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Reduction of False Alarms in Neonatal Vital Sign Monitoring

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Movements of neonates compromise vital sign monitoring and create a high rate of false alarms.

We intend to eliminate the false alarms by combining data from multiple sensor technologies.

Two Technologies to Work Together (Fig. 1)

- Near-infrared spectroscopy (NIRS) measures brain oxygenation. **This poster focuses on NIRS**.
- Computer vision (CV) determines the heart- and respiratory rate.

→ The combination of two technologies makes alarm generation more robust.

Near-Infrared Spectroscopy (NIRS)

Near-infrared light easily passes through the brain of a newborn (Fig. 2). The received light carries the information on brain tissue oxygenation (StO_2).

Side note: Near-infrared is non-ionizing and safe.

Characteristics of our sensors:

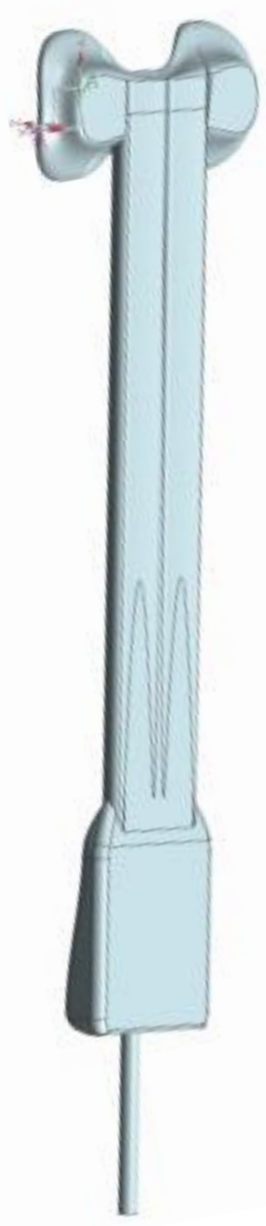
- Four different wavelengths
- Self-calibrating principle [1]
- Real-time processing and visualization
- Used in neonatal intensive care units (NICU)

Progress of work

- Novel sensor shape
  - Casing for new hardware
  - Symmetry for self-calibration reasons
- Proprietary headband
  - Holds sensor in place
  - Provides quiet background as field of view of CV
  - Fulfills requirements of medical staff

Conclusion

The NIRS instrument progresses as expected. The head band facilitates easy handling and the NIRS sensor will fit closely to the curvature of the head. The self-calibrating property leads to a higher precision of the measurements.



