Fachgebiet Audiokommunikation

Prof. Dr. Stefan Weinzierl

Master thesis

Deep learning supported active noise control device

Active noise control (ANC) systems are used to reduce or control the sound level by generating an anti noise signal. Variety of algorithms has been used over the last sixty years to minimise noise pollution in different settings such as industrial facilities, transportation and private accommodations [1]. The algorithm generates an anti-noise wave to cancel the original noise wave out. Over the years a variety of different algorithms were used, including FX-LMS and others. However, with the fast miniaturisation of the microphones and loudspeakers and lower cost of computational resources more advanced algorithms can be used. Furthermore, the unprecedented development of the deep learning methods in the last years gives an entirely new family of methods.

Due to the nature of the ANC problem Reinforcement Deep Learning (RL) [2,3,4] seems to be the most suitable for the task. In contrast to supervised or unsupervised learning, RL does not require explicit feedback but is rather based on the self-thought actor that is trying to understand the environment by obtaining punishments and rewards. The unique features of this learning are trial-and-error searching and delayed reward. From a more formalised perspective, we want to solve a Markov Decision Process where the agent is given a state (S - background noise) and chooses an action (A - produced counter-wave) that maximises hers reward (r noise at the measuring point). Using a well-chosen neural net architecture an Agent will be able to learn an optimal policy function, that is a function p: AxS → [0,1] that gives the probability distribution on the set of possible actions describing the optimal (in terms of the reward) response in a given state. What is more, such learnt algorithms can be afterwards shared with different agents operating in similar environments.

The goal of the thesis is to develop a self-adjustable ANC device that pushes the edge of the noise cancelling. Using the method of reinforcement learning, knowledge transfer and sharing the device will be able to adjust to local conditions and transfer the knowledge to other devices. There are a few different parts of the thesis: setting a training algorithm for an ANC problem, building a prototype of the device where the algorithm can be tested, providing a possibility of the device to be self-adjustable and finally providing a transfer of knowledge. The main programming part should be done in Python or C depending on preferences.

Literature

[1] Lam, Bhan, et al. "Active control of broadband sound through the open aperture of a full-sized domestic window." *Scientific reports*10.1 (2020): 1-7.

[2] Sabzevari, Seyed Amir Hoseini, and Majid Moavenian. "Application of reinforcement learning for active noise control." *Turkish Journal of Electrical Engineering & Computer Sciences*25.4 (2017): 2606-2613.

[3] Sutton, Richard S., and Andrew G. Barto. *Reinforcement learning: An introduction*. MIT press, 2018.

[4] Mnih, Volodymyr, et al. "Playing atari with deep reinforcement learning." *arXiv preprint arXiv:1312.5602* (2013).

Qualifications

Knowledge of programming (preferably python), room acoustics, electronics, interest in deep learning and reinforcement learning.

Supervision

Dr Bartłomiej Matejczyk, matejczyk.bartlomiej@gmail.com
Prof. Dr Stefan Weinzierl, EN 322, stefan.weinzierl@tu-berlin.de