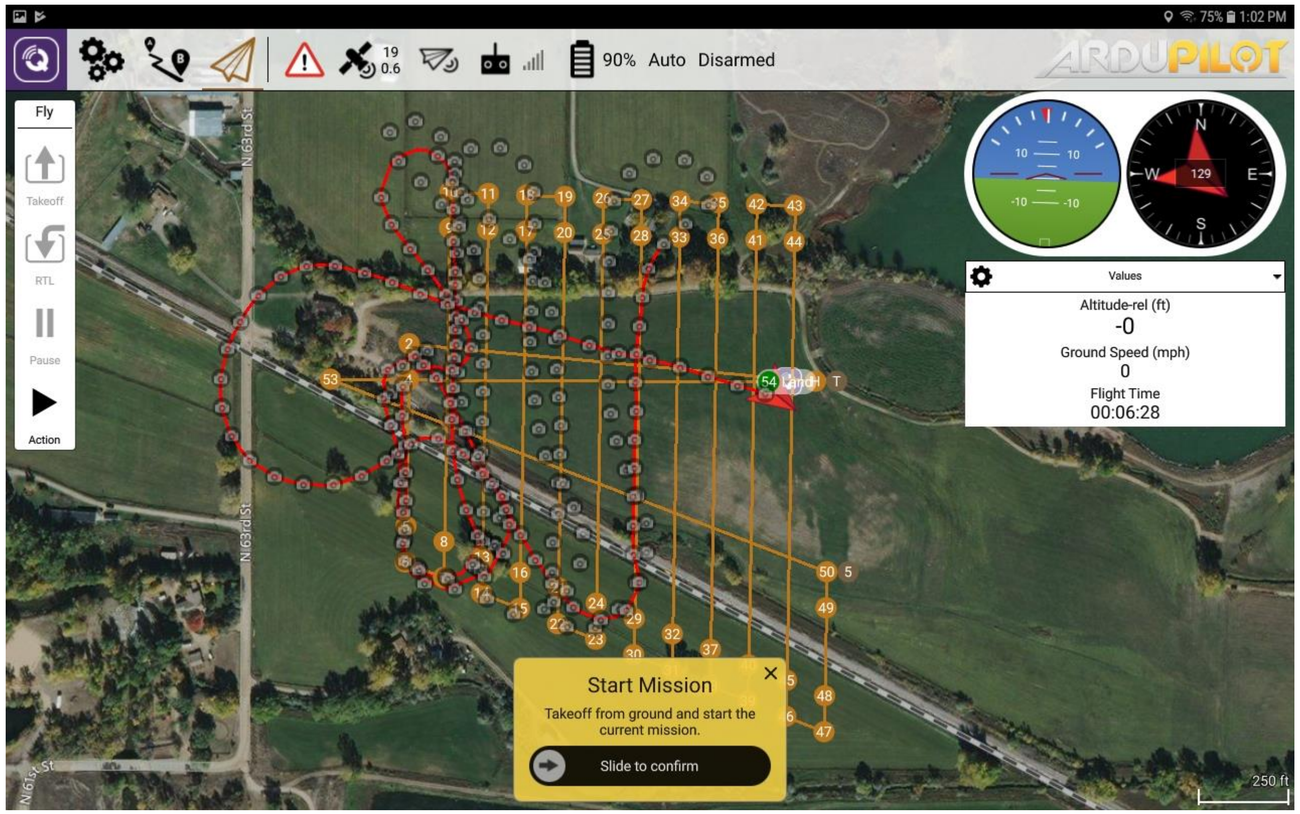
Mission planning





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UAV mission planning software

	Name	Software (SW) Options	Operating System	Home Page	Type of License
Flight planning app	Pix4Dcapture	Planar flights; Double gridded flights; Circular Flights.	Android/iOS/Windows	http://pix4d.com/product/pix4dcapture	Free to use
	DJI GS Pro	3D mapping	iOS	http://dji.com/ground-station-pro	Free to use
	Precision flight free	Resume interrupted flights.	Android	http://precisionhawk.com/precisionflight	Free to use
	DroneDeploy	Planar flights; Cloud-based orthomosaics.	Android/iOS	https://www.dronedeploy.com/	Free to use
	Litchi	Art computer vision algorithms; the gimbal and the drone's yaw axis.	Android/iOS	https://flylitchi.com/	Proprietary SW
	Phenofly Planning tool	Photographic properties, GCP placement, Viewing angle estimation	JavaScript browser	http://www.phenofly.net/PhenoFlyPlanningTool	Free to use & modify
Ground station software	MAVProxy	Loadable modules.	Portable Operating System (POSIX)	https://ardupilot.github.io/MAVProxy/html/index.html	Free to use
	Mission Planner	Hardware-in-the-loop UAV simulator.	Windows	http://ardupilot.org/planner	Free to use
	APM Planner 2/Mission Planner	Live data; Initiate commands in flight.	Linux/OS X/Windows	http://ardupilot.org/planner	Free to use
	QGroundControl GCS	Multiple vehicles.	Android/iOS/Linux/OS X/Windows	http://www.qgroundcontrol.org/	Free to use & modify
	UgCS	Photogrammetry; Custom elevation data import; battery change option.	OS X/Linux/Windows	https://www.ugcs.com/	Proprietary SW
	mdCOCKPIT	Real-time telemetric data; Flight analytics Module.	Android	http://microdrones.com/en/mdaircraft/software/mdcockpit	Proprietary SW
	UAV Toolbox	Telemetry data conversion.	Android	http://uavtoolbox.com/	Proprietary SW
	eMotion 3	Supports both fixed-wing and multirotor operations; Full 3D environment for flight management.	Windows	http://sensefly.com/software/emotion-3.html	Proprietary SW

