On the use of Generative adversarial neural networks for computing photonic crystal fiber optical properties

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Abstract

Photonic crystal fibers (PCF) for specific applications are designed and optimized by both industry experts and researches. However, the potential number of combinations possible for a single application is huge. This issue combined by the speed of PCF numerical simulation techniques causes the task to take significant amount of time. As stated in the previous works, artificial neural networks (ANN) can predict the result of numerical simulations much faster. However, there are two issues with the methods proposed previously. Namely, the required number of samples for training and generality of the designed network. In this paper, we have proposed the use of generative adversarial networks (GAN) to fabricate additional data to be used in training and a unique ANN design that can work with wider range of configurations.

I. Introduction

Importance of PCF and SPR, written by AY or HA

Importance of ANN, deep neural networks, GAN

Literature survey

Short explanation of GAN/ANN

This paper is organized as follows. Section II details the use of GAN to generate additional training samples for ANN as well as the proposed neural network architecture. Photonic crystal fiber design that is used for testing is described in details in section III. Detailed analysis of the experimental results are discussed in section IV. Finally, concluding remarks are made in section V.

II. Proposed method

Details of the overall architecture

A. Artificial neural network design

Particulars of ANN design

Explanations for Adam optimizer and batch normalization

B. Generative Adversarial networks

Explain GAN

Explain how GAN is used in this design

III. Photonic crystal fiber design

PCF design details, written by AY

IV. Experiments

A. Experimental setup

Details of the dataset, machine that is used to run simulations

Metrics used in the comparisons

B. Performance of ANN

Performance of ANN design alone, compared to the other method

C. Performance boost of GAN

Experiments regarding to the GAN

D. Computational performance

Training and execution time of ANN versus simulation method

V. Conclusion

about the improved speed

reduced amount of training samples

increased generality of the system

Machine learning approaches has an inherit strength on top of classical simulation methods: they could model hidden parameters in a system which we have no knowledge about. Therefore, not only ANN can improve the speed of PCF simulation, but also accuracy of the simulations. However, this final claim requires further analysis and experimentation.