Master Thesis Proposal
AI-based RIS-aided localization in 6G communication systems

Keywords
6G, artificial intelligence (AI), intelligent surfaces, localization.

Introduction

With the introduction of 5G, radio localization using 5G signal is improved enormously thanks to higher carrier frequencies, wider bandwidths (up to 400 MHz), and multiple antennas. Radio localization has been a part of 5G standards, and it is expected to become one of the pillars of 6G communication system [2].

To achieve better localization performance in future 6G systems, reconfigurable intelligent surface (RIS) [1]-aided localization has attracted many interests in recent years, mainly for their ability to offer an extra location reference, extra measurements, and controllable multi-paths [3]. By controlling the phase profile of the RIS, signals sent from the base station can be reflected to the direction of the user (if we have a prior knowledge of the user position). With these reflected signals from the RIS, the user aims to estimate its position by a position estimator.

The goal of this thesis is to design RIS phase profile controller and user position estimator with machine learning to achieve better localization performance than conventional methods, mainly under hardware impairments where the assumed mathematical models might differ from reality. Two neural networks will be optimized jointly via an end-to-end manner [4], i.e., RIS phase controller acts as an encoder and user position estimator acts as a decoder. Specifically, to make the scenario feasible in practice, reinforcement learning will be used such that NNs can be trained without differentiable models for the hardware and channel [5].

Thesis Outline

The thesis will consist of the following tasks (with support from the supervision team):

[1]https://www.youtube.com/watch?v=bY1_-eJtfNU
• Mathematical problem definition.
• Literature review of RIS-aided localization.
• Implement NN-based RIS phase controller and position estimator. NNs are optimized based on position criterion via supervised learning.
• Extend the optimization to over-the-air operation using reinforcement learning.
• Write a thesis report summarizing the findings including recommendations for future work.

The work has a high probability for leading to a publication in a leading IEEE conference. If you are interested, we will guide you in this process.

Student Background

• Master’s degree students in MPICT, MPSYS, MPCAS, etc.
• Solid background in mathematics and programming is needed.
• Knowledge in wireless communication, signal processing, Python, or machine learning are a plus.

Duration

• For 1 or 2 students: 1 semester, 30 ECTS points
• For 1 student: 2 semesters, 60 ECTS points (outstanding academic track record needed)

Application

• Attach your resume, transcript, and cover letter (stating your interests and thoughts within the given area).
• Send your application by email to yibo@chalmers.se.

Research Group and Supervisors

The thesis will be carried out within the Communication Systems Group in the Department of Electrical Engineering at Chalmers. The thesis can be started from January 2023 or earlier.

For more information, please contact Yibo Wu (yibo@chalmers.se). Other supervisors: José Miguel Mateos-Ramos (josemi@chalmers.se), Musa Furkan Keskin (furkan@chalmers.se), Christian Häger (christian.haeger@chalmers.se), and Henk Wymeersch (henkw@chalmers.se). The examiner is Henk Wymeersch.
References


