

# An Overview of CustoMed



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<http://er.cs.ucla.edu>

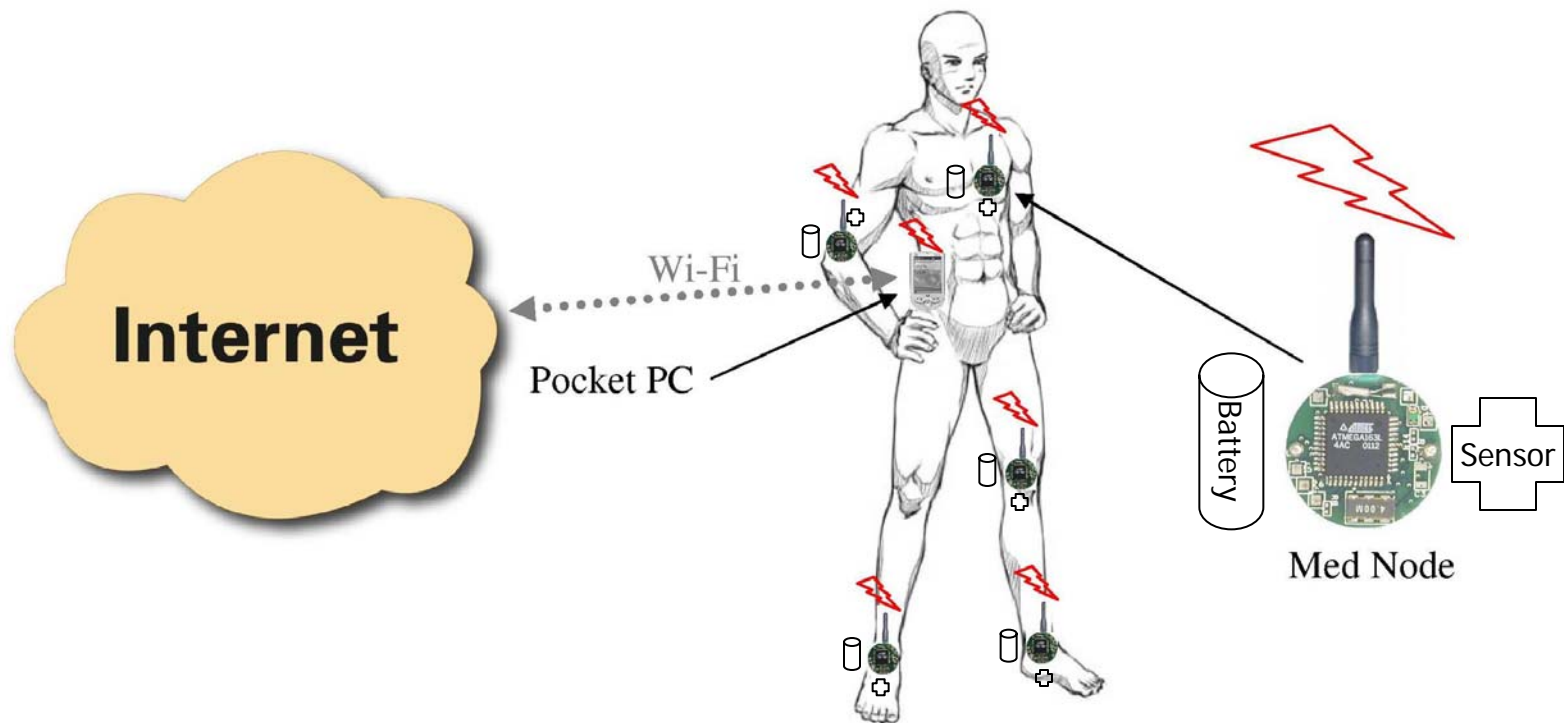


# Outline

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- Introduction
- System Design Requirements
- Driver Applications
- System Components
- Experimental Analysis
- Challenges

# Model System Setup





# Requirements

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- Rapid prototyping/ Quick Customization
  - Device-level/Software customization
- Compact size/ Wearability
- Customization by non-technical staff
- Real-time medical monitoring
- Utilizes various types of wearable sensors
- Internet Connectivity



