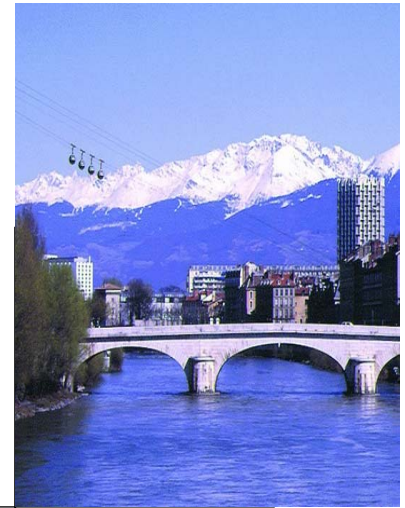


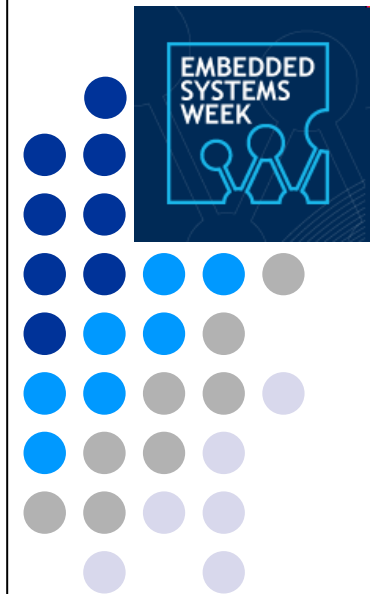
Smart Cameras and Visual Sensor Networks



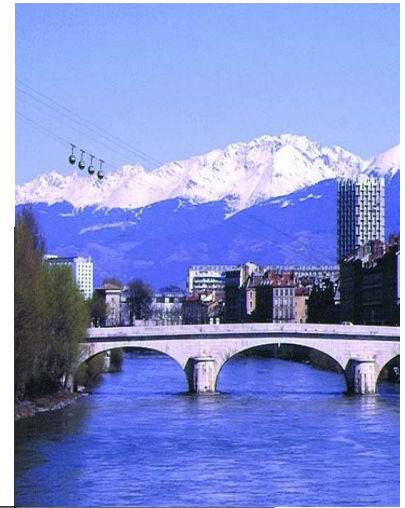
Tutorial at ESWEEK 2009

Bernhard Rinner, François Berry, Dominique Ginhac, Joel Falcou

http://pervasive.uni-klu.ac.at/SCSN_tutorial

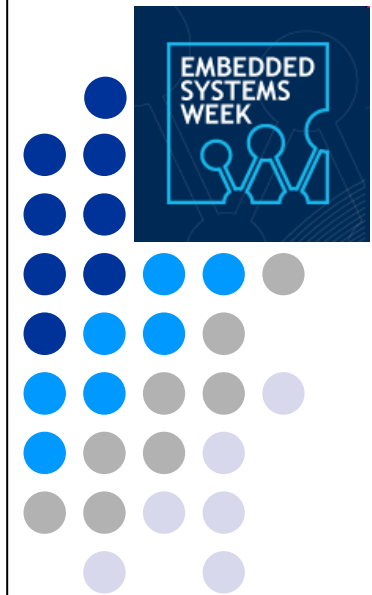


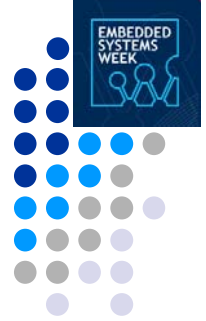
Smart Cameras and Visual Sensor Networks



Part 1 Introduction

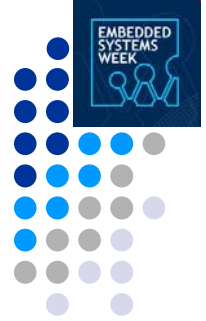
Bernhard Rinner





Some Questions to start with

- What are Smart Cameras (SC) and Visual Sensor Networks (VSN)?
- Why is this important to me (as ES person)?
 - System/Application for my ES research
 - Related research challenges
- How can my ES research benefit from SC and VSN?

