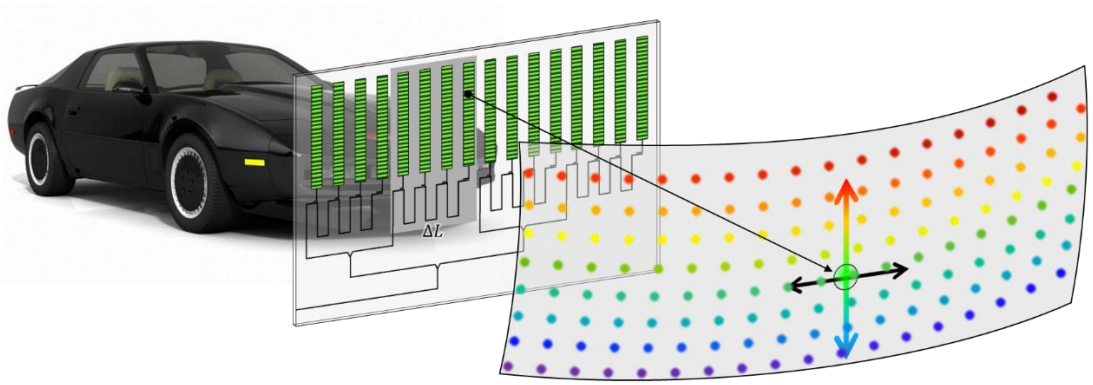

Dispersive Optical Phased Arrays for Multiplexed Coherent LiDAR

Light Detection and Ranging (LiDAR) is a remote sensing technology based on laser light to measure the distance to objects and thus create a 3D map of the surroundings with great precision. It is consider the crucial enabling technology for the widespread adoption of autonomous vehicles (cars, drones, …). A typical LiDAR contains two key functional parts: the ranging engine (which determines the distance to the objects) and the beamforming/beamsteering engine, which scans the beam over the scene.

The focus of this PhD topic is mostly on the second function. Today, beamsteering is mostly done using mechanical techniques, but to make the technology mode scalable, solid-state solutions are preferred, and if possible implemented on a chip with a small form factor and low power consumption. A promising approach to this is the use of Optical Phased Arrays (OPA). These consist of a large array of optical emitters (“antennas”) arranged in a period array. While each small antenna emits a wide-angle beam, together the antennas will behave as a single, much larger emitter, producing a focused beam that can be projected over a long distance. A prerequisite for this to work is that the optical signals of all antennas have a well-controlled phase relation. That is why OPAs are generally accompanied by a large array of optical phase shifters.

In this PhD we take a slightly different approach, using dispersive OPAs. Instead of using an actively controlled phase shifter, we just add a section of delay line in the form of an optical waveguide. This introduces a wavelength-dependent phase shift, which allows us to steer the beam by changing the wavelength of the input light, without need for additional control and power consumption. This concept has already been widely published, but proved difficult to scale. Ghent University and IMEC recently came up with a variation of this scheme that can scale to large arrays [1]. This PhD will build on this concept.

This concept of OPA makes it possible to steer the beam of light over a wide angle, both horizontally and vertically. But the OPA still needs to be combined with the ranging engine, which also imposes a number of constraints. In our case, we want to use a coherent ranging engine, based on the frequency modulated continuous wave (FMCW) principle. This concept also uses a tunable laser, and it is of course important that the requirements on the laser need to match the requirements of the beam steering [2]. One approach to do this is to use multiple lasers that are multiplexed into the same OPA

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and each scan different parts of the scene. While this approach has been theoretically described, it should be elaborated and further engineered to prove that it can effectively achieve its promise.

The Photonics Research Group at Ghent University is seeking a candidate for a PhD position to research a this concept for multiplexed dispersive OPAs, which can be used for the next-generation chip-based LiDAR system. The PhD student will participate in an international team in an EU-funded Doctoral Network project called NiteLiDAR. This project consists of 10 Ph.D. students at 3 universities, an international R&D organization, and a company. The project has partners from four different EU countries. All 10 PhD projects are within the overall theme of photonic and electronic integrated circuits for next-generation LiDAR technologies, which will provide excellent opportunities for the students to interact and exchange knowledge.

This PhD project will take place at Ghent University (UGent). Apart from the time at UGent there will be opportunities for secondments. This can be locally, for instance at IMEC, Belgium, or in one of the other partners or affiliate partners in the project, such as the company Scantinel in Germany. There will also be common meetings with the other 9 PhD students in the doctoral network, including 3 training schools.

As a participant of the project, the PhD student will become part of a team at UGent with expertise in design, simulation, nanofabrication, characterization, and application of large-scale photonic integrated circuits (PIC). The team of prof. Wim Bogaerts, who will also be the main supervisor of this PhD, is part of a large research group with 12 professors and more than 60 PhD students, also giving many opportunities for interaction and learning. The activities within the project will benefit from synergies with other projects in the group as well as with other activities at the department.

