Authors
Au, Lawrence
Wu, Winston
Batalin, Maxim
et al.

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Context-aware, Energy-aware Sensing of Physiological Signals

Lawrence Au, Winston Wu, Maxim Batalin, Dustin McIntire, William J. Kaiser
Actuated, Sensing and Coordinated Embedded Networked Technologies (ASCENT) Lab – www.ascent.ucla.edu
UCLA Electrical Engineering Department

Introduction: Wireless Monitoring of Physiological Signals

Microsensor Technology

- Recent technology advancement permits miniaturization of conventional physiological sensors
  - Can be unobtrusively attached to human body or embedded in clothing.
  - Some examples: electrocardiogram (ECG), electromyography (EMG), electroencephalography (EEG)
- Data acquisition ***introduces large energy demand***
  - Requires high sampling rate—in excess of 250 Hz
  - Requires high resolution—in excess of 16 bits

Wireless Monitoring

- Combines sensors with low-power processing and wireless interfaces
  - Inexpensive and lightweight
- Enables patient monitoring in home and workplace environments in addition to the clinic
- Improves patient wearability of the sensors by eliminating intrusive cables
- Introduces ***large energy demand*** when streaming raw samples at high data rates

Problem Description: Energy Constraint

Large Energy Demand

- Required to support energy-intensive sensing
- Required to support power-hungry biological transducers
- Required to support high-data rate streaming
- Supported by a battery in a compact package

Long System Lifetime

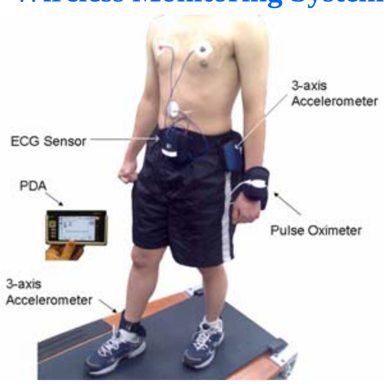
- Extending the system lifetime is a major objective
  - Particularly critical to battery-powered wearable platforms
  - Power-hungry components must be power-cycled efficiently

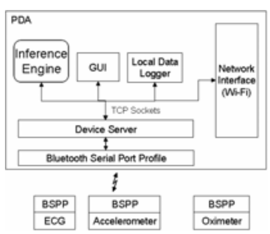
Optimize Real-time Sensing Requirements

- Context-aware algorithms
  - Use patient context to determine when to turn the sensors on/off
  - Systematically activate more sensors as required
- Energy-aware algorithms
  - Require hardware/software integrated solution
  - Hardware design provides accurate platform energy consumption computation
  - Software architecture provides control of major system components

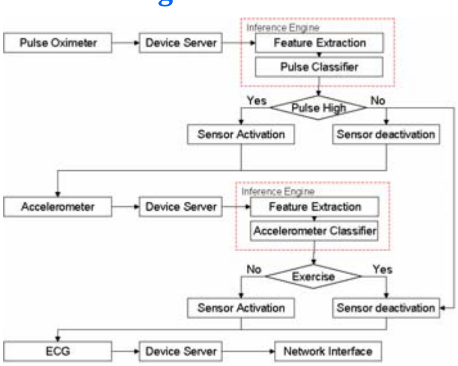
Proposed Solution: Context- and Energy-awareness

Wireless Monitoring System



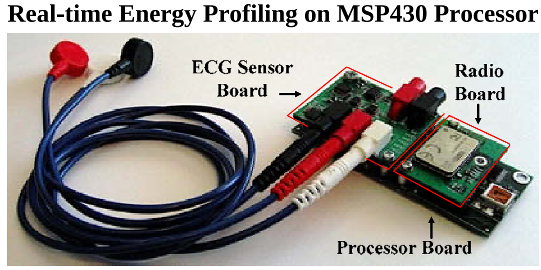


Context-aware Algorithm[1]

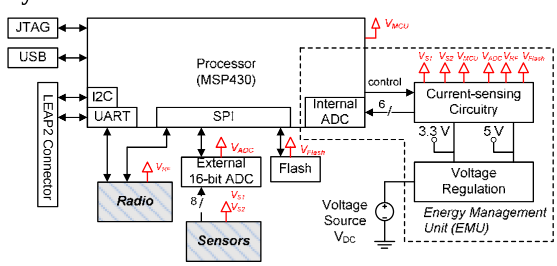


MicroLEAP: Energy-aware Wearable Sensor Node[2]

Real-time Energy Profiling on MSP430 Processor



System Architecture



Power Consumption of System Components

	Active	Low-power
Processor	Active (running two tasks)	Active
Radio	Tx @ 115200 bps	Sniff
Flash memory	On(idle/low power)	Off
Sensor, MEMS	On	Off
Sensors, ECG	On	Off
16-bit ADC	Sampling @ 250 Hz	Off

Component	Active		Low-power	
	Power (mW)	%	Power (mW)	%
Processor	2.69	1.95%	2.81	19.93%
Radio	72.74	52.70%	9.40	66.57%
Flash memory	0.029	0.02%	0.027	0.19%
Sensor, MEMS	1.18	0.86%	0.001	0.01%
Sensor, ECG	55.41	40.14%	0.24	1.70%
16-bit ADC	5.97	4.33%	1.64	11.60%
Total	*138.04*		*14.12*	

1. W.H. Wu, M.A. Batalin, L.K. Au, A.A.T Bui, W.J. Kaiser, "Context-aware Sensing of Physiological Signals," 29th Conference of IEEE Engineering in Medicine and Biology Society (EMBC 2007).

2. L.K. Au, W.H. Wu, M.A. Batalin, D.H. McIntire, W.J. Kaiser, "MicroLEAP: Energy-aware Wireless Sensor Platform for Biomedical Sensing Applications," IEEE Biomedical Circuits and Systems Conference (BioCAS 2007).