CALL FOR PHD STUDENTS

NCN Preludium BIS Project: ***[BayesOM] Bayesian inference in optical metrology***

Project Principal Investigator: PhD DSc Maciej Trusiak, WUT professor, Head of the Quantitative Computational Imaging Lab at Institute of Micromechanics and Photonics
https://qcilab.mchtr.pw.edu.pl/

Position in the Project: PhD student in the Faculty of Mechatronics, Warsaw University of Technology
Institution: Photonics Engineering Division, Institute of Micromechanics and Photonics, Faculty of Mechatronics, Warsaw University of Technology

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What we offer:

1. Scholarship contract and competitive remuneration package.
2. 6 month paid scientific stay in The Arctic University of Norway, Tromso in prof. Balpreet Ahluwalia group.
3. Work in dynamic and competent scientific group (QCI LAB https://qcilab.mchtr.pw.edu.pl/) with excellent research environment and international cooperation promoting publications in high impact journals.
4. Financial support of abroad scientific visits and attending conferences.
5. Encouragement and support in preparing grant applications and engaging in personal development.

Requirements:

1. Master's degree in math, data sciences, physics, optics or engineering.
2. Good knowledge of Matlab and/or Python environments. Algorithmic background in image processing and preferably Bayesian inference will be additionally beneficial.
2. Experience in signal/image analysis methods.
3. Fluent spoken and written English.
4. Strong motivation and passion for scientific work (theoretical, numerical, and experimental) both independently and as part of a team in an interdisciplinary environment, with the ability to creatively propose solutions to problems at hand, pay close attention to detail and to meet deadlines.
5. Very good social skills.

General description of the Preludium BIS project:

The semiconductor industry, a driving force in science and technology advancements, relies heavily on metrology for successful manufacturing. Optical metrology techniques offer precise and rapid nanoscale-precise measurements without invasive procedures. Full-field interferometry, a scanning-free method, is particularly valuable for widefield measurements, capturing information about semiconductor geometry and refractive index distribution through phase-encoded interferometric fringe patterns. Advancements in fringe pattern analysis methods are necessary to meet demanding metrological requirements in challenging conditions like additive manufacturing. While the widely used phase-demodulation technique based on phase-shifted interferograms offers reliability, it requires a complex and costly phase-shifting module and lengthens the measurement process. The accuracy of this technique depends on phase shifting precision, fringe pattern quality, and the phase demodulation algorithm itself, with limitations related to pixel-size displacement and phase errors near abrupt height changes.
In the proposed [BayesOM] project, we introduce a groundbreaking approach to phase demodulation using Bayesian inference in a single-shot setup. Previous single-shot algorithms employing Fourier, Hilbert, or wavelet transforms faced challenges with ill-posed problems and errors, particularly in measuring abrupt height changes in step-like objects such as waveguide structures. Our novel idea is to leverage Bayesian inference in optical metrology, exploring different Bayesian models to estimate posteriors and encode geometry parameters of waveguide structures (height, width, tilt, inclination, etc.). Preliminary studies demonstrate sub-pixel height profile variation sensitivity, coupled with violet laser illumination and Twyman-Green or Linnik-type interferometric setups, enabling unprecedented Angstrom-level optical full-field measurement precision. We will investigate various models under simulated and experimental conditions, considering different objects, fringe noise and contrast levels, and employing numerical algorithms to minimize noise and enhance fringe contrast.
These innovative advancements hold significant importance in semiconductor metrology, particularly in waveguide measurements critical to on-chip fluorescent nanoscopy pioneered by Professor Balpreet Ahluwalia's group at The Arctic University of Norway (Tromso). This research project requires a PhD student to spend six months in Professor

Ahluwalia's lab, mastering waveguide optical measurement procedures and implementing Bayesian inference. Collaborating with Dr. Maciek Wielgus from the Max Planck Institute for Radio Astronomy in Bonn, Germany, known for his expertise in the Black Hole Initiative Event Horizon Telescope, further strengthens our approach. Dr. Wielgus has developed Bayesian inference-based algorithm techniques for estimating black hole parameters from radioastronomical data. We aim to build upon this success and apply it delivering novel solutions in angstrom-sensitive widefield optical metrology for semiconductor quality control.

Type of NCN Project: Preludium BIS – ST.
Application deadline: 31.07.2024, 23:59.
Please submit the following documents (or direct any questions) to: maciej.trusiak@pw.edu.pl

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Conditions of employment:
Total income from the project offered to the PhD candidate: 5000 PLN net per month for first 24 months (+ Doctoral School stipend around 3500 PLN net) and 6000 PLN net per month for second 24 months (+ Doctoral School stipend around 4300 PLN net), stipend contract for a total of 48 months.
Position starting time: 1st October 2024 after successful enrollment in the Doctoral School of Warsaw University of Technology (with important online application deadlines throughout July-August 2024).

Additional information required:
Motivation letter (in English).
CV (in English).
Master thesis.
Contact details of the scientific supervisor and other referees (if available).

To apply, please send your application, including motivation letter, CV with the list of your publications and achievements, Master's degree thesis alongside with contact information to the scientific supervisor and other referees (if available) to the following e-mail address: maciej.trusiak@pw.edu.pl. Incomplete applications will not be considered.
We thank all applicants for their interest; however, only selected candidates may be invited for an interview. Applications will be accepted until the position is filled. If the winner of the competition resigns from signing the contract, we reserve the right to choose the next best person from the ranking list.

Due to the entry into force of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016, all candidates are requested to provide consent to the processing of his or her personal data by the institution which carries out the recruitment process.

Thus, please include in your application the following statement: "I hereby agree to the processing of my data included in the application documents by Warsaw University of Technology, Warsaw, Poland, to carry out the recruitment process."

Your personal data is processed on the basis of the Article 6 Part 1 Points (c) and (f) of the Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (GDPR; Official Journal of the European Union L 119/1).