Video Based Heart Rate Monitoring

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HR monitoring


http://www.newegg.com
Video based HR monitoring

• Why?

• Contact / touch-less; untethered
• Existing hardware
• Cheap (webcam)
• Non-proprietary hardware & software
Video based HR monitoring

- Application areas
  - Medical
  - Self monitoring
  - Human Computer Interaction
    - novel interfaces / monitoring
  - Exergaming


Video based HR monitoring

- Application areas
  - Affective / physiological computing
  - Monitoring mental work load
  - Biofeedback
  - Occupational health and safety

http://www.truckaccidentattorneysroundtable.com/blog/facial-recognition-technology-predict-truck-accidents/
Our Approach

• Detect HR through:
  • hidden signal (blood flow) underneath the skin
    – face detection and a skin color filter
    – exclude background and unwanted information in the frame

• Use Red, Green, and Blue video channel as an independent time-series signal

• Independent Component Analysis (ICA) to extract the hidden HR signal from the three components
Our Approach

(a) Input

(b) Magnified

(c) Spatiotemporal IT slices

http://people.csail.mit.edu/mrub/vidmag/
Our Approach
Our Approach

• Approach based on method by Poh et al.
• We introduce several enhancements:
  • skin color filter
  • raw data detrending
  • pulse spectral maximum frequency-density selection (PSMFS)
  • Kalman filter into the methodology
Process

- Video capture
- Face tracker
- Skin colour filter
- Signal enhancement (data detrending)
- ICA
- Pulse Spectral Maximum Frequency-Density Selection (PSMFS)
- Kalman filter
Evaluation

• 15 participants (2 females) 20-35 years
  • 3 minute sessions
  • Web cam (30 fps, 640*480)

• 2 participants
  • 5 * 2-minute recordings after exercise (jump squats)

• Pulse Oximeter: CONTEC CMS60D
Results

![Bar chart showing differences in beats per second (bpm) for various approaches.]

- Original Approach: 7.64 ± 1.00
- PSMFS Approach: 6.78 ± 0.75
- PSMFS: Kalman Filter: 3.77 ± 0.35
- PSMFS: Detrending: 6.02 ± 0.55
- PSMFS: Skin Color Filter: 3.95 ± 0.45
- PSMFS: Kalman Detrending + Skin Color Filter: 2.73 ± 0.30
Results

Estimation of heart rate after intensive exercise

Heart rate (bpm)

Time (sec)
Discussion / Conclusion

• Our approach improves accuracy over original approach
  • 7.7 bpm vs. 2.7 bpm difference to benchmark

• Accuracy after exertion low (error 23.4 bpm)
  • Maybe due to faster changes in HR – frequency smearing

• Lighting has impact (e.g. natural vs. artificial light)

• Background potential impact

• Webcams sampling rate relatively low
  • at least 5 second video needed
  • better cameras may improve performance
Discussion / Conclusion

• Many new opportunities & limitations
  
  • Medical applications - accuracy?
  
  • Human Computer Interaction, Gaming,
  
  • Self monitoring
  
  • Occupational health and safety