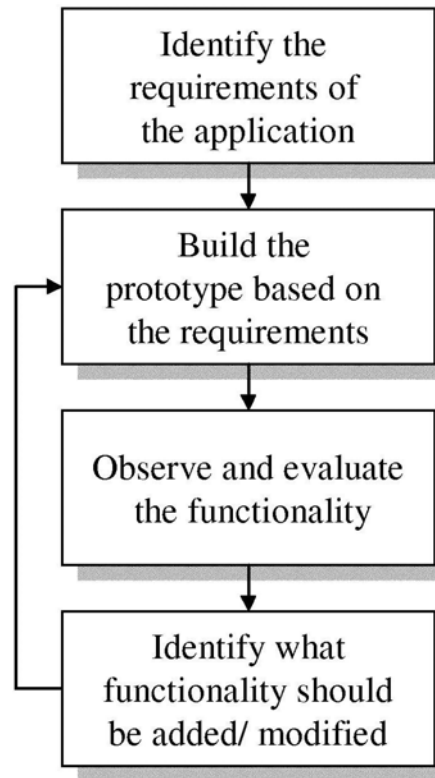
# Requirements Form

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- name: **CustoMed**
- purpose: **Health care monitoring**
- inputs: **Biological signals**
- outputs: **Interpreted bio-signals**
- functions: **Monitoring/ Actuation**
- performance: **Collect 1-10 samples per second**
- manufacturing cost: **\$1000**
- power: **Small size batteries**
- physical size/weight: **wearable/less than 2lbs**



# CustoMed



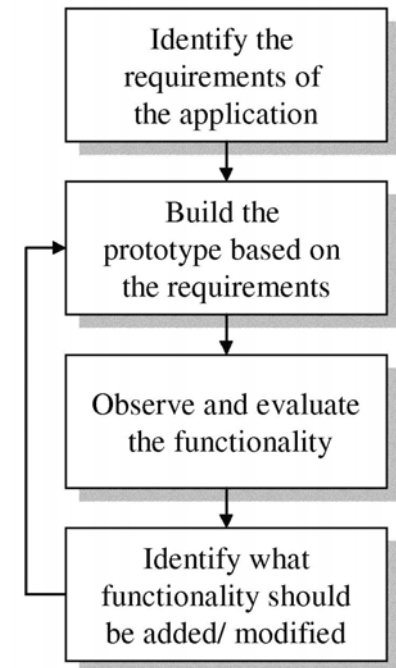
Application Development  
Cycle

Instead of building and debugging circuit boards, firmware and low-level protocols...



# CustoMed

- early evaluation of service ideas
- profit opportunities
- user aspects
- technological feasibility of the applications
- generates an evolving pool of innovation prototypes for future
- creates services and products that can be productified
- provides justification and validation for services





# Driver Applications

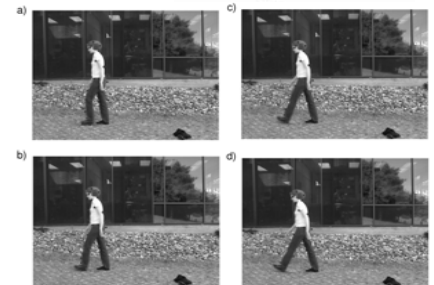
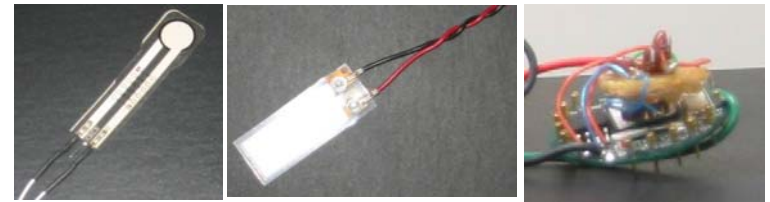
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- Post-knee surgery tracking of patients
  - Track the angular motion of the knees (flex sensors)
  - Measure forces and pressures under the foot (pressure sensors)
- Aid Alzheimer's patients
  - Detect arousal and/or agitation by measuring skin conductance (galvanic skin response sensors)
    - When agitation is sensed, proper verbal cues is issued
    - Other personnel is notified
  - Detect physical abuse
    - Notify personnel

