ビデオと音声の分析により睡眠時無呼吸症候群の検出

Apnea Detection via Depth Video & Audio Analysis

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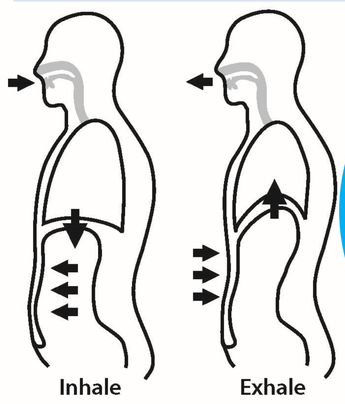
Non-intrusive respiratory and heart rates estimation using Microsoft Kinect™

Motivation: Non-intrusive bio-signal estimation via **RGB** cameras  is sensitive to ambient lighting conditions.

Solution: Estimating bio-signal using **DEPTH** sensing devices, e.g., MS Kinect™  , must overcome the low bit-depth and acquisition noise.

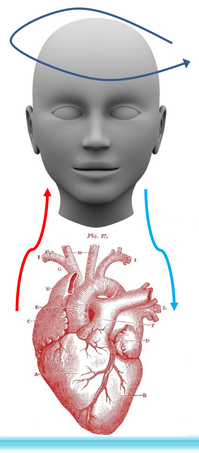
1. Respiratory rate estimation.



Noticeable respiratory-related **chest and abdominal** movement

video recording → graph-based video denoising → body part modeling → motion tracking → feature extraction and classification

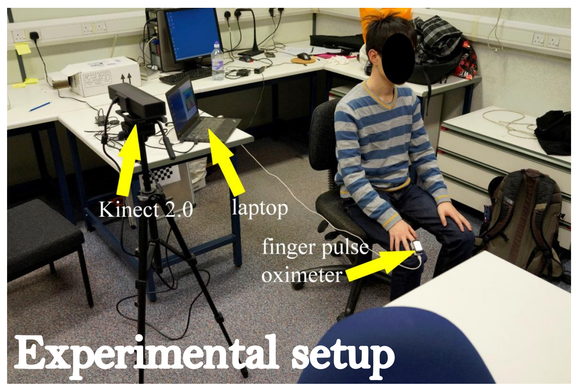
2. Heart rate estimation [1,2].



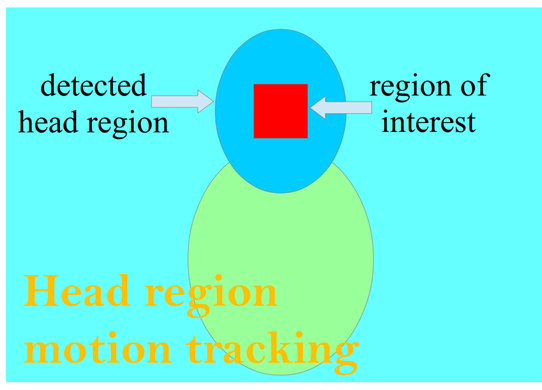
Subtle heart beat-related **head** movement

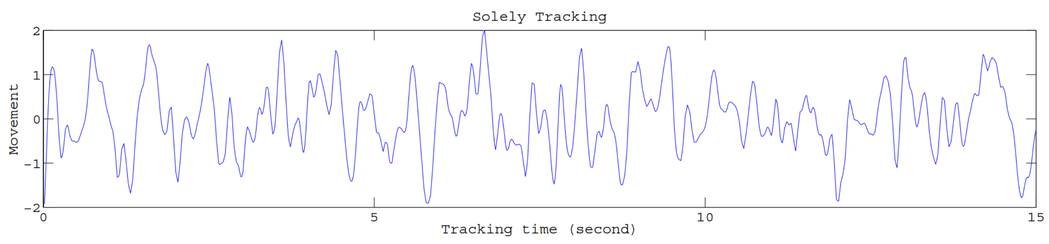
video recording and graph-based denoising → motion tracking → *frequency analysis*: estimate heart rate; *peak detection*: estimate heart beat **regularity**

