Mobile applications and wireless sensor networks

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VTT in brief - VTT Electronics

6 Units:

- **VTT Electronics**
- VTT Information Technology
- VTT Industrial Systems
- VTT Processes
- VTT Biotechnology
- VTT Building and Transport

Staff: 2982
Turnover 219 M€

**VTT Electronics**

- Embedded SW
- Telecommunication systems
- Optoelectronics
- Advanced Interactive Systems

- Staff 300
- Turnover
Sensor-related R&D activities at VTT Electronics

Sensors
• to find out or to develop sensor components for specific applications
• modelling the physical phenomenon concerning especially the following measurements
• electromagnetic measurements, optical measurements, biometric measurements

Sensor electronics
• preamplifiers
• analog signal processing
• A/D-interface
• digital signal processing

Wireless communication:
• ultra-low power consumption of sensor nodes, autonomous power supply

Sensor Signal Analysis
• analysis of sensor signal in order to identify methods for feature extraction from sensor signals
• processing in restricted platforms

Sensor-based applications
• sensor-signal analysis and processing in order to add value for (mobile)applications
Mobile Applications, wireless sensors and data-processing

• Mobile application and mobile user
  • Most of the time people are equipped with a powerful networked computing platform (Mobile Phone)
  • Mobile Application & services is an interesting and growing business. There is a need for easy-to-use technologies in UI
    • Sensing technologies one possible solution

• Sensor-based activity sensing
  • Health care, fitness and wellbeing apps.
  • Reality Enhanced Gaming Experience

• Data Processing (Context recognition)
  • Processing: Sensor signal => features
  • Mapping: Features => meaningful activities (Context atoms)
  • Adaptation of applications: based on users activities
=> Sharing users activity data (e.g. games, other apps)
SoapBox, a generic sensing and communication module developed by VTT Electronics (VTT, 2000 -

- An intelligent module incorporating a microcontroller, short-range wireless communication and a set of sensors
- Ultra low power operating modes
- Multiple powering options
- Embedded basic software (communication protocols, sensor drivers, API)
- Application software programmable by C
- Flexibly configurable and extensible
- Small size:

SoapBox is a platform for research projects as well as for rapid demonstrations and prototyping
SoapBox, hardware

- A single 8-bit flash microcontroller
- A 10 kbps RF proprietary data link operating at 868.3 MHz unlicensed band, range ~15 m
- RS-232 serial port
- Sensors (can be easily changed or removed):
  - acceleration (3 axis)
  - compass/magnetic
  - proximity
  - light intensity
  - temperature
- General purpose analog and digital I/O port
- Real time clock
- Supply voltage regulator with a large input voltage span (1.5 - 28 V)

- Constructed of commercial components on a PCB
- Remote and central nodes of network have identical HW
Public demonstrators using SoapBox-platform

- Short range wireless data links
- Gesture recognition user interface for TV, DVD player, PC etc.
- Two player maze game with novel user interface
- Indoor location estimation
- Sensor-enhanced UI for handheld device
- Compass for an autonomous robot
- Diverse sensors for outdoor data collections
- Wireless sleep disorder monitoring system
- Wearable sensing
- Physical browsing of objects by pointing
- etc.
Smart-its-project

Smart-its (2001 - 2003)

• "Interconnected embedded technology for digital augmentation of everyday objects + collective awareness"

• VTT in the project
  • context determination based on sensor-information (e.g. physical proximity, acceleration, etc.)
  • artefact-centric context management approach; contexts (permanent characteristics, static and dynamic) which are relevant for objects
  • light-weight software architecture for collective context recognition by objects

• Use Scenario: Smart-objects determines their context co-operatively. One of the objects sends the conclusion to the server.
  • Mobile phones / sensors + networking (GPRS/BT) as a wireless sensor network.
  • existing infrastructure, easy programming platform, big number of nodes

Partners: Univ.Lancaster, ETH, Univ.Karlsruhe, Interactive sinstitute, VTT
Nomadic Media-project

Adaptive Interaction with Ubiquitous Services

The focus of VTT in Nomadic Media:

- Context capture using e.g. wireless body area sensing network
- Context description format and ontology
- XML-based description language for user interfaces
  - Special emphasis on adaptability (context, user, terminal, modality),
  - Support for alternative modalities like speech, gestures & pointing
- An open architecture for:
  - context information sharing,
  - adaptive service development

Future work at VTT

Applications
- Domains
  - Everyday use of mobile technology
  - Fitness
  - Support for elderly people
  - Digital augmentation of real world objects
- Environmental sensing
  - Single sensors => network of sensors
    - reliability, flexibility
  - Use of diverse inexpensive sensors
  - Light-weight data processing in nodes

Technologies
- Sensors
  - Optical measurements
  - Biometric measurements
  - Electromagnetic measurements
  - Sensor electronics, sensor signal processing, noise analysis

=> Further development of SoapBox-platform
- Data processing
  - Context fusion (which contexts are relevant for application, high-level context detection)
  - Application adaptation to contexts (taking action on behalf of the user automatically is tricky)
Features

- low sampling rate: 12 Hz
- simplicity of step detection: peak count of magnetic sensor data
- independent analysis of each step
- all data processing in time domain
- simplicity of step classification: small look-up tables
- small need in computing resources
Context from audio analysis
Health monitoring

Sensors and devices do not solve the problem: need for processing and infrastructure to draw any advantages!