Transport of highly sensitive strain based fiber optic transducers

1. Company information

Somni Corporation B.V. is a Dutch company which develops, manufactures and sells sensors based on fiber optics. Founded late 2017 Somni is marked a start-up.
The majority of last year's turn-over sprung from R&D activities. The Somni development team has worked (and currently is working on) topics such as miniature pressure sensors for in-vivo cardiovascular applications and hydrophone developments to detect under water vehicles among other topics. Next to these contract developments Somni focuses on their in-house sensor portfolio. Main focus for 2019 is on accelerometers. 2 accelerometer types have been released and brought to the market by the end of 2018. Sensor sales is both on-line and through a distributor network.

2. Problem

- background and urgency of the problem

Somni has developed an fiber optic accelerometer to detect of ultra-low-level, low-frequency vibrations. The application field is specifically for structural health monitoring of large structures such as bridges, archways, overpasses and foundations. There is an urgent need for these type of sensor as given the current state of the aging bridges in Europe. The recent collapse of the Genua bridge in which 43 people lost their life is a catastrophic example in which monitoring could have prevented a disaster. Closer to home we had an incident with the Merwedebrug (A27). Inspection in October 2016 revealed small cracks which gave immediate safety concerns and heavy traffic was banned from crossing the bridge. Later investigations stated that without these precautions the bridge would have certainly collapsed within days.

- why we need help from the physics community

Somni has developed a very sensitive strain based accelerometer able to detect ultra-low-level, low-frequency vibrations based on fiber optics (fiber Bragg gratings). The major drawback of the sensor is however in the ability to transport and install the sensor without breaking the sensor. A simple mechanical locking mechanisms in which the moving mass is fixed is not feasible due to the micrometer movements of the mass. In addition, the role of temperature effects during transportation (-40°C to 70°C) are in the same order of magnitude due to the coefficient of thermal expansion. Clearly a mechanical solution does not suffice, therefore Somni is turning to the physics community to either provide a solution to the transportation issue or come up with a whole new sensor concept with similar performance but without the fragility issues.

- which physics disciplines we expect to be relevant to solve this problem

Somni uses fiber optics, more specifically Fiber Bragg Gratings as the sensing element. Therefore, some relevant (fiber-)optic experience is required. Next a profound knowledge of materials and transducer mechanisms is helpful and in addition, the fiber optic sensors need to be interrogated using either sweeping lasers or spectrometer based interrogators. Knowledge of such systems is required to be able to asses sensor system performance, i.e. interrogator and sensor combination.

Figure 1: picture of Somni fiber optic accelerometers

- possible solutions or directions toward solutions to the problem

The sensor needs to be shielded from high impact shocks (e.g. above 4g). These shock are often associated with high frequencies (e.g. something hitting or bumping into the sensor). Perhaps a solution might be to submerge the transducer in a fluid which acts as a solid at high frequencies (>100 Hz) and works as a fluid at low frequencies (<100 Hz).

- boundary conditions (e.g. technical, organisational, or budgetary requirements)

One of the boundary conditions is to use fiber optics, specifically fiber Bragg gratings as the transducing element. The transducer mechanism needs to be such that the physical parameter of interest, in this case acceleration, is measured by converting acceleration in to strain onto the optical fiber at the position of the fiber Bragg grating. Sensor read-out needs to comply to an off-the-shelf interrogator system.