Concurrent mechano- and photo-plethysmography

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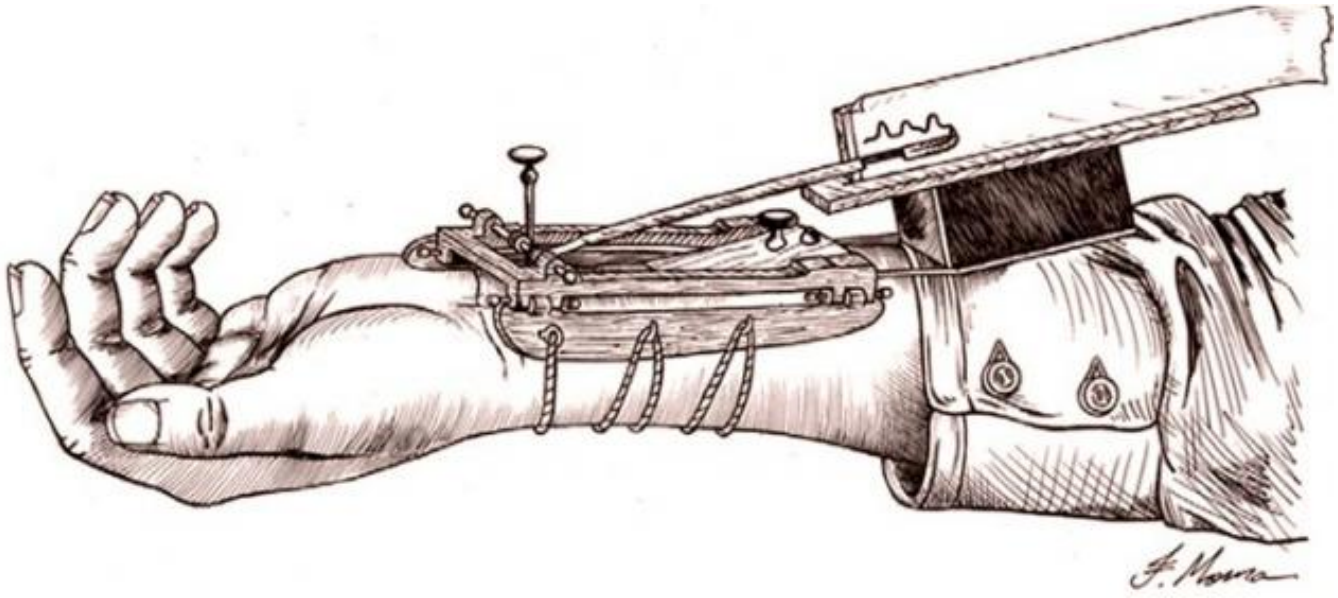
No Disclosures

Victorian Wearable Tech!



Mechano-plethysmograph (MPG)

Today's Wearable Tech

Photo-plethysmograph (PPG)

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 ?

