



Contribution ID: 5

Type: **Tutorial lecture**

## **From Shannon Communication Theory to Semantic Coding: Towards Mining Zettabytes of Satellite Images**

*Monday, 28 November 2011 09:45 (45 minutes)*

**Abstract** During the past years, our capability to store, organize, and access large volumes of data has greatly exceeded our capability to extract information from the data. This has led to an enormous problem in accessing the data content, to extract the meaningful and useful information and knowledge. Thus, there have been developed new concepts and methods to deal with large data sets as: query by image content, data mining, and knowledge discovery. A broad range of techniques has been developed to deal with particular data types, such as natural language text, sound, and numerical records, and with heterogeneous data types, e.g. combining video and sound. Particularly, image information mining systems require both database, visual and linguistic capabilities, but there is an important bottleneck between these information concepts: the semantic gap. In his seminal paper “A mathematical theory of communication”, Shannon identified and recognized from the very beginning the semantic role of messages. However, at that moment he discarded its discussion, only considering as relevant the fact that communication system shall work independently of the message nature. From the Communication Theory perspective, a main challenge in extracting the image content is the fundamental difference between a traditional database record and images as signs. Faced with the image content extraction and communication to people, it is assured that the distinction between the perceptions of information as signals-signs-symbols is generally not dependent on the form in which the information is presented but rather on the content in which it is perceived, i.e. upon the intentions and expectations of the perceiver. The relation between the image as a sign and its information content expressed at semantic level is generally given by a similarity function. However, the relation of similarity is too generic to represent signification. Therefore, the image database requires specific interaction with the users, in form of a dialogue that enables the definition of an image semantics adapted to the user conjecture. The proposed solution is the assimilation in the Coding Theory of the Principle of Semantic Compositionality: the meaning of a whole is a function only of the meanings of its parts together with the manner in which these parts were combined. In this frame, there will be presented the basic evolution steps from Shannon communication channel to a semantic communication system, in which the image content is coded as a meaningful message: semantic coding. The semantic communication channel is modeled hierarchically from the signal level to the abstract semantic representation of the user. Generative models are used for conceptual representations, and latency is analyzed to extract the meaningful content. The presentation will continue with recent results in the algorithmic theory of complexity and their computational approximations. Finally, examples of applications dealing with parameter free data and image mining will be shown. The new concepts are exemplified with a variety of methods and systems for Image Information Mining, and Image Semantic Coding.

**Presenter:** DATCU, Mihai (German Aerospace Center DLR)

**Session Classification:** Imaging