Plastic Fiber as potential Bending Sensor

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Endoscopes are used for the investigation of not attainable cavities. The difficulty of flexible endoscopes is, that the deflection of the distal end (tip of the endoscope) is not exactly known. Therefore the actual angulation, which results by activating the steering wires, is difficult to forecast.
The goal is thus to develop a sensor, which can give designation of the deflection of the distal end. This simplifies orientation and handling for the user. As the sensor has to fit in the close space conditions of an endoscope, it must be manufactured as thin as possible. For this reason the suitability of plastic fibers as bending sensor is examined.

The bend of polymer optical fibers (POF) is detected by the analysis of transmitted light. The angular intensity distribution of the light and hence the shift of the light cone are measured. Thereby, the absolute intensity has no influence. Thus the measured results are independent of the variation of light intensity. The used POF has a diameter of 1 mm. For further development the fiber can be selected thinner, i.e. 0.75 mm or even smaller, so that the finished sensor can fit optimally into endoscopes.

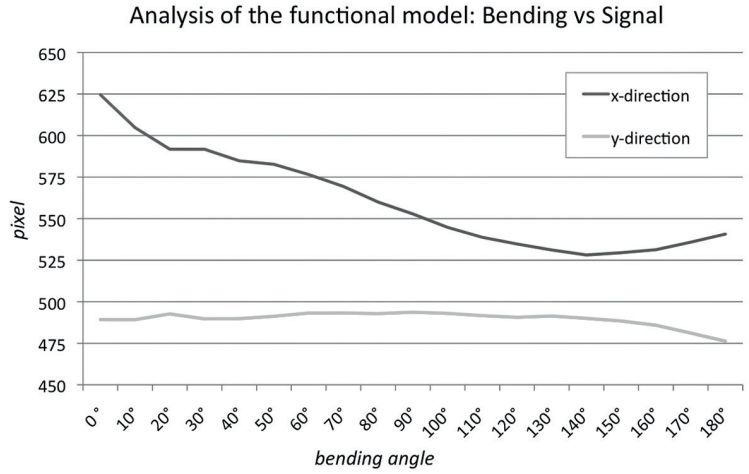
Experimental setup

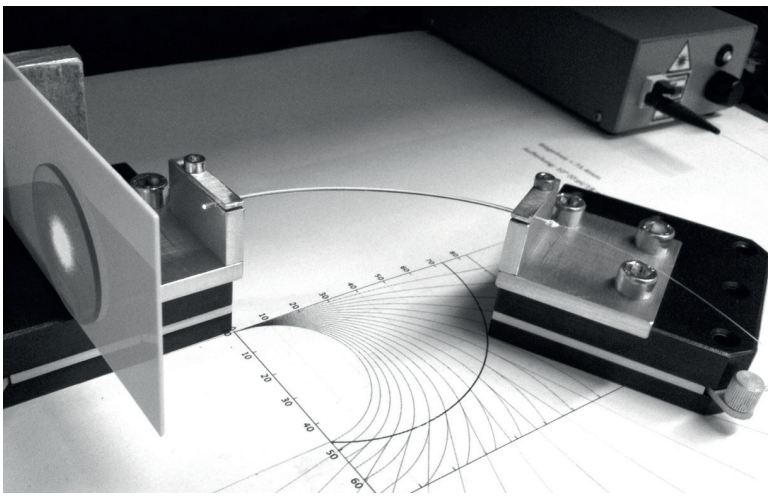
A first goal is to bend a fiber in a defined radius to accomplish reproducible measurements. It is important that the length of the fiber remains constant and that the radius stays equal over the whole fiber. By changing the radius, different curvatures evolve, which can be expressed in a bending angle.
This behavior is described and calculated with the mathematical software program «Octave».
Onto the plastic fiber a laser source is further linked with a single mode fiber. The POF is fixed on both sides on magnetic feet. The transmitted light at the end of the fiber is displayed and photographed on a diffusing screen.
Last an upgraded functional model is built by bonding a small (3.8mm(o.d.)x15mm) camera to the end of the fiber to assume imaging.

Measurement and results

The resulting measurements reveal that intensity distribution correlates with bending. Thus polymer optical fibers can be used as bending sensors. The bend is consistent but only over a certain range. This range can be still optimized by further development.
No technical details are publicly accessible because of a forthcoming patenting.

Linda Welter





Setup for bending experiments