


Chapter 5: Conclusions
Smart Cameras and Visual Sensor Networks



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Agenda



Chapter 5: Conclusion

- Research Challenges
- Summary
- Further information

Research Challenges

#1: Architecture

How to design resource-aware nodes and networks

- Low-power (high performance) camera nodes
 - Dedicated platforms: vision processors, PCBs, systems
 - Many examples: CITRIC, NXP
- Visual/Multimedia Sensor Networks
 - Topology and (multi-tier) architecture
 - Multi-radio communication
- Dynamic Power Management
 - For sensing, processing and communication

#2: Networking

How to process and transfer data in the network

- Ad hoc, p2p communication over wireless channels
 - Providing RT and QoS
 - Eventing and/or streaming
- Dynamic resource management
 - (local) computation, compression, communication, etc.
 - Degree of autonomy: dynamic, adaptive, self-organizing
 - Fault tolerance, scalability
 - Network-level software, middleware

#3: Deployment, Operation, Maintenance

Consider the entire life cycle of the camera network

- Development support for applications
 - Model/simulate the application (function, resources, QoS)
 - Reuse/exchange of software/libraries
 - Software updates, debugging etc.
- Autonomous calibration and scene adaption
 - Avoid manual procedures
 - Adapt to different scenes and settings
- Network configuration

#4: Distributed Sensing & Processing

Where to place sensors and analyze the data

- Sensor placement, calibration & selection
 - Optimization problem
 - Distributed approaches eg., consensus, game theory, multi-agent systems
- Compressive Sensing
- Collaborative data analysis
 - Multi-view, multi-temporal, multi-modal
 - Sensor fusion
- Online/real-time processing
 - Can not effort to store large amounts of data

#5: Mobility

How to exploit networks of mobile cameras

- Mobile cameras are ubiquitous
 - PTZ, vehicles, robotics etc.
 - Mobile phones
- Advanced vision algorithms
 - Ego motion, online calibration
 - Closed-loop control, active vision

#6: Usability

How to provide useful services to people

- Ease of deployment, maintenance
 - Self-* functionality
 - “Smart cameras for dumb people”
- Privacy and Security
 - Trust of the user
 - Control the privacy setting
- Interaction with the camera network

#7: Applications

What applications can (only) be solved by DSC

- Demonstrations
 - Large scale networks eg., for surveillance
 - Small scale networks eg., for entertainment, home environments
 - Only single camera application?
- Market opportunities
- Killer Application

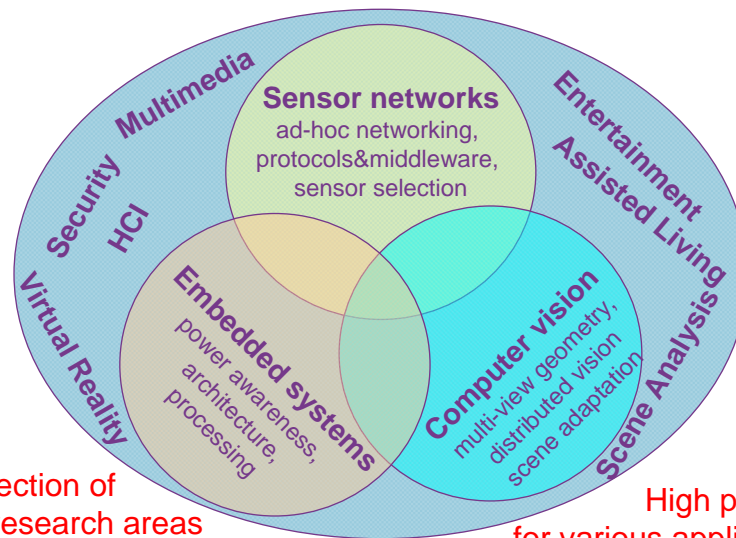
(Potential) further Applications

- Entertainment (computer games)
 - in 3D environments
- „Smart Rooms / Smart Environments“
 - detection gestures, sign language, room occupancy ...
- Environmental monitoring
 - sensor fusion, habitat monitoring
- Security
 - Safety enhancement (trains, cars), access control, surveillance
- „Virtual Reality“
 - augment real world with digital information
- ...

Smart Cameras

- combine
 - sensing,
 - processing and
 - communicationin 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 (multi-camera system)

Interdisciplinary Research



Intersection of
"hot" research areas

High potential
for various applications

Further Information

- Tutorial Site
http://pervasive.uni-klu.ac.at/SCVSN_tutorial

Literature

- Introduction, Surveys etc.
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 5. Aghajan, Cavallaro (Eds.). Multi-Camera Networks. Elsevier 2009
 6. Belhabir (Eds.) Smart Cameras. Springer 2010
 7. Kisacanin et al. (Eds.) Embedded Computer Vision. Springer 2009
 8. Bhanu et al. (Eds.) Distributed Video Sensor Networks. Springer 2010

Selected Journals & Conferences

- Journals
 - ACM Transactions on Sensor Networks
 - IEEE Transactions on Image Processing
 - Machine Vision and Applications
 - IEEE Transactions Circuits and Systems for Video Technology
 - ...
- Conferences, Workshops
 - ACM/IEEE Intern. Conference on Distributed Smart Cameras
 - IEEE Workshop on Embedded Computer Vision
 - ACM/IEEE Intern. Conf. on Information Processing in Sensor Networks
 - ...
 - Various dedicated workshops at major conferences

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- Winkler, Rinner. Securing Embedded Smart Cameras with Trusted Computing. EURASIP Journal on Wireless Communications and Networking, 2011
- Winkler, Rinner. TrustCAM: Security and Privacy-Protection for an Embedded Smart Camera based on Trusted Computing. In Proc. AVSS. pages 593-600, Boston, MA., USA. 2010.
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- Yahyanejad et al. Incremental Mosaicking of Images from Autonomous, Small-Scale UAVs. IEEE AVSS, Sept. 2010