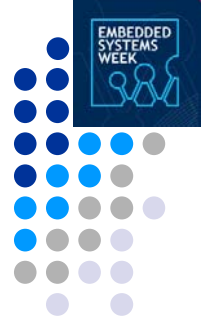


Revolution in Cameras

- Ongoing technological advances in
 - lenses
 - image sensors
 - onboard processing
 - networking

transform camera as box delivering images into **spatially distributed** that generate **data and events**

- Huge amount of visual information is processed in a **network of resource-limited embedded nodes** in dynamic environment
- Interesting **application domain** with **challenging research** questions for **ES community**



Principle of Smart Cameras

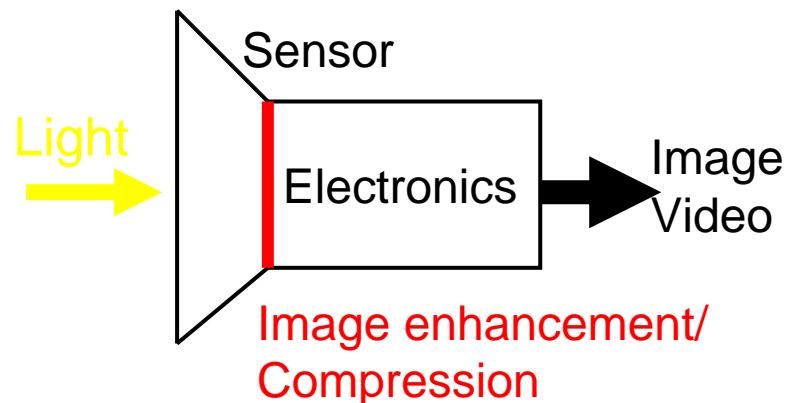
- Smart cameras combine
 - **sensing**,
 - **processing** and
 - **communication**in a single embedded device
- perform **image and video analysis** in **real-time** closely located at the sensor and transfer only the results
- **collaborate** with other cameras in the network

Traditional vs. Smart Cameras

Traditional Camera

- Optics and sensor
- Electronics
- Interfaces

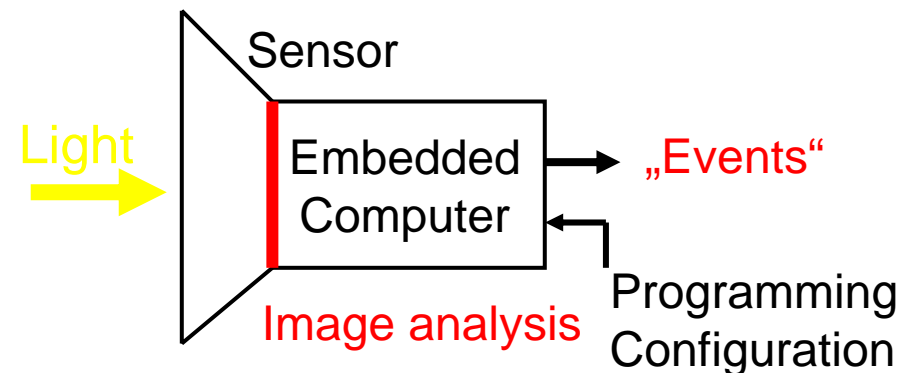
delivers data in form of (encoded) images and videos, respectively



Smart Camera

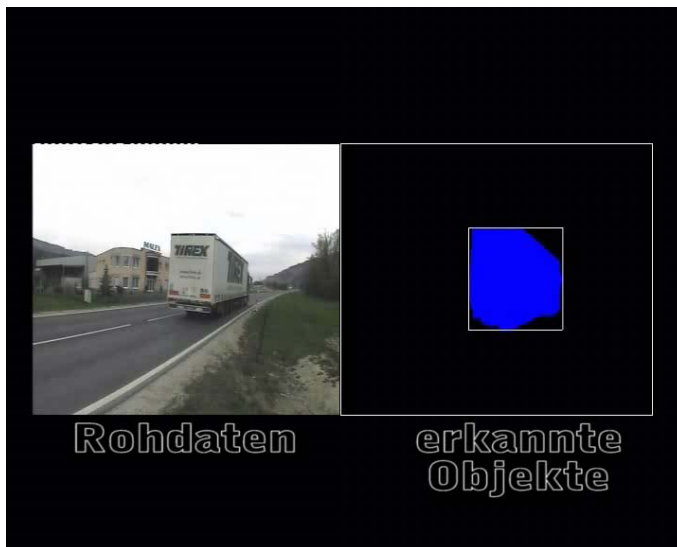
- Optics and sensor
- **onboard computer**
- Interfaces

