Multi Sensor Wrist Device for Surveillance of Elderly Persons Developed within the FP6 Project EMERGE

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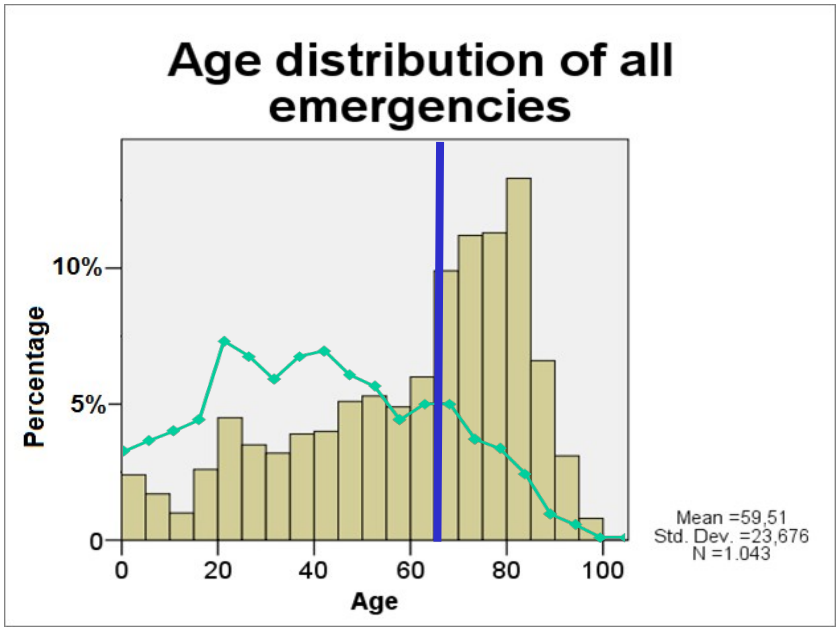
ART OF TECHNOLOGY

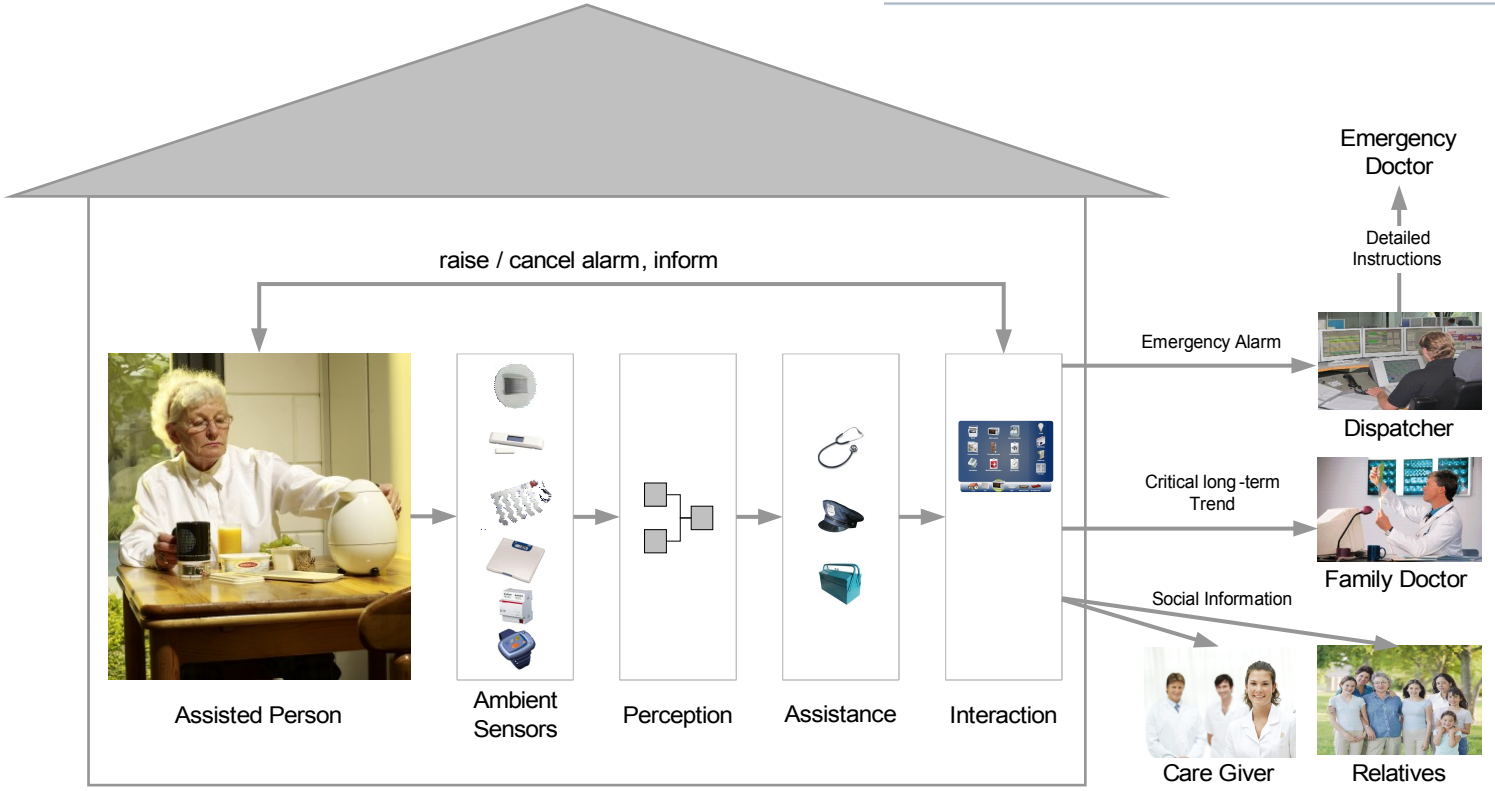
European Commission
Information Society and Media