[1] W. Bogaerts, S. Dwivedi, R. Jansen, X. Rottenberg, and M. S. Dahlem, “A 2D Pixelated Optical Beam Scanner Controlled by the Laser Wavelength,” *IEEE J. Sel. Top. Quantum Electron.*, vol. 27, no. 1, pp. 1–12, Jan. 2021, doi: 10.1109/JSTQE.2020.3017230.

[2] W. Bogaerts, M. Kandil, and M. S. Dahlem, “Integrated Optical Beam Scanning and FMCW Ranging using Multiplexed Tunable Lasers,” in *2022 IEEE Photonics Conference (IPC)*, Vancouver, BC, Canada: IEEE, Nov. 2022, pp. 1–2. doi: 10.1109/IPC53466.2022.9975452.

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Responsibilities and tasks

The new concepts for dispersive OPAs have not yet been explored in great detail. This is why the PhD will involve a wide variety of activities, where first the different concepts will be modelled and combined into a larger system model, and then translated to practical experiments. To ensure a rapid start, some small-scale experiments have already been designed and are currently in fabrication on a silicon chip.

The project is expected to involve

1. Building efficient simulation models for large-scale optical phased arrays. This can start from existing software that is already available in the group
2. Exploring (numerically) different architectures to multiplex ranging engines using the dispersive OPA, and evaluate the impact on the trade-offs on the overall system
3. Design experiments for large-scale OPA tests and then implement the actual corresponding chip layouts. These will then be fabricated using semiconductor processes in IMEC or in the Ghent University clean room.
4. Design the characterization experiments for measuring the operation of the chips. This can build on measurement infrastructure at either Ghent University or IMEC. Characterization can also be part of a secondment.

Qualifications

Candidates must have a two-year master's degree (120 ECTS points) or a similar degree with an academic level equivalent to a two-year master's degree in photonics, electro, applied physics or similar. **Further obligations**: The doctoral candidate (DC) is expected to travel to network partners under two secondments for a typical total duration of 3-5 months. Additionally, the DC is expected to participate in outreach activities including, but not limited to, YouTube videos, social media updates, participation in public events and campaigns, as well as dissemination to popular press. Furthermore, due to the mobility rules of the Marie Skłodowska-Curie program, the applicant must not have resided or carried out their main activity (work, studies, etc.) in Belgium for more than 12 months in the 36 months immediately before their recruitment date.

Approval and Enrolment

The scholarship for the PhD degree is subject to academic approval, and the candidate will be enrolled in doctoral degree programme of the Faculty of Engineering and Architecture at Ghent University. For information about our enrolment requirements and the general planning of the PhD study programme, please see the UGent rules and regulations for PhDs.

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We offer

Ghent University is a leading university globally recognized for the excellence of its research, education, innovation and scientific advice. It is internationally oriented, and this can definitely be said for the photonics research group. We strive for academic excellence in an environment characterized by collegial respect and academic freedom tempered by responsibility.

Salary and appointment terms

The salary and appointment terms are consistent with the current rules for PhD degree students at Ghent University. The standard duration of a PhD at Ghent University is 4 years.

Further information

Further information may be obtained from Prof. Wim Bogaerts (wim.bogaerts@ugent.be).
You can read more about the Photonics Research Group at https://photonics.intec.ugent.be

Desirable start for the PhD position: August – September, 2024.

Application procedure

Your complete online application must be submitted no later than **1 April 2024**.

Please apply for this vacancy through:

http://photonics.intec.ugent.be/contact/vacancies/Application.htm

Applications must be submitted as **one PDF file** containing all materials to be given consideration. To apply, please open the link "Apply online", fill out the online application form, and attach **all your materials in English in one PDF file**. The file must include:

- A letter motivating the application (cover letter)
- Curriculum vitae
- Grade transcripts and BSc/MSc diploma (in English) including official description of grading scale

You may apply prior to obtaining your master's degree but cannot begin before having received it.

Applications received after the deadline will not be considered.

All interested candidates irrespective of age, gender, race, disability, religion or ethnic background are encouraged to apply.

The recruitment is taking place following the European Code of Conduct for Recruitment of Researchers, which all candidates are encouraged to study.

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Selection process: NiteLiDAR is open to researchers regardless of gender, religion, ethnicity, disability, sexual orientation, political views, language, age and nationality. Applications from highly qualified applicants from outside the EU will thus be equally considered to other applicants. The integration of refugees is an EU priority and we will ensure equal opportunities to the researchers whose scientific careers have been interrupted. To ensure a gender balance in the project and work towards the Commission's own policies on narrowing the gap between the genders in research, should two applicants be found to be equally qualified the preference will be given to the one that will balance the gender distribution in the entire Network. After the deadline, all submitted applications will be checked against the defined admissibility and eligibility criteria (e.g. submitted electronically, readable, complete, in English, including grades and references), and applicants will be informed by email within two work weeks on the outcome. The following interviews and selection process will be carried out by a temporary Selection Committee constituted by the Coordinator (when possible) and the supervisors. Evaluation criteria include: Scientific background, capacity for creativity and independent thinking and leadership, mentoring and presentation abilities.

Protection of personal data: The personal data of the applicants will be handled in compliance with applicable EU and national law on data protection (GDPR).

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