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# Computer Vision for U.A.V.



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[www.vision4uav.eu](http://www.vision4uav.eu)

# Autonomy for U.A.V.

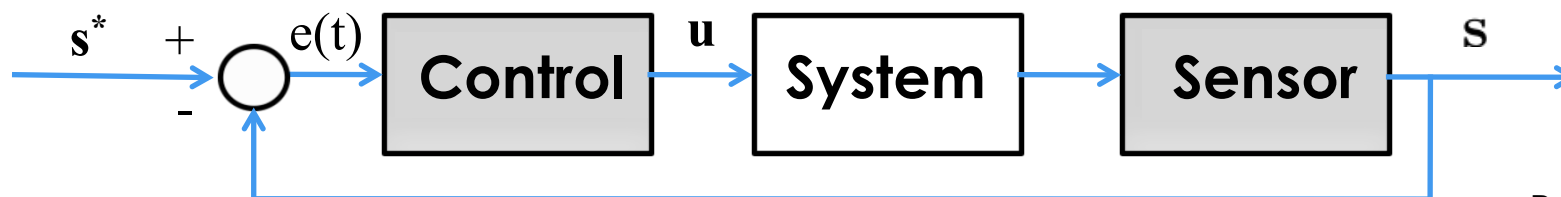


IMU:

- Acelerometers
- Gyroscopes
- magnetometers



GPS



Range sensors:

- Ultrasonic
- Lasers
- Barometers

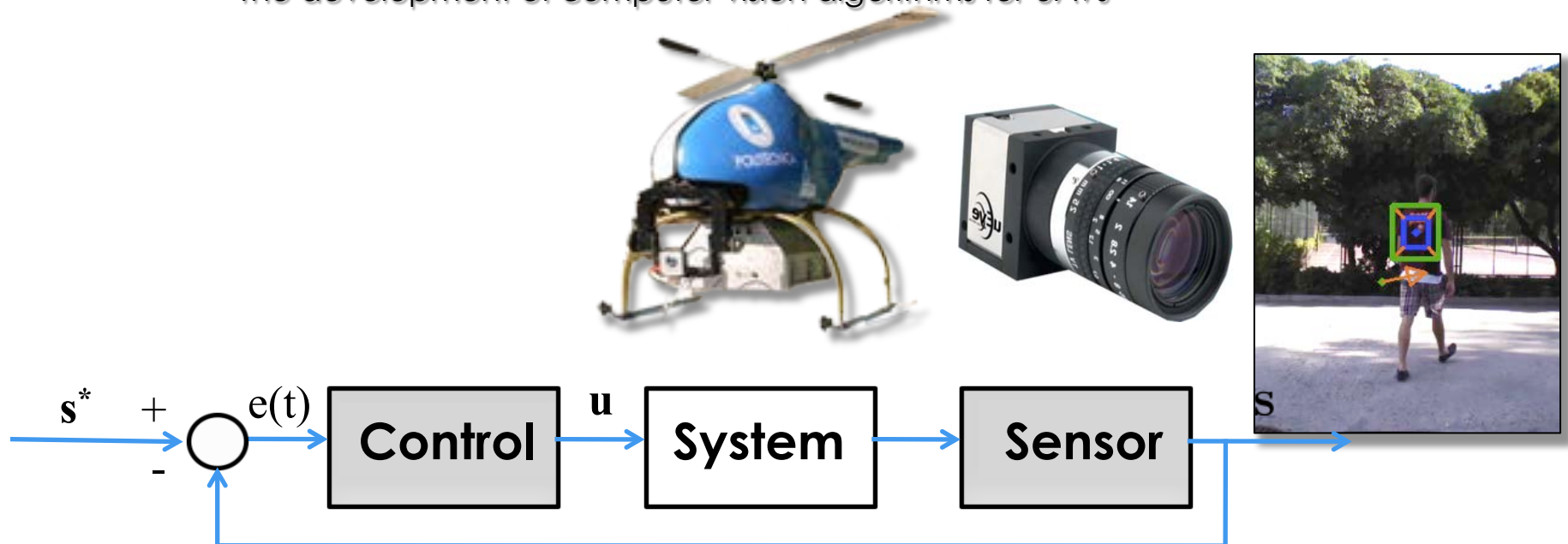


# Autonomy through Vision

**The Computer Vision Group CVG**  
**Universidad Politécnica de Madrid**

**Focus on:**

- Vision for UAVs
- The development of computer vision algorithms for UAVs



# Rotary wings UAV for maneuvering

## Helicopters

Gas powered helicopter  
Rotomotion LLC



Electric powered helicopter  
Rotomotion SR-20



## Multirotors

Oktokopter from Mikrokopter



Pelican from AscTec



LinkQuad from UAS Technologies Sweden



AR.Drones from Parrot



# Vision for UAVs [www.vision4uav.eu](http://www.vision4uav.eu)

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Our **Vision** is to provide Unmanned Aerial Vehicles (**U.A.V.**) with the highest degree of **autonomy** by exploiting the powerful sensor of **vision**.

Our **Mission** is to be always at the front end of the technology in **Image Processing and Control techniques** in order to achieve **technology transfer** into demanding U.A.S. civil applications.

Our **Values** are:

- Permanent **updating** with the latest worldwide R&D in may related fields is essential for improving our research
- Having **challenging aims** and **testing** the proposed **solutions** are two essential components for innovating our research and products
- **International cooperation** is important for enriching the knowledge and the solutions



# Civil Applications of U.A.V.

## ***Civil Protection***

- Disaster prevention
- Post disaster relief
  - Human sources (Nuclear accidents, ...)
  - Natural source (Storms, Earthquakes, Forest fires, Volcanic eruption,...)

## ***Security***

- Sensitive sites monitoring
- Industrial inspection
- Border inspection
- Traffic monitoring

## ***Environment***

- Monitoring and protecting natural environment (wild life, forests, coastal,...)
- Fisheries
- Precision Agriculture

## ***Communications***

## ***Filming and aerial Fotoraphy***

- Propaganda
- Cartography and maps





# What is an Micro/Mini U.A.V. ?



Aerovironment Black Widow – 2.12 oz.



Sig Kadet II RC Trainer – 5 lb



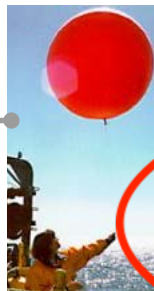
Boeing/ Insitu ScanEagle – 33 lb



Gen. Atomics – Predator B – 7,000 lb



BAE Systems Microstar – 3.0 oz.



NOAA Weather Balloon  
2-6 lb



Allied Aero. LADF – 3.8 lb



Micro

Mini

Category name	Mass [kg]	Range [km]	Flight Altitude [m]	Endurance [hours]
Micro	< 5	< 10	250	1
Mini	<25/30/150	< 10	150/250/300	< 2
Close Range	25 – 150	10 – 30	3000	2 – 4
Medium Range	50 – 250	30 – 70	3000	3 – 6
High Alt. Long Endurance	> 250	> 70	> 3000	> 6



# WHAT IS VISION ON BOARD FOR ?

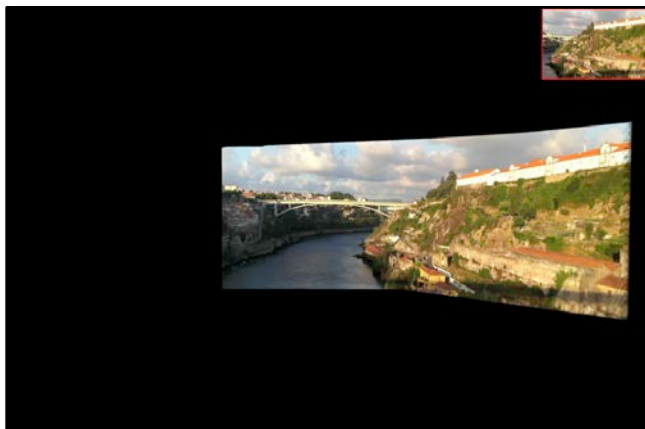
1. Visual Information enhancing (e.g. objet tracking, mosaicking, stabilization)
2. Visual Detection and Pattern Recognition
3. Pose estimation and Map estimation (VSLAM)
4. Visual Control (Image based V.C and Position based V.C.)