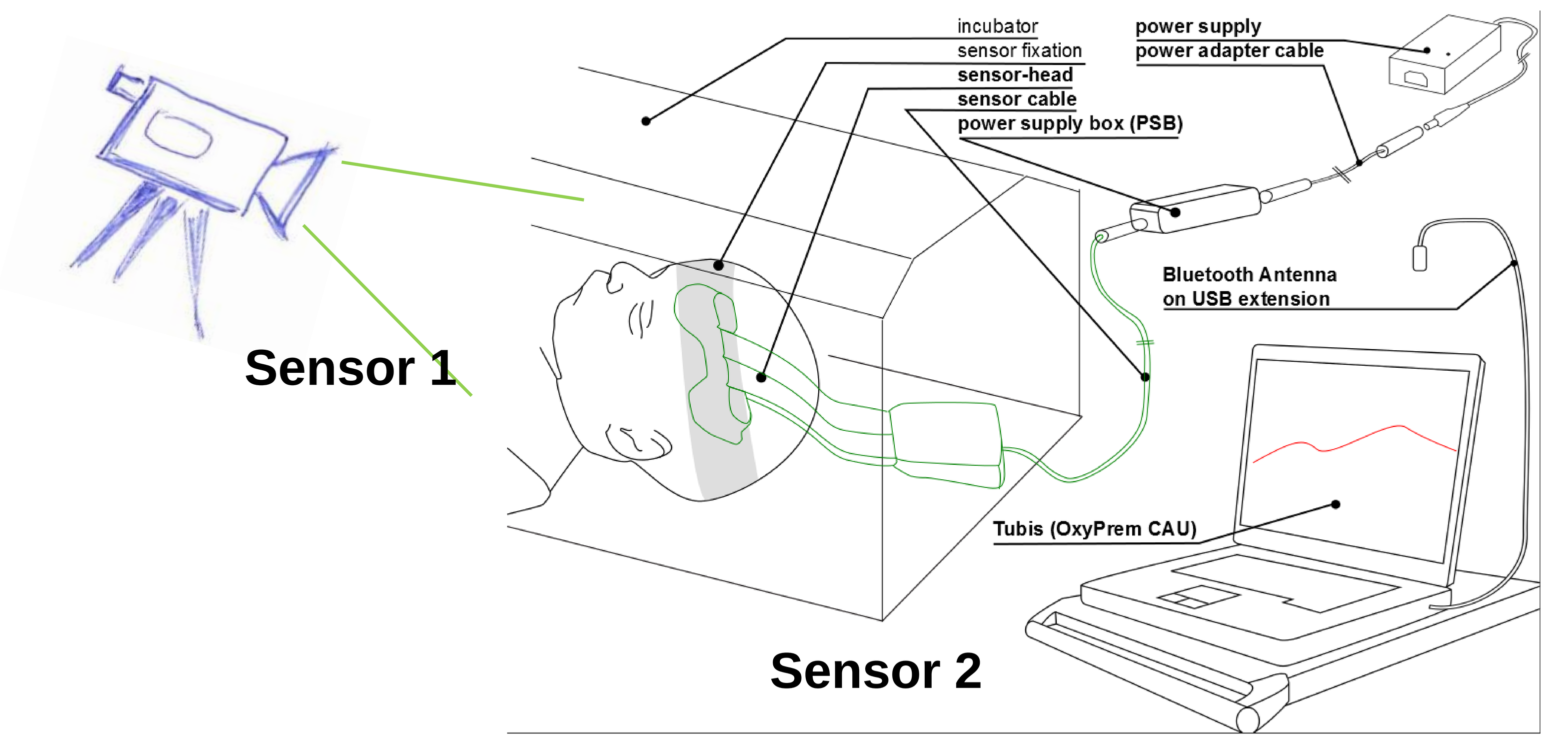
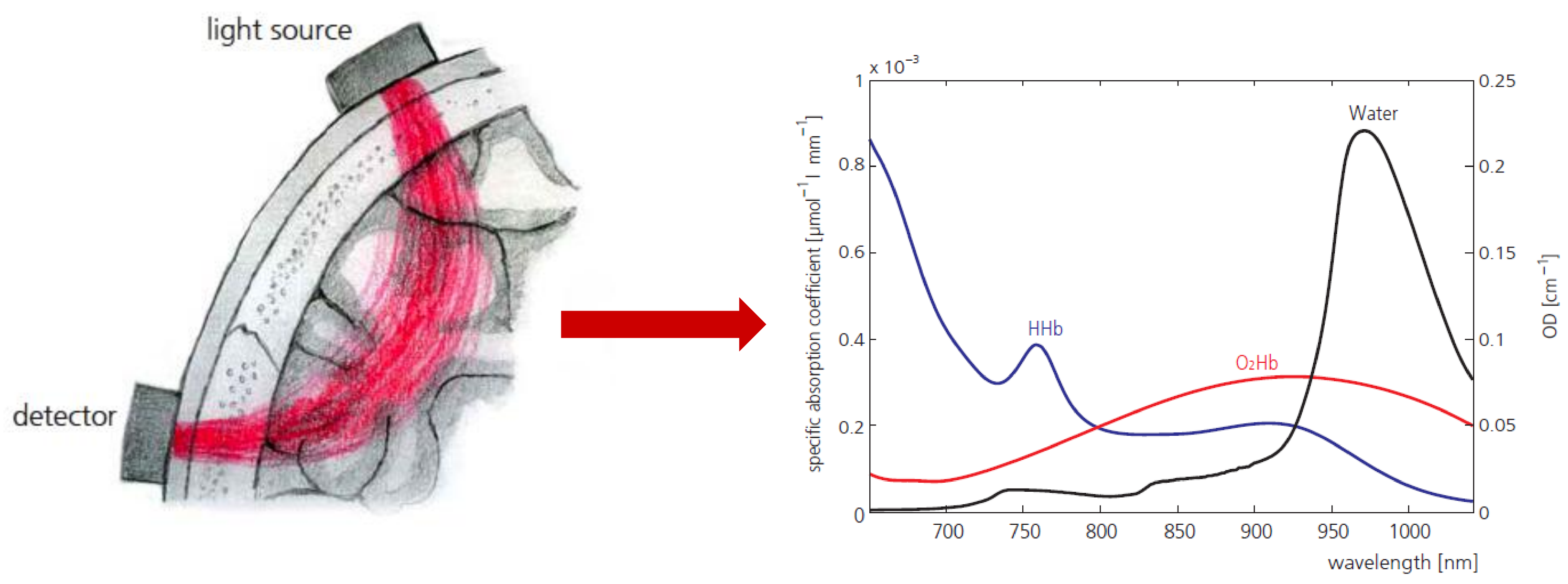