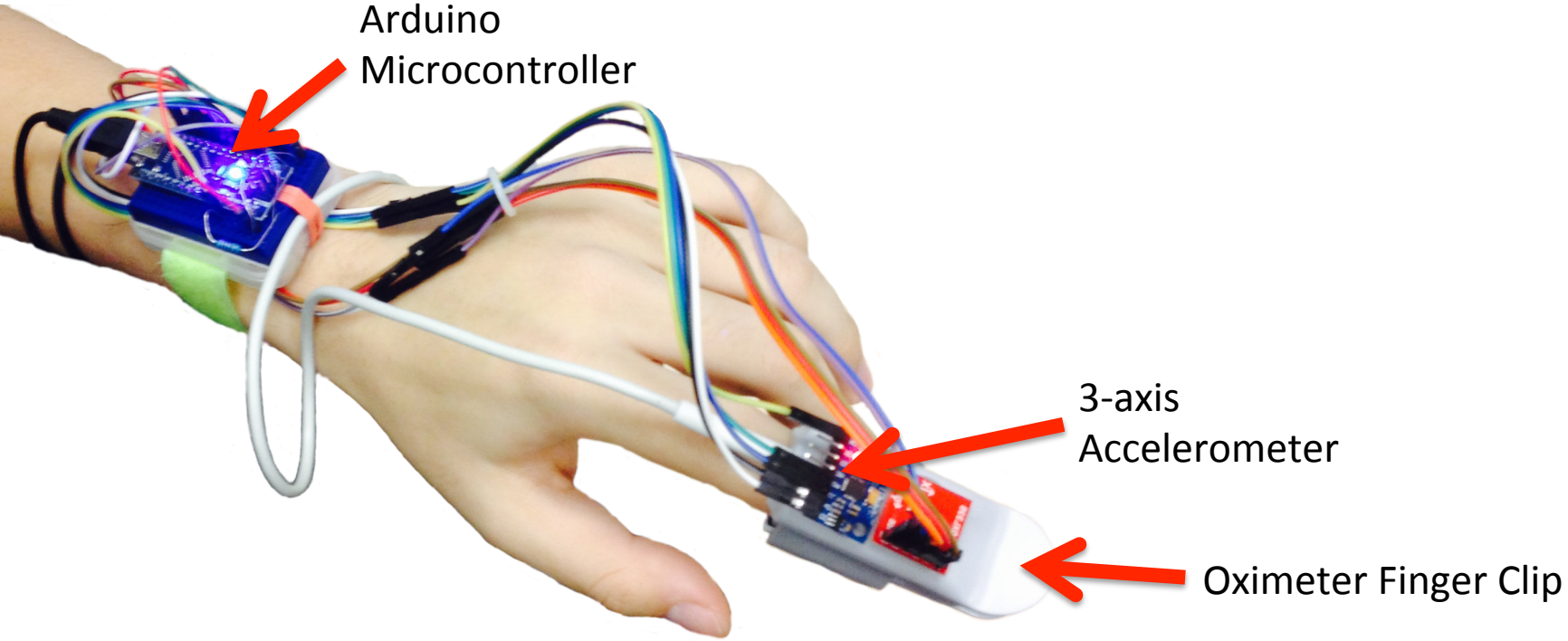
Clinical Pulse Oximetry

- SpO2 requires PPG based sensor

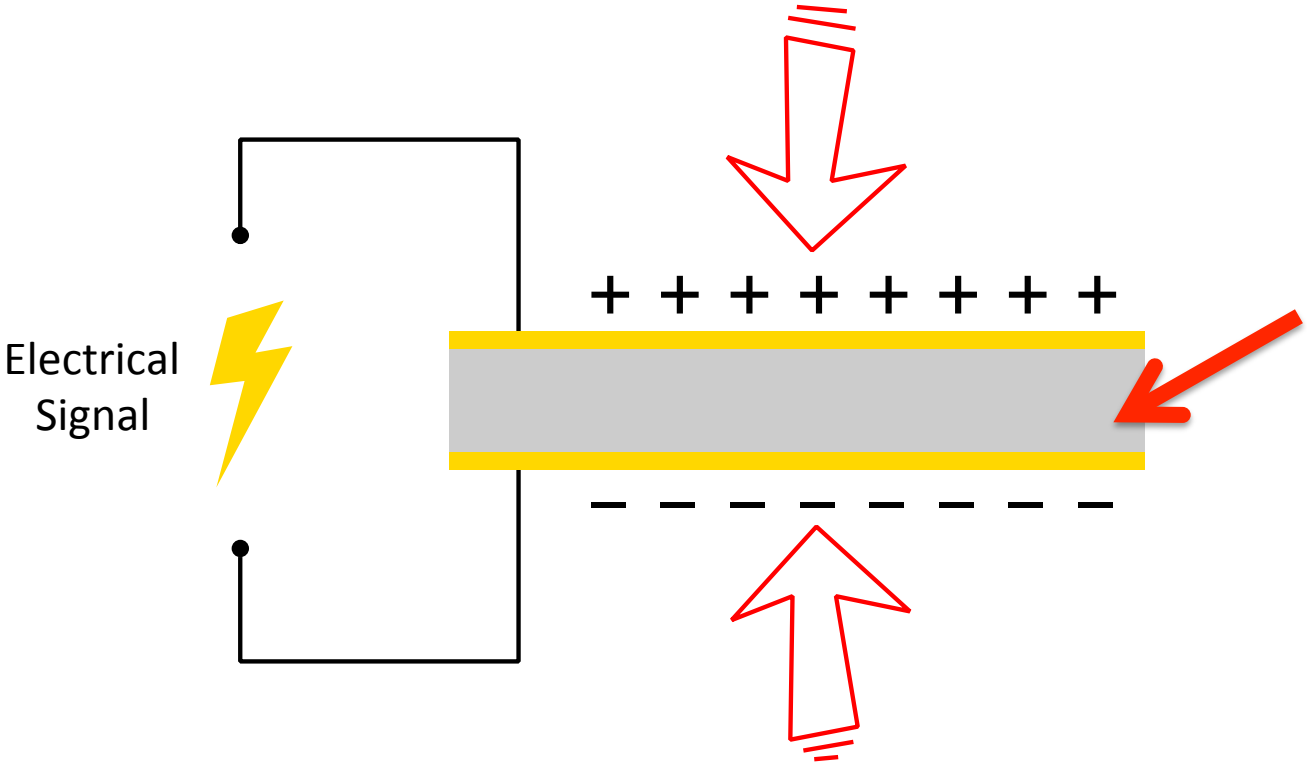
- Signal quality is critical
  - Clinical decision support
  - Micro-desaturations
  - Waveform morphology

