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MMI sensor for diameter measurement

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Introduction

Radial growth control:

- Oil or gas transportation infrastructure the pressure in the pipeline is high, causing deformation and/or fatigue and consequently a disruption;

- The monitoring of the tree diameter change is directly related to irrigation, since it depends on the soil water deficit and trees are important in the global circulation of heat and water, in addition, tree growth is affected by the CO_2 rate and air pollutant.

Introduction

Multimodal Interference (MMI)

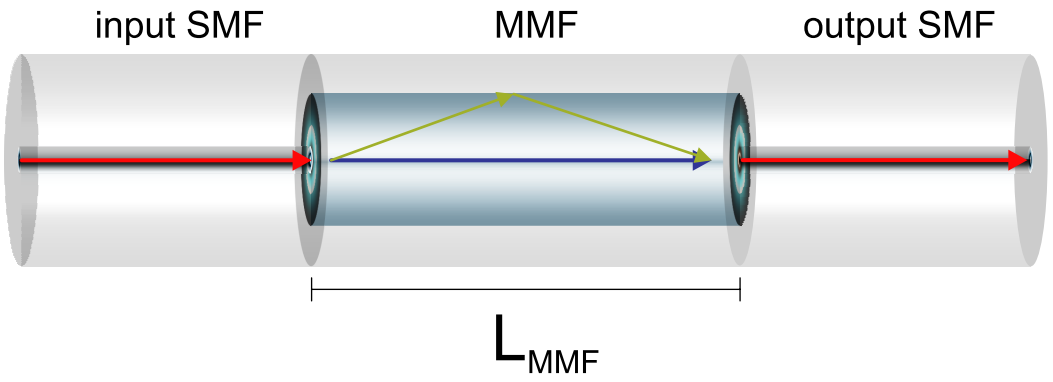
- Devices based on fiber optics have been extensively investigated in recent years for different applications as sensors to detect physical parameters such as:

1. Temperature;
2. Strain;
3. Vibration;
4. Flow rate.

Introduction

Multimodal Interference (MMI) – SMS structure

- A traditional SMS structure, consists of a short MMF section spliced between two SMFs;
- The MMF couples part of the light that travels along the core of the input SMF to the cladding of the output SMF, and this coupling induces a loss of power in the transmitted signal that travels along the core.

