

### **Tragbare Sensoren zur Erfolgsbewertung in der Schlaganfallstherapie**

**FP-7 project StrokeBack** 

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innovations for high performance microelectronics





#### Key facts about IHP

- Material Research, Technology, Circuit Design, System Design
- About 320 employees
- Class A clean room pilot line for prototyping (250 nm, 130 nm)

Focus on silicon-based systems, highest-frequency integrated circuits, and technologies for wireless and broadband communication





### Sensor networks research group

~ 20 scientists + 10 students

#### Competencies

- Autonomous monitoring systems
- Mobile wireless communication
- Embedded systems
- Hardware accelerators and Systems on Chip (SoC)
- Integrated security and privacy

#### Application areas

- Environmental monitoring
- Telemedicine and e-Health
- Homeland security
- Automation control







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### FP7 project StrokeBack

Runtime: 10.2011 – 12.2014



PartnerIHP GmbH, (Coordinator)

- Brandenburgklinik Bernau
- MEYTEC GmbH

Budget

Total: 4.3 Mio €

- University of Potsdam, Institut of Informatics
- University of Southampton (GB)
- Research for Science, Art and Technology (GB)
- Intracom Telecom (Griechenland)
- University of Pannonia (Ungarn)

EC contribution: 3.03 Mio €







### Idea of StrokeBack



#### Empowering stroke patient to train theirself

- Development of automated remote rehabilitation system for home settings
- Useable without presence of therapists

# Goal: Patients can do rehabilitation in their own home while still remaining under medical and physiotherapy control

- Patients train with small games at training station
  - 3D cameras monitor exercises and body alignment (<u>Demo-Video</u>)
- Online personal health record coordinates therapy and stores results
- Monitoring of impact of training also in normal life situations by <u>wearable sensor</u> <u>system</u>
  - Monitoring of upper limb activities
  - Classification of Activities of Daily Living
  - Reach & Grasp, Lifting object, Lifting object (Tremor)

#### Therapists want to have some daily statistics

### **Requirements for wearable sensing system**

#### Plug and play for patients!

- No cables, no connectors, freely wearable during the day
- Useable without help
- >= 12h operation time
- Compact and very flat design
  - Water resistance demanded
- Integrated security and privacy
- Ideally one sensor node per patient only
  - Depends on quantitative measures to be realised
- Extendability
- → Wireless charging required
- $\rightarrow$  No gloves or sleeves
- $\rightarrow$  Ultra low power consumption
- $\rightarrow$  No permanent streaming
- → Integrated AES and ECC crypto modules





### **GHOST sensing platform**

#### Wearable sensor system with inertial sensors

- Accelerometer, Gyroscope, Magnetometer, Vibration, Tilt
- Integrated AES and ECC cipher hardware
- Bluetooth Low Energy + on-board antenna
- Qi-compliant wireless power supply
- 128 MB Flash memory

#### Detection or Activities of Daily Living (ADL)

Arm movements, step counter, drinking etc.



#### Goal: Measuring therapy outcome

- Affected vs. Unaffected body parts
- Quality of movements
- Speed, angles etc.





### 4 options of power supply



- 1. Wireless power transfer
- 2. USB
- 3. Lithium cell (250 mAh)
- 4. External voltage input





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### Preliminary power consumption and housing

#### **Power consumption**

- Basis platform: <0.5 mA (standby); 2-5 mA (operation)</p>
- BT-LE: <= 21 mA @ 3.3 V</p>
- Sensors: < 10 mA; typical: 3-5 mA</p>
- Total maximum consumption: < 40 m @ 3.3V @ 1 MHz</p>

#### Case is completely closed

- Water resistant if glued
- permeable to infrared light











### **Case study**

#### Recognition of activities based on K-means clustering approach

- Task A: Reach and retrieve object
- Task B: Lift cup to mouth and return to table
- Task C: Swing arm in horizontal plane

	Subject	Position	Features	A%	<b>B%</b>	С%	Accuracy
H E A L T H Y	Subject1	Acc_wrist	11	100	100	100	100
	Subject2	Gyro_wrist	27	100	80	60	85
	Subject3	Acc_wrist	7	95	100	80	95
	Subject4	Acc_wrist	23	95	100	85	94
	Subject	Position	Features	A%	B%	С%	Accuracy
P	Subject Subject 1	Position Acc_wrist	Features 19	<b>A%</b> 80	<b>B%</b> 90	<b>C%</b> 100	Accuracy 88
P A T	Subject1Subject2	Position Acc_wrist Acc_wrist	Features 19 19	<b>A%</b> 80 90	<b>B%</b> 90 10	<b>C%</b> 100 100	Accuracy           88           73
P A T I E N	Subject1Subject2Subject3	Position Acc_wrist Acc_wrist Acc_wrist	Features           19           19           21	<b>A%</b> 80 90 95	<b>B%</b> 90 10 100	C% 100 100 10	Accuracy           88           73           75

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### Summary



#### Wearable sensor system with inertial sensors of matchbox size

Including BT-LE, wireless power transfer and lithium cell

#### Detection or Activities of Daily Living (ADL)

Arm movements, step counter, drinking etc.

#### Measurment of therapy outcome feasible

- Affected vs. Unaffected body parts
- Quality of movements (Speed, angles etc.)

#### Next steps

- Version 2 with IHP-crypto-microcontroller in process
- New cases with better usability



## Thank you for your attention!

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