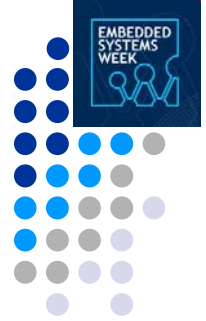
delivers **abstracted image data** is configurable and programmable



SCs look for important things

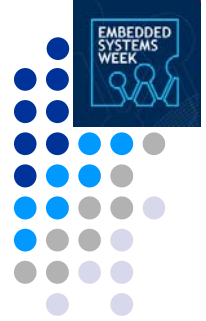
- Examples for **abstracted image data**
 - compressed images and videos
 - features
 - detected events





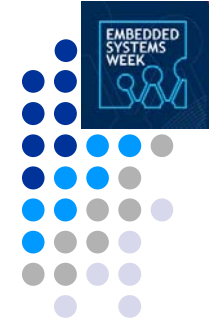
Smart Cameras collaborate

- Connect autonomous cameras in a network
 - exploit smart cameras' capabilities (eg. avoid raw data transfer)
 - relax centralized/hierarchical structure of MC networks
 - introduce dynamic configuration (structure and functionality)
- Distribution of sensing and processing imposes several challenges
 - camera selection and placement
 - calibration & synchronization
 - distribution of data and control
 - (ad-hoc) networking
- Form a **visual sensor network**

