

Monitoring of heart and respiratory rates in newborn infants using video sequences

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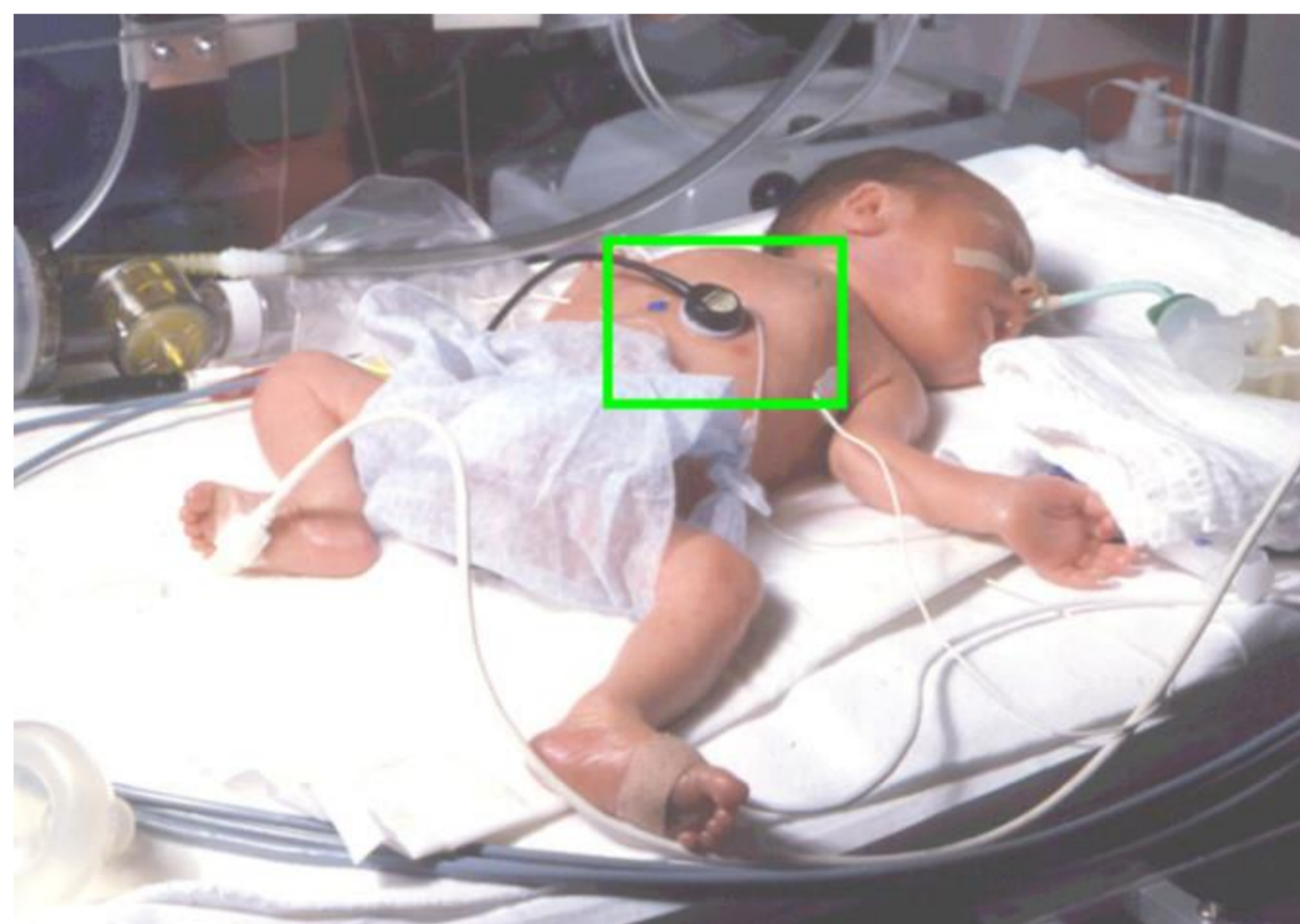
Motivations

In Switzerland, 9% of the infants are born prematurely and it is crucial to continuously monitor heart and respiratory rates. The current monitoring systems are facing some limitations:

- Prone to frequent body motion artifacts
- Very high rate of false alarms (87.5%) sent to the nurses, leading to stressed and desensitized caregivers and discomfort for the neonates
- Lack of accurate **contactless technology**



Region of Interest tracking and skin segmentation



ROI tracking



Skin segmentation



Proposed approach tracking by feature detection based on Struck (Hare et al., 2011):

- **Real-time** implementation possible
- **Robust** to drift over long periods of time
- **Multi-scale tracking** of several regions
- **Accuracy** can be improved by learning the most relevant features from a large set of videos.

