Direct spectral modulation of pulse oxymeter light signals with a micromirror array

B. Weber[1, 2], B. Nestler[1, 2], H. Gehring[2, 3]

[1]Medical Sensors and Devices Laboratory, Luebeck University of Applied Sciences, Luebeck, Germany
[2]Centre of Excellence for Technology and Engineering in Medicine (TANDEM), Luebeck, Germany
[3]Department of Anesthesiology, University Medical Center of Schleswig-Holstein, Luebeck

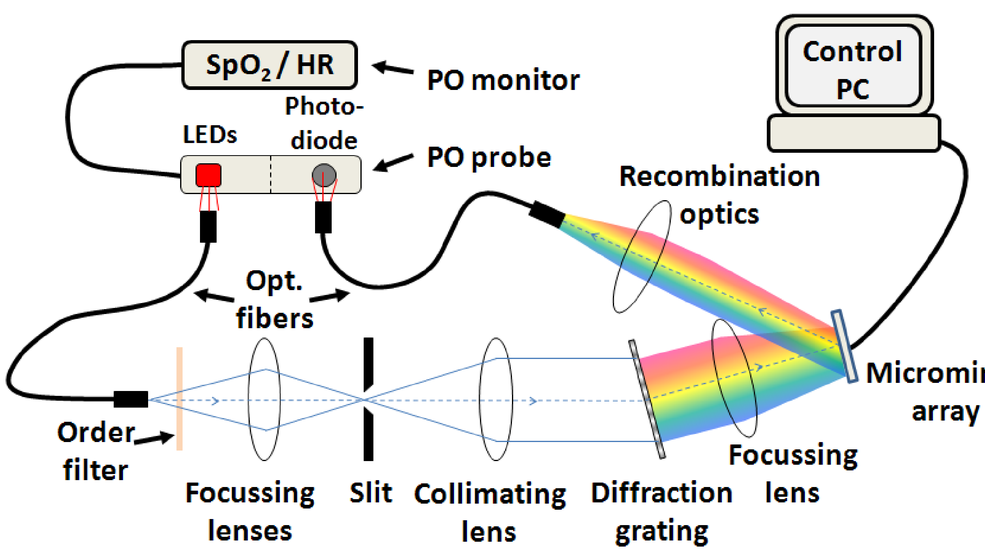
Introduction

- Pulse oxymetry (PO) determines functional arterial oxygen saturation (S_pO_2) in blood by means of light extinction at different optical wave-lengths [1].
- The method works non-invasively and continuously.
- It is part of the standard monitoring in emergency and intensive care, as well as during surgical procedures.

Problem

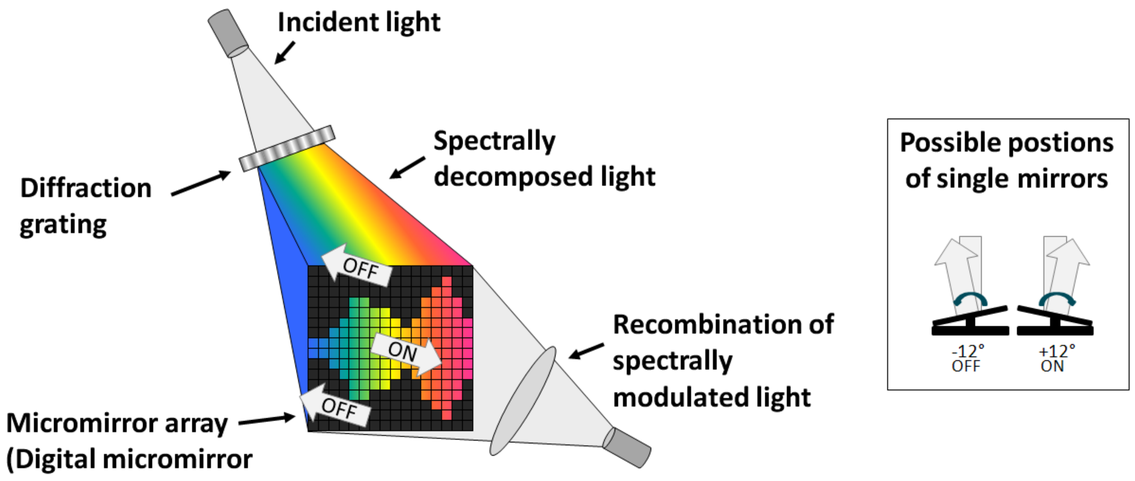
- Pulse oxymeters can only be calibrated by complex controlled desaturation/hypoxemia studies [2].
- This is not an ethically justifiable calibration method for multiparameter systems (S_pO_2, COHb, MetHb, …).
- Legal metrological controls are currently not possible in clinical routine.