the Clinical Challenge

- Difficult to discriminate subtle artifacts
  - Accelerometer ineffective
  - Can we use correlation with the MPG?



the Piezoelectric Effect

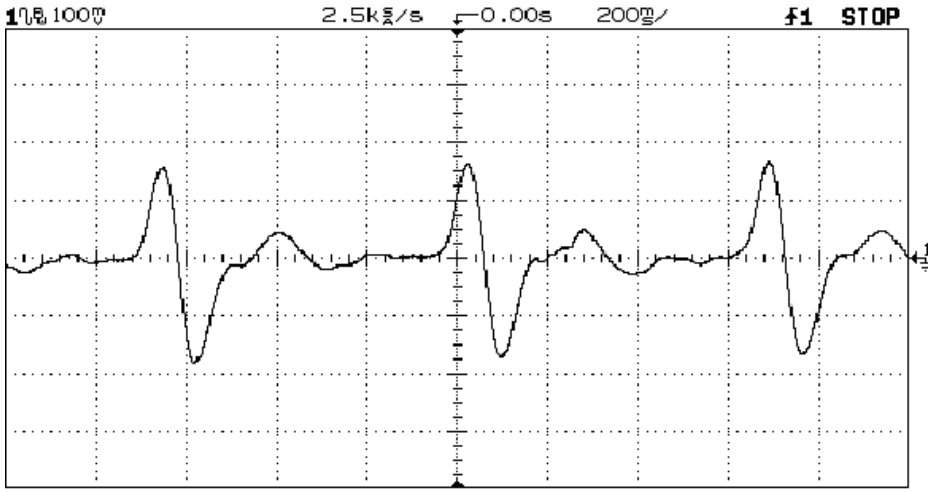


PZT
Lead Zirconate Titanate
$Pb[Zr(x)Ti(1-x)]O_3$

Greek piezō (πιέζω):
To squeeze or press

Quartz SiO_2

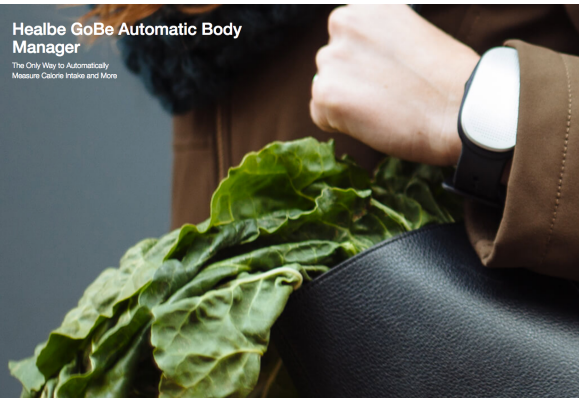
Piezo-based Biosensors



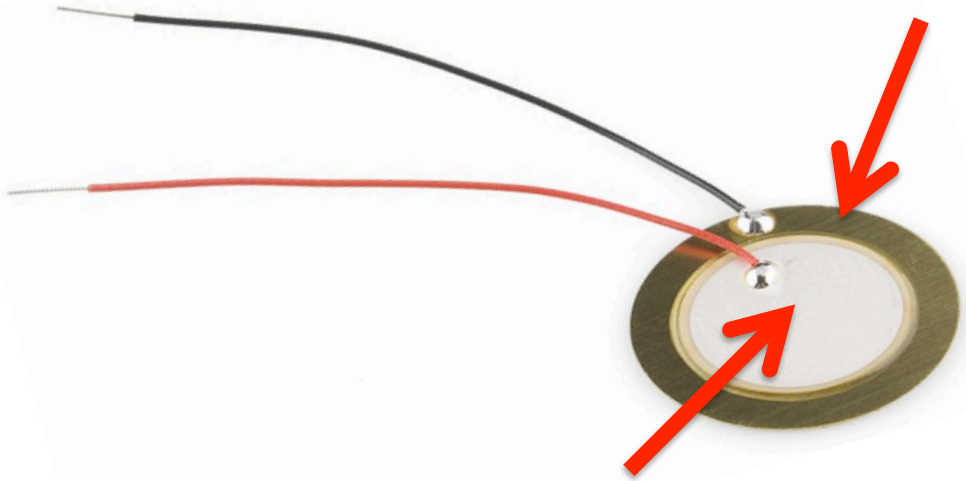
Wade D. Peterson, David A. Skramsted and Daniel E. Glumac 2004