Heart rate estimation with different views

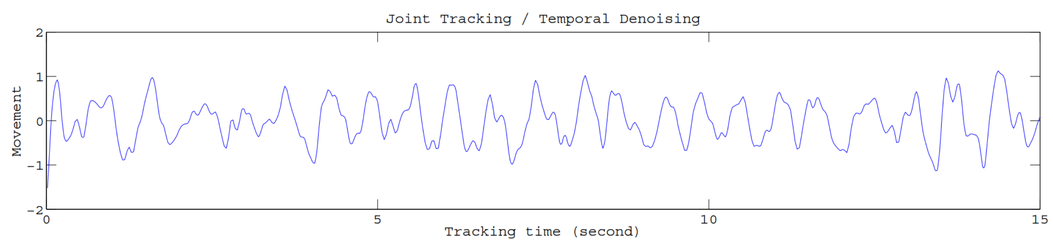


Experimental setup

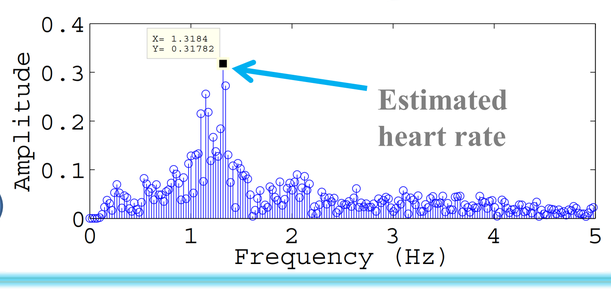




noisy temporal data



denoised temporal data

frequency analysis → 

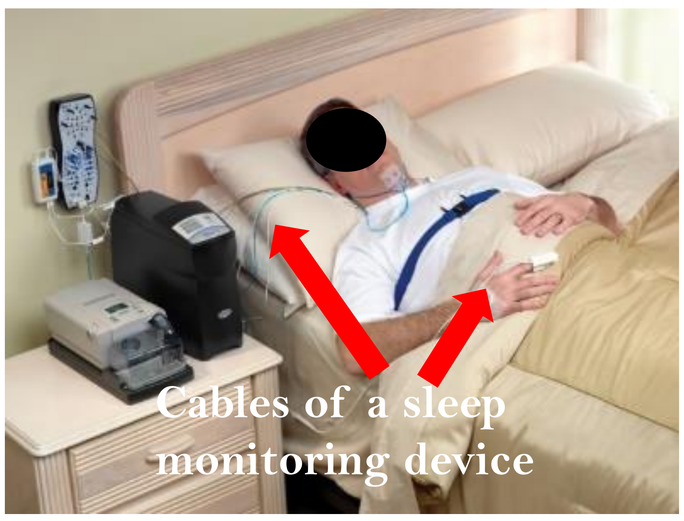
peak detection

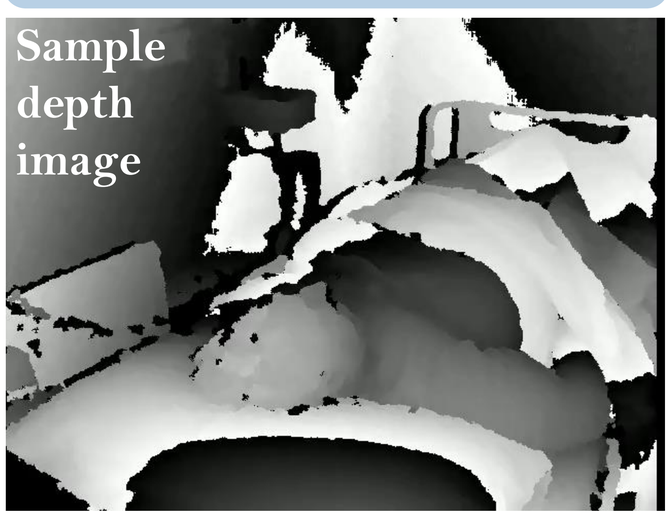
➢ **Estimating heart beat regularity: Compute the standard deviation of the distance between neighbouring detected peaks.**