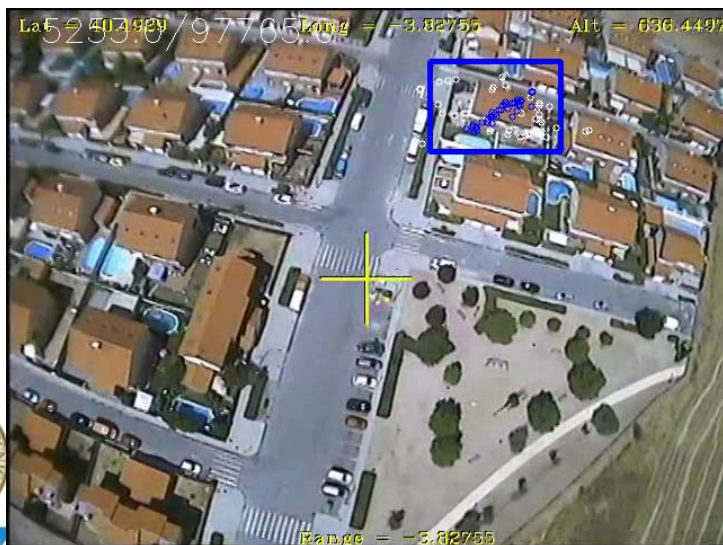


# Visual enhancement

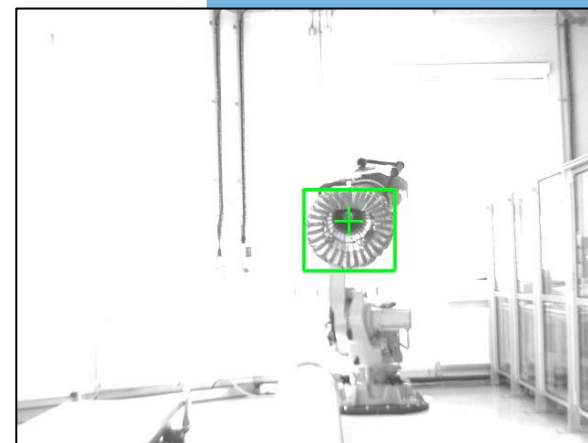
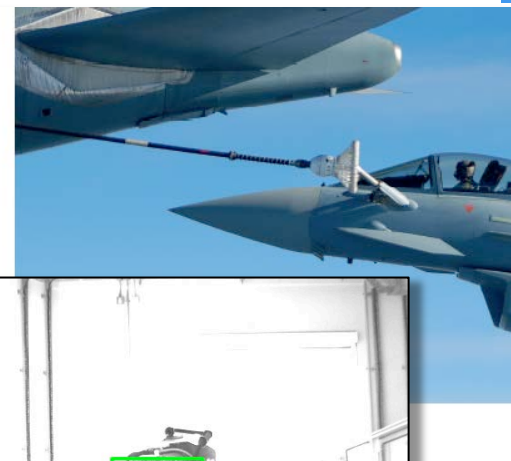
## Mosaicking



Douro river by Porto



## Robust tracking



Air to air refuelling  
For Cobham with University of Bristol

Licenced Sw for  
Airelectronics S.L.

