Joint Carrier-Phase Synchronization and LDPC Decoding

Soft feedback from an LDPC decoder would enhance performance of a PLL.

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A method has been proposed to increase the degree of synchronization of a radio receiver with the phase of a suppressed carrier signal modulated with a binary-phase-shift-keying (BPSK) or quaternary-phase-shift-keying (QPSK) signal representing a low-density parity-check (LDPC) code. This method is an extended version of the method described in "Using LDPC Code Constraints to Aid Recovery of Symbol Timing" (NPO-43112), *NASA Tech Briefs*, Vol. 32, No. 10 (October 2008), page 54. Both methods and the receiver architectures in which they would be implemented belong to a class of timing-recovery methods and corresponding receiver architectures characterized as pilotless in that they do not require transmission and reception of pilot signals.

The proposed method calls for the use of what is known in the art as soft decision feedback to remove the modulation from a replica of the incoming signal prior to feeding this replica to a phase-locked loop (PLL) or other carrier-tracking stage in the receiver. "Soft decision feedback" refers to suitably processed versions of intermediate results of iterative computations involved in the LDPC decoding process. Unlike a related prior method in which hard decision feedback (the final sequence of decoded symbols) is used to remove the modulation, the proposed method does not require estimation of the decoder error probability.

In a basic digital implementation of the proposed method (see figure), the incoming signal (having carrier phase θ_c) plus noise would first be converted to in-phase (I) and quadrature (Q) baseband signals by mixing it with I and Q signals at the carrier frequency $[\omega_c/(2\pi)]$ generated by a local oscillator. The resulting demodulated signals would be processed through one-symbol-period integrate-and-dump filters, the outputs of which would be sampled and held, then multiplied by a soft-decision version of the baseband modulated signal. The resulting I and Q products consist of terms proportional to the cosine and sine of the carrier phase θ_c as well as correlated noise components. These products would be fed as inputs to a digital PLL that would include a number-controlled oscillator (NCO), which provides an estimate of the carrier phase, $\hat{\theta}_c$.

This work was done by Marvin Simon and Christopher Jones of Caltech and Esteban Valles of the University of California, Los Angeles, for NASA's Jet Propulsion Laboratory.

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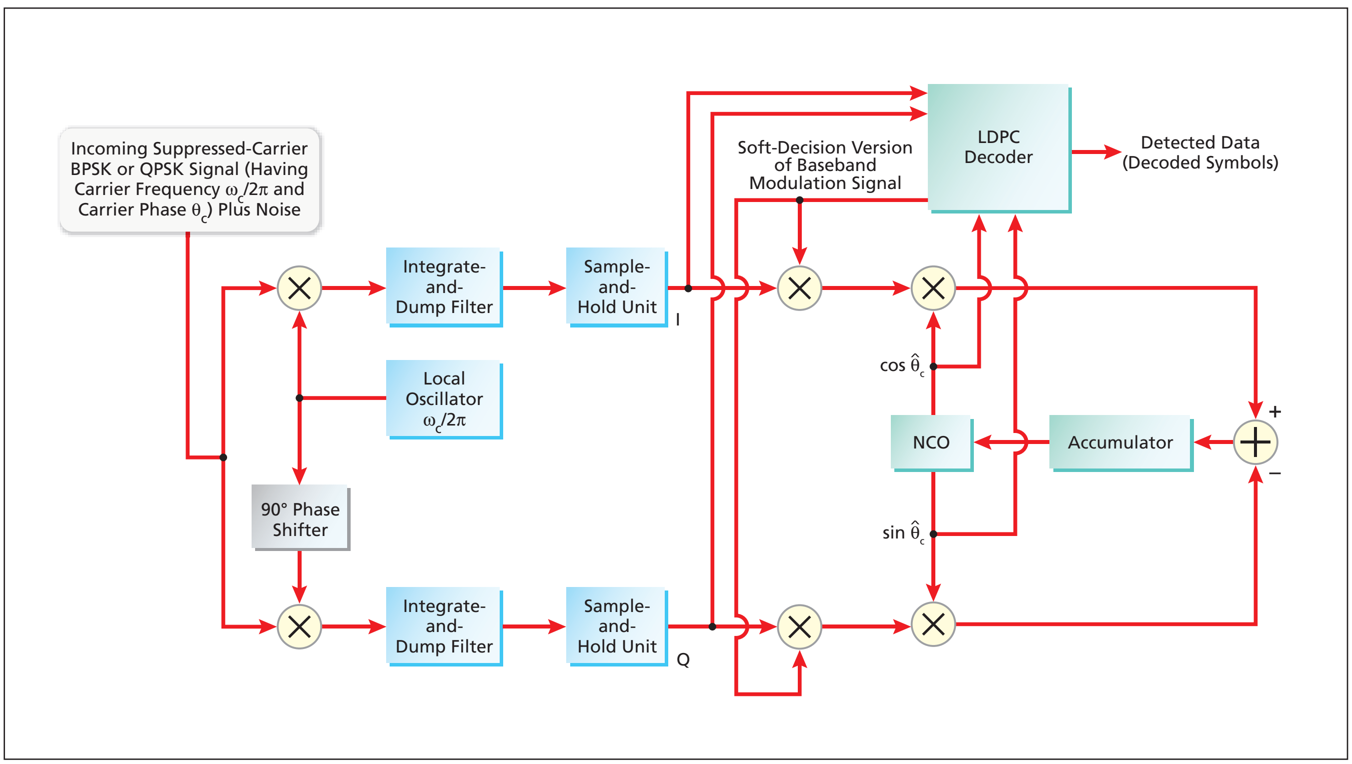

This **Digital Signal-Processing System** iteratively removes carrier phase modulation from the incoming suppressed carrier modulated signal.