Concurrent mechano- and photo-plethysmography

Christian L Petersen, Nancy Luo, J Mark Ansermino & Guy A Dumont

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No Disclosures
Victorian Wearable Tech!

Mechano-plethysmograph (MPG)
Today’s Wearable Tech

Photo-plethysmograph (PPG)

Brought a @FitbitUK for my wife, though I'm not sure I entirely believe its output. (PS my wife is not a satsuma)
the Wearable Challenge

• An optical sensor draws electrical energy
  – PPG LEDs are in fact very power hungry
    • Low power consumption = low accuracy

• A mechanical one does not!
  – On the contrary, the MPG harvests energy
    • However, it is very sensitive to motion

• Can we combine the two to an advantage?
Clinical Pulse Oximetry

- SpO2 requires PPG based sensor

- Signal quality is critical
  - Clinical decision support
  - Micro-desaturations
  - Waveform morphology
the Clinical Challenge

• Difficult to discriminate subtle artifacts
  – Accelerometer ineffective
  – Can we use correlation with the MPG?
the Piezoelectric Effect

Greek πείζω: To squeeze or press

PZT Lead Zirconate Titanate Pb[Zr(x)Ti(1-x)]O_3

Quartz SiO_2
Piezo-based Biosensors

Wade D. Peterson, David A. Skramsted and Daniel E. Glumac 2004
Commercial Example

Piezoelectric Transducer

GoBe™
The Original 100% Automatic Body Manager™

Healbe GoBe Automatic Body Manager
The Only Body to Actually Measure Calorie Intake and Burn

a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA
the “Buzzer”

Brass disc

PZT coating

$0.03 / each @ 100

Responsible for disharmonic industrial beeps everywhere!
Modified Oximeter Boot

Piezoelectric “Buzzer”

Oximeter Finger Boot
the Prototype Setup
the Piezo-Plethysmogram

150 mV
Hybrid Finger Sensor

- Optical PPG components mounted on piezo MPG elements connected in (anti)series
  - Optimal position for both sensor types
  - Doubles the MPG amplitude
  - Rejects common mode motion artifacts
Potential Benefits

• The MPG signal can gate the PPG
  – Ensure high quality plethysmogram data
    • Improved clinical SpO₂ accuracy
  – Avoid driving LEDs when signal compromised
    • Potentially substantial power savings

• Potential new physiological information
  – Phase lag between MPG and PPG related to peripheral blood pressure?
Summary

- Mechano- and photo- plethysmography can be combined in conventional oximeter sensors

- The combination offers a new approach to signal quality assessment & possibly more

- Piezo elements are inexpensive, making this a viable addition to clinical oximeter sensors
Thank You!

Chris Petersen
cpetersen@cw.bc.ca