Motivation

- 44% of Emergency Medical Services' (EMS) system resources are dedicated to patients older than 65 years of age
  (statistical report of the town of Kaiserslautern 2005)
  - 24,5% of elderly people are living alone
  - only 3% of the affected people in emergency situations have a PERS at hand
  - From these
    - 40% used PERS, PERS indicated 37%
    - 60% did not use PERS, PERS indicated 67%
  - In total, the PERS was used only in 1.3% of all cases to report the incident
- Automatic detection and alarming of emergencies and potentially arising emergencies would be a great benefit



EMERGE – Overview

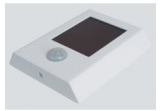


Sensors

- **Vital Data**
  - Electronic weight scale
  - Electronic blood pressure device
  - Pulse and skin temperature with wrist device (watch)
  - Heart frequency and breathing with bed mat
- **Activities (Sensors in the environment)**
  - Light switches, blind switches (home automation)
  - Position tracking of persons at areas of interest (movement sensors)
  - Usage of furniture, doors, windows (contact sensors)
  - Object usage (toilet, shower, faucet)
  - Device usage (power measurement)
  - Fall detection: Wrist device (watch)
  - In general:
    - Sensors in the environment, mountable afterwards
    - Battery/batteryless operation
    - Wireless data transmission

