Open Thesis / Project

Transmission of Compressed Speech over Low-bandwidth Networks

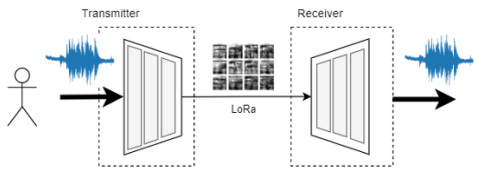
Thesis Type

Master Project / Master Thesis

Motivation

Communicating over large distances by simply talking into a device has become natural. To enable this, a fixed infrastructure (e.g., cellular and satellite network) or specialized solutions (such as Walkie Talkies) covering multiple kilometres is necessary. However, in an emergency or disaster scenario, *infrastructure might not be available*, rendering most of the existing solutions unusable. Moreover, there is a need for *energy-efficient* solutions in order to allow a prolonged use of devices. Walkie Talkies – while being a great alternative – may require 0.5 – 5W to operate, which impairs usability.

Our goal is to transmit compressed speech over infrastructure-less low-bandwidth networks (e.g., low-power wide area networks such as LoRa), ideally using micro-controllers that require just a few mW to run. This entails two challenges. First, audio data is bulky, as common audio codecs require the transmission of hundreds of kB to MB of data. However, technologies such as LoRa can only handle ~ 27 kbps. Whilst lightweight codecs achieving bit rates as low as ~ 2 kbps exist (e.g., Codec2 used by HAM radio operators), the resulting audio quality may suffer significantly. Second, enabling long-range communication on low-power devices is not trivial. For example, LoRa is widely used for communication up to a few kilometres, but it is typically used to send only a few bytes per hour, which does not cope well with the transmission of speech.



Goals and Tasks

Within this context, students can explore several directions and perform different tasks, such as:

- On-device speech compression, where the goal is to achieve real-time compression and decompression of speech on a low-power microcontroller (such as Nordic Semiconductor's `nRF5340`). The ultimate idea is to find new or refined ML models to efficiently compress speech, without compromising its quality.
- Transmission of speech over low-power wide area networks such as LoRa, where the goal is to improve and optimize the transmission of encoded speech data and achieve long-range, bidirectional communication. This entails tackling the trade-offs and challenges of long-range communication (e.g., reduced data rates) in order to create a functioning prototype.

Target Group

- Students of ICE/Telematics;
- Students of Computer Science;
- Students of Electrical Engineering.

Required Prior Knowledge

- Good knowledge of machine learning;
- Good skills in Python and C programming;
- Experience with embedded microcontrollers.

Contact Person

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