Optical setup for spectral modulation with a micromirror array (MMA)

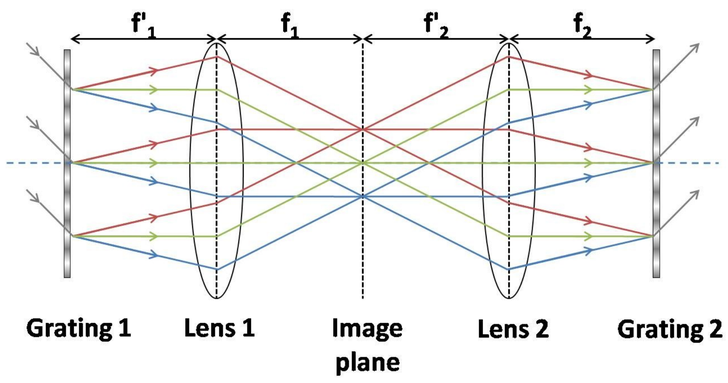


Top — PO light signals are spectrally decomposed by a grating. The spectrum is imaged to the surface of the MMA and modulated. The reflected light is guided back to the PO probe.

Bottom — The incident optical wavelengths are distributed along the MMA columns. Only light reflected by ON state mirrors is recollected. The ratio of ON to OFF state mirrors controls the amount of reflection for the different wavelengths.

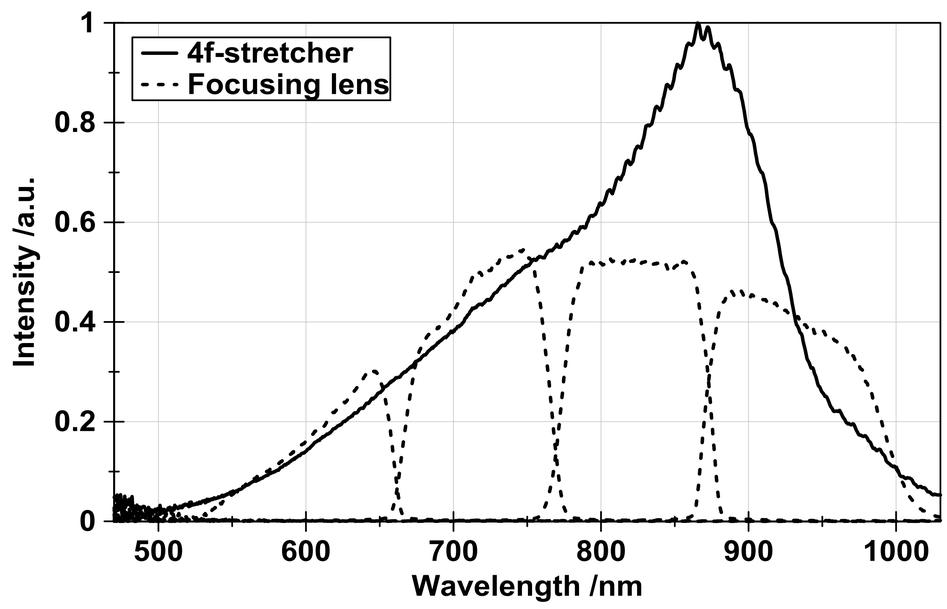


Spectral recombination



Left — Scheme of a 4f-setup with two gratings for improved spectral recombination.

Right — Spectral range of recombined light is improved with the 4f-setup, compared to a focussing only setup.



Results and outlook

- PO light can be spectrally modulated by the described experimental setup and is accepted by the PO monitor as a physiological signal.
- The optical throughput can be improved by a diffractive recombination of the previously decomposed light.
- Detailed characterization regarding spectral and intensity transfer function still to be performed.

References

[1] T. Aoyagi, *„Pulse oximetry: ist invention, theory, and future“,* Journal of Anesthesia, No. 17, pages 259-266, 2003

[2] *„ISO 80601-2-61:2011 Medical electrical equipment—Particular requirements for basic safety and essential performance of pulse oximeter equipment,”*, International Organization for Standardization, 2011

Luebeck University of Applied Sciences
Medical Sensors and Devices Laboratory
Benjamin Weber, M.Sc.
Tel.: +49 (0)451 300-5520
Email: benjamin.weber@fh-luebeck.de
http://www.msgt.fh-luebeck.de

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