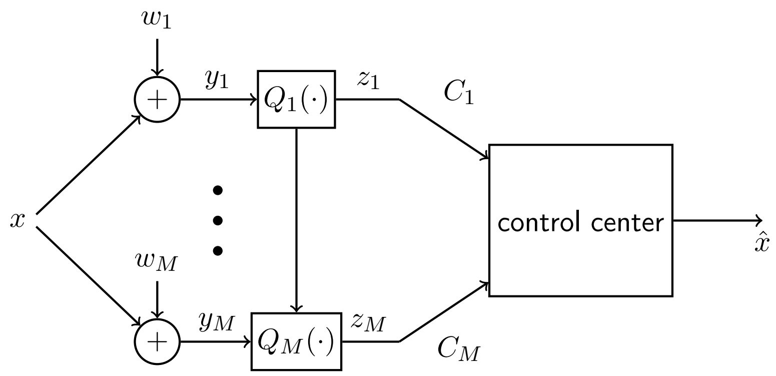
Title of Project / Master Thesis:

Digital Sensing for Partially Cooperating Sensors

Description:

Monitoring and control of technical systems rely heavily on sensing and communication. With the vision of the Internet of Things (IoT), billions of simple metering devices are expected to forward their measurement to control units leading to massive machine-to-machine communications. Regarding the efficiency of these systems, sensing, communication, and signal processing have to be jointly optimized to optimally infer the desired information.



In this thesis, the depicted system model is considered. Multiple sensors m observe noisy versions y_m of a signal of interest, called the relevant signal x. In order to forward these measurements to a common control center, each sensor has to perform a compression to fulfill the capacities C_m of subsequent links. Without cooperation of the sensors, this setup is widely known as the CEO problem. An extended scenario shall allow the communication among sensors, but the available rates are limited and might be even smaller than the channel capacities of the forward links. Moreover, broadcast, multicast and unicast communications between sensors have to be distinguished.

In this thesis, a quantizer optimization algorithm shall be developed being able to exploit partial cooperation of the sensors. Starting point will be the existing Greedy Distributed Information Bottleneck (GDIB) algorithm. It optimizes the quantizers successively using the statistics of previously designed quantizers as side-information. The extension to support partial cooperation requires the design of multiple quantizers depending on the particular side-information from other sensors provided during run-time. As the number of quantizers to be designed grows exponentially with the amount of side-information, the run-time side-information has to be compressed by means of the information bottleneck method. In this way the exchange of side-information can be limited to a few bits only while preserving as much relevant information as possible.

The required tasks for this thesis are:

- Literature review on the CEO problem and the Information Bottleneck method, especially the GDIB algorithm
- Familiarization with the current implementation of the GDIB algorithm in Python
- Derivation and implementation of an extended GDIB algorithm, allowing partial co-operation among sensors
- Performance analysis of developed algorithm, comparison to the classic GDIB algorithm and the optimal vector quantizer, influence of the amount of exchanged side-information

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