Commercial Example

Piezoelectric Transducer



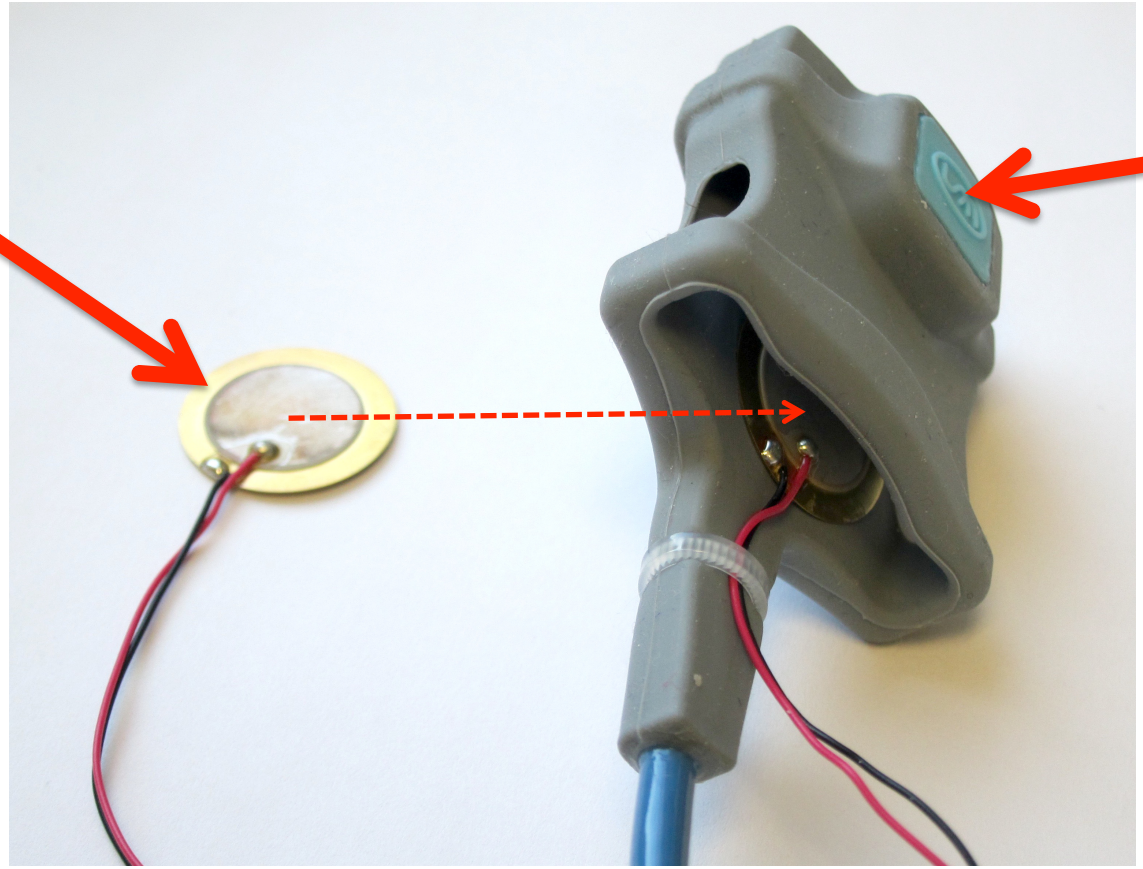
the "Buzzer"