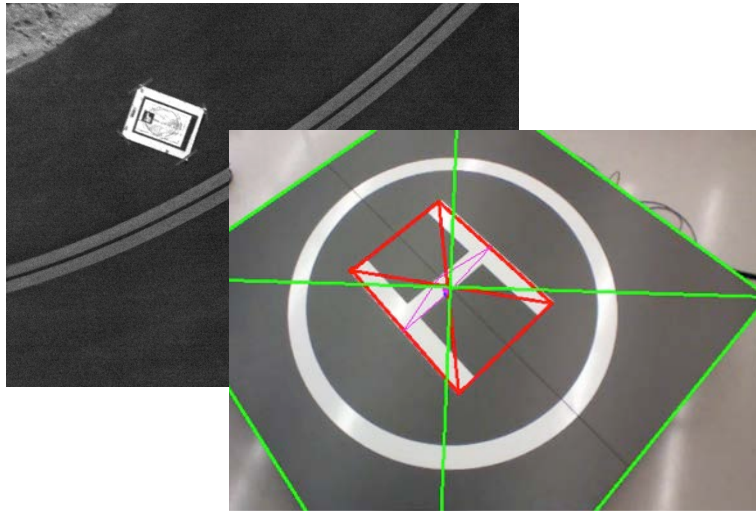


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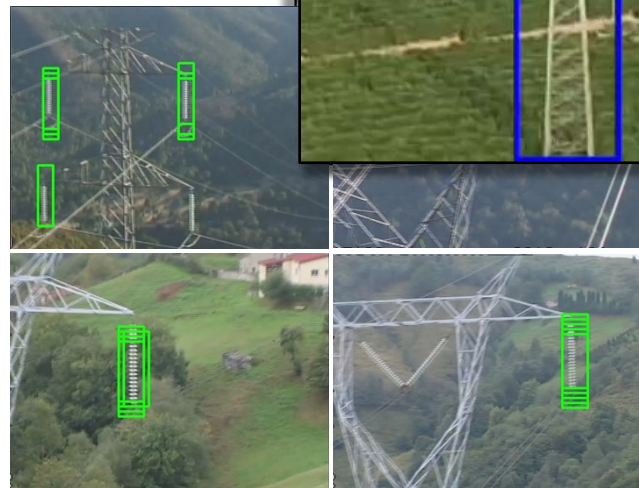
# Visual Detection and Recognition

Helipad detection and recognition



for autonomous landing

Tower detection and tracking



Isolator detection and fault recognition

for Union Fenosa, Project "INNPACTO"  
Spanish Economics Ministry



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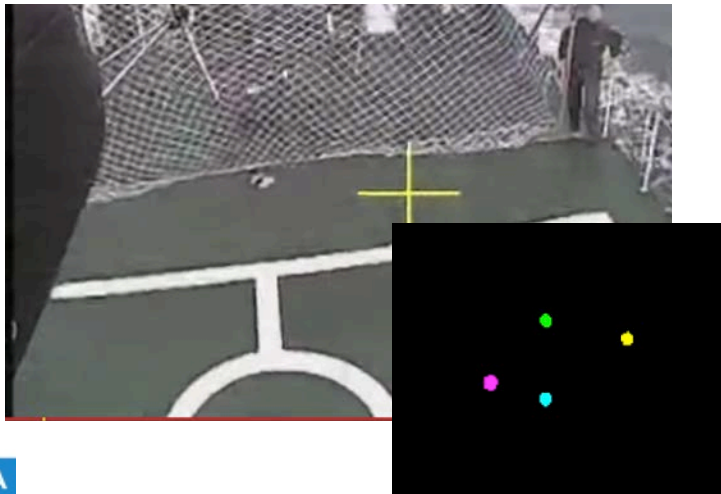


# Pose and Map estimation (VSLAM)

## Pose estimation using external codes



Autonomous landing  
at Arganda campus



Net recovery  
For Usol S.L.



