A Long-Term Sensory Logging Device for Subject Monitoring

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Motivation

Group focus: Pervasive Computing

- sensor networks: ultra-low power protocols/hardware (e.g. WoR, superimposing signals)
- context/activity recognition: non-personalized with high number of classes

Logging Device Requirements

- **Creation of context recognition data sets**
- **Local data storage (as op-posed to transmission)**
- **Easily modifiable**
  - Data preprocessing
  - File formatting
- **Easy access to data**
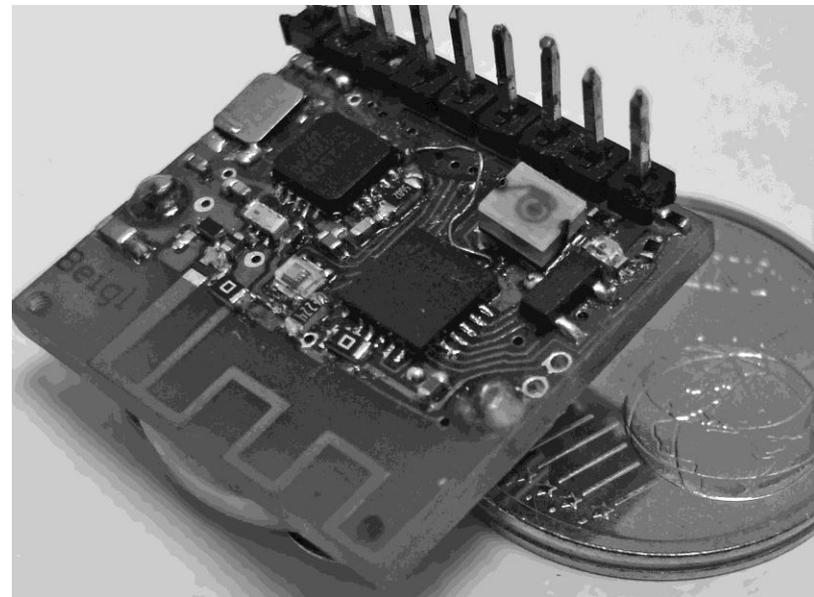
Requirements and Hardware

Lightweight for 24/7 wearable use

- **< 25g w/ CR2477 >7 days**
- **< 50g w/ AAA >26 days**
- **Sensor board (Akiba)**
  - PIC18
  - Light, Temperature, Vibration
 - 3 pin A/D external
- **Memory Board**
 - PIC32
  - microSD
  - 'Eject' button
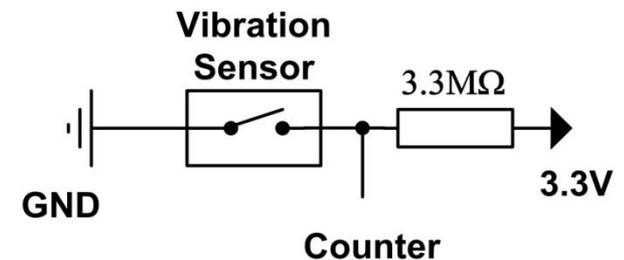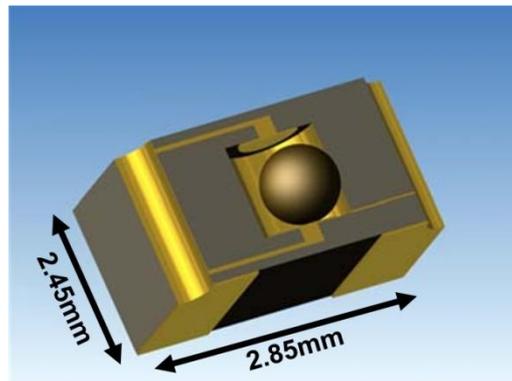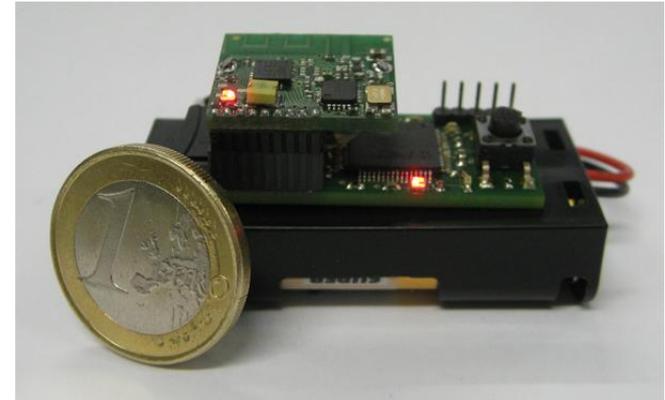
Requirements and Software

