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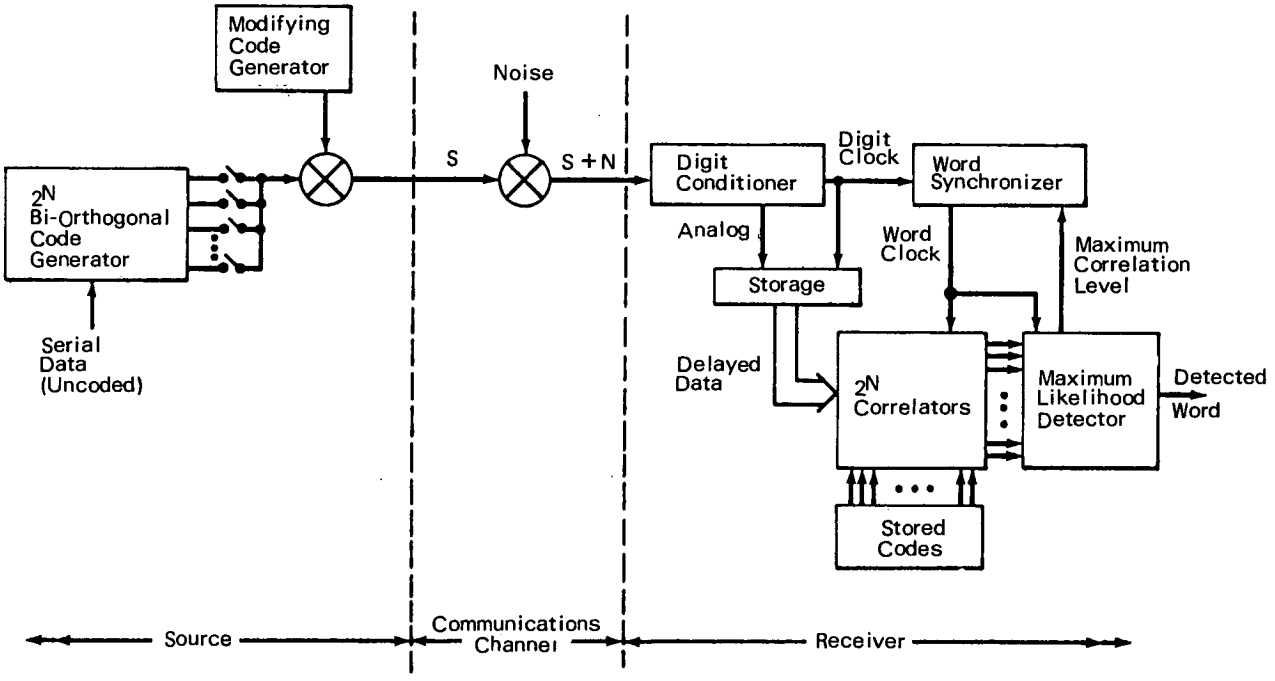
NASA TECH BRIEF

Goddard Space Flight Center

Self-Synchronizing, Bi-Orthogonal Coded PCM Telemetry System

A communications and data handling system employs a self-synchronizing, bi-orthogonal binary code that improves the signal-to-noise ratio when the transmission channel is perturbed by noise. The coded telemetry system for long distance communication consists of an airborne source, a gaussian additive-noise channel, and a ground receiver unit (see fig.). The airborne unit receives a random binary signal from the aircraft data handling subsystem and transforms it into a bi-orthogonal code. This code is modified by a self-synchronizing code, and the result is a binary code which needs only a single communication channel without additional bandwidth for word synchronization information.



The ground receiver unit consists of a digit conditioner, a storage unit, a set of cross-correlators, a maximum likelihood detector, and a word synchronizer. The digit conditioner input consists of the coded source digits which have been perturbed by channel noise. The output is a stream of periodic pulses, which are synchronous with the incoming source digits and channel noise for a digit clock period.

Correlating the received signal with stored replicas of the code set is accomplished by first storing the analog level from the digit conditioner for one word period. This stored information is then correlated with the stored code replicas (one correlator

(continued overleaf)

is used for each possible source code). The gaussian noise perturbs a transmitted code, and the noisy signal is cross-correlated with all members of the code set. The output of each correlator is normally distributed about the noise-free correlation values once synchronization is obtained. The maximum likelihood detector selects the correlator with the maximum correlation level, thereby providing an optimum decision for each word-period at word synchronization time.

Word synchronizing is obtained by utilizing the self-synchronization property of the source code set and the digit clock which generates word pulses. Coherence between the derived word pulses and the code synchronizing time is obtained by using the self-synchronizing property of the code set. In the out-of-phase position, the maximum correlation level at the correlator outputs can vary from maximum to minimum values in the absence of noise. In this class of code sets, the set with the lowest average correlation in the out-of-phase position has the best synchronizing property, since coherence is achieved by synchronizing on the maximum word-period correlation value occurring at the word synchronizing time. A word error-detector is incorporated to provide a quantitative measure of overall system performance. Word errors are detected by comparing a known source signal, before coding, with the detected signal at the output of the maximum likelihood detector.

The advantages achieved by this telemetry system as compared to an uncoded system include a 40% farther communications capability, with given probability of bit error and with the same transmitter power.

Note:

The following documentation may be obtained from:

National Technical Information Service
Springfield, Virginia 22151
Single document price $3.00
(or microfiche $0.95)

Reference:
NASA-TR-R-292 (N68-36333), Self-Synchronizing Bi-Orthogonal Coded PCM Telemetry System

Patent status:

No patent action is contemplated by NASA.

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