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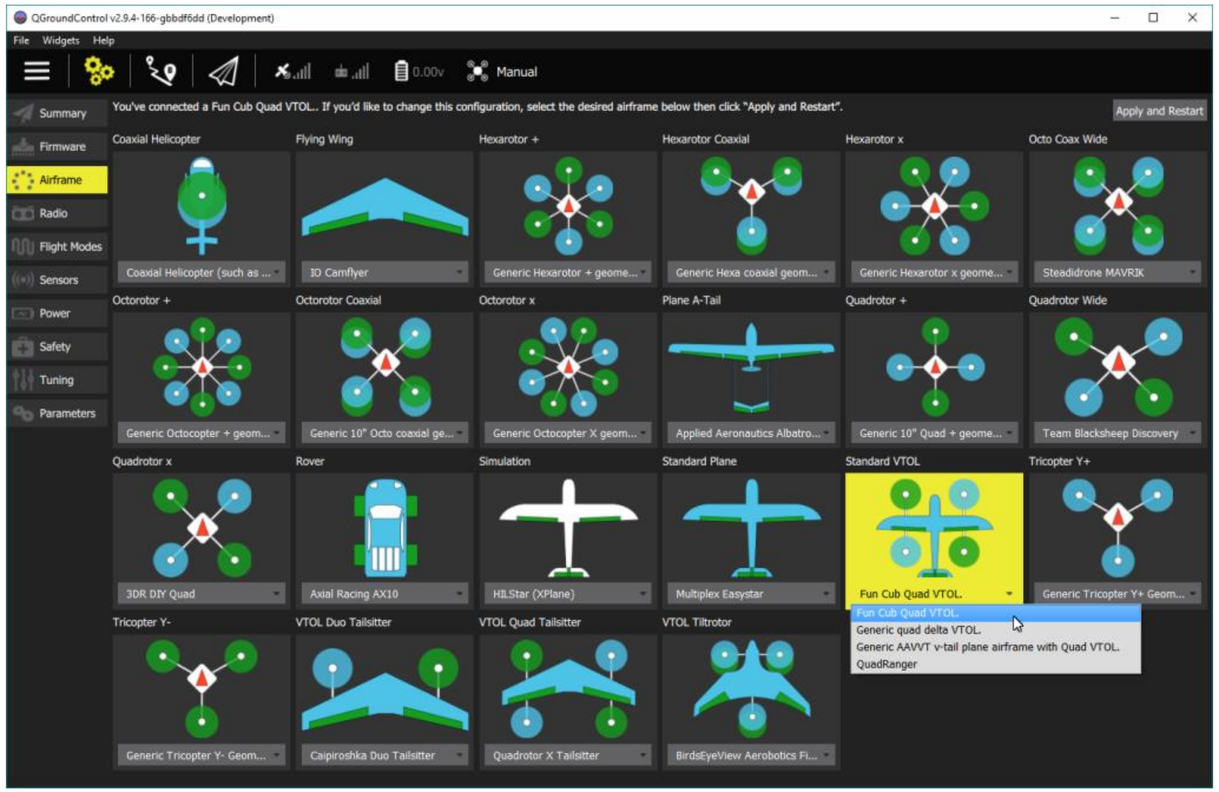