Trajectory planing at IMAV 13





# Pose and Map estimation (VSLAM)

Pose estimation using Visual Odometry



IARC 14 Competition  
Using optical flow and sensor fusion

Map construction  
using stereo odometry



map construction at ETSII



# Visual Control

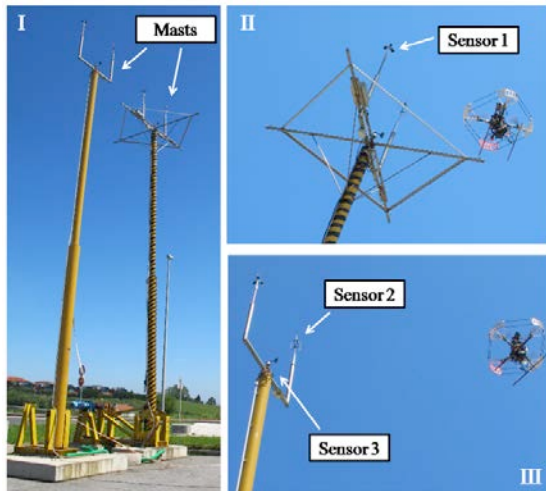
Image based V.C



Window inspection at ETSII



Person following



Meteo mast inspection  
EchoRD project



See & Avoid for Usol S.L.



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# Visual Control

Position based V.C.





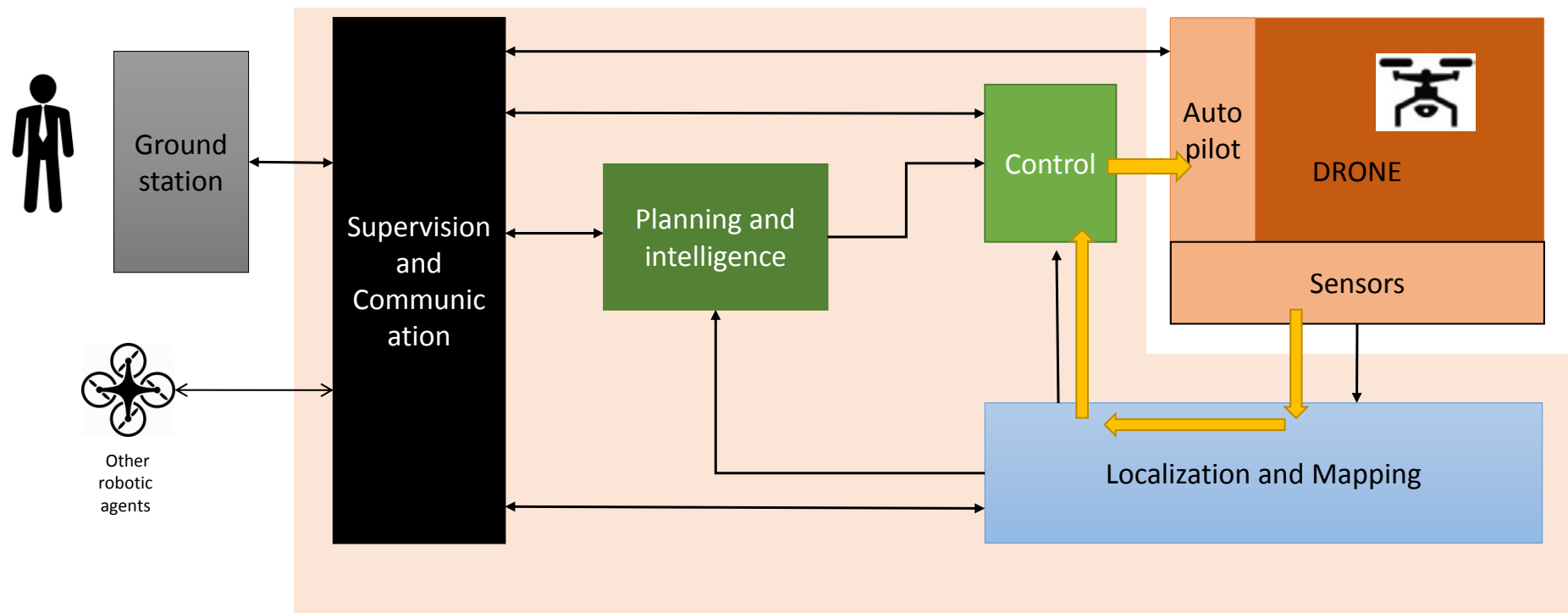
A Software Framework  
for Aerial Robotic Systems