# System Components

- Sensors

- Flex
- Pressure
- Piezoelectric film
- Galvanic skin response
- Temperature
- Accelerometers
- Cameras: Used to search for visual cues, but only when the devices with a smaller footprint trigger them.
- Pedometer



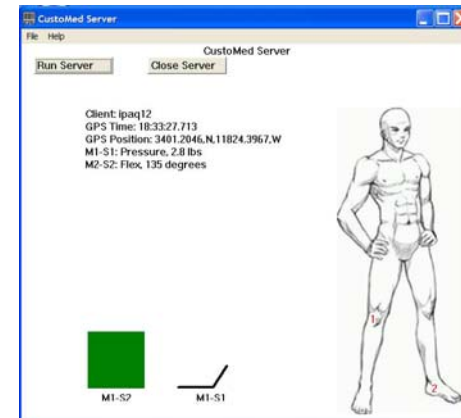
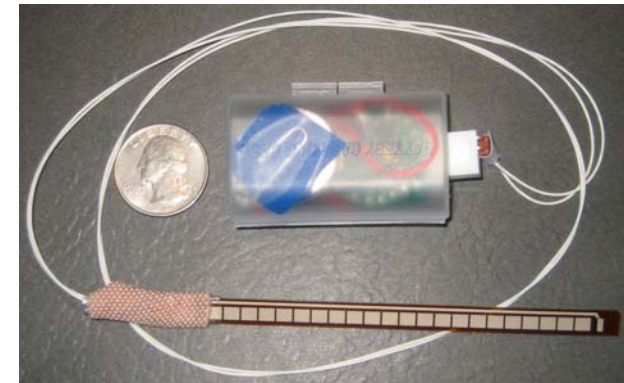
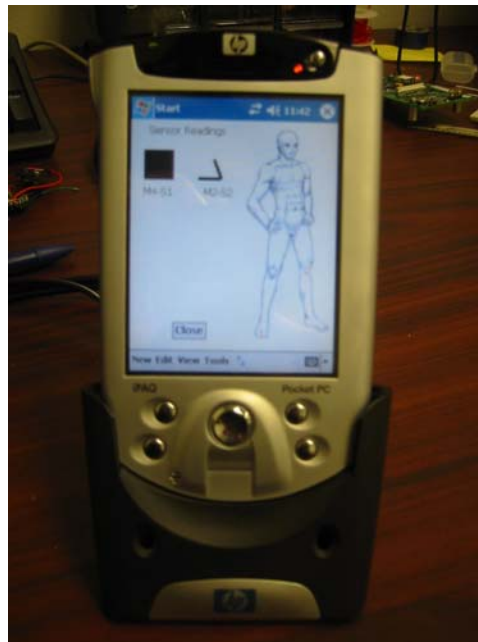
# System Components

- Processing Units:  
Berkeley Motes
  - Devices that incorporate communications, processing, sensors, and batteries into a small package
  - ATmega128 8-bit RISC processor
  - 4K bytes of EEPROM, 4K bytes of SRAM
  - 2x USARTs, ADC and I2C
  - Radio module