Position changes in/of the tracked region contain information about the respiratory rate

Color changes over time in the skin pixels carry information about the heart rate



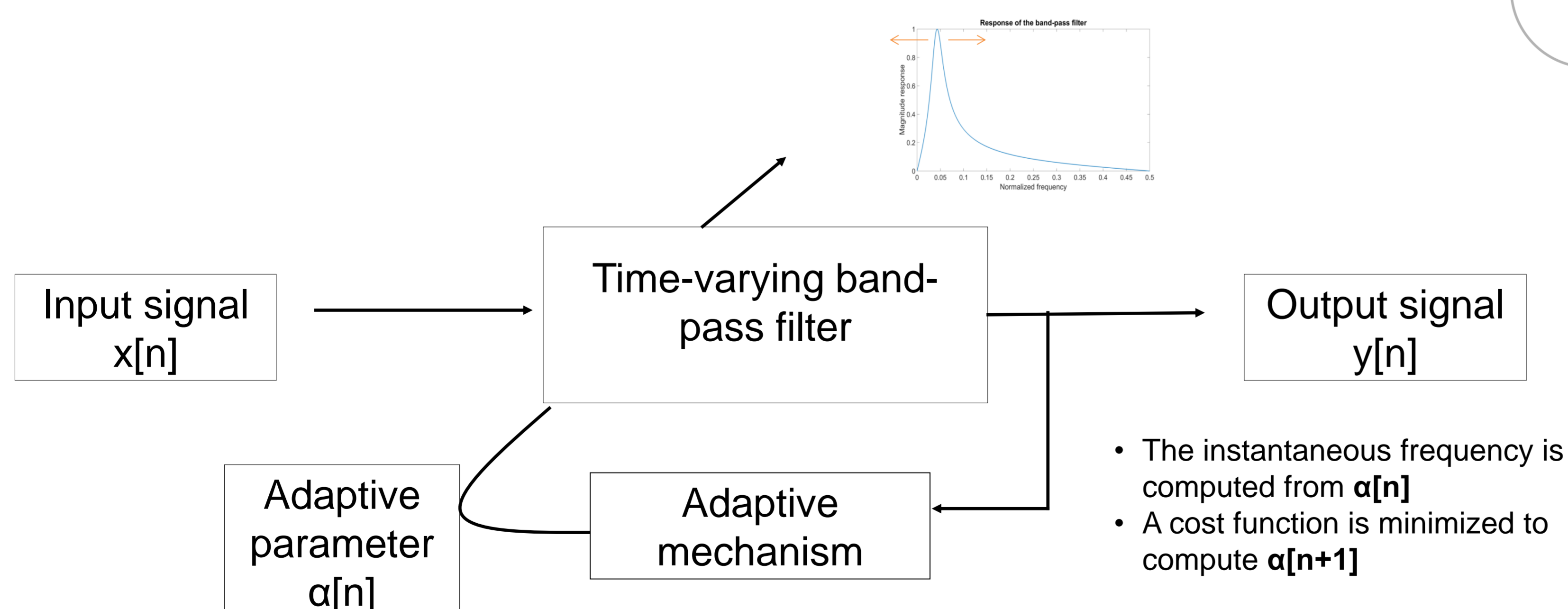
Heart and respiratory rate estimation



After skin segmentation:

- Separation of the 3 RGB channels
- Averaging of the pixels in the ROI for each frame and each color
- Processing of the time series for heart and respiratory rates extraction:

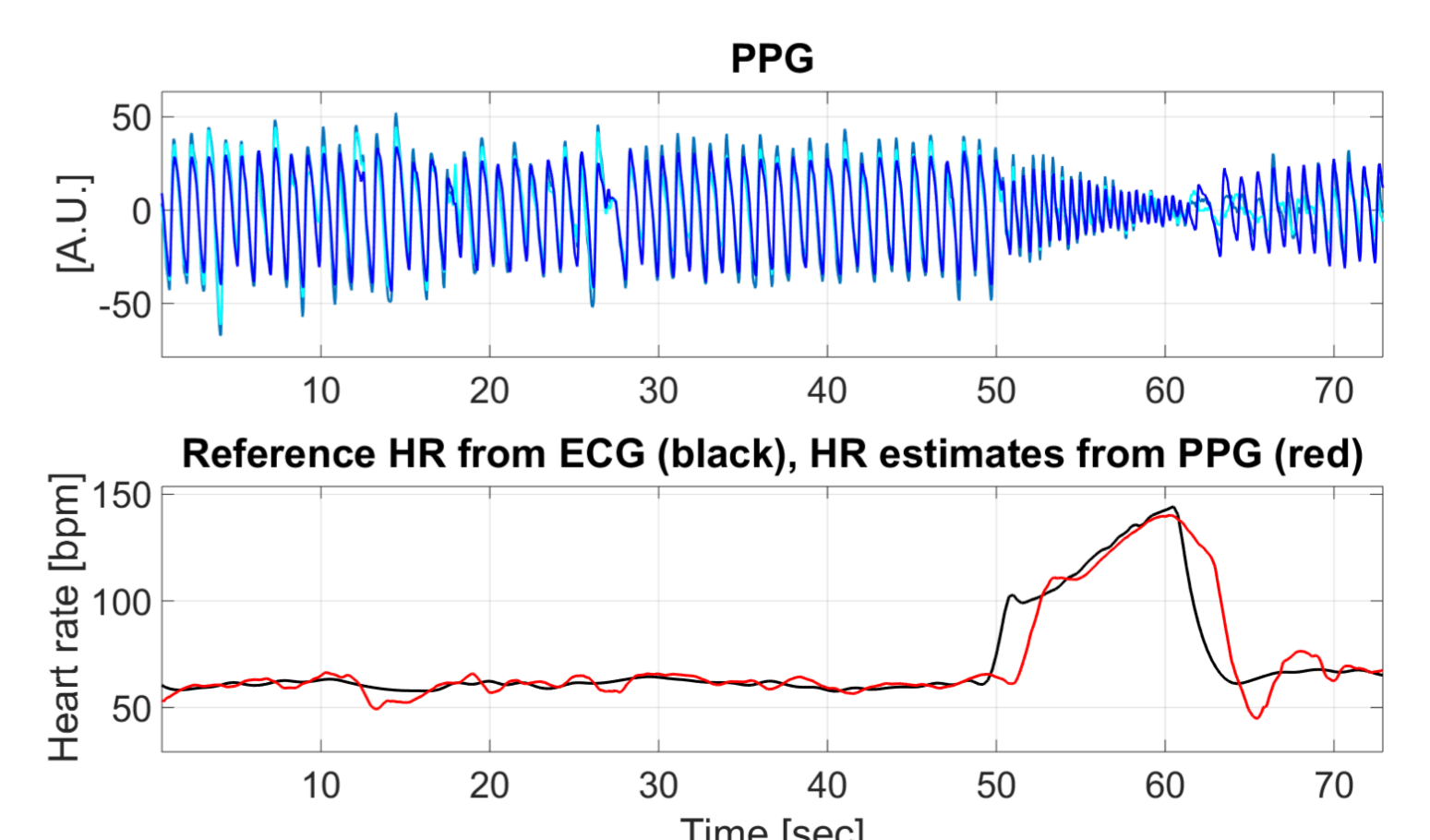
Principle of adaptive frequency tracking:



Existing methods:

- ICA + FFT (Poh et al., 2010)
- PCA + FFT (Lewandowska et al., 2011)
- Wavelet transform (Bousefsaf et al., 2013)
- AR modelling and pole cancellation (Tarassenko et al., 2014)

Proposed approach: **Adaptive frequency tracking**



Example of adaptive frequency tracking applied to multi-channel PPG waveforms for heart rate estimation during a sudden increase of heart rate

Advantages of adaptive frequency tracking:

- Can be implemented in **real-time**
- Accuracy can be improved when using **multivariate data**
- Can be used for **heart and respiratory rates** extraction
- The contribution of each input signal is weighted according to an SNR criteria