Report on current work in signal design and compression algorithms for satellite data.

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In this talk I will report on two areas of my current research. The first part of the talk will be about approaches to the design of emitted radar waveforms. The second part will be about recent work on the design of practical compression algorithms for certain populations of satellite data.

Concerning the first part of the talk, the purpose of radar is to detect the presence of an object, and insofar as possible to also provide information about several of the object’s properties - for example, its location, its direction and rate of motion, and its scattering properties. This is accomplished by the emission of a signal and a subsequent analysis of the reflected signal for clues about the nature of the object.

A crucial component of an effective method for achieving this, the precise form of which depends on the information being sought, is the proper design of the emitted signal, together with the development of algorithms designed to take advantage of the resulting properties of the returned waveform.

There are natural limitations on the precision of such a process, connected with the uncertainty involved in any attempt to simultaneously reconstruct the range and velocity of a target system from the returning echo of an emitted signal. This is a manifestation of a pervasive principle in mathematics and physics, namely a form of Uncertainty Principle.

In radar waveform design, there is a function which expresses this uncertainty, called the Ambiguity Function, and my talk will be devoted to an exposition of some of the topics suggested by the above brief account - in particular the role of the Ambiguity Function in waveform design, as well as a description of my own approaches to these problems, some of which have been implemented in various software systems.

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The later part of the talk will be more in the character of a report on work in progress. I will discuss my approaches to the compression of Hyperspectral sounder data from NOAA's environmental satellites. I have been able to achieve quite high compression ratios for this data, which is critical in view of hardware limitations, and there is a high likelihood that my algorithms, or closely related ones, will be implemented for this purpose.

This research is undertaken for NOAA's GOES R Earth observation satellite series, to be launched in the year 2013, to enable greater distribution and use of NASA/NOAA's science data, both within the U.S. and internationally and is sponsored by NOAA/NESDIS. One of the algorithms that I have recently developed for satellite data compression is at the early stage of testing for robustness and error propagation tolerance. The techniques involve various ideas from Fourier analysis, as well as aspects of numerical analysis and statistics.