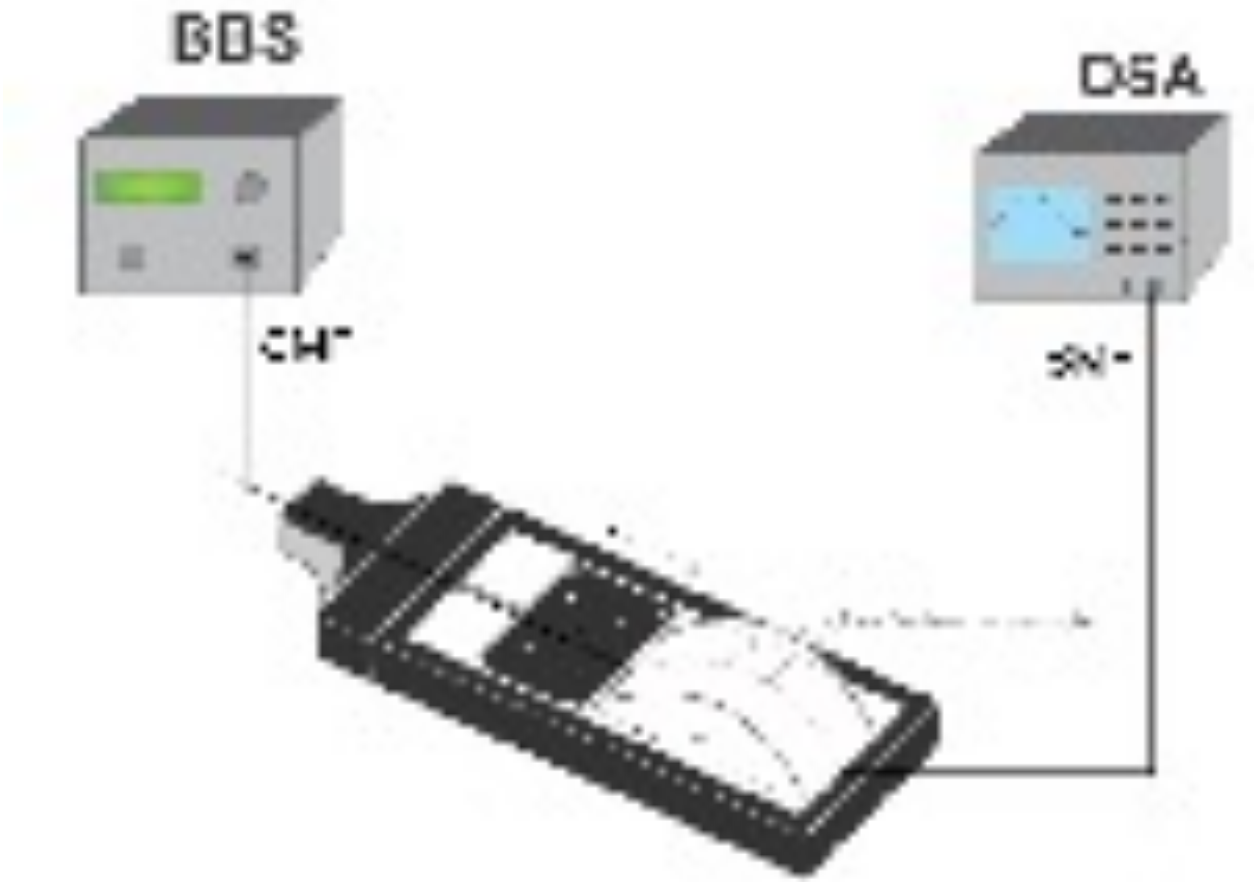


Experimental Setup

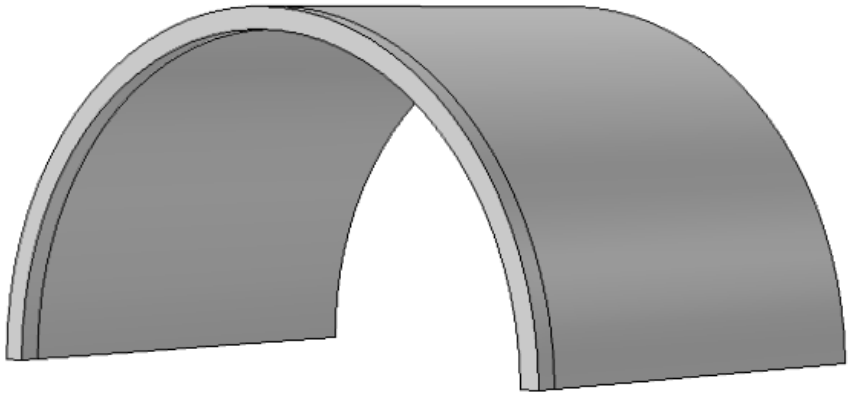
- It was used a linear translation stage, to apply tension by moving the linear stage away from the fixed support. Thus, it is possible to introduce a strain force in the sensor

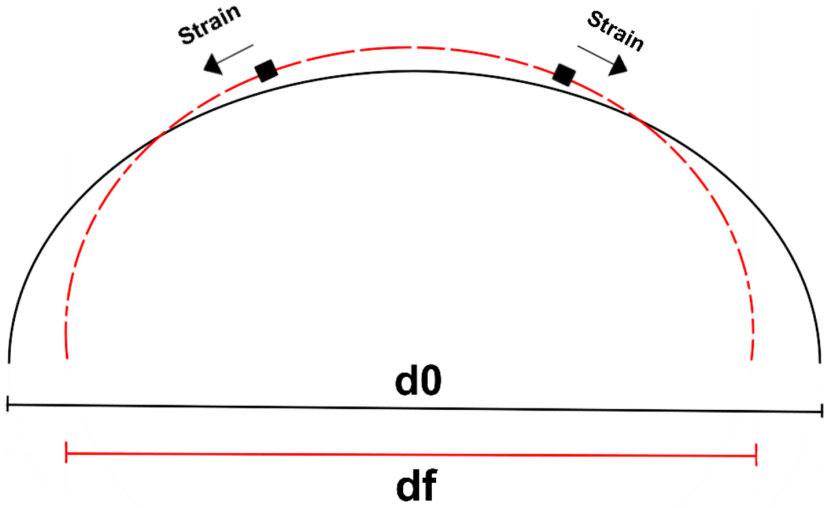
- Two cylindrical structures were developed on a 3D printer, with different diameter sizes (d_0), 80 mm and 110 mm, to assist in monitoring the diameter changes (Δd);

- Fixed points: 5, 10 and 15 mm.