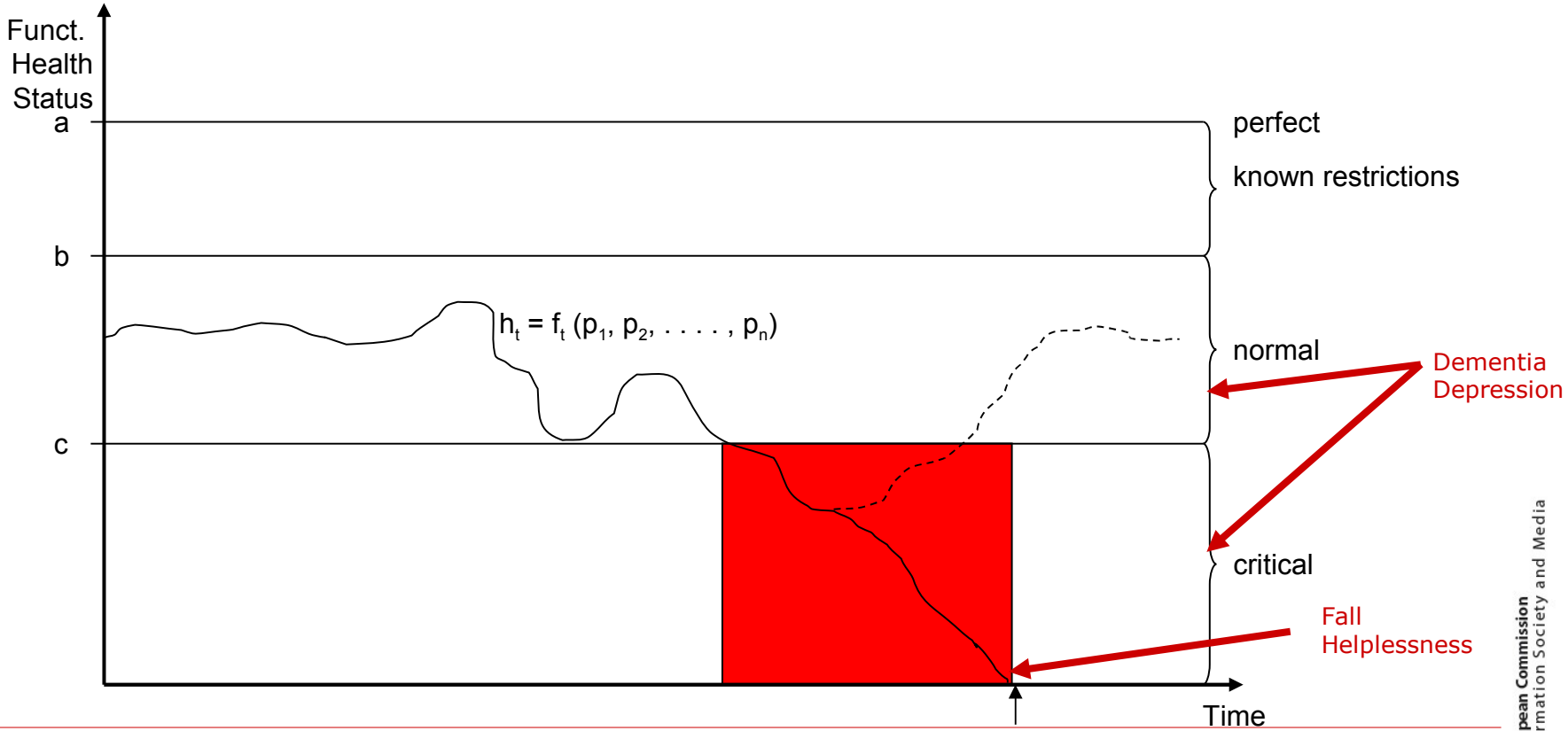




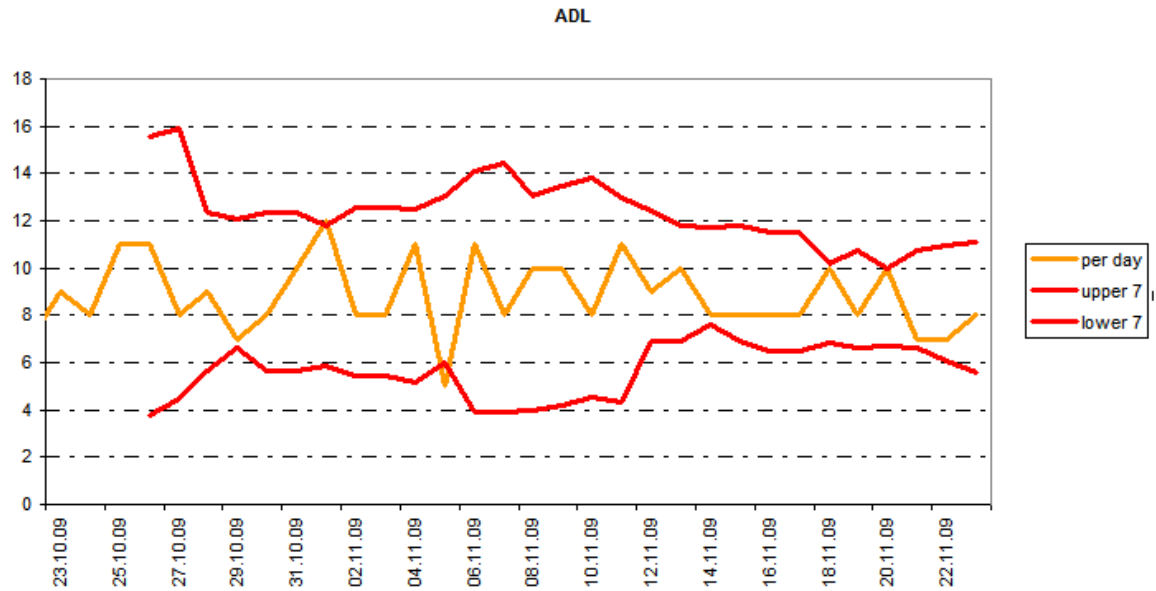



Functional Health Status



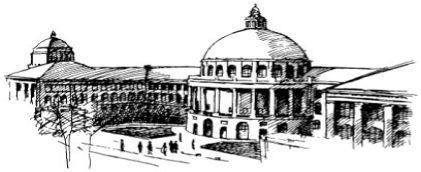
Example of Activity of Daily Living (ADL) Supervision

- Daily measure (orange)
- Personalized region of normality (red)
  - Calculated dynamically
  - Upper limit
  - Lower limit
  - Self learning
- Assessment for various time periods
  - Day -> Week
  - Week -> Month
  - Month -> Half year



Art of Technology AG

- Founded in 1999 as a Spin-Off of the ETH Zurich
- Has its roots in the EU project EUROPRACTICE (1995), Dissemination of the HDP/MCM technology in Europe
- Contract Developer for
  - Miniaturization, Medical, Aerospace, Fixed and Wireless Communications, Sensor Technology, Computer and many other
- Certified QS-System
  - ISO9001:2008 and ISO 13485:2003 (medical)
- Since 2005 situated in Technopark Zurich
- Staff: 9 Engineers + 2 Management/Sales + 1 Administration