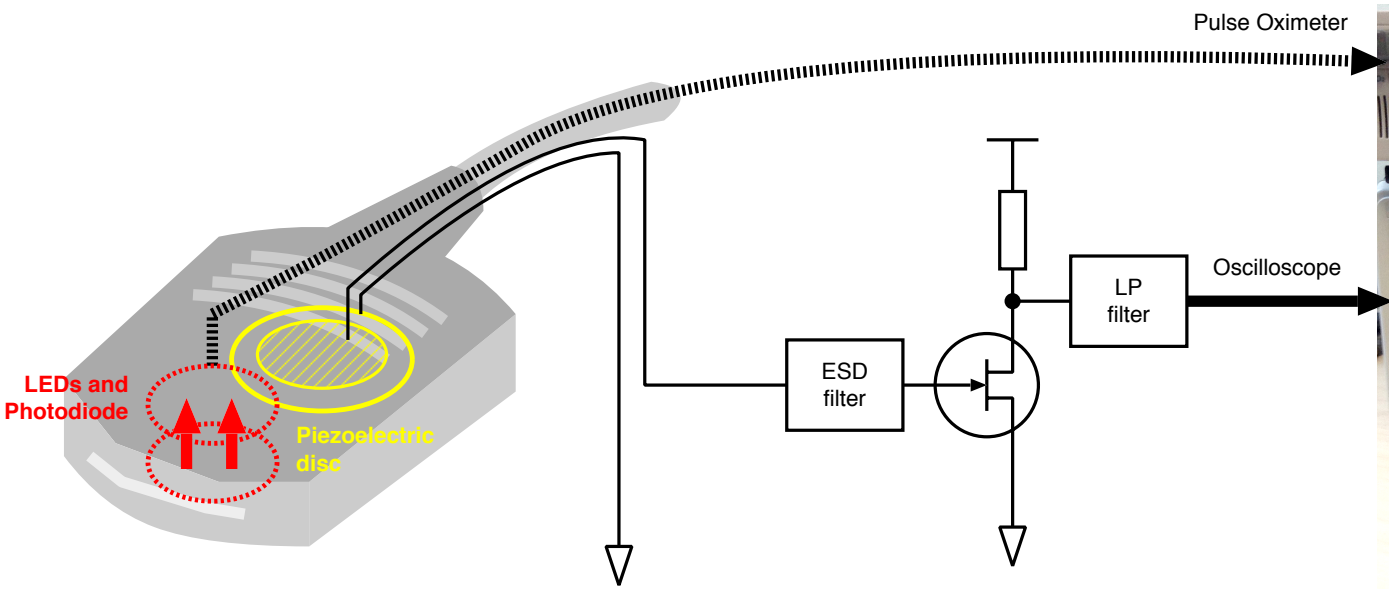
$0.03 / each
@ 100

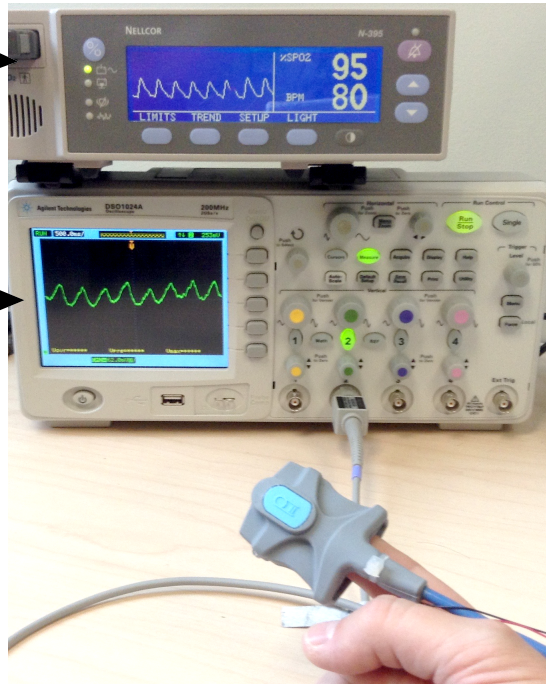
Responsible for disharmonic industrial beeps everywhere!

