TurbFish: An Open Source Smart Sensor for Water Quality Monitoring

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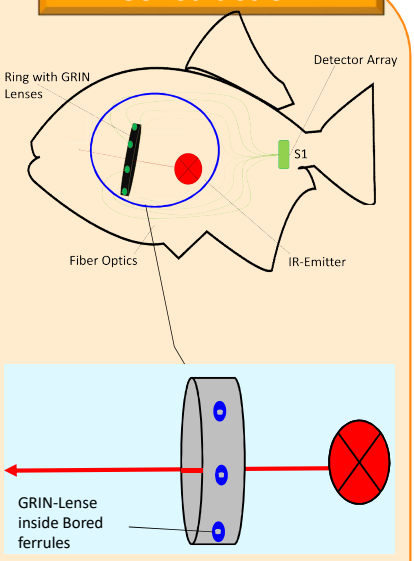
Abstract

In spring 2016, a massive fish death occurred in the German stream Brigach. With classical analytics, no poison could be identified yet. One possibility to monitor changing water quality is to measure turbidity continuously. In this paper we describe an open source project, which focusses on the construction of a turbidity measuring sensor. Embedded in a casing shaped like a fish, the sensor will continuously monitor the water quality of rivers without influencing the wildlife. An autonomous inline (Web 4.0) water quality sensor can be achieved by combining optical components with a microprocessor.

Construction

Higher reliability → Increasing the number of detectors from one to seven, which are arranged on a ring around the scattering volume; further noise reduction is achieved by lock-in detection.
Reduction of sensor size → GRIN (GRadient INdex) lenses and optical fibers are used.

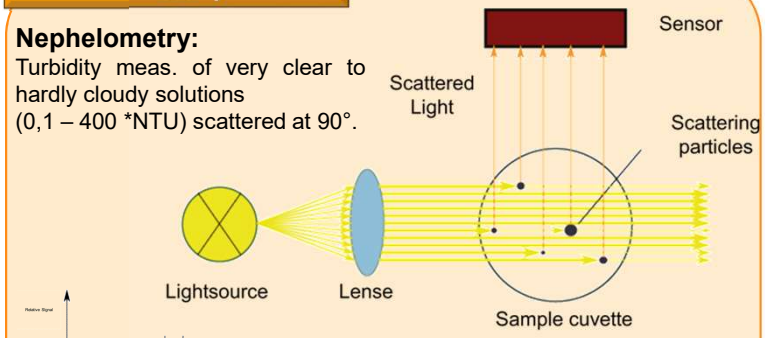
Ring: Bored ferrules (2.50 mm² x 8 mm) were fixed to holes by inserting GRIN lenses on the inside and attaching fiber optic cables to the outer side. The use of wire end ferrules simplifies the contact between GRIN lens and optical fiber without the need to stick them together.

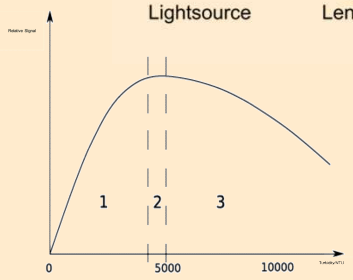


Reasons for the fish:
- Adapts to the environment
- Passers will not be noticed
- Animals are not disturbed

Theory

Nephelometry:
Turbidity meas. of very clear to hardly cloudy solutions (0,1 – 400 *NTU) scattered at 90°.





Region 1: Few particles

Region 2: Signal remains constant.

Region 3: Very cloudy liquids.

*NTU: Nephelometric Turbidity Unit

Scientific & Technological Goal

- A cheap, smart sensor; low maintenance.
- Low energy consuming, power harvesting setup.
- Waterproof case according to the IEC standard 60529 definition IPX8.
- Measuring range: 0.1 and 800 NTU.
- Two parts of set-up: TurbFish and buoy.

→TurbFish: the detection and the amplification of the signal is done inside.

→Buoy: has the task of pre-processing the data in combination with wireless connection to a network. With this feature, the turbidity signal will be directly sent to a server, where it can be obtained on the homepage of the fishermen.

Conclusion & Outlook

Turbidimetry (Nephelometry) is a valuable and fast technique to detect the amount of solid particles in watercourses, or to verify the correct function of filter systems, waste water treatment and other process relevant activities. The arrangement of two separate segments, the TurbFish and the buoy, enables us to realize a turbimeter for inline detection in rivers for under 200 €. The possibility of pre-processing and the connection to the internet for exchanging information enhances the system towards a smart sensor. This is provided by adding a microcontroller with a wireless shield. Efforts like this will be necessary in the future: not only controlling fluctuating systems in process plants, discrete factories and the environment, but also predicting trends will be a challenging task within the next decades.