Gradient-based grating profile optimization: steps to shape-independent optimization

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In most grating optimization problems the groove shape is given as an a-priori assumption. Usually some simple profile shapes are chosen, such as rectangular, triangular or sinusoidal. However, it is not guaranteed that in some particular case the grating with one of these simple profile types is the optimal one. Gratings with a more complicated but still practically realizable groove profile shape can exhibit more decent properties than those with simple profile shapes. Moreover, it is important to make no special assumptions (except practical realizability) concerning the profile shape, so that it could be optimized as well. Thus, the grating groove shape can be given as a result of the optimization process. Such type of the optimization problem is referred to as shape-independent optimization (i.e. no a-priori assumption on the groove shape is given).
The optimization algorithm for such type of optimization problem, when almost any profile type has to be described by one and the same set of parameters, the number of optimization parameters is sufficiently large. In this case efficient and reliable methods are required, such as gradient-based optimization methods. They are much more stable and much faster in case of a large number of optimization parameters, in comparison to zero-order methods (such as Nelder-Mead method).
In this work the application of gradient-based optimization technique to grating opmization problem is discussed. The optimization problem is set as a merit function minimization problem. The merit function gradient is computed through obtainig the solution of the adjoint differential equation. The optimization problem is solved firstly for a-priori determined grating profile shapes. The application of this method for shape-independent optimization is discussed, the possible grating parametrizations are discussed as well.