Smart Shoe for Balance, Fall Risk Assessment and Applications in Wireless Health

UCLA Wireless Health Institute

Wireless Health

• The convergence of wireless, microsensor technologies with medical sciences
  – Fundamental advance in healthcare quality and accessibility

• Deliver healthcare
  – Adapted to each individual
  – Continuous and global

• Wireless Health Institute
  – Leadership at UCLA
  – Campus-wide collaboration
  – Industry and community partners
Wireless Health Institute

• Campus Community
  – School of Medicine
  – Medical Center
  – School of Engineering
  – School of Nursing
  – School of Public Health
  – College of Letters & Science
  – Anderson School of Management

• Unique approach
  – End-to-end integration from sensing to medical informatics to call center
  – Develop and verify new healthcare methods and services
  – Establish standards for efficacy, reliability, interoperability, and security
Why Preventing Falls?

- Instability is the major cause of morbidity in elders
- Falling is second cause of accidental death in the US
- Detecting precursors to a fall can be used as early warning
Why Preventing Falls?

• 75% of the victims of falls are Elders
• Falls are responsible for 70% of accidental deaths in persons 75 and older
• 5% of hospitalization and 40% of nursing home admission rate are related to fall
Why Preventing Falls?

- Hospitalization after falls cost health systems from $25,000 to $75,000.
- Cost of imbalance in the United States is about $20 billion and by 2020 this cost will be increased to approximately $32 billion.

![Graph showing rates of hospitalisation, non-hospitalisation, and fatalities due to falling.](image)
Bringing Balance Everywhere

- Smart Shoe
  - Electronic Shoe + Software
  - Portable
  - Affordable
  - Multipurpose
    (Doctors, Elderly, Runners and...)

- Measuring imbalance using variety of techniques
  - Insight into users daily walking patterns
  - Personalization
  - Context
• Proposed SmartShoe takes advantage of data modeling to shift the accuracy and influence capability of mobile platform
Architecture

Processing unit
Radio/Bluetooth Interface
- gyro
- x-accel

Pressure Sensors in the insole

Fall Risk
Monitoring Software
Variability of a temporal feature (swing phase) in three different walking patterns computed by Hermes.

Trend and variance of swing for three different walking patterns computed by SmartShoe. By removing the trend line from original signal, the variability is isolated and the variance is computed.
Fall Risk Analysis

Distribution of temporal features at various speed shows sensitivity in detecting variance in 1mph.

Distribution of computed risk factors shows effectiveness of computed risk value, where inconsistent walk always has higher risk value compare to normal walk.
Thank You