

VU Research Portal

Compressive Sensing Enhanced by Machine Learning

Li, Wei; Abrashitova, Ksenia; Osnabrugge, Gerwin; Amitonova, Lyubov V.

published in

2023 Conference on Lasers and Electro-Optics Europe and European Quantum Electronics Conference (CLEO/Europe-EQEC)

2023

DOI (link to publisher)

[10.1109/CLEO/EUROPE-EQEC57999.2023.10231825](https://doi.org/10.1109/CLEO/EUROPE-EQEC57999.2023.10231825)

document version

Publisher's PDF, also known as Version of record

document license

Article 25fa Dutch Copyright Act

[Link to publication in VU Research Portal](#)

citation for published version (APA)

Li, W., Abrashitova, K., Osnabrugge, G., & Amitonova, L. V. (2023). Compressive Sensing Enhanced by Machine Learning. In *2023 Conference on Lasers and Electro-Optics Europe and European Quantum Electronics Conference (CLEO/Europe-EQEC): [Proceedings]* Institute of Electrical and Electronics Engineers Inc.. <https://doi.org/10.1109/CLEO/EUROPE-EQEC57999.2023.10231825>

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

E-mail address:

vuresearchportal.ub@vu.nl

Compressive Sensing Enhanced by Machine Learning

Wei Li¹, Ksenia Abrashitova¹, Gerwin Osnabrugge¹, Lyubov V. Amitonova^{1,2}

1. Advanced Research Center for Nanolithography (ARCNL), Science Park 106, 1098 XG Amsterdam, The Netherlands
2. LaserLAB, Department of Physics and Astronomy, Vrije Universiteit Amsterdam, De Boelelaan 1081, 1081 HV Amsterdam, The Netherlands

We present our work on the using of machine learning to enhance the reconstruction quality of multimode fiber (MMF) based compressive sensing system [1]. MMF represents the ultimate limit in miniaturization of imaging endoscopes [2,3]. However, the spatial resolution and acquisition speed are usually limited in this system [4]. With a data-driven machine learning framework, we can solve both the problems. We implement a generative adversarial network (GAN) to explore the sparsity inherent to the model. This gives the possibility to provide compressive reconstruction images that are not sparse in a representation basis. The proposed method exceeds other widespread compressive imaging algorithms in terms of both image quality and noise robustness. We also experimentally demonstrate GAN enhanced ghost imaging below the diffraction limit at a sub-Nyquist speed through a thin MMF probe. The following Fig. 1 illustrates the idea of how to using GAN to improve the reconstruction quality of the compressive sensing problem. While Fig 1(a) shows the simple setup and Fig 1(b) shows the calculation theory, Fig 1(c) give the examples of the comparison of GAN reconstruction with other traditional sparsity based algorithms, where GAN shows clear advantage. Meanwhile, we also discuss the noise robustness of the methods by introducing artificial noise to both the measurement matrix and the measured signal, where GAN also shows superior behavior. Due to its potential in applications in various fields ranging from biomedical imaging to remote sensing, this method is of great significance.

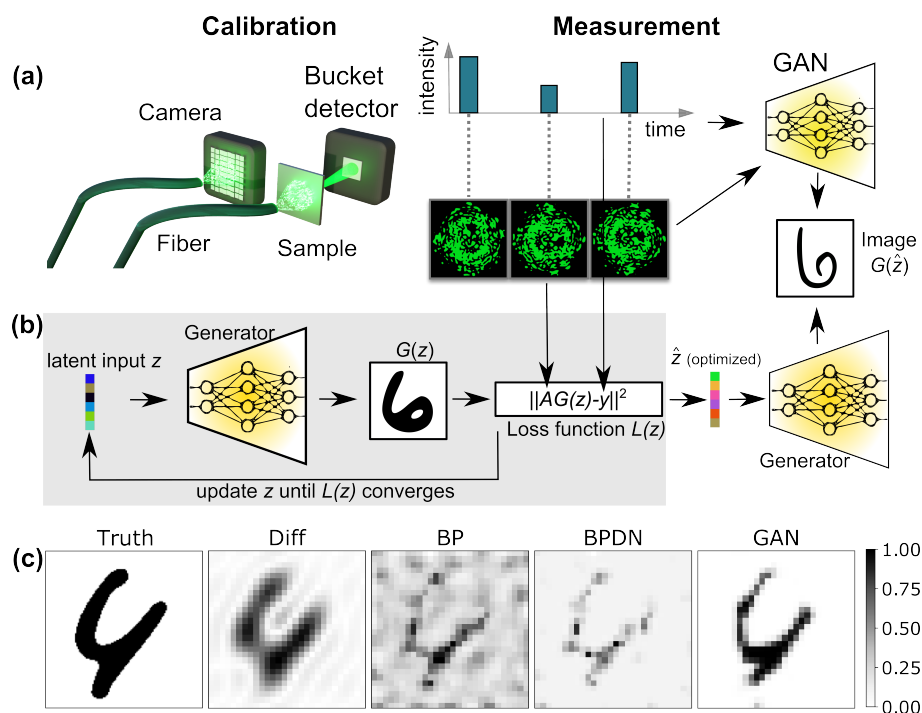


Fig. 1 Illustration of the idea of using GAN to improve the reconstruction of compressive imaging system. (a) shows the simple experimental setup. (b) shows the theory of the reconstruction process using GAN. (c) shows the examples of reconstruction comparison with other methods.

Example References

- [1] Li, W., Abrashitova, K., Osnabrugge, G. and Amitonova, L. V. "Generative Adversarial Network for Superresolution Imaging through a Fiber," *Phys. Rev. Appl.* **18**, 034075 (2022).
- [2] L. V. Amitonova and J. F. de Boer, "Endo-microscopy beyond the abbe and nyquist limits," *Light: Science & Applications* **9**, 1 (2020).
- [3] M. Pascucci, S. Ganesan, A. Tripathi, O. Katz, V. Emiliani, and M. Guillon, "Compressive three-dimensional super-resolution microscopy with speckle-saturated fluorescence excitation," *Nature communications* **10**, 1 (2019).
- [4] Calisesi, G., Ghezzi, A., Ancora, D., D'Andrea, C., Valentini, G., Farina, A., and Bassi, A, "Compressed sensing in fluorescence microscopy," *Progress in Biophysics and Molecular Biology*, **168**, 66 (2022).