EUROPRACTICE MCM SERVICE

TECHNOPARK® ZÜRICH

Wrist Wearable Device Current capabilities

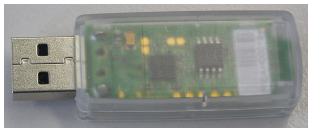
- Watch with reachargeable Battery
- ZigBee „Sensor"
- Alarms sent to Gateway
  - Alarm Button that sends Alarm and starts measurement
  - No activity alarm
  - Battery Low Alarm
  - Not Worn Alarm
  - Fall followed by helplessness alarm
- Measurements (once per minute)
  - Activity Level and no activity detection
  - Skin Temperature
  - Pulse rate (does not clamp impossible values)
- USB Device for charging, setting time and configuration

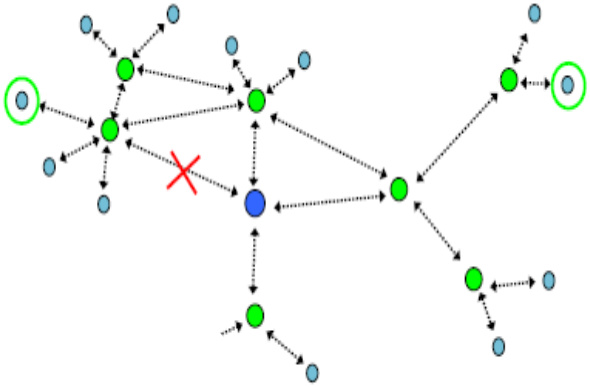
Minimal Configuration for Inhouse use

- In EMERGE the WMD is integrated into a Multi-Sensor Enviroment
- This is not a requirement but we must assume that the WMD is not worn during night
- The minimal Configuration is
  - WMD
  - Gateway
  - Sleep monitor in bed
  - or reduced: Presence Sensor in Bedroom

Gateway

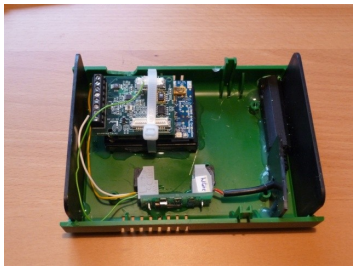
- A Gateway can be
  - USB stick in any computer
  - Adhoco residential gateway