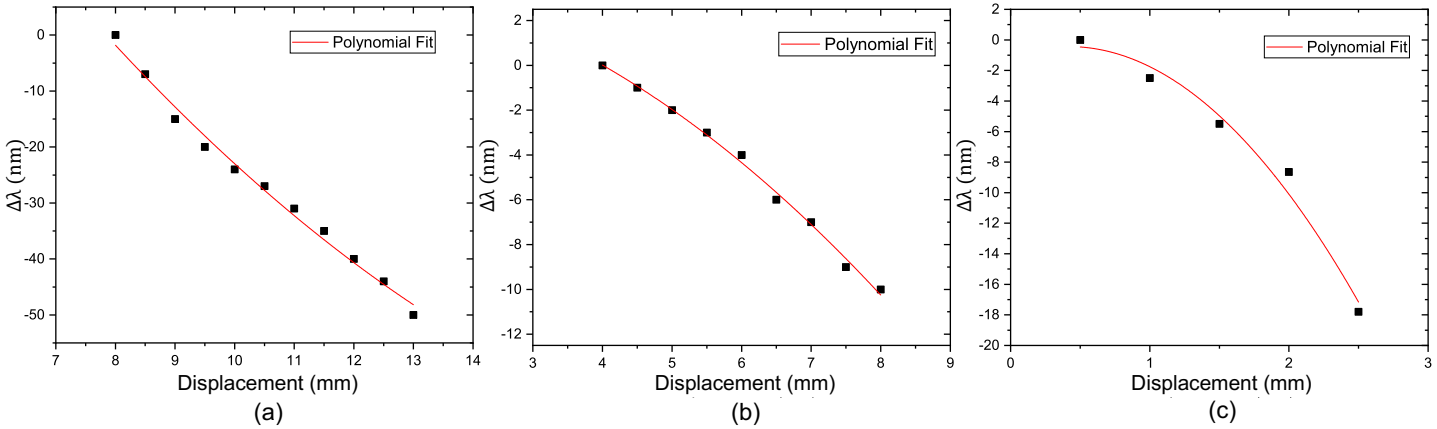
Experimental Setup

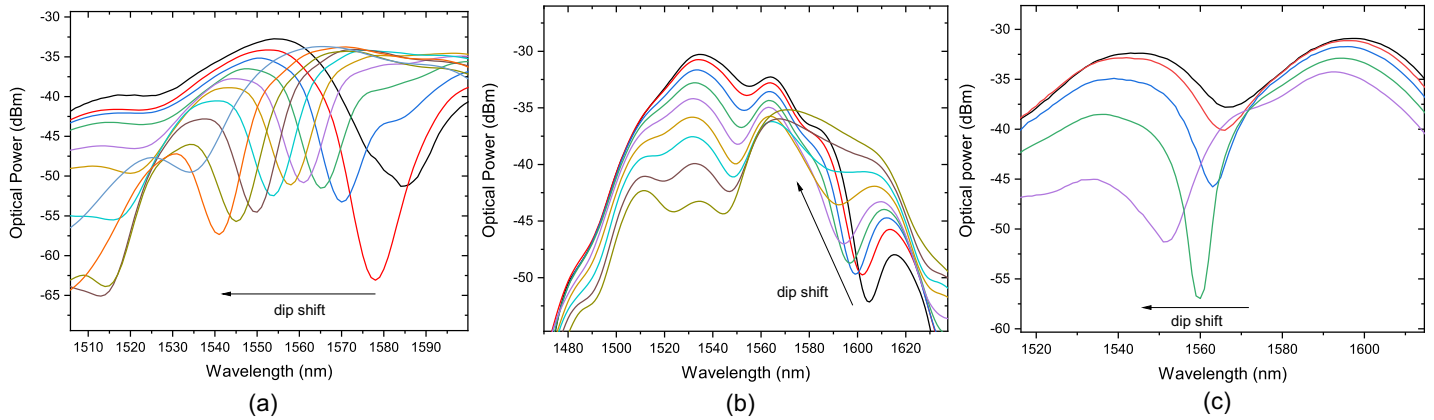




Results and Discussion – DS: 80 mm

- The sensor presents dips shift of the transmittance spectrum due to the induced curvature and strain force;

