



Univ. Udine, December 2014
**Visual Sensor Networks
Research Overview**



**ALPEN-ADRIA
UNIVERSITÄT**
KLAGENFURT | WIEN GRAZ

FAKULTÄT FÜR TECHNISCHE WISSENSCHAFTEN

Institut für Vernetzte und Eingebettete Systeme

Bernhard Rinner

<http://bernhardrinner.com>

The AAU: An innovative university in southern Austria

- Leading academic educational and research institution in Carinthia
- Research achievements with national and international recognition
- An inimitable campus with modern infrastructure provides a stimulating atmosphere for students and research activities
- Approximately 1,300 members of staff produce outstanding achievements in teaching, research and administration
- Organized in **4 Faculties**: Humanities, Interdisciplinary Studies, Management and Economics, Technical Sciences



Young university, powerful history: An overview

- 1970** – The College of Educational Sciences is founded in Klagenfurt
- 1975** – The College is re-named „University of Educational Sciences“
- 1993** – The name of the university is changed to „Universität Klagenfurt“, a Faculty of Cultural Studies and a Faculty of Economics, Business Administration and Informatics are inaugurated
- 2004** – The Institute of Interdisciplinary Research and Education (IFF) is established as the university’s third faculty
- 2007** – Foundation of the Faculty of Technical Sciences
- 2012** – Establishment of the University Centre „School of Education (SoE)“