Title	User Guide
Date	October 28, 2015





# General Control System Architecture: Control Loop



## Runing Industrial projects

“AEROS: Autonmous Working **Windmill Inspection**”

RETOS-Colaboración RTC-2014-1977-3, with Diagnostiqa, Ixion Industry Aerospace y CENER-CIEMAT, Starting: February 2014, Finishing: May 2016

“MESOANTEN: Security Improvement in UAV Operations in **Naval Aplications**”

RETOS-Colaboración RTC-2014-1762-8, with Unmanned Solutions S.L.  
Starting: April 2014, Finishing: Dicember 2016

“TAISAP: Alternative Technologies for Security Improvement on **Precise Landing** of UAVs”  
Program AEESD, ref. nr. TSI-100103-2014-177, contracted by Unmanned Solutions S.L.  
Starting: Deecmbre 2014, Finishing: May 2016

“I2L: Intelligent **Power Line Inspection**”

INNPACTO IPT-2012-0491-120000, with Unión Fenosa S.A., INTA and Prysma S.A.  
Starting: September 2012, Finishing: December 2015

“**Visual servoing** for a gimbal”

Licenced to Airelectronics S.L.  
Starting: June 2015



## Relevant recent industrial projects

“SUPVERT: UAV for Outdoors Vertical **Structure Inspection**”  
Program AVANZA ref. nr. TSI-020602-2012-43, contracted by , Ixion Industry Aerospace.

“E-Vision II: Prototype of a **See and Avoid** system for UAVs”  
Contracted by Unmanned Solutions S.L. within AVANZA Program Ministry of Industry.  
Starting: September 2012, Finish: December 2014

“Automatic drug detection system based on a **visual test**”  
contracted by the company Vincilab S.L.. S  
Starting: May 2013, Finish: August 2013

“On board Control and Visual Guidance of a New Prototype of **Urban Vehicle**”  
Contracted by Siemens España S.A. and supported by the CDTI  
Starting: April 2010, Finish: June 2011

“DOLBA: Development of a New Device for **Low Altitud Observation**”  
Contracted by Aries Ingeniería y Sistemas S.A.  
Starting: January 2010, Finish: May 2011



## International prizes in competitions

- **Two special awards** on "**Best Obstacle Avoidance Award**" and "**Best Trajectory Controller**" in the World's Premier Aerial Robotics Challenge IARC14, where there were no winners for this first edition of the 7th Mission of the International Aerial Robotics Competition that is the longest running collegiate aerial robotics challenge in the world in Yantai, China, August 2014.
- **First Prize in "Indoors Autonomy"** at international competition IMAV13, International Micro Air Vehicle Conference and Flight Competition held in Toulouse, September 2013.
- Special Prize to the "**Best Automatic Performance**" and the **2nd overall prize** in "Indoor Flight Dynamics -Rotary Wing MAV" at the IMAV12 International Micro Air Vehicle Conference and Flight Competition held in Braunschweig July 2012.





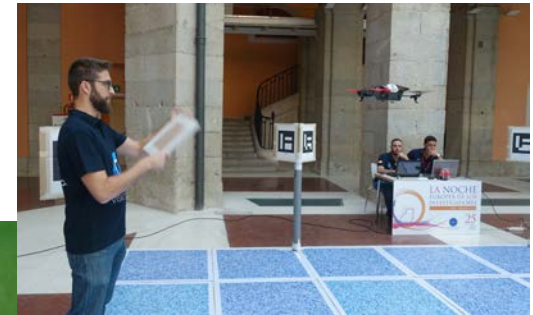
vision4UAV





Than you for your attention

Questions ?



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