# Pervasive Computing

Institute of Networked and Embedded Systems

## OpenLab 2010

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**Founded in 2007, the Pervasive Computing Group at Klagenfurt University is part of the Institute of Networked and Embedded Systems (NES). The group is led by Professor Bernhard Rinner and currently consists of 14 people.**

Pervasive computing is the trend towards increasingly ubiquitous, connected computing devices in the environment. This trend has being leveraged by a convergence of advanced technologies such as embedded computing, wireless communication and sophisticated sensing. Pervasive computing devices are not personal computers as we tend to think of them, but very tiny—even invisible —devices, either mobile or embedded in almost any type of object imaginable.

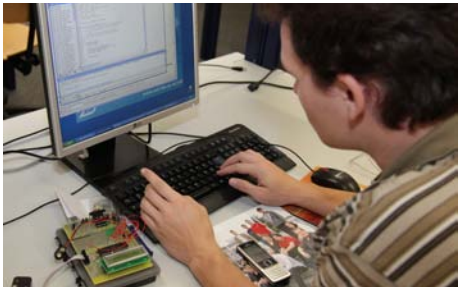
The Pervasive Computing Group addresses the theoretical and practical aspects necessary for making computers easily accessible within any environment. The integration of computers in everyday objects and communication creates networks of intelligent objects. The research group deals in particular with pervasive computing technologies such as middleware software, sensor networks and distributed embedded systems. These technologies are used for instance in distributed "smart" cameras – an innovative research topic in which the researchers at Klagenfurt cooperate with international partners.

**Our teaching activities cover fundamentals, technologies and applications of Pervasive computing for students of Information Technology and Informatics. Dedicated lab courses help students to acquire practical experiences, and seminars address recent topics of pervasive computing research.**

Pervasive computing uses information and communication technologies to interconnect the physical and digital worlds. Computer components are becoming smaller and cheaper, making them suitable for embedding in everyday objects; they can also communicate with each other via wireless networks. This technology is rapidly finding its way into every aspect of our lives.

Whether it's how we shop, how we get from one place to another or how we communicate, pervasive computing is clearly woven into the way we live.

The Pervasive Computing Group covers the most important aspects of this rapidly evolving discipline in its teaching portfolio. We offer courses for the studies of Information Technology and Informatics at the Bachelor-, Master- and PhD-level. The lectures cover fundamentals, technologies and applications of pervasive computing. At the graduate level, we currently offer courses on fundamentals and advanced topics on pervasive computing, digital signal processors and artificial vision. At the undergraduate level, we offer a lecture on digital system design and a lab course on fundamentals of ICT.



**We are currently looking for committed students for our open Research Projects and Master Theses.**

**Energy optimization for Geobashing** The Geobashing game is a mobile massive multiplayer online game where players carry GPS-enabled devices (like cell phones) and periodically report their position to the Geobashing server. The task in this thesis is to find methods to minimize the energy usage at the client devices while preserving the game flow. One possible approach is to minimize the expensive network connection time for clients using the server-side control mechanism for the update interval. *Master Thesis*

**Ensuring security and privacy for players in the Geobashing game** The Geobashing game is a mobile massive multiplayer online game where players carry GPS-enabled devices (like cell phones) and periodically report their position to the Geobashing server. This indicates that the server holds privacy sensitive data. In this work the task is to find a method to secure the communication and ensure privacy of players. The overall goal is to prove that with this method it is not possible to track a certain user while playing the game. *Research Project and/or Master Thesis*

**Pervasive Smart Cameras** In the PSC project we run a network of radio-connected camera nodes deployed at our institute. The nodes consist of an embedded platform powered by an ARM processor running Linux, and a DSP. We are looking for students interested in programming for C, C++ and Python to evolve our nodes into more powerful self-configuring platforms. Furthermore students interested in computer vision for embedded systems and programming DSPs in C and C++ are invited to do a research project or a master thesis in course of this project. *Research Project and/or Master Thesis*

**SmartPhone as SmartCam** The latest generation of smartphones combines high-resolution video sensors with powerful processors and large memories. An integration of smart phones into a dedicated PSC network enables the

user to interact with the camera network using camera sensor and display. Students interested in programming software for smart phones (C++ on Symbian) are invited to do a research project or a master thesis in this area. *Research Project and/or Master Thesis*