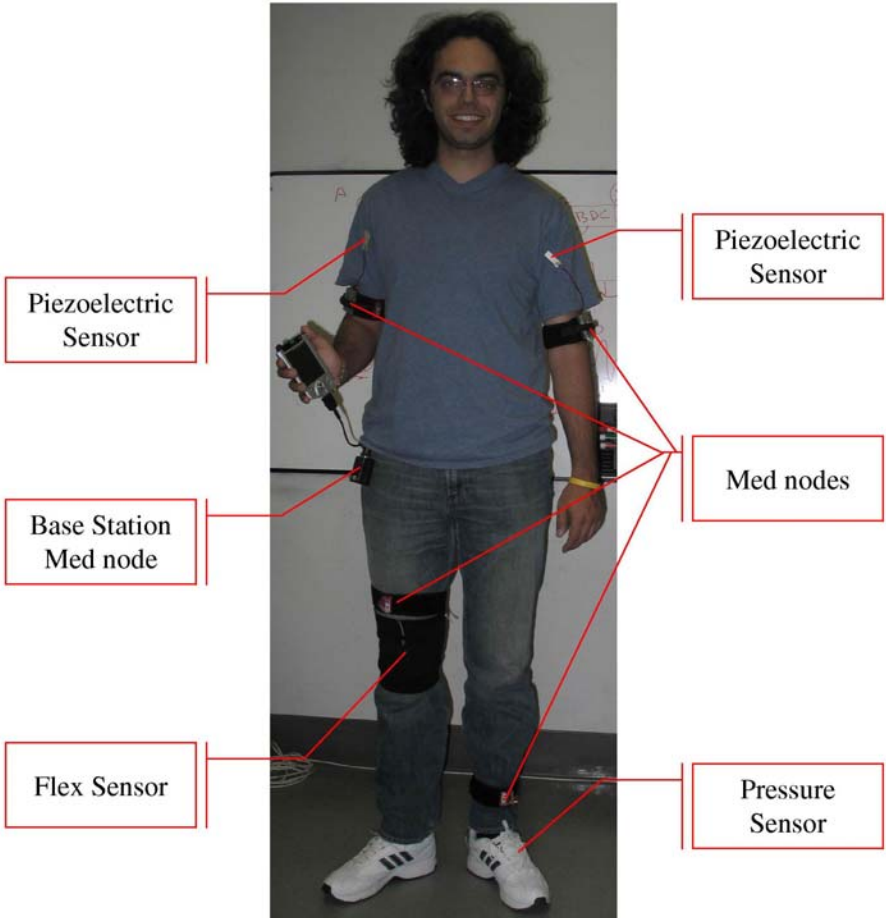


# System Components

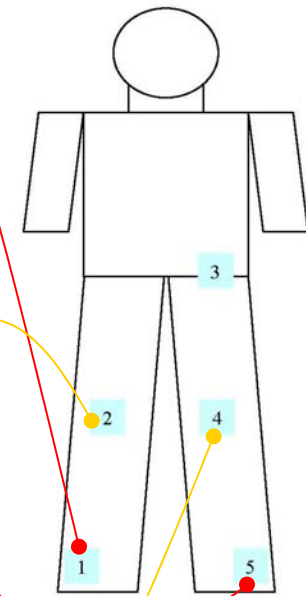
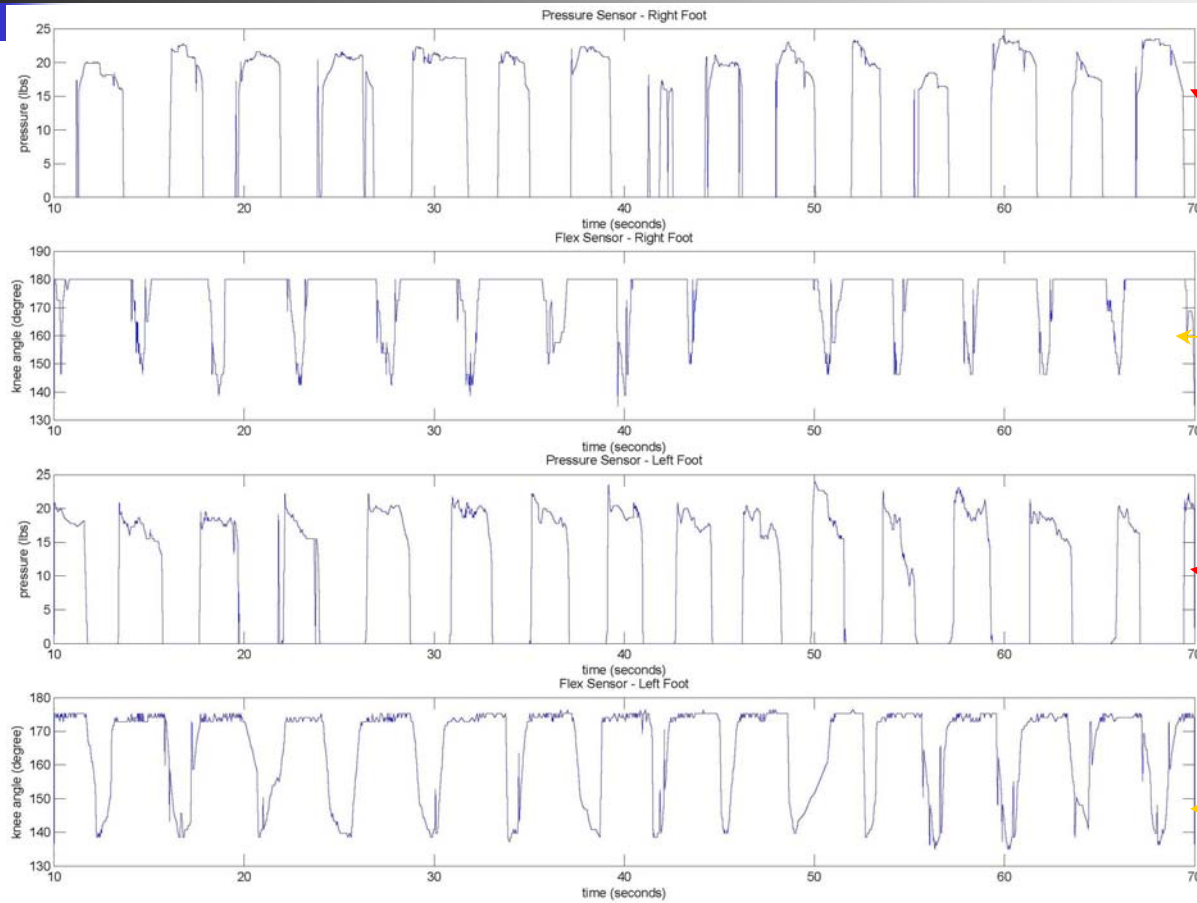
- Med Nodes
  - Mica2dot
  - Battery
  - Sensor
- Pocket PC
- Server