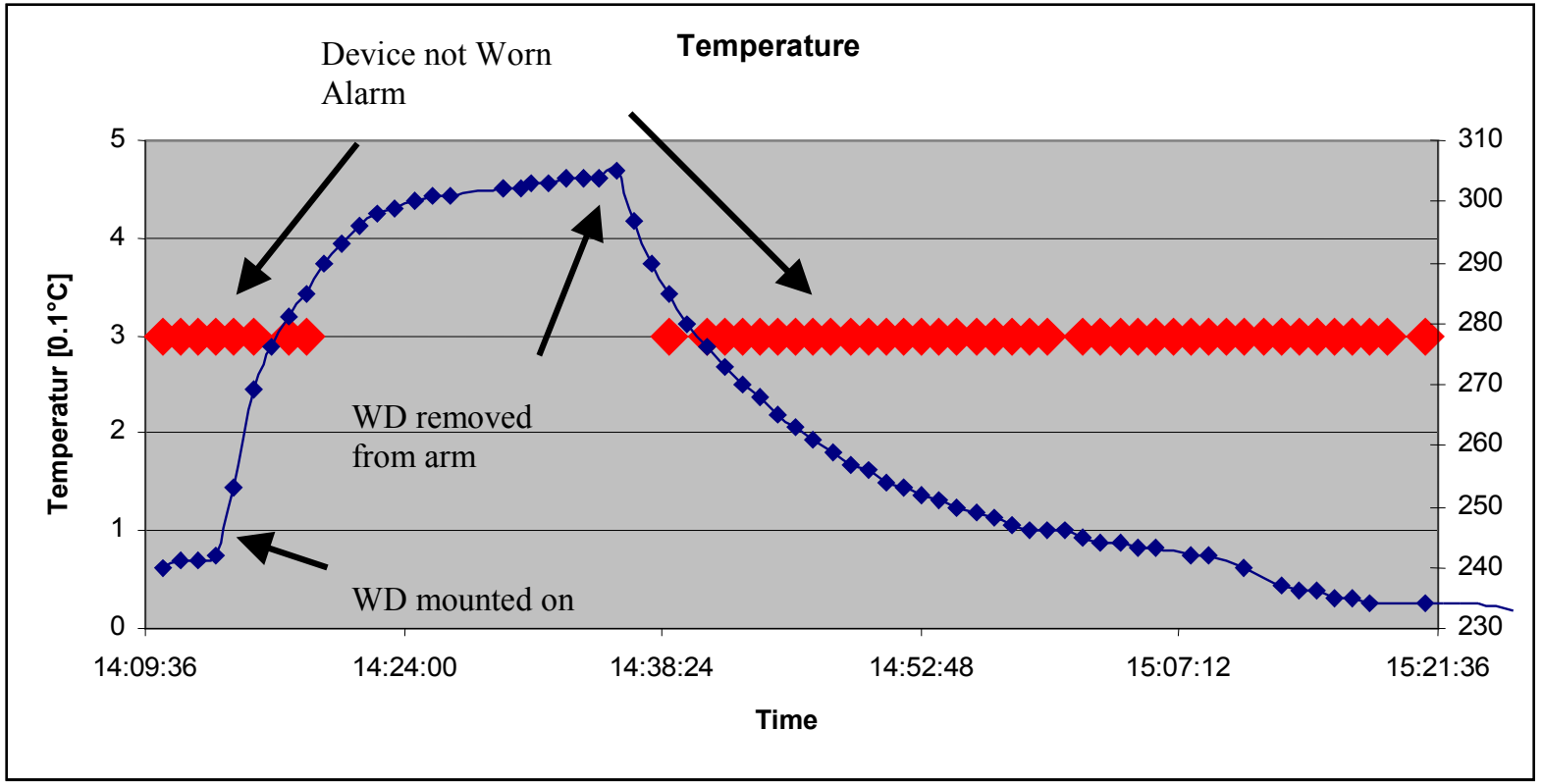


Sleep Monitor (EMICS)

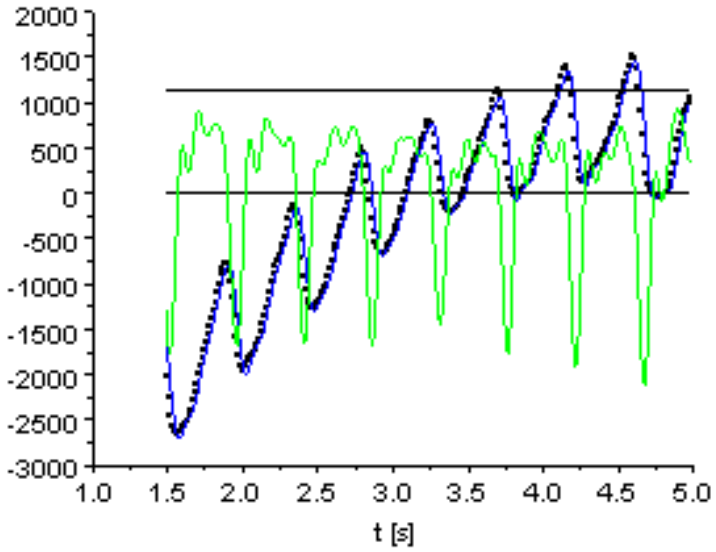
- Raw signal provided by EMFIT sensor, charge proportional to change in pressure
- Signal analysis
  - Presence
  - Activity
  - Heart rate
  - Breathing rate
  - Sleep / Non-sleep
- Transmission over IEEE 802.15.4 (MAC layer below ZigBee) to PC



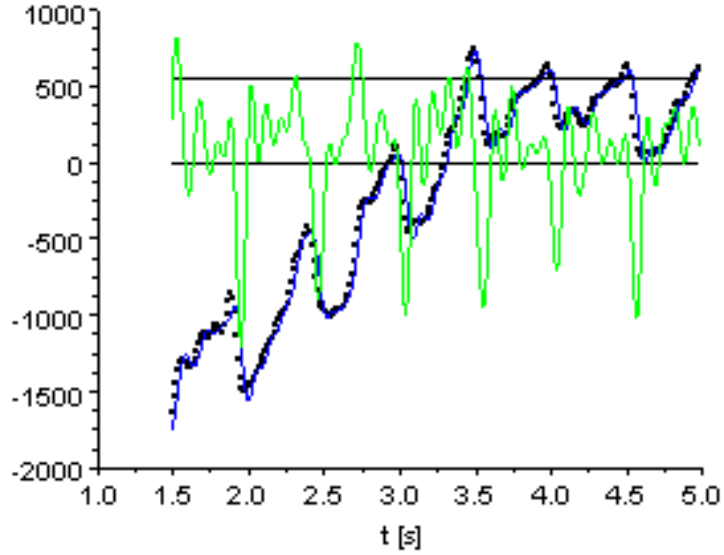
WD Temperature Measurement/Simple Worn Recognition



