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NASA TECH BRIEF

Langley Research Center

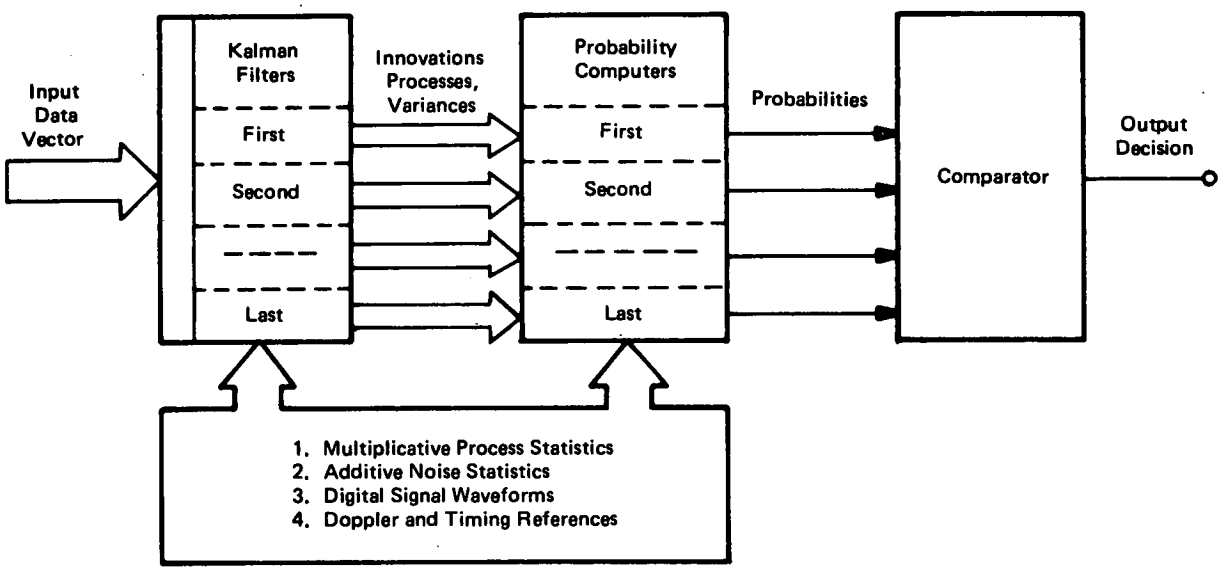
Anti-Multipath Digital Signal Detector

A digital signal detector was developed which operates in conjunction with the radio frequency portion of a receiver to detect digital signals transmitted in known modulation formats. The transmitted signal is constructed by assigning known and distinct modulation waveforms to a sequence of message symbols, or digits. The basic digital message, which the detector is to reconstruct, consists of a sequence of digits, each lasting for a fixed time and each picked from an alphabet of arbitrary, but fixed, size. It reconstructs the transmitted digital sequence with a minimum probability that any reconstructed digit will be in error.

The detector does not operate on the received signal continuously in time. Rather, operation is on samples of the received signal, taken at time intervals spaced uniformly within the basic digit interval. The number of data samples taken during detection of one message digit is a design variable, restricted only by the speed of the detector digital logic. Each data sample is encoded into a digital format, suitable to the detector logic, by the analog-to-digital converter. The detector operates on the samples recursively, requiring storage of no more than one data sample at any given time.

Internally, the detector produces estimates of the perturbations of the received signal which were caused by the multipath. The estimates are used to improve detection of the transmitted digital symbol. It is a multipath canceling device which makes maximum use of digital computation, which markedly reduces physical size and complexity over analog, nonsampled-data versions, or nonrecursive digital versions.

Digital data from an analog-to-digital converter is routed to paralleled inputs of Kalman filters, as shown in the illustration. This data may be in vector form, resulting from in-phase and quadrature demodulation of the signal carrier. Innovations processes and their



Digital Signal Detector

(continued overleaf)

variances are routed from each filter to a corresponding probability computer. There are as many filter-probability computer combinations as there are digits in the transmitted alphabet (two for a binary signal, three for a ternary signal, etc.).

The first filter produces (possibly vector) estimates of the multipath perturbations of the received signal, under the assumption that the modulated signal corresponding to the first digit in the alphabet was transmitted. Each other filter produces multipath estimates under the differing assumptions that the other digits were transmitted. From these estimates and the corresponding computed error variances, the innovations processes and their variances are formed, as a byproduct of the filtering process. These latter quantities are routed to each corresponding probability computer.

The first computer calculates the probability that the first digit