# CustoMed



# Experimental Analysis





# Experimental Analysis

- Highly Dynamic Wireless Channel Characteristics
  - Body position
  - Environmental noise/interference

RTT(ms)/Loss Rate(%)	1	2	3	4	5
1	-	52.9 / 11.5	75.7 / 14.4	62.2 / 9.3	53.4 / 10.1
2	52.9 / 11.5	-	54.3 / 15.2	65.7 / 7.7	86.3 / 6.3
3	75.7 / 14.4	54.3 / 15.2	-	75.8 / 2.6	106.8 / 2.6
4	62.2 / 9.3	65.7 / 7.7	75.8 / 2.6	-	99.3 / 0
5	53.4 / 10.1	86.3 / 6.3	106.8 / 2.6	99.3 / 0	-

Normal Walk

RTT(ms)/Loss Rate(%)	1	2	3	4	5
1	-	62.1 / 16.9	82.7 / 12.4	62.5 / 10.73	59.9 / 5.6
2	62.1 / 16.9	-	63.6 / 4.0	53.0 / 2.1	74.6 / 0
3	82.7 / 12.4	63.6 / 4.0	-	72.9 / 4.9	135.6 / 3.6
4	62.5 / 10.7	53.0 / 2.1	72.9 / 4.9	-	94.4 / 0
5	59.9 / 5.6	74.6 / 0	135.6 / 3.6	94.4 / 0	-

Slow Walk

Time Delay / Packet Loss Rate



# System Challenges

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- Rapid-prototyping/ Quick Customization
- Security
  - Privacy of Patients
  - Attack on Invasive systems
  - Adversary pretend to be “Hospital”
  - Adversary pretend to be a legitimate “CustoMed”
- Power-awareness
  - Distributed batteries
  - Communication is very expensive (upto 4x computation)
- Communication, Collaboration and Control
- Communication Constraints and Architectural Implications
- Software Partitioning
- Fault Tolerance
- Environmental Adaptability