Raw Pulse Measurements

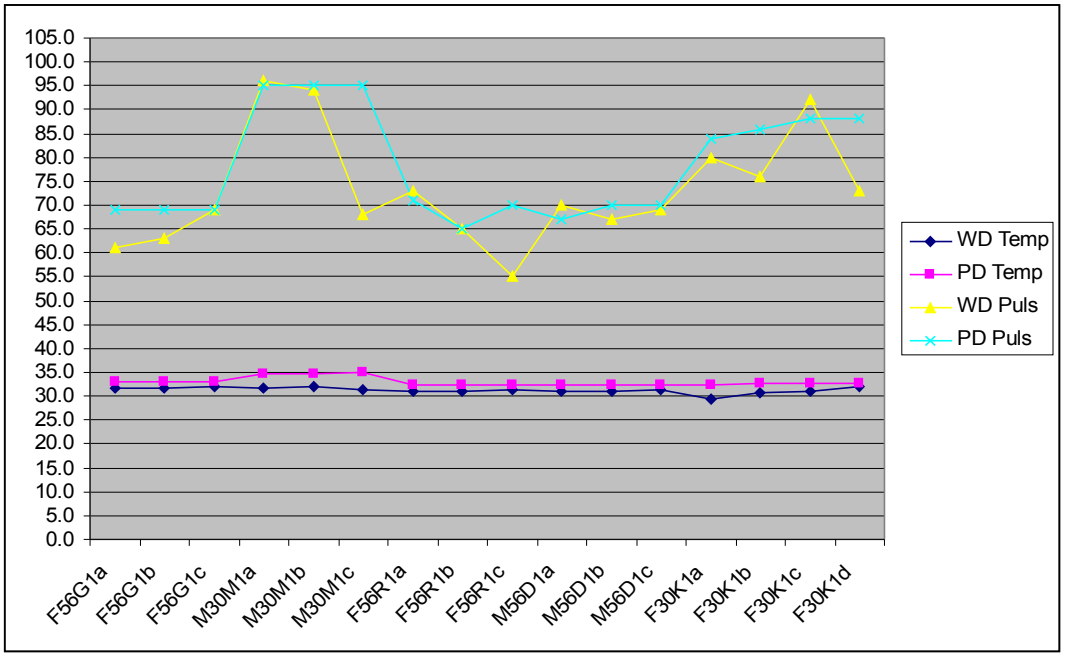


- Raw Curve black
- Filtered blue
- Pulse Indication green



Evaluation results: Pulse and Temperature

- Comparison vs. Polar like Device
  - WD measures pulse
  - PD measures rythm
  - Both do not fully agree with medical grade devices



Evaluation results: Fall detection

- Scenario based evaluation
- Method of measurement
  - Movement measures in 3 axes and overall for activity measures sent out regularly
  - Impact recognition followed by a period of no movement raises a fall alarm
  - No movement over a longer period rises a no-movement alarm

Test Setup	# performed	# positive
Fall of Watch	9	9
Sideways Fall	1	1
Forward Fall	4	1
Forward Roll	1	1
Backward Fall	1	1
Slowly Downwards	1	1
No Movement	7	7

