Predicting an optical filter's parameters from its transmission spectrum

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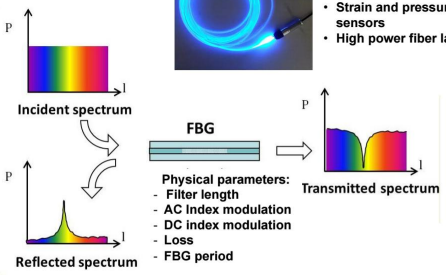
1. Problem statement

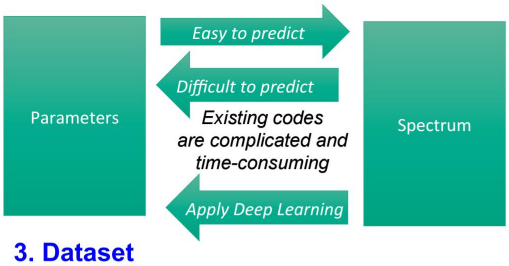
Given the transmission spectrum of an optical filter, specifically a fiber Bragg grating, can we use deep learning to predict its essential physical parameters: index modulation, fiber loss, and the DC:AC modulation ratio ?

2. Motivation

Optical fibers are used for:
- World-wide communication
- Internet connectivity
- Strain and pressure sensors
- High power fiber lasers ….



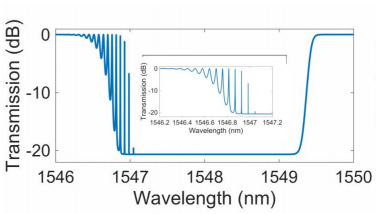
Adapted from http://www.fbgs.com/technology/fbg-principle/



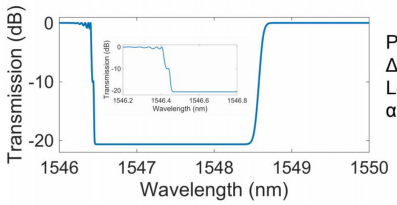
3. Dataset

- Since this is a fairly niche problem, no publicly available dataset exists
- Thus, the dataset was created in-house
- A well-known MATLAB code, developed on transmission theory, was used to create the transmission spectra
- The data was pre-processed to extract its features before using it as the input to the neural network

4. Examples of data



Parameters:
$\Delta n = 2.2 \times 10^{-3}$
Loss = 5.3×10^{-2}
α= 0.7

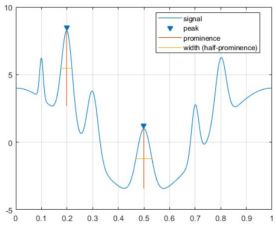


Parameters:
$\Delta n = 2.1 \times 10^{-3}$
Loss = 3.1×10^{-2}
α = 0.4

5. Feature extraction from spectra

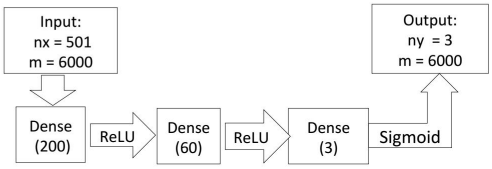
The image of the spectrum cannot be used as is due to the enormous resolution (~9 million points/image) it would take to encode the many different peaks in the spectrum.

The six most important features of the transmission spectra were extracted from the figures

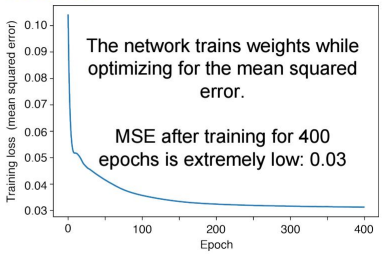


1. Presence of peak (0/1)
2. Peak height $\in R(0,1)$
3. Distance from previous peak $\in R(0,\infty)$
4. Peak width $\in R$
5. Peak prominence $\in R(0,1)$
6. Bandwidth

6. Neural network architecture



7. Results



For one example in test set:

Truth	Predicted
$\Delta n = 3.23 \times 10^{-3}$	$\Delta n = 3.22 \times 10^{-3}$
Loss = 0.21	Loss =0.16
α = 0.57	α = 0.57