### Introduction

Visual and inertial sensing are two sensory modalities that can be explored to give robust solutions on image segmentation and recovery of 3D structure from images, increasing the capabilities of robotic systems and enlarging the application potential of vision systems. Estimating the egomotion of an autonomous system is required in many important applications, e.g. navigation, 3D human-computer-interaction, and surveillance. Two sensing modes prove to be of particular value to achieve this task: visual and inertial sensing. The "beauty" of combining these two sensor modalities is the complementary characteristics of camera and inertial sensors. On one hand, the inertial sensors have large measurement uncertainty at slow motion and lower relative uncertainty at high velocities. Inertial sensors can measure very high velocities and accelerations. On the other hand, the cameras can track features very accurately at low velocities. With increasing velocity tracking is less accurate since the resolution must be reduced to obtain a larger tracking window with same pixel size and, hence, a higher tracking velocity.

In humans and in animals the vestibular system in the inner ear gives inertial information essential for navigation, orientation, body posture control, and equilibrium. In humans this sensorial system is crucial for several visual tasks and head stabilisation. Neural interactions of human vision and vestibular system occur at a very early processing stage. The information provided by the vestibular system is used during the execution of visual movements such as gaze holding and tracking. Micromachining enabled the development of low-cost single chip inertial sensors. These can be easily incorporated alongside the camera imaging sensor, providing an artificial vestibular system. The noise level of these sensors is not suitable for inertial navigation systems, but their performance is similar to biological inertial sensors and can play a key role in artificial vision systems.



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## Workshop on

# Integration of Vision and Inertial Sensors



University of Coimbra

June 29th, 2003

### **Organizing Committee**

Markus Vincze:	ACIN, Vienna University of
	Technology, Austria
Jorge Dias:	ISR, University of Coimbra,
	Coimbra, Portugal
Peter Corke:	CSIRO Manufacturing &
	Infrastructure Technology,
	Brisbane, Australia
Stefan Chroust:	ACIN, Vienna University of
	Technology., Austria
Jorge Lobo:	ISR, University of Coimbra,
	Coimbra, Portugal

### **Program Committee**

Ernst Dickmanns:	Universität der Bundeswehr
	München, Germany
William Hoff:	The Colorado School of
	Mines, CO, USA
Axel Pinz:	EMT, Graz University of
	Technology, Austria
Thierry Vieville:	INRIA, Sophia Antipolis,
	France
François Berry:	LASMEA, Université Blaise
	Pascal, France.
Marnix Nuttin:	Katholieke Universiteit
	Leuven, Belgium

### **Workshop Site**

The workshop will take place at the Institute of Systems and Robotics, at the Polo II University of Coimbra Campus (see map on the back).

http://paloma.isr.uc.pt/icar/workshop/inervis/

## Sunday 29<sup>th</sup> June 2003

#### 14:00 - 14:25

## An Inertial and visual Sensing System for a Small Autonomous Helicopter

Peter Corke (CSIRO, Kenmore, Australia)

#### 14:25 - 14:50

#### Navigation aided image processing in UAV surveillance - Preliminary results and design of airborn experimental system Jonas Nygårds, Morgan Ulvklo (Swedish Defense Research

Agency; Linkoping University, Sweden), Per Skoglar (Swedish Defense Research Agency, Sweden), Tomas Högström (SAAB Aerospace, Sweden)

#### 14:50 - 15:15

#### Vision Based Intelligent Wheel Chair Control: the role of vision and inertial sensing in topological navigation

Toon Goedemé (ESAT-PSI- University of Leuven, Belgium), Marnix Nuttin (PMA - University of Leuven, Belgium), Tinne Tuytelaars, (ESAT-PSI- University of Leuven, Belgium), Luc Van Gool (ESAT-PSI- Univ. of Leuven, Belgium; BIWI -ETH Zurich, Switzerland)

#### 15:15 - 15:40

#### Fusing Visual Contour Tracking with Inertial Sensing to Recover Robot Egomotion

Guillem Alenyà (Robotsoft, France), Elisa Martínez (Ramon Llull University of Barcelona, Spain), Carme Torras (CSIC-UPC-Barcelona, Spain)

#### 15:40 - 16:00

#### Coffe-Break

#### 16:00 - 16:25

## A Flexible Software Architecture for Hybrid Tracking

Miguel Ribo (CDLAMT, Graz University, Austria), Markus Brandner, Axel Pinz (IEMMSP, Graz University, Austria)

#### 16:25 - 16:50

#### Inertial Sensed Ego-motion for 3D vision Jorge Lobo, Jorge Dias (ISR- University of Coimbra, Portugal)

#### 16:50 - 17:15

## Omnidirectional Vision and Inertial Clues for Robot Navigation

Irem Stratmann, Erik Solda (AIS, Fraunhofer Institute, Schloss Birlinghoven, Germany)

#### 17:15 - 17:40

## Fusion of Vision and Inertia Date for Motion and Structure Estimation

Stefan Chroust, Markus Vincze (ACIN, Vienna University of Tech., Austria)

#### 17:40 - 18:00

Coffe-Break

#### 18:00 - 18:25

### Online Motion Estimation from Image and Inertial Measurements

D.Strelow, S.Singh (CMU, Pittsburgh, USA)

#### 18:25 - 18:50

#### Principles of Fusion of Inertial Navigation and Dynamic Vision Stevica Graovac (University of Belgrade, Serbia and Montenegro)

#### 18:50 - 19:15

Discussion Panel: Towards Applications of Inertial and Vision Sensing Integration