Fig. 1: Computer vision & NIRS combined enable more reliable vital sign monitoring and alarm generation



source: Dr. T. Mühlemann, Matcher et al., 1994

Fig. 2: When near-infrared light passes through the brain, its intensity (I) is mainly attenuated by oxy- (O_2Hb) and deoxyhemoglobin (HHb).

$$\begin{bmatrix} \log(I_{\lambda 1}(t_1)) - \log(I_{\lambda 1}(t_2)) \\ \log(I_{\lambda 2}(t_1)) - \log(I_{\lambda 2}(t_2)) \end{bmatrix} = \begin{bmatrix} \varepsilon_{HHb,\lambda 1} & \varepsilon_{O_2Hb,\lambda 1} \\ \varepsilon_{HHb,\lambda 2} & \varepsilon_{O_2Hb,\lambda 2} \end{bmatrix} \cdot \begin{bmatrix} \Delta c_{HHb} \cdot DPF \cdot d \\ \Delta c_{O_2Hb} \cdot DPF \cdot d \end{bmatrix}$$

$$StO_2 = \frac{c_{O_2Hb}}{c_{O_2Hb} - c_{HHb}}$$

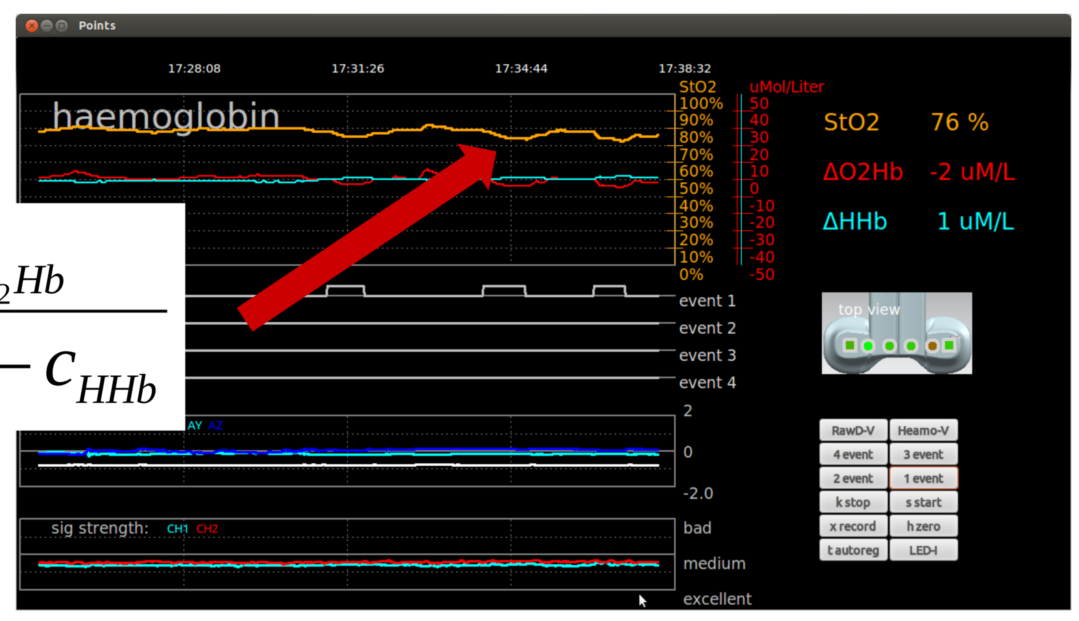


Fig. 3: Real-time visualization of StO_2 at the bedside.

