Software Radar and the Framer Pattern:
Applying Context to Continuously Recorded RF Data

Philip J. Erickson¹, Frank D. Lind², William J. Rideout³

¹Atmospheric Sciences Group, MIT Haystack Observatory, Westford, MA 01886 USA; pje@haystack.mit.edu
²flind@haystack.mit.edu
³wrideout@haystack.mit.edu

Abstract

Recent advances have created Software Radar implementations for pulsed radar systems. To maximize flexibility, continuous received and transmitted waveform voltage level recording of a given RF center frequency and bandwidth can be utilized along with a framer agent. The framer is a general software pattern which determines boundaries within recorded data streams and applies metadata to those intervals. We will discuss the nature of the framing software pattern and show implementation examples from the Millstone Hill MIDAS-M Software Radar system. We will also discuss mitigation strategies for framer implementation challenges, and will conclude by examining real time processing burdens.

Extended Summary

Recent advances in computing and software technology have allowed the production of Software Radar implementations for pulsed radar systems, where the largest extent of signal processing is implemented in software using general purpose computers and languages [1]. Software Radar architectures enable the practical processing of received radio frequency (RF) data with different signal processing choices and analysis goals, either during or following a radar experiment. To maximize the amount of flexibility, continuous voltage level recording of a given RF center frequency and bandwidth for both received and transmitted waveforms can be utilized. In order to analyze this data, this approach imposes the additional system requirement of a framer agent. The framer is a general software pattern which determines boundaries within recorded data streams and applies metadata to those intervals. In the specific context of pulsed radar experiments, framers determine radar illuminator parameters either from pre-existing metadata or from analysis of the transmitted waveform recording, and subsequently divide the continuous receiver data into individual radar pulses or frames. Key metadata components generated by radar framers include transmitted waveform amplitude and phase along with UTC referenced timing information. The radar framer agent is faced with challenges that include an inherently degenerate search space for identification of transmitted waveform sequences typical to ionospheric radar systems, and difficulties in locating the leading edge of radar pulses due to imperfect analog transmitter amplitude and phase performance.

We will discuss the nature of the framing software pattern and show examples from its implementation in the production quality Millstone Hill MIDAS-M Software Radar system, which operates the megawatt class incoherent scatter radar system at MIT Haystack Observatory for upper atmospheric remote sensing. We will also discuss mitigation strategies for radar framer metadata generation difficulties through injection of a minimum set of constraining information generated by the transmitting radar control system. We will conclude by examining processing burdens for real time framing performance.

References