A temporal video-processing method to improve

Heart Rate Estimation

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TISSUE ANALYTICS

Outline

- Team 7
  - Project Overview
  - Current Approach
- Paper
  - Goal
  - Overview of Methods
  - Summary of Findings
  - Critique
  - Impact/Relevance
  - Questions/Comments

Team 7 - Project Overview

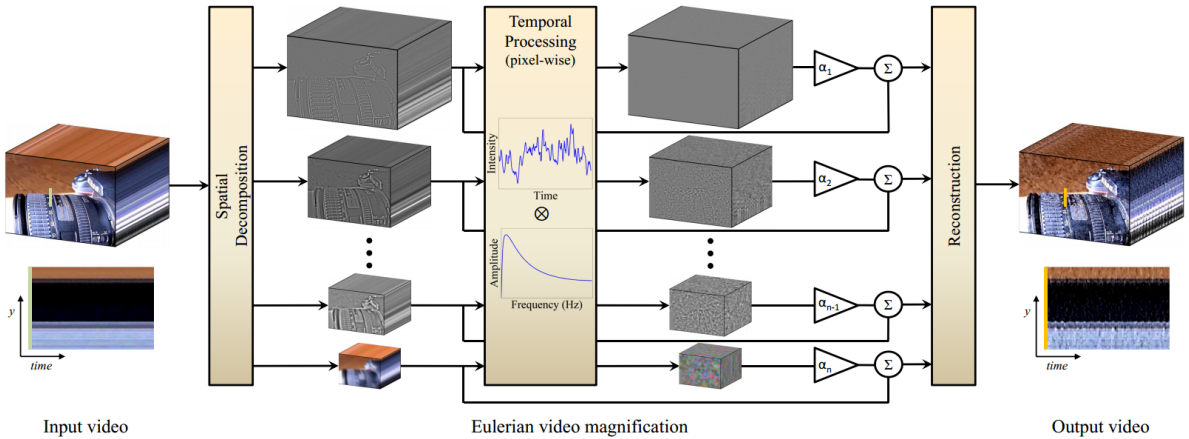
Mobile Perfusion Analysis - Generate an integrated software-and-hardware solution that allows a clinician to extract a usable metric assessing local blood flow using a images/video captured via mobile device.

***We want local perfusion assessment that is*:**

- Effective
- Cost Efficient
- Portable

Team 7 - Current Approach: EVM

- Method of magnifying color fluctuations and spatial distortions
- Spatio-temporal video processing
- Eulerian, as opposed to Lagrangian



Goal

- Evaluate efficacy of a particular algorithm utilizing spatiotemporal video processing as a non-contact method of estimating patient heart rate
- Compare FFT, zero crossing, and peak detection as heart rate extraction methods

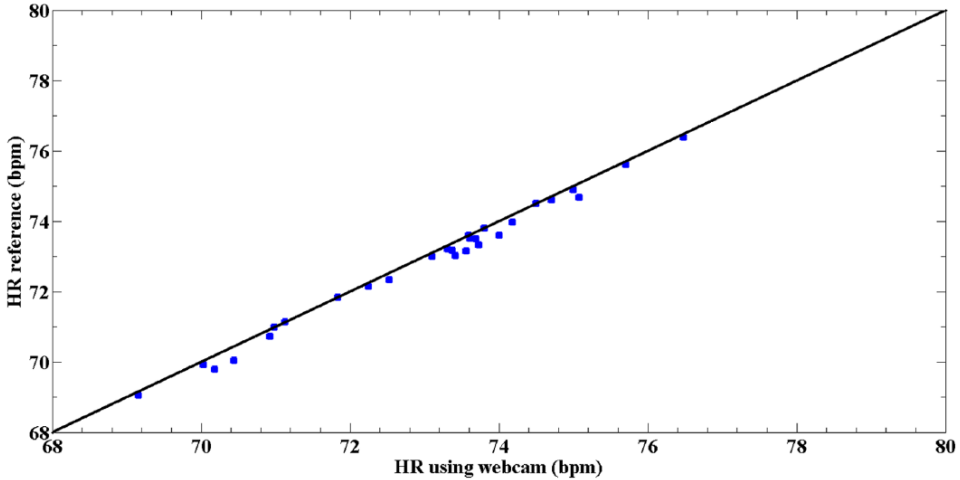
Overview of Methods - Experimental Setup

- 32 Participants (6 males and 26 females in age range of 10-75 years)
- Participants sitting still at table, illuminated by ambient sunlight
- Low resolution (640x480) webcams placed
  - 400 cm from face
  - 50 cm from left hand
- Video recorded for 15 minutes
- PPG signal recorded from third finger of left hand as ground truth
- Induced heart rate variability:
  - Baseline (“anything”)
  - Relaxing music
  - Fast music

Overview of Methods - Algorithm

- In each frame of video
  - Face detection (OpenCV) to create bounding box around face
  - Choose middle 60% of bounding box as region of interest (ROI) - this becomes basis of the input to the EVM algorithm
- Apply EVM to each 10 second sequence of frame ROIs
  - Spatial - Full Laplacian pyramid decomposition (increase SNR)
  - Temporal - Ideal bandpass filter, range 12 Hz
- Extract heart rate from signals
  - FFT/zero crossing/peak detection
- 90 data points per participant
  - Face EVM signal
  - Hand EVM signal
  - PPG signal

Discussion of Findings



- Optimally extracted heart rates were 92.15% accurate (CAND index) when compared with PPG readings
  - Mean bias of -0.04 bpm (Bland-Altman, bias being [extracted - PPG])
  - 95% limits of agreement at -3.22 bpm to +3.22 bpm
  - Correlation coefficient of 0.89

Discussion of Findings (cont'd)

- Optimal extraction method: **Peak detection** with **face** of participant

	FFT	**Zero Crossing**	**Peak Detection**
# Measurement Pairs	2880	2880	2880
CAND (Hand-PPG)	86.71%	87.73%	92.13
CAND (Face-PPG)	82.80%	82.89%	92.15
Mean bias (bpm)	0.09	0.095	-0.04
Mean absolute bias (bpm)	10.23	12.07	5.44
SD of Bias (bpm)	6.25	17.35	1.66
95% Limits (1.96 SD) (bpm)	-/+ 9.26	-/+ 12.78	-/+ 3.22
Correlation Coefficient	0.77	0.75	0.89

Critique

- Well thought out experimental protocol
- Detailed statistical analysis of results
- Lack of detail in processing algorithm
    - EVM Parameters

Impact/Relevance - General

- Validate offline heart rate extraction via spatiotemporal processing of segmented 10-second videos of face and hands
    - Used processing method of segmentation followed by EVM
- Identify peak detection-based heart rate computation as more closely correlated with PPG readings than zero-crossing- or FFT-based heart rate computation

Impact/Relevance - Team 7

- Validate EVM as means of extracting blood-flow related information (pulse) from video of face and hands
- Provide baseline accuracies to compare our algorithms against
- Suggest segmenting video frames prior to spatiotemporal processing
  - Possibly reduce computation
  - Possibly reduce motion
- Suggest peak-detection as method of heart rate computation
- Suggest natural lighting for testing
- Suggest means of varying heart rate without motion

Questions/Comments?