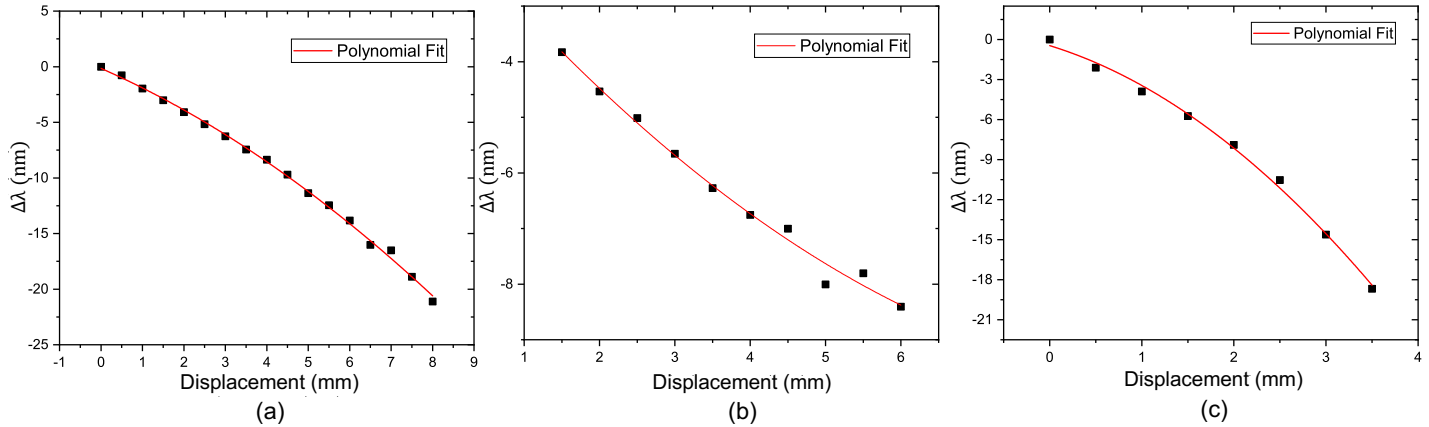


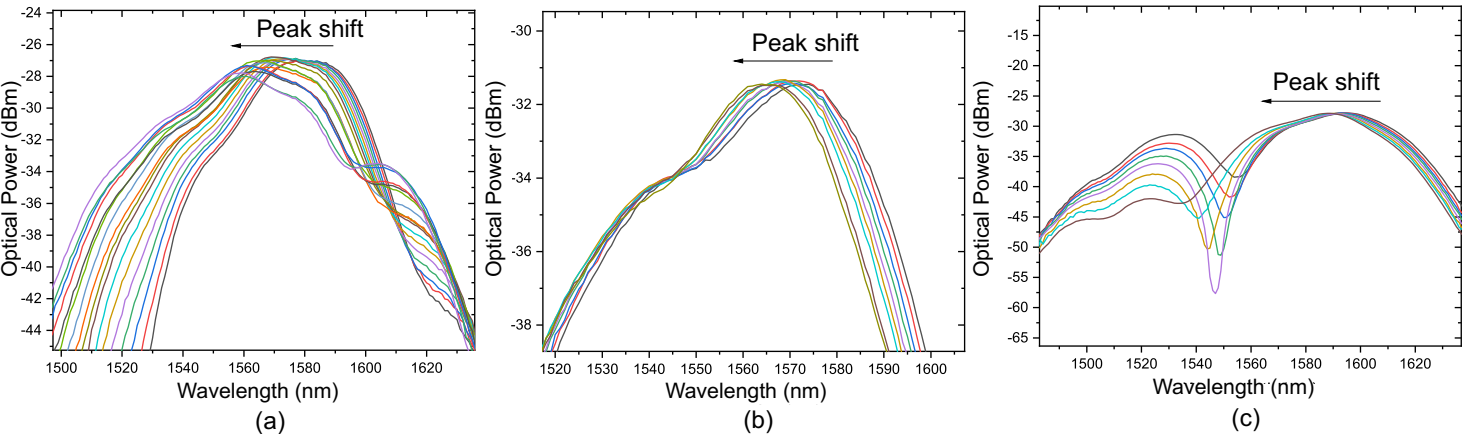


Fixed points (mm)	Sensitivity (nm/mm)	Dynamic range (mm)	R^2
5	-0.876	5	0.9909
10	-0.3892	4	0.9954
15	-0.691	2	0.9811

Results and Discussion – DS: 110 mm

- The sensor presents peaks shift of the transmittance spectrum due to the induced curvature and strain force;





Fixed points (mm)	Sensitivity (nm/mm)	Dynamic range (mm)	R^2
5	-0.22	8	0.9979
10	-0.2284	4.5	0.9888
15	-0.691	3.5	0.9892

Conclusions

- The results demonstrate that it is possible to monitor the diameter using the strain gauge based on SMS sensor proposed in this work;
- The results present good sensitivities values, excellent coefficient of determination and dynamics ranges with several possibilities to practical application such as in pipelines and tree trunk growth;
- The next step will be to analyze other possible configurations since with the correct arrangement, it is possible to optimize the structure and their characteristics.

Thank you for your attention!

Questions?

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