Modified Oximeter Boot



the Prototype Setup

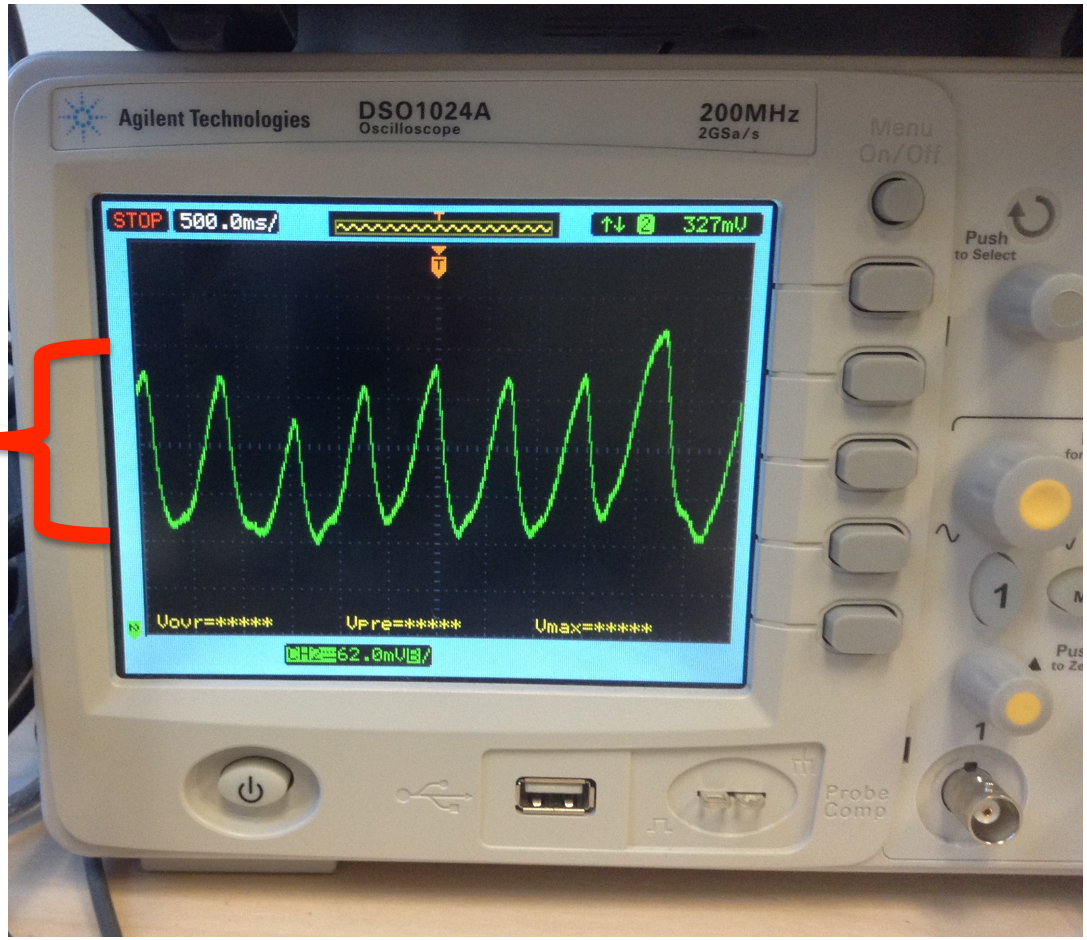




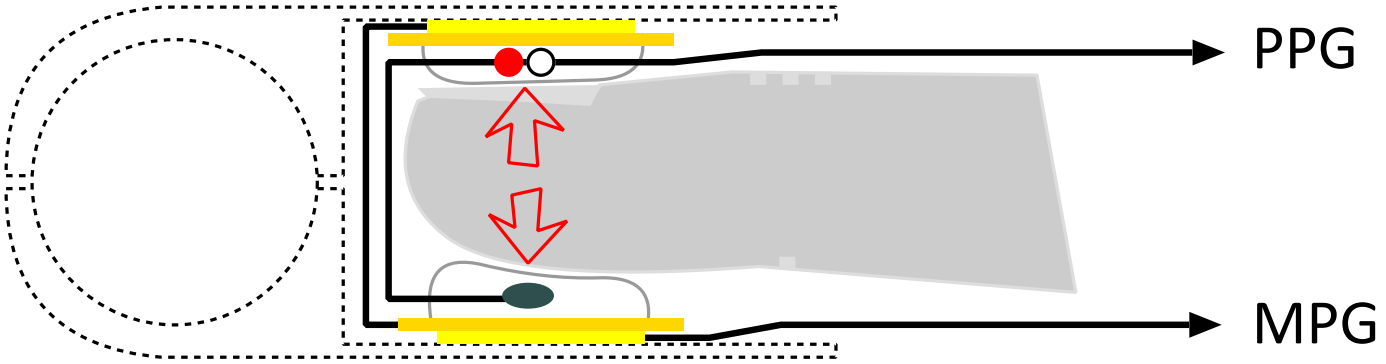
Pulse Oximeter finger sensor

Pre-amplifier

the Piezo-Plethysmogram



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 SpO_2 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!

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