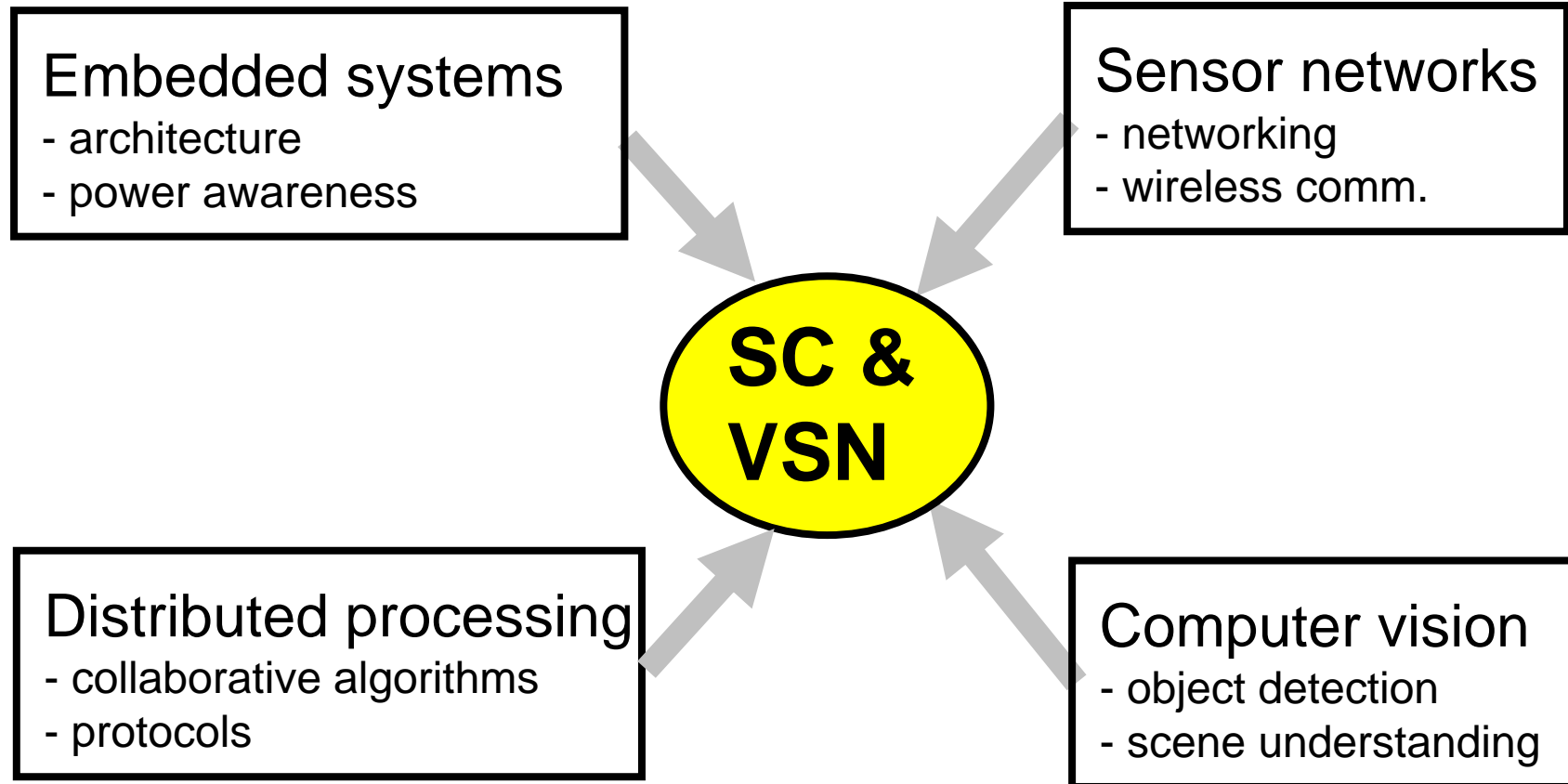


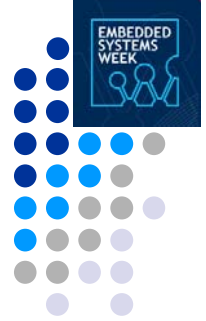
Advantages of DSC

- Scalability
 - no central server as bottleneck
- Real-time capabilities
 - Short round-trip times; “active vision”
- Reliability
 - High degree of redundancy
- Energy and Data distribution
 - Reduced requirements for infrastructure; easier deployment?
- Sensor coverage
 - Many (cheap) sensors closer at “target”; improved SNR
- ...



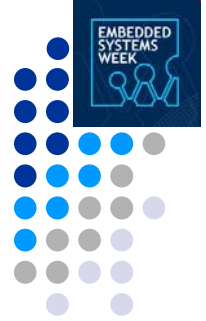
Multidisciplinary field





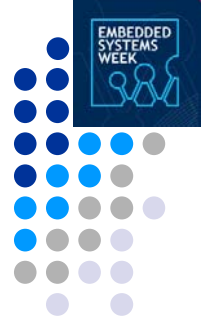
New Applications

- From traditional cameras to **pervasive smart visual sensor networks**
 - distributed surveillance and security
 - vision-based interpretive applications
 - smart homes / smart buildings
 - ambient intelligence
 - office automation through occupancy sensing
 - human-computer interfaces
 - mobile and robotic networks
 - virtual reality systems
 - ...



Differences to traditional WSN

- Sensing & processing **directional, multi-dimensional data**
 - Larger data volumes
 - More demanding algorithms
- More **powerful computing & networking infrastructure**
 - Camera nodes and wireless network
- More **complex data distribution**
 - Streaming as well as eventing
- Network **coordination and control**
 - Active camera control (eg. PTZ cameras)
 - Real-time operation
 - Sensor selection



Tutorial Agenda

1. Introduction

2. Smart imager and smart cameras

3. Embedded image processing

- Heterogeneous Platforms (FPGAs, DSPs ...)
- Dedicated Processors (GPU and cell)

4. Visual Sensor Networks

- Distributed Sensing and Processing

5. Conclusion

- Research Challenges