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Tesis: **"RESEARCH AND PROTOTYPING OF AN OPTICAL FIBRE REFRACTOMETER WITH CUSTOMIZED ELECTRONIC CONTROL"**

Resumen:

Refractometers are sensory devices that measure the refractive index of liquids, gasses or solids. The refractive index of a medium indicates how fast an electromagnetic wave propagates through that medium. This measurement can be used to identify a chemical or measure certain characteristics of a substance. Using optical fibre as a sensory device provides many advantages, including, but not limited to, being chemically passive, corrosion resistant, electromagnetically immune, small in size, lightweight and highly sensitive.

The refractometer developed in this Masters project utilizes the coherent optical frequency domain reflectometry technique as interrogation method. This technique requires an optical (tunable) source that scans linearly through wavelength in time. A reference cavity with reflectors at the start and end of the cavity will cause a reflection of light. These reflections interfere and produce an interference pattern called a beat signal. The same applies for a sensing cavity – a reflection will occur at the starting interface of the cavity and the interface at the end, being the cleaved tip of the optical fibre. This beat signal produced from the sensing cavity contains data about whatever substance the cleaved tip of the optical fibre comes in contact with. Through various signal processing algorithms, an accurate measurement of the refractive index of the analyte can be obtained.

Custom electronics are designed and built to implement this method and to drive the distributed feedback laser diode that is used as the tunable source. An algorithm coded in a microcontroller controls a generated saw-tooth waveform. The produced voltage output from the microcontroller is then provided as input to a current source. This current source drives the laser diode with specific selected power characteristics to create a near linear saw-tooth wavelength emission, while keeping the laser diode within maximum power specifications. This stable spectrum generation results in stable frequencies of the beat signals, and consequently concentrated magnitudes in discrete linear frequency points when FFTs are performed by the coded microcontroller. These peaks in magnitude of frequency are key to the calculation of the refractive index.

Various signal processing steps are applied to the beat signals utilizing the microcontroller – the sensor is first calibrated employing the reference cavity. Systemic error is calculated and considered with measurements. Irregularities in spectra are noticed and resolved. Different modulation frequencies are selected and compared.

The refractometer is compact and portable, not being confined to the laboratory, making it convenient to take measurements anywhere. Another important attribute is that the sensor of the refractometer is disposable – the tip of the optical fibre can simply be cleaved if the intensity of the reflections are reduced or if there is major damage to the sensor, it can be replaced by a FC/PC fibre patch cord. The resolution of the tested refractometer is 10-3 refractive index units, well in the range of existing commercial refractometers..