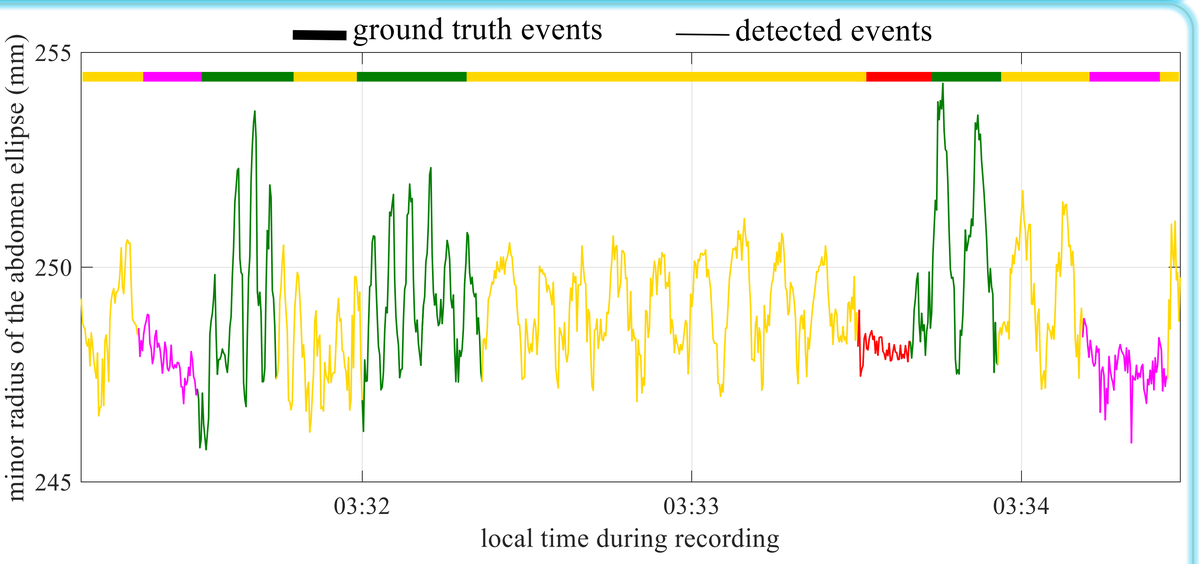
Example application of respiratory rate estimation: Sleep monitoring

Motivation: detect sleep apnea events (temporary respiratory cessation) non-intrusively and reliably.

Solution: Record depth video and audio, extract relevant features, train classifiers to detect obstructive / central apnea, hypopnea [3,4,5].





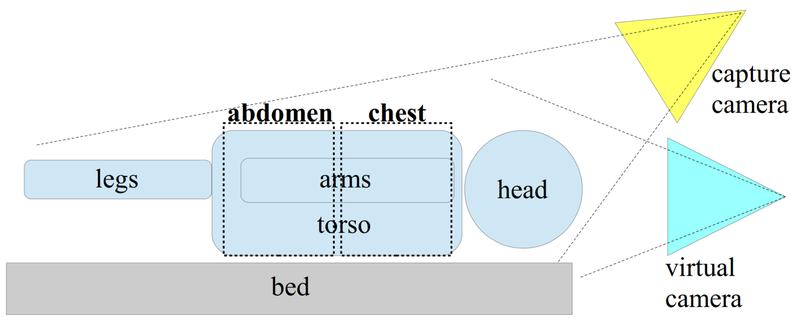


Changes of the fitted abdomen ellipse over time (3 minutes out of 8-hour sleeping data)

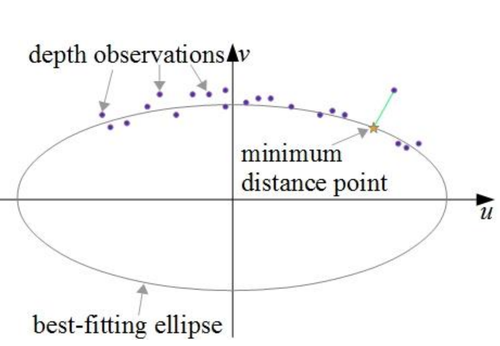
4-class classification: central apnea; obstructive/mixed apnea; hypopnea; normal breathing.

Sleep monitoring with Kinect™ **Audio**

- ❑ When the captured depth video is obstructed, one could still use the audio signal to detect sleep events.
- ❑ Audio features can be extracted using, e.g., non-negative matrix factorization.



Two cross-sections of the human torso: chest and abdomen



Fitted ellipse of each cross-section

References:

[1] C. Yang, G. Cheung, V. Stankovic, "Estimating heart rate via depth video motion tracking," in *IEEE International Conference on Multimedia & Expo*, Turin, Italy, June 2015.

[2] C. Yang, G. Cheung, V. Stankovic, "Estimating heart rate and rhythm via 3D motion tracking in depth video," submitted to *IEEE Transactions on Multimedia*, Apr. 2016.

[3] C. Yang, G. Cheung, K. Chan, and V. Stankovic, "Sleep monitoring via depth video recording & analysis," in *IEEE International Workshop on Hot Topics in 3D*, Chengdu, China, July 2014.

[4] C. Yang, Y. Mao, G. Cheung, V. Stankovic, and K. Chan, "Graph-based depth video denoising and event detection for sleep monitoring," in *IEEE International Workshop on Multimedia Signal Processing*, Jakarta, Indonesia, Sept. 2014.

[5] C. Yang, G. Cheung, V. Stankovic, K. Chan, and N. Ono, "Sleep apnea detection via depth video & audio feature learning," submitted to *IEEE Transactions on Multimedia: Special Issue on Multimedia-Based Healthcare*, Jan. 2016.

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