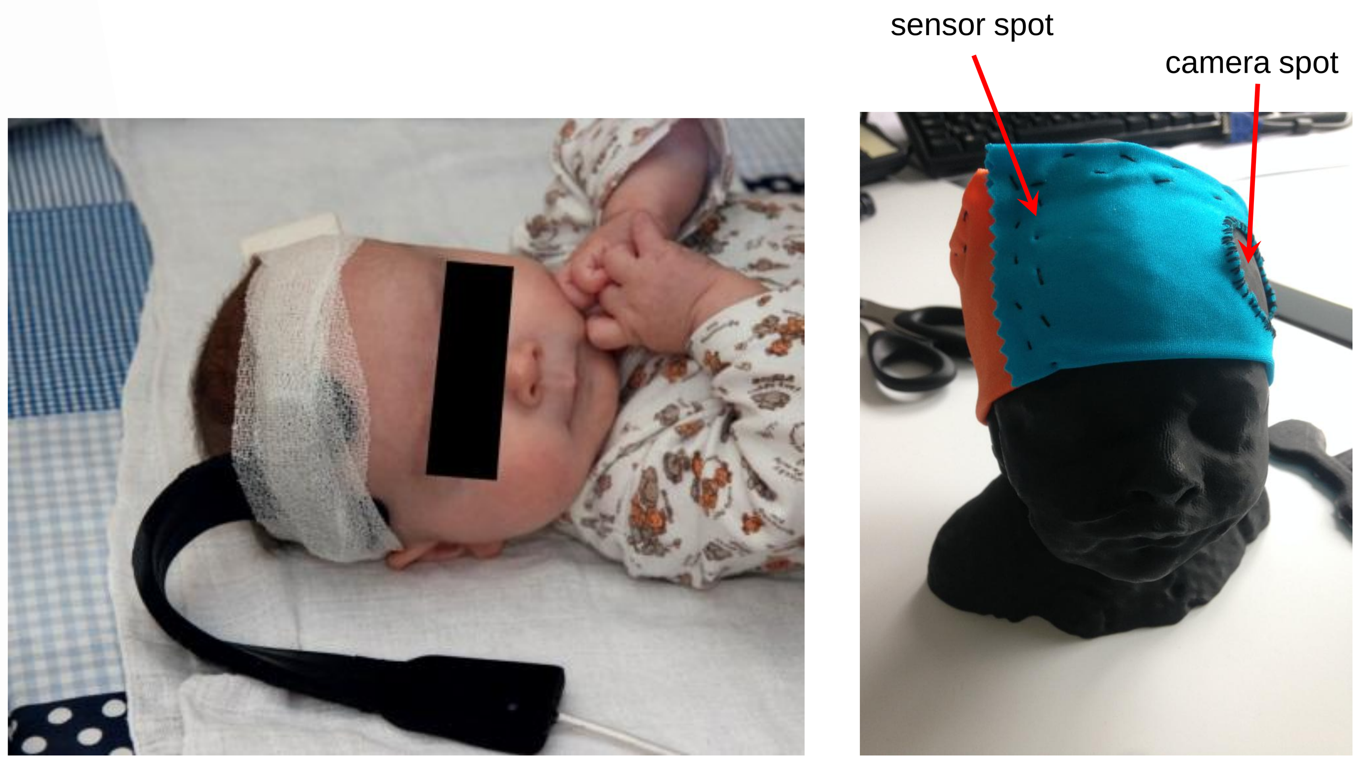


Fig. 4: Novel sensor shape, prototype in action, LoFi Headband

[1] Hueber, D., et al. (1999). "New Optical Probe Designs for Absolute (Self-calibrating) NIR Tissue Hemoglobin Measurements" SPIE Vol. 3597.