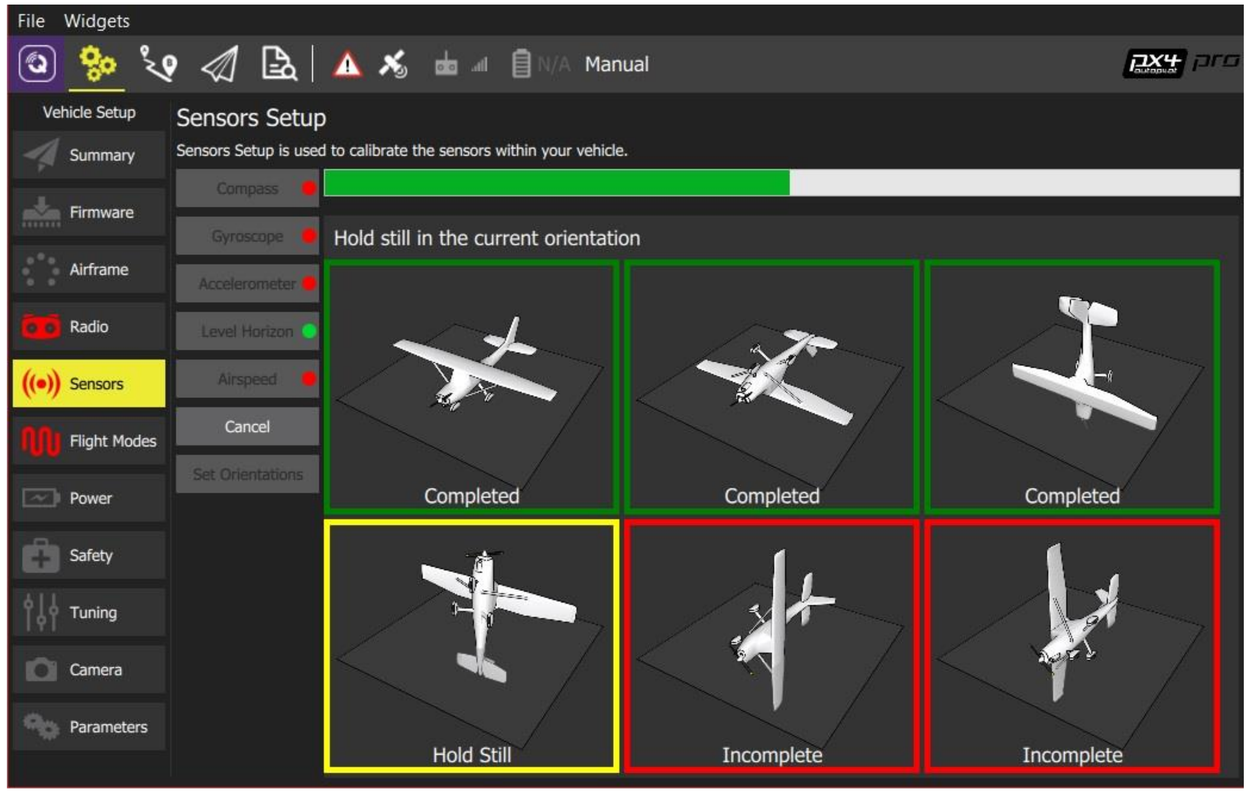

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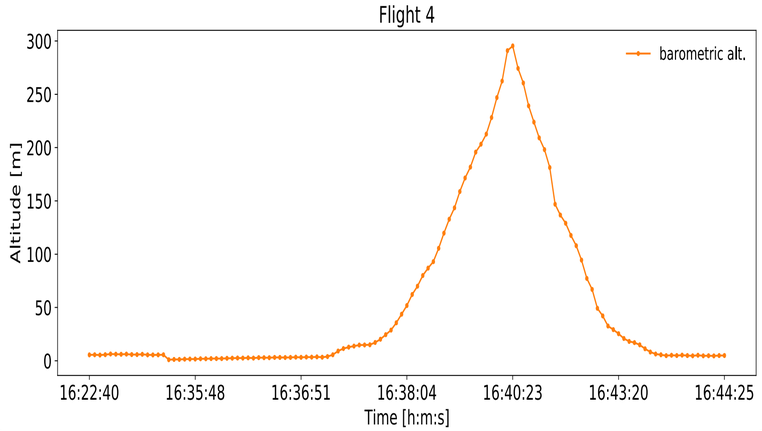
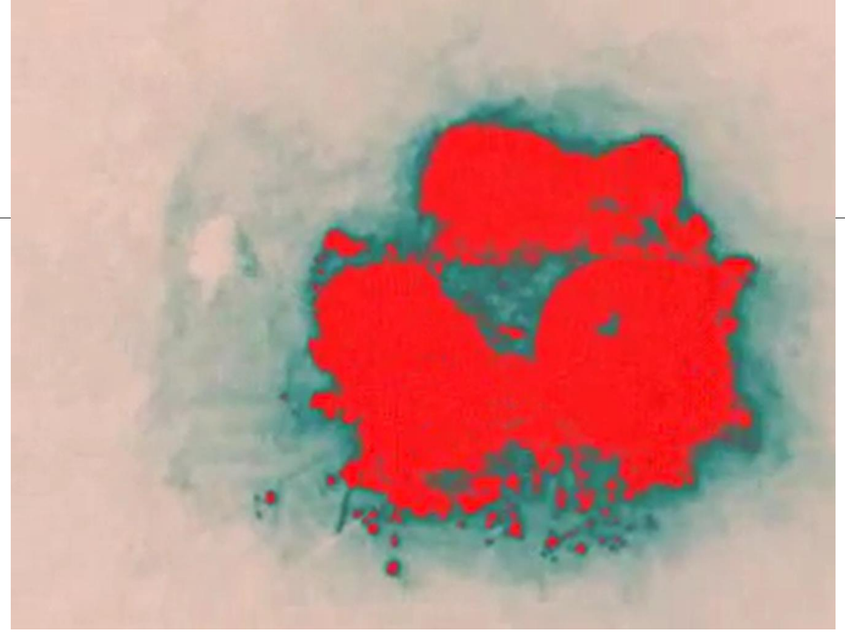
Data processing, synchronization, and fusion





Eye in the Sky Project – adai.pt/eyeinthesky

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