Students´ Figures

- 10.500 students
- 1.700 students from abroad

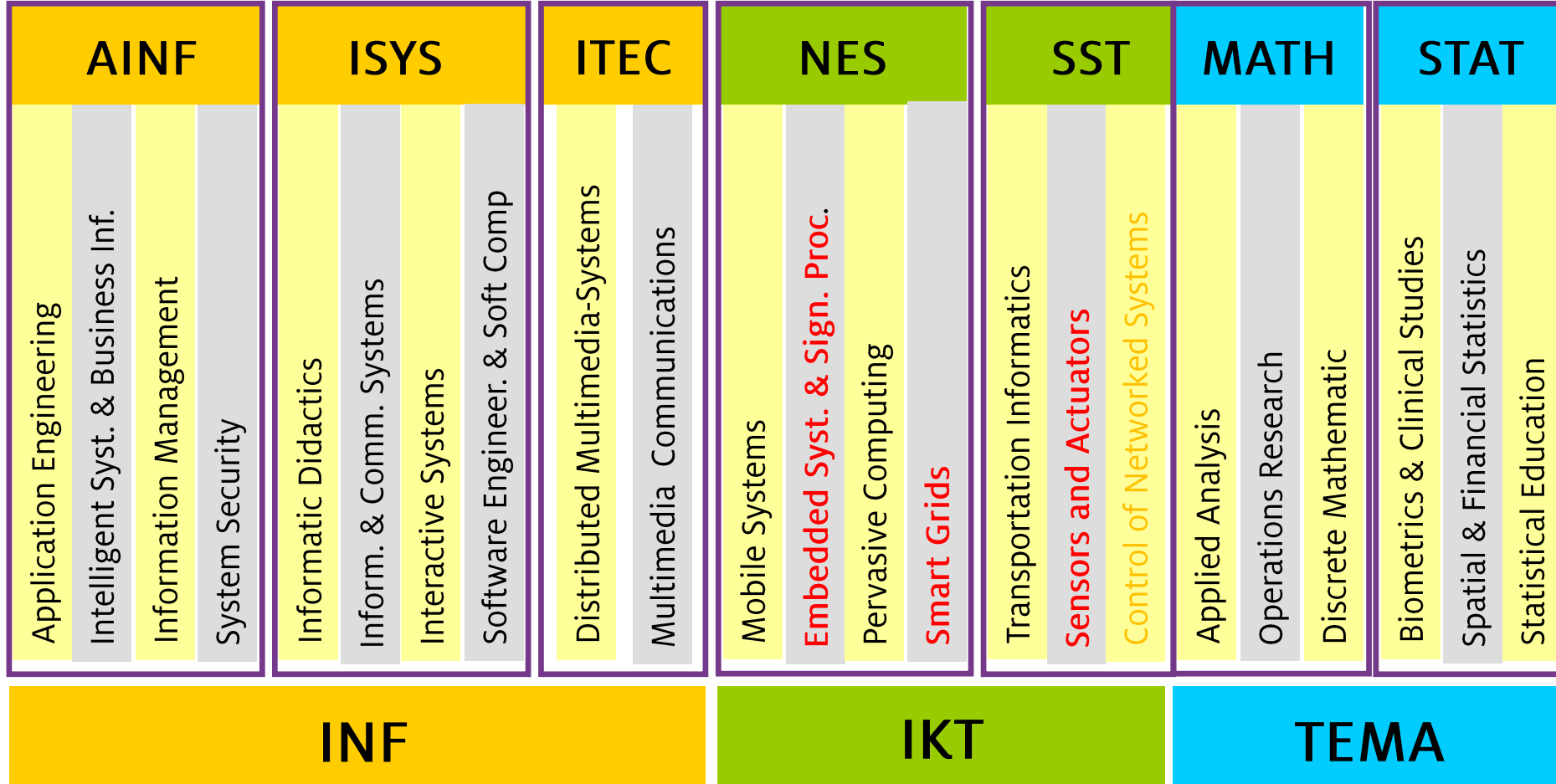


Our degree programs

- 17 Bachelor degree programs
- 22 Master degree programs
- 9 Secondary school teacher accreditation programs
- 5 Doctoral degree programs



Faculty of Technical Sciences



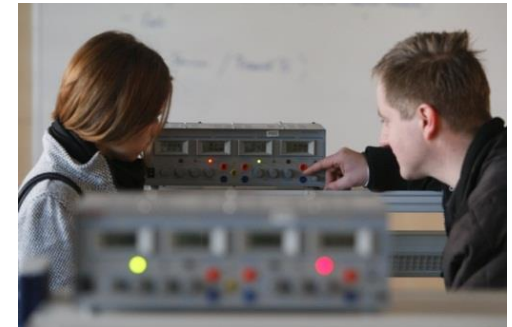
Academic Programs

- Computer Sciences
- Information and Communications Engineering (Information Technology)
- Technical Mathematics
- Information Management

All master programs are taught **in English**

Teacher training programs

- Informatics and Information-Management
- Mathematics

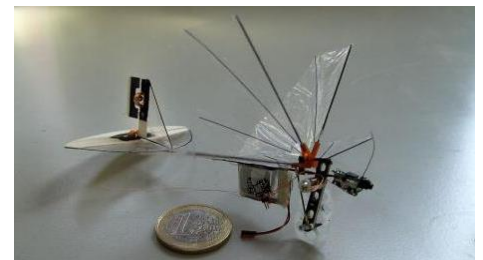


Research in Smart Cameras Visual Sensor Networks

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Ubiquitous Cameras

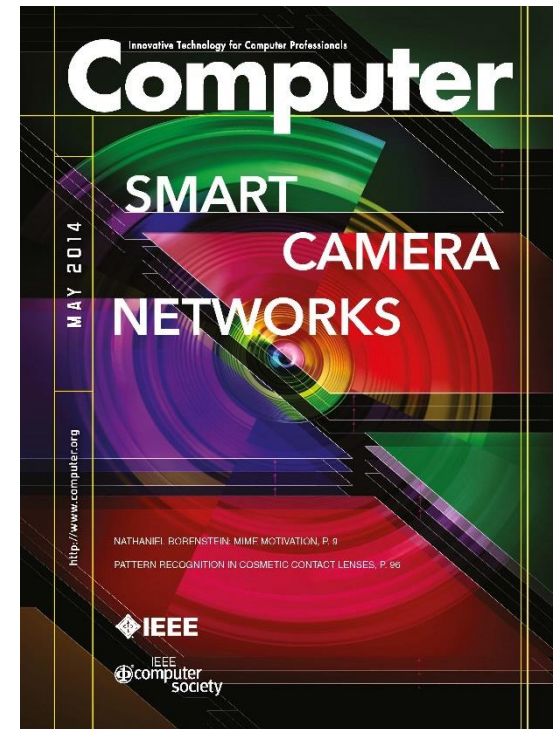
- We are surrounded by **billions of cameras** in public, private and business spaces
- Various well-known domains
 - Transportation
 - Security
 - Entertainment
 - Mobile
- Cameras serve a **purpose** and provide some **utility**
 - Providing documentation/archiving
 - Increasing security
 - Enabling automation
 - Fostering social interaction



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Paradigma Shifts in Video Processing