**Efficient object detection** The goal of this work is to implement an algorithm that can detect the orientation and position of objects with a known structure. The main focus is an efficient and robust algorithm which can be executed on an embedded platform. The required skills include knowledge in C/C++ programming, software-development and the estimation of computational and storage requirements of algorithms. *Research Project and/or Master Thesis*

**Extracting 3D Information** In the cDrones project we use small-scale UAVs to fly over an area and take images or record videos from a relatively low altitude. Hence, even small height-variations on the ground result in significantly different images when the drone moves. The goal of this project is to extract rough depth information out of two overlapping images by methods also found in the domain of stereo vision and thus find feature points in both images lying on a common plane for later image stitching. *Research Project and/or Master Thesis*

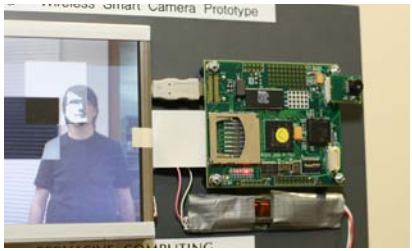
**Evaluation of hardware platforms for SRSnet sensor nodes** The task in this work is to find and evaluate suitable hardware platforms for our sensor nodes. The platforms must be able to perform audio and video analysis as well as networking in real time. The goal of this work is to find and evaluate hardware of different processing power and energy usage and to implement a software environment for our algorithms. *Research Project and/or Master Thesis*

**CUDA-implementation of probabilistic occupancy map person tracking** Using probabilistic occupancy maps is a very promising but resource-demanding approach for multi-camera person tracking. In this work a method to implement POM-tracking on a nVIDIA CUDA enabled device should be found. This includes parallelization of this approach and comparing the CUDA-implementation with the original approach. *Research Project and/or Master Thesis*

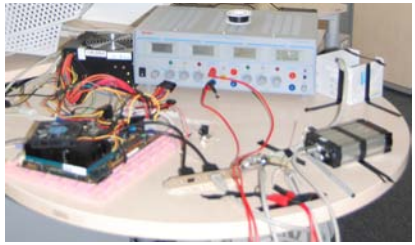
**Our research is conducted in close collaboration with national and international partners both in academia and industry. National partners include Lakeside Labs, Graz University of Technology, Vienna University of Technology, EFKON AG and TTTech. At the international level, we collaborate among others with Georgia Tech, University of Central Florida and University of Udine.**

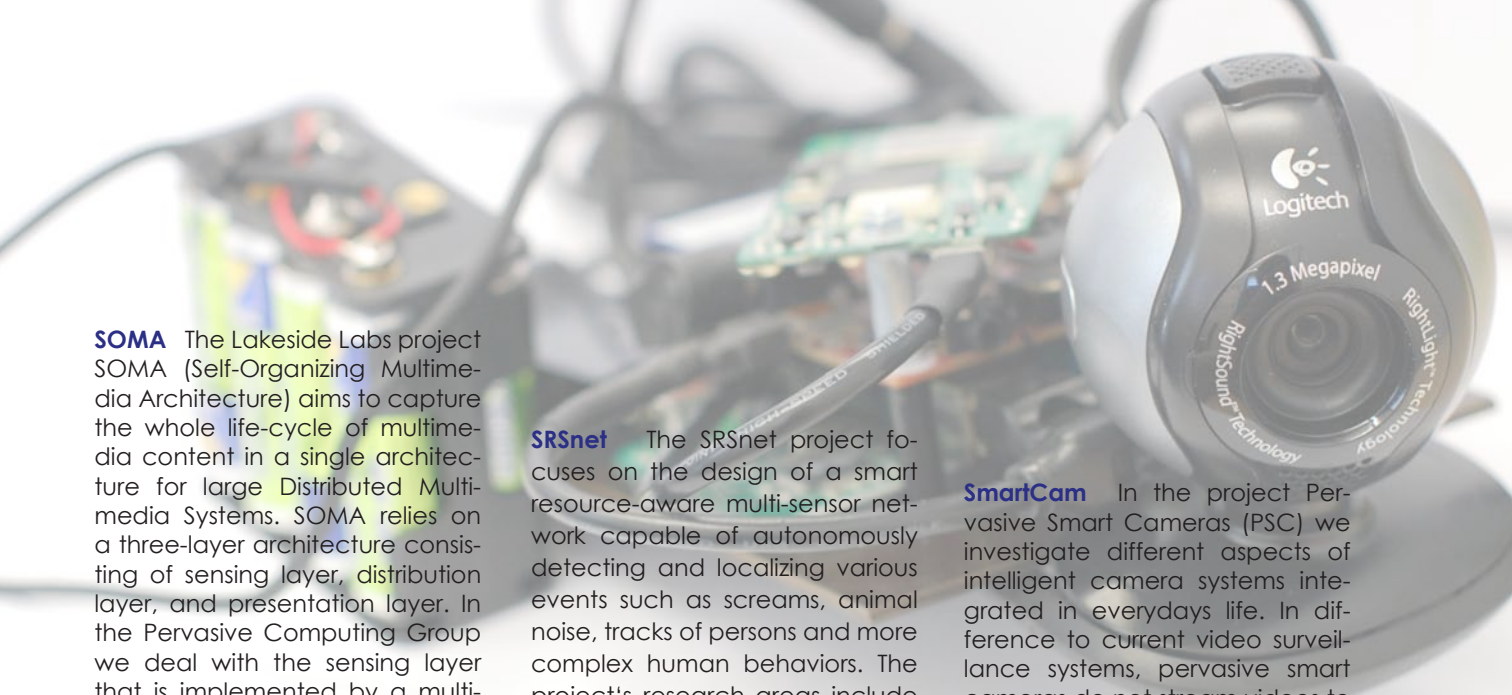
**Collaborative Microdrones** In the cDrones project we develop an aerial system comprising a number of unmanned aerial vehicles (UAVs). The idea is to have multiple UAVs that fly over a pre-defined area and take images during flight. These aerial images are used to generate a consistent overview image and detect objects of interest. Research topics in this project include coordination and cooperation of multiple UAVs during flight as well as analysis of aerial images. Different master theses and research projects in this domain are open on request.