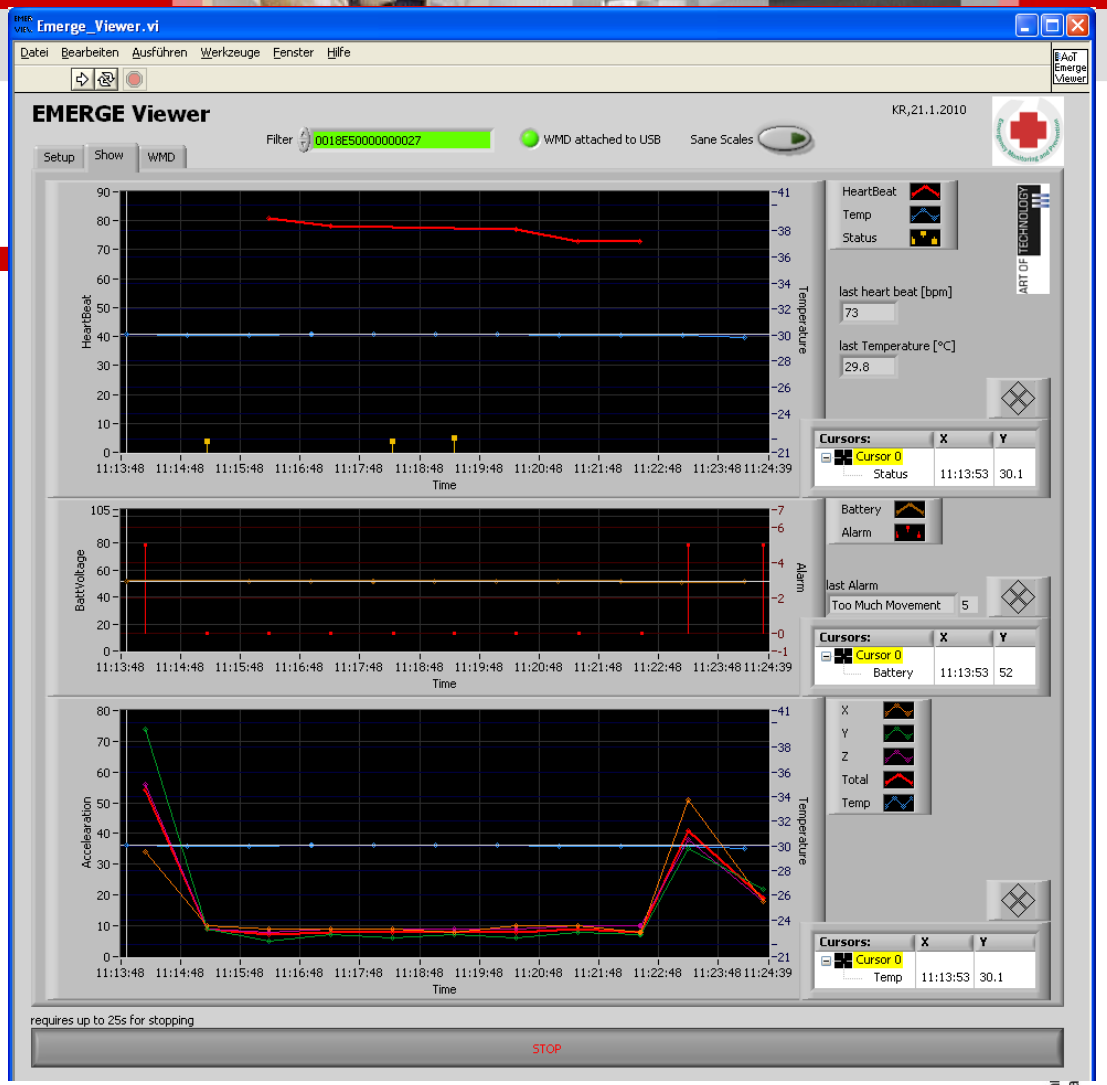
Elderly User Opinions

- Levels
  - 1 disagree stronly
  - to 6 agree strongly
- Usefullness: 4.6
- Attractiveness: 3.2
- Usability: 3.42
- Comfort: 4.1
- Acceptance: 3.5
  - Measurement technology not known to users
  - Design too fancy

	User Code F56R1	User Code M56D1	User Code M30M1	User Code F30K1	User Code F74IG	User Code F62ER	User Code F62SH	User Code F60XX	User Code F65IR	User Code F74HB	User Code F68ZH	User Code M80IL	User Code F56XX	User Code M69EK	Average
Usefulness															
An alarm system could save lives	6	5	4	6	6	6	6	6	5	4	5	5	6	3	**5.38**
Only people with a heart problem need something like this	4	3	5	2	3	1	1	1	1	2	5	1	4	1	**4.46**
I only need help when I am at home	4	2	3	1	1	0	2	1	5	1	1	5	4	0	**4.69**
I consider the functions useful	5	3	1	3	6	4	5	0	3	1	0	5	5	0	**3.73**
Attractiveness															
It is light and comfortable to wear	6	5	3	1	5	3	4	6	2	5	0	3	2	6	**3.75**
I can envisage wearing it instead of my wrist watch	6	3	2	2	3	5	3	6	2	5	5	2	4	0	**3.69**
I do not like the design	3	4	6	2	4	3	3	5	5	0	1	4	1	0	**3.85**
The display is easy to read	3	2	1	1	1	5	5	3	1	2	1	3	1	0	**2.23**
The display is easy to understand	1	3	2	2	1	3	3	3	1	0	3	5	2	0	**2.42**
Usability															
The usage is intuitive	1	3	2	2	4	2	2	1	0	3	0	3	1	0	**2.18**
The buttons are easy to use	3	1	2	3	2	2	3	2	3	5	0	2	2	0	**2.50**
The usage is too complicated	4	4	5	5	1	0	4	6	4	2	0	4	5	0	**3.62**
I would not be able to cope with it without help	2	3	5	5	4	0	3	0	4	1	1	3	3	0	**4.38**
I would have to learn too much in order to use the system	4	2	2	2	4	2	3	5	4	0	1	3	2	0	**4.38**
Comfort															
Wearing a transmitter belt is uncomfortable and cumbersome (tiresome)	5	4	3	6	1	4	5	1	6	0	1	1	6	0	**3.58**
I prefer to wear a transmitter belt	3	2	2	1	1	2	2	3	1	3	1	5	1	0	**4.92**
I would be willing to pay more (in order) to avoid wearing a transmitter belt	4	6	2	5	4	5	6	4	1	1	1	5	5	0	**3.77**
I would prefer a different colour	white	ok	ok	pink/ blue	white	white	red		black		0	0	cream	black	
Acceptance															
I have more trust in the heart rate measurements than the pulse measurements	6	1	6	3	4	4	4	4	3	5	3	4	4	0	**3.08**
I would buy it for someone else	3	5	1	6	6	5	4	6	1	0	4	3	4	0	**4.00**
I would buy it for myself	3	3	1	1	4	5	4	5	4	0	1	3	5	0	**3.25**
I would like to receive it as a present	3	1	1	4	4	5	4	6	2	0	0	4	4	0	**3.45**
I have no need for technological knick-knacks (gimmitry)	5	3	1	1	4	4	3	3	5	5	1	5	2	0	**3.77**
1: disagree strongly; 2: disagree; 3: tending towards no; 4: tending towards yes; 5: agree; 6: agree strongly;														***Yellow highlight = Inverse Value***	**3.53**