- **Software consists of two entities**
- **Sensor board software**
  - Samples sensors
  - Preprocesses data (unit conversion etc.)
  - Minimal application
- **Memory board software**
  - **FAT32** system on microSD
  - Communication with Sensor board (UART)
  - Card ejection and insertion

Demonstative Application

- **Demonstrate sensing / preprocessing / saving**
- **Inspired by medical activity monitoring**
- **Classify activity level based on vibrational intensity**
- **3 activities selected**
- **2 subjects used to create thresholds**
- **1Hz storage rate:**
  - Sample (>10 kHz)
  - Calculate activity level
  - Save to memory board
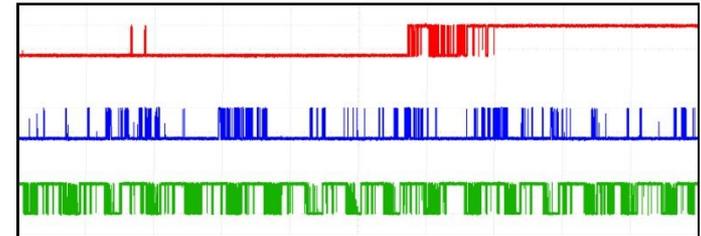
Typing	Walking	Jump-Rope
0	648	1966
0	228	1266
0	594	2040
0	1000	2734
0	1188	1628
0	1444	1898
34	2172	1284
14	1506	1236
0	1484	1972
0	1262	1986

ID	Level	Repr. Activity	Levels
1	Low	Typing	≤ 550
2	Medium	Walking	551 - 1508
3	High	Jump-Rope	≥ 1509

Evaluation

- **3 subjects (2 + 1) used for evaluation**
- **30s per activity per subject**
- **Mixed results:**
  - Inter-personal variance
- **Overall: 74% recognition**
- **Possible causes**
  - Less than optimal thresholds (more training data)
  - Poor classifier (see further work)
  - Inter-personal differences (personalization)
- **Rate of consumption: 4.478mW, >26 days 2 x AAA**

CLASSIFICATION RATES IN PERCENT BY USER AND ACTIVITY

	Subject 1	Subject 2	Subject 3
Low (Typing)	81	97	100
Medium (Walking)	72	69	86
High (Jump-Rope)	0	66	97

CONFUSION MATRIX FOR CLASSIFIER OUTPUT IN PERCENT

	Low	Medium	High
Low (Typing)	95	3	2
Medium (Walking)	6	75	18
High (Jump-Rope)	2	43	55

A Lesson Learned

- **Energy Consumption strongly dependent on microSD card**
- **Large variance between brands**
- **Energy consumption correlates with transfer speeds**

	Nokia	Kingston 4GB	Kingston 2GB	SanDisk
Write	0.5µJ/B	3.05µJ/B	3.15µJ/B	0.27µJ/B
Read	0.1µJ/B	0.5µJ/B	0.53µJ/B	0.09µJ/B
Write speed	83.3KB/s	43.1KB/s	49.9KB/s	115.5KB/s
Read Speed	216.9KB/s	179.8KB/s	170.6KB/s	228.4KB/s

Further Work

- **Time synchronization of nodes**
  - Using our Beacon-based approach (~5us max drift)
  - Base for communication present
- **Annotation**
  - HC interface for user input
  - Keypad (chord)
- **Embedded classifiers**
  - C4.5 Decision tree
  - kNN
  - Fuzzy inference system

Thank you!

Questions?