**CLIC** The objective of the CLIC (Closed-Loop Integration of Cognition, Communication and Control) project is to integrate real-time image analysis, adaptive motion control and synchronous communication. The combination of these areas enables innovative control and security mechanisms as well as improved energy efficiency. The sample application will be a crane that can autonomously avoid collisions with stationary and moving objects. The Pervasive Computing Group is responsible for object detection using distributed smart cameras.




**EVis** The EVis research project focuses on three major aspects of future autonomous traffic monitoring systems. First, vision-based detection and classification methods are augmented by self-learning and scene adaptation mechanisms reducing the effort of manual configuration. Second, visual data is fused with data from other sensors such as acoustic and laser sensors exploiting various multisensor data fusion techniques at feature and decision level. Finally, the developed vision and fusion methods are implemented and evaluated on a distributed embedded platform.






**SOMA** The Lakeside Labs project SOMA (Self-Organizing Multimedia Architecture) aims to capture the whole life-cycle of multimedia content in a single architecture for large Distributed Multimedia Systems. SOMA relies on a three-layer architecture consisting of sensing layer, distribution layer, and presentation layer. In the Pervasive Computing Group we deal with the sensing layer that is implemented by a multi-tier sensor network that consists of different sensor nodes, such as smart cameras or microphones. The sensed data is processed and fused on the sensor nodes to detect domain-specific events. These events are provided to the upper layers and can refer to multimedia streams. Research topics include ad-hoc networking, embedded video analysis, audio analysis, and data fusion.

**SRSnet** The SRSnet project focuses on the design of a smart resource-aware multi-sensor network capable of autonomously detecting and localizing various events such as screams, animal noise, tracks of persons and more complex human behaviors. The project's research areas include (i) collaborative audio and video analysis, (ii) complex event detection and (iii) network reconfiguration. The SRSnet will be demonstrated in an environmental case study at the Hohe Tauern National Park. This project is joint work with the Institute of Smart Systems Technologies at Klagenfurt University, the University of Udine and Lakeside Labs.

**SmartCam** In the project Pervasive Smart Cameras (PSC) we investigate different aspects of intelligent camera systems integrated in everydays life. In difference to current video surveillance systems, pervasive smart cameras do not stream videos to a central monitoring station but analyse the scene in-node and distribute information about unusual events only. In our group we focus on questions about hardware and software architectures, on security and privacy and on the interaction with the user. A network of radio-connected cameras is deployed at our institute to see our ideas running on real hardware.

CONTACT DETAILS

This birds eye view was taken by one of our microdrones (project „cDrones - Collaborative Microdrones“)

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