

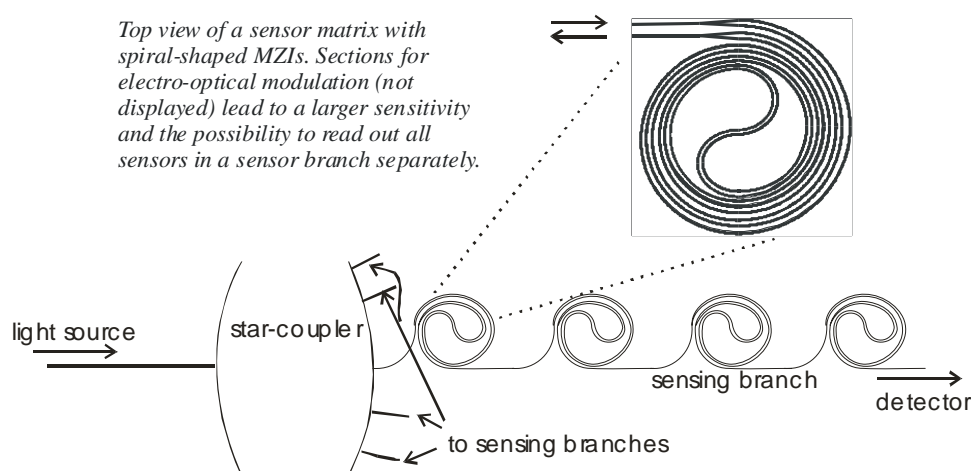
Modeling and Design of a Spiral-Shaped Mach-Zehnder Interferometric Sensor for Refractive Index Sensing of Watery Solutions

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Abstract

The modeling and design of a spiral-shaped Mach-Zehnder Interferometric sensor (sMZI sensor) for refractive index sensing of watery solutions is presented. The goal of the running project¹ is to realise a multi-sensing array by placing multiple sMZIs in series to form a sensing branch, and to place several sensing branches in parallel, as is illustrated in the figure below. In such an arrangement it is possible to use a single light source for several sensors. Each sensor will contain an electro-optical modulator, which makes it possible to separately interrogate and accurately read-out each sensor in the same sensing branch.



One of the novelties in this project is the spiral-shaped layout of the MZI, which has several advantages: a long sensor window length can be placed in a compact sensor chip: within an area of $1 \times 1 \text{ cm}^2$ lengths of several tens of cm are feasible. Another advantage of the spiral shape is that if both MZI branches are identical (except for the sensor layer) the sensor should be very insensitive to fluctuations in temperature and even to temperature gradients across the chip. Beside robustness, the spiral shape also allows cascading of several sensors. A parametrised sMZI has been designed such that the position, slope, and curvature are continuous.

The sensors can each be coated with *e.g.* a specific immunolayer to be able to detect changes in concentration of viri, bacteria or enzymes. In this project, technology is being developed for the immobilisation and photolithographical patterning of such immunolayers, which should result in a demonstrator to monitor the ripening process of cheese by measuring changes in the concentration of several different enzymes involved in this process.

Keywords: Mach-Zehnder interferometric sensor, spiral-shaped, refractive index sensing, immunolayer, multi-sensing array

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