Machine Learning-Based Beamforming for 5G V2X Networks

JOB DESCRIPTION

Vehicle-to-everything (V2X) communication is key application area of 5G, with the motivations to enhance road safety, traffic efficiency and environmental sustainability (considering the energy usage and emission of vehicles). V2X applications require 5G network technology to support both Ultra-Reliable Low-Latency Communication (URLLC) services and non-URLLC services. The typically highly varying V2X communication environment, due to potential high-speed mobility of the vehicles, poses significant challenges for 5G to fulfil the requirements of the diverse V2X applications.

Beamforming and massive single/multi-user MIMO technologies are important 5G components to increase coverage, link quality and network capacity by steering radio signals towards targeted users and avoiding interference in unwanted directions. Adaptive beamforming is desired in V2X communications in order to dynamically react to the changes in radio propagations due to movement of the vehicles in terms of timely selecting the best possible beam direction and beam width, considering the impact of the latter on both the effective antenna gain and the robustness of the transmission. Such adaptivity comes at an overhead cost of (often frequent) control signalling via the air interface. It may be promising to develop Machine Learning (ML)-based beamforming optimization approaches striking an optimal trade-off between performance, complexity and signalling overhead.

The key objectives of the proposed graduation project are:

- *(i)* To *identify V2X scenarios* where adaptive beamforming is applicable and *analyse the-state-of-the-art* (SoTA) (particularly also ML-based) adaptive beamforming solutions in determining the most suitable precoder for beamforming.
- *(ii)* To *propose one or more ML-based beamforming optimization approaches*, which tackles identified challenges in potentially high-speed V2X communications and outperforms SoTA approaches in flexibility and the attainability of a good trade-off between performance, complexity and signalling overhead.
- *(iii)* The *quantitative assessment* of the proposed ML-based beamforming optimization approaches, comprising a mutual comparison and a benchmark against key SoTA algorithms, as well as a sensitivity analysis w.r.t. key scenario aspects, in order to demonstrate attainable gains and identify the best candidate. This requires the specification of suitable and realistic scenarios in terms of system, propagation and traffic aspects and the development/application of a simulation tool to do the assessment.

The graduation project is carried out as part of the European Horizon 2020 5G-HEART project (www.5gheart.eu). You will learn about the broader context of the overall project and will gain the necessary knowledge about both the V2X vertical application domain and mobile telecommunication technology.

REQUIREMENTS

You are a graduate student pursuing a Master's degree, preferably in the direction of Electrical Engineering or Computer Science. You have affinity with / interest in mobile networks, computer simulations and programming experience. You have an enterprising, flexible and cooperative nature. You are also communicative, creative and innovative. Duration of the graduation project is about nine months.

ABOUT TNO

TNO is an independent research organisation whose expertise and research make an important contribution to the competitiveness of companies and organisations, to the economy and to the quality of society as a whole. Innovation with purpose is what TNO stands for. We develop knowledge not for its own sake but for practical application. To create new products that make life more pleasant and valuable and help companies innovate. To find creative answers to the questions posed by society. We work for a variety of customers: governments, the SME sector, large companies, service providers and non-governmental organisations. We work together on new knowledge, better products and clear recommendations for policy and processes. In everything we do, impact is the key. Our product and process innovations and recommendations are only worth something if our customers can use them to boost their competitiveness.

TERMS OF EMPLOYMENT

You want to work on the precursor of your career; a work placement gives you an opportunity to take a good look at your prospective future employer. TNO goes a step further. It's not just looking that interests us; you and your knowledge are essential to our innovation. That's why we attach a great deal of value to your personal and professional development. You will, of course, be properly supervised during your work placement and be given the scope for you to get the best out of yourself. Naturally, we provide suitable work placement compensation.

CONTACT US

Geert Heijenk