**Title: Adaptive Data Acquisition for Communication Networks**

**Abstract:** In an increasing number of communication systems, such as sensor networks or local area networks within medical, financial or military institutions, nodes communicate information sources (e.g., video, audio) over multiple hops. Moreover, nodes have, or can acquire, correlated information sources from the “environment”, e.g., from data bases or from measurements. Among the new design problems raised by the outlined scenarios, two key issues are addressed in this dissertation: 1) How to preserve the consistency of sensitive information across multiple hops; 2) How to incorporate the design of actuation in the form of data acquisition and network probing in the optimization of the communication network. These aspects are investigated by using information-theoretic (source and channel coding) models, obtaining fundamental insights that have been corroborated by various illustrative examples.

To address point 1), the problem of cascade source coding with side information is investigated. The motivating observation is that, in this class of problems, the estimate of the source obtained at the decoder cannot be generally reproduced at the encoder if it depends directly on the side information. In some applications, such as the one mentioned above, this lack of consistency may be undesirable, and a so called Common Reconstruction (CR) requirement, whereby one imposes that the encoder be able to agree on the decoder's estimate, may be instead in order. The rate-distortion region is here derived for some special cases of the cascade source coding problem and of the related Heegard-Berger (HB) problem under the CR constraint.

As for point 2), the work is motivated by the fact that, in order to enable, or to facilitate, the exchange of information, nodes of a communication network routinely take various types of actions, such as data acquisition or network probing. For instance, sensor nodes schedule the operation of their sensing devices to measure given physical quantities of interest, and wireless nodes probe the state of the channel via training. The problem of optimal data acquisition is studied for a cascade source coding problem, a distributed source coding problem and a two-way source coding problem assuming that the side information sequences can be controlled via the selection of cost-constrained actions. It is shown that a joint design of the description of the source and of the control signals used to guide the selection of the actions at downstream nodes
is generally necessary for an efficient use of the available communication links. Instead, the
problem of optimal channel probing is studied for a broadcast channel and a point-to-point link
in which the decoder is interested in estimating not only the message, but also the state sequence.
Finally, the problem of embedding information on the actions is studied for both the source and
the channel coding set-ups described above.

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Publications
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2. B. Ahmadi and O. Simeone, Distributed and Cascade Lossy Source Coding with a Side
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