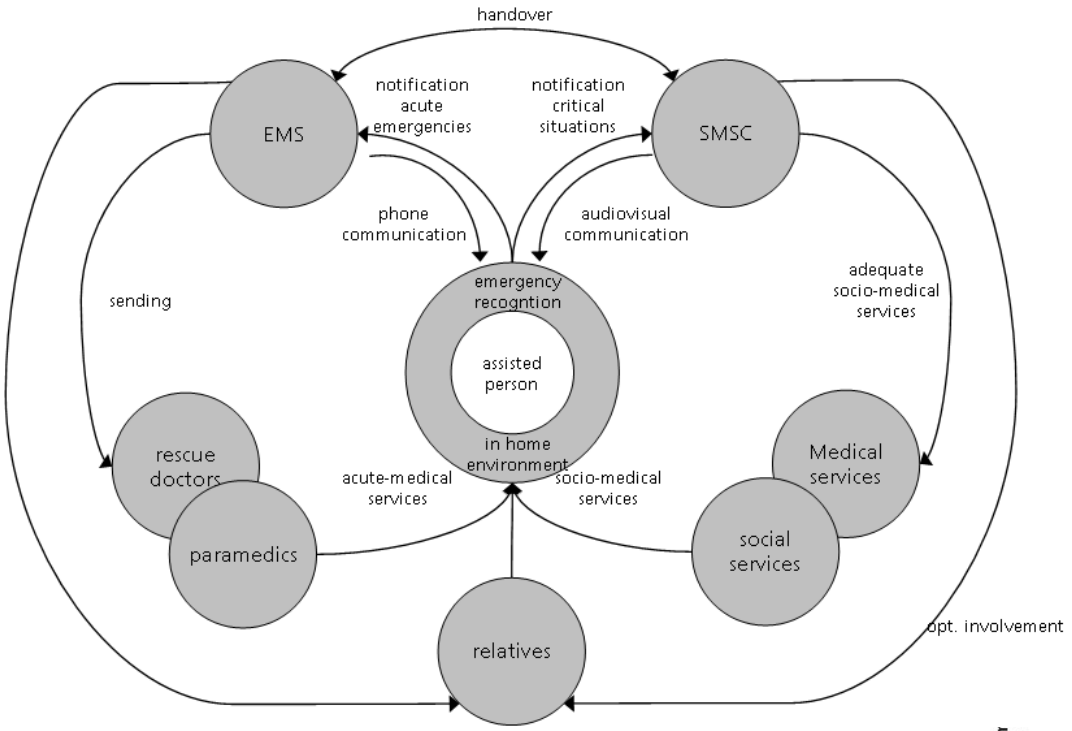
Multi Sensor Wrist Device for Surveillance of Elderly Persons

Viewer



Outlook Overall

- **Socio-medical service center**
  - Care center for assisted living
  - Extension of EMS dispatch center
  - Hospitals: Rehabilitation at home
- **Automatic notification***
  - ***restricted by law**
- **Interaction facilities**
  - Contact via phone
  - Contact via video phone (with web cams)
  - Remote control of home automation
  - Remote assistance with robot
- **Handover to EMS**
- **Triggering service providers**
  - Social service
  - Psychological service
  - Medical service
  - Emergency service



Outlook Wrist Wearable

- The wrist device is a key product for a continuous, unobtrusive monitoring. All sensors are integrated in a watch like device.
- AOT is ready to provide the Wrist Device as building block into monitoring services. Possible Partners are not yet selected.
- With service partners the requirements for series device shall be defined and then a commercial version developed.

Thank you

- for your attention
- Contact
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