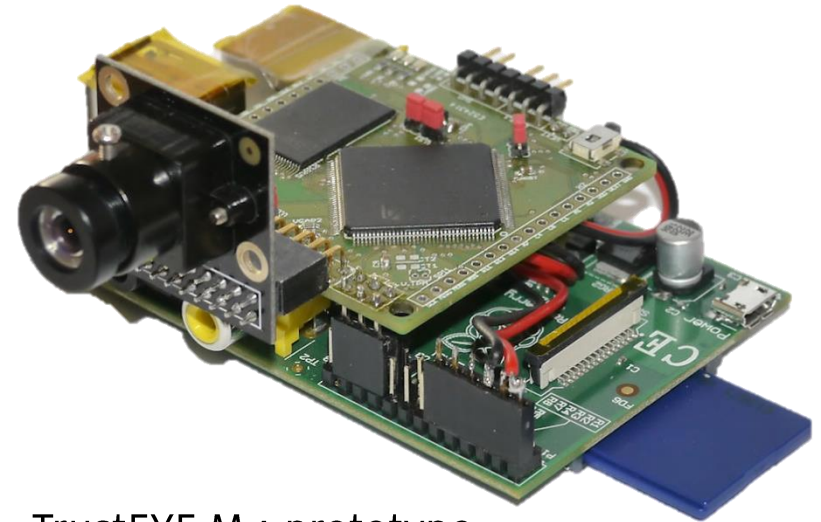
- Towards **online/onboard processing**
- Towards **distributed, in-network analysis**
- Towards **ad-hoc deployment**
and **mobile and open** platforms
- Towards **user-centric** applications



Emergence of Smart Camera Networks !

Smart Cameras as Enabling Technology

- Smart cameras combine
 - sensing,
 - processing and
 - communicationin a single embedded device



TrustEYE.M4 prototype
on top of RaspberryPI

- perform **image and video analysis** in **real-time** closely located at the sensor and transfer only the results
- **collaborate** with other cameras in the network

[Rinner, Wolf. [A Bright Future for Distributed Smart Cameras](#). Proc. IEEE, 2008]

#1 Security and Privacy Protection

- How to embed security and privacy protection in camera nodes
- Hardware-supported embedded protection
- Onboard privacy filter
- Exploration of utility/protection trade-off



- Development of TrustEYE prototypes

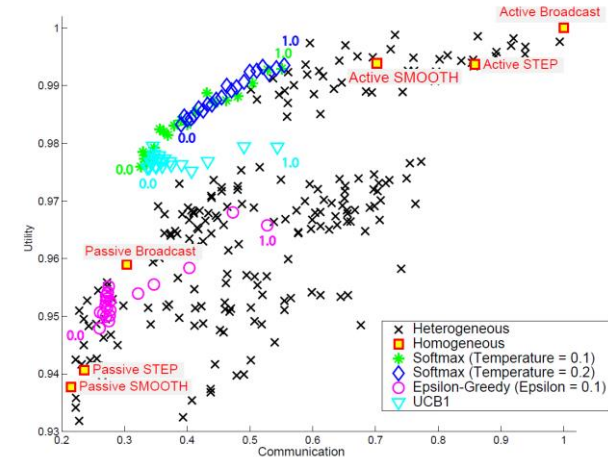
Winkler, Rinner. [Security and Privacy Protection in Visual Sensor Networks: A Survey](#). *ACM Computing Surveys*, pages 38, 2014.

Erdelyi et al. [Adaptive Cartooning for Privacy Protection in Camera Networks](#). In *Proc. AVSS*, August 2014.



#2 Self-Organizing Camera Networks

- How to control individual cameras in order to achieve/improve network-wide behavior
- Autonomous market-based topology learning and tracking handover
- Online learning for to improve communication/performance tradeoff
- Development of autonomous multi-camera tracking network
 - Esterle et al. [Socio-Economic Vision Graph Generation and Handover in Distributed Smart Camera Networks](#). *ACM Trans. on Sensor Networks*, 10(2), 2014.
 - Lewis et al. [Learning to be Different: Heterogeneity and Efficiency in Distributed Smart Camera Networks](#). In *Proc. SASO 2013*.



#3 Aerial Visual Sensor Networks

- How to deploy a multi-UAV system for autonomous coverage and search&rescue
- Path planning under sensing and communication constraints
- Incremental image mosaicking
- Development of small-scale multi-UAV system
Andre et al. [Application-Driven Design of Aerial Communication Networks](#). *IEEE Communications Magazine*, May 2014.
Yahyanejad, Rinner. [A fast and mobile system for registration of low-altitude visual and thermal aerial images using multiple small-scale UAVs](#). *ISPRS Journal*, Sept. 2014



Acknowledgements & Further Information



Pervasive Computing group

Institute of Networked and
Embedded Systems

<http://nes.aau.at>

<http://bernhardrinner.com>

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- FFG „ProSecCo - Progressing towards Secure and Cooperating Smart Cameras”
- FP7 FET “Engineering Proprioception in Computing Systems”
- LakesideLabs/KWF/EC „Collaborative Microdrones“ & „Self-organizing Intelligent Network of UAVs“