Wearable Data Acquisition System

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Purposes

- Monitor acceleration signature of individuals at risk for falls

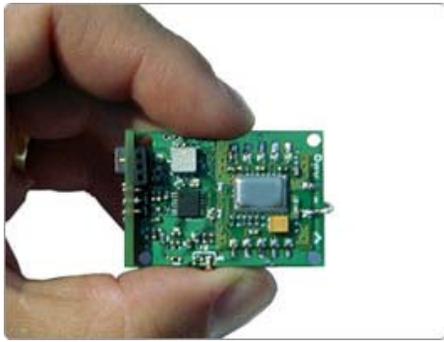- Warn of impending loss of balance

- Recognize and monitor activities

Hardware Elements

- Sensors

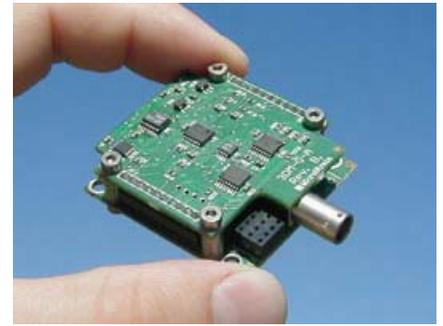- Wireless Interface

- Microcontroller

Sensors

- OKI ML8950 3D accelerometer
  - Small single chip – 5 by 5 by 1.4 mm
  - +/- 3G range
  - 10-bit digital output
  - 10-bit gain and offset registers
  - 200 samples/sec
  - SPI and I2C interfaces
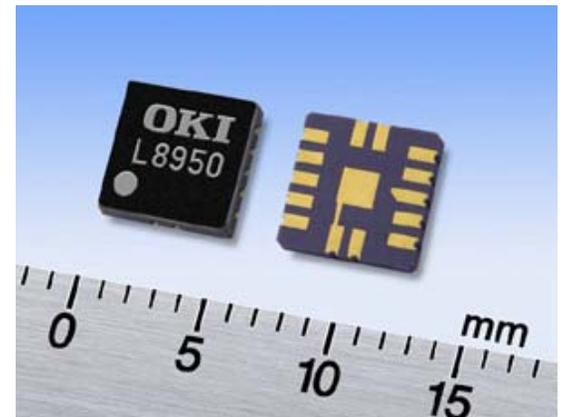
Other Sensors

- Microstrain G-Link Wireless Sensor
  - 3-axis accelerometers
 - 30 meter range
  - Data logging, 3 Mb memory

- Microstrain 3DM-GX1 Orientation Sensor
  - 3-axis gyros, accelerometers, magnetometers
  - Serial interface

ZigBee Wireless Features

- Low cost
- Long battery life – 37,000 hrs with 750 mah AAA battery – 10 mw active, 10 uw sleep - .1% duty cycle
- 65,000 nodes
- 128-bit AES security
- Direct sequence spread spectrum
- 30 – 70 m range
- 866/900 Mhz & 2.4 Ghz frequency
- 20 – 250 kbps data speeds

ZigBee Communication

- Star, mesh, and cluster tree networks
- Redundant data pathways
- Node configurations:
  - Single personal area network
  - Full-function (pass packets along)
  - Reduced function (lowest cost)
- Protocol stack of 32 Kb (vs 128 Kb+ for Bluetooth)
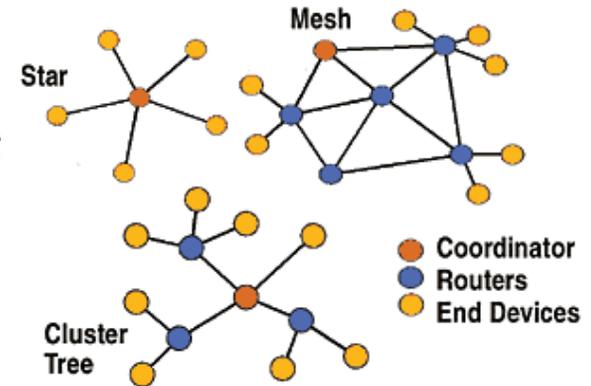
ZigBee Developer Starter Kit

- Freescale 13192DSK-A00:
  - 2.4 Ghz transceiver
  - Microcontroller
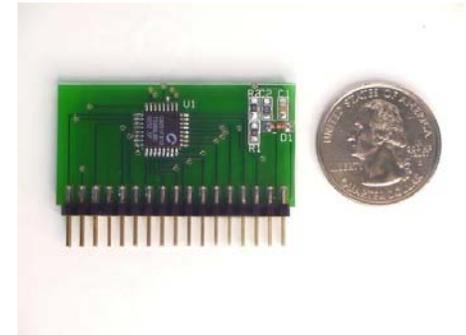 - 1-axis and 2-axis accelerometers
  - Software
  - $199
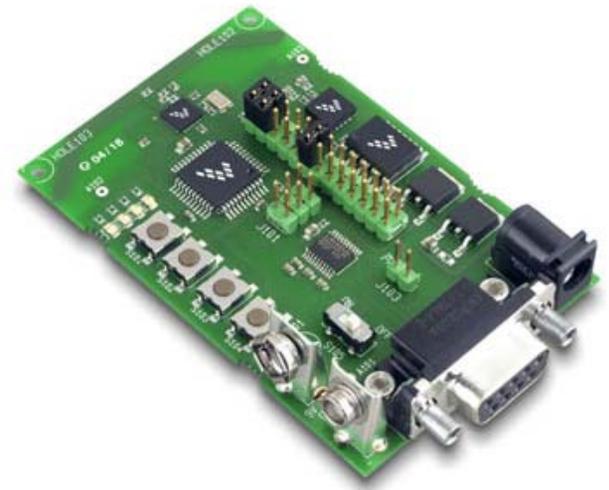
Microcontroller Requirements

- SPI and/or I2C interfaces for Oki part
- Physically small
- Battery powered – low power mode
- Programmable in Forth – serial port

Microcontroller Choices

- AMR Gadets
  - Silicon Labs 8051

- R2 Controls HyperCores
  - Silicon Labs 8051

- Z-World RabbitCore
  - Rabbit CPU (Enhanced Z80)

Operation

- Acquire multiple channels of 3-axis data
- Perform local calculations:
  - Average
  - Standard deviation
  - Slope
  - Thresholds
  - Magnitude and angle

Transmit Data

- When to transmit data:
  - Periodically at programmable intervals
  - When threshold changes
  - When a simple pattern is recognized

Receive Commands

- Commands:
  - Change operational mode
  - Change thresholds, etc.
  - Calibrate sensors
  - Download new code

Host System

- Collects data from all nodes
- Runs pattern matching algorithms
- Store data
- Display interface for user
- Connect to Internet

URLs

- Oki - http://www.oki.com/en/press/2004/z04054e.html
- ZigBee - http://www.zigbee.org
- Freescale Kit - http://www.motorola.com/mediacenter/news/detail/0,,4277_3620_23,00.html
- AMR 310 Gadget - http://www.amresearch.com/gadget.310.html
- R2 Controls - http://www.r2-controls.com/r2web/products/r108hypercore.htm
- Z-World RabbitCore - http://www.zworld.com/products/rcm2000/