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NewbornCare RTD 2013

FNSNF

Newborn Monitoring based on Multiple Vison Sensors

csem

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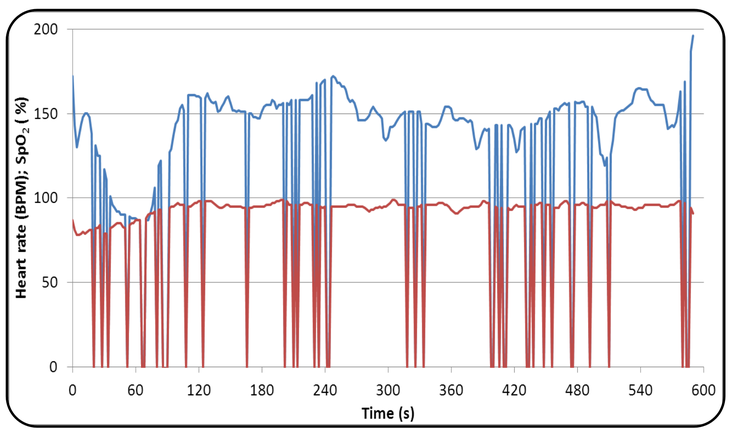
Motivations

In Switzerland, 9% of the infants are born prematurely and it is crucial to monitor continuously their vital parameters comprising mainly heart and respiratory rates and arterial oxygen saturation. 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**
- Brain is not yet monitored, despite it is the most sensitive organ



Examples of artifacts: heart rate and SpO2 signals

Heart Rate Monitoring

Innovative method: remote sensing of the reflectance photoplethysmogram (PPG) using a simple video camera, which is typically positioned one meter away from the patient's face.

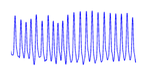
Implementation: Visible + NIR camera, embedded system (algorithms and communication).

Cardiac cycle induces periodic changes of blood volume

Amount of the reflected light is modulated

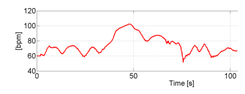
Computer vision algorithms to extract the oscillation of interest

Conversion into time series



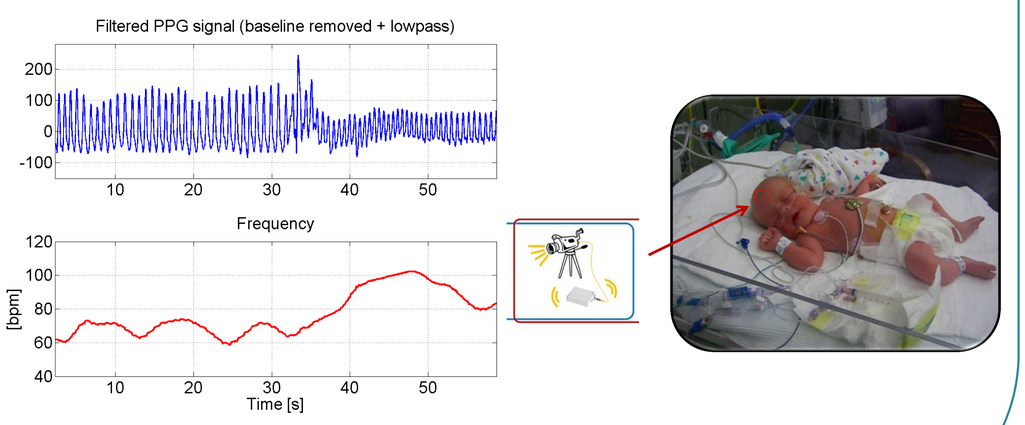
Adaptive frequency tracking algorithms

Continuous heart rate estimation



Detection of cardiac arrhythmia

Generation of alarms



Example of PPG signal and frequency tracking

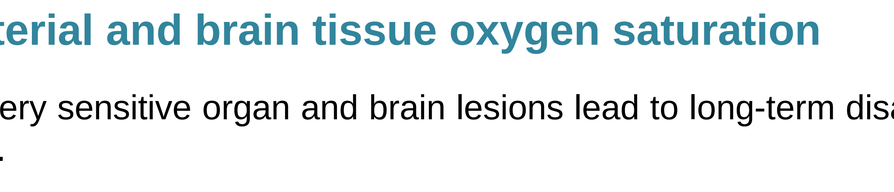
Arterial and brain tissue oxygen saturation

The brain is a very sensitive organ and brain lesions lead to long-term disabilities in ~25% infants.

Implementation:
Multi-optical sensor device integrated into a headband:
- Near-Infrared Spectroscopy (NIRS)
- SpO2 dedicated system

Measured parameters:
NIRS: changes in the concentration of cerebral oxygenated and deoxygenated haemoglobin.

SpO2: changes in the concentration of arterial oxygenated and deoxygenated haemoglobin.



Respiratory rate monitoring

The respiratory rate (normally is the range 30-60 bpm for the newborns) is an indicator of potential respiratory dysfunctions.

Implementation: Visible + NIR camera, embedded system (algorithms, communication)

Principle: Video-based tracking of thoracic motion

Respiration induces body surface movements in the thoracic region

Path length of the illumination light is modified

Reflected light carries oscillating changes proportional to the frequency of the respiratory events

Conversion into time series

Adaptive frequency tracking algorithms

Continuous estimation of respiratory rate

Generation of alarms

Dedicated Mobile Application

The aim is to obtain a continuous and remote monitoring of the babies. A system for the generation of alerts on the smartphone will be implemented in order to reduce the response time of the medical employees.

Modalities: Wireless communication (bluetooth 4.0, WiFi)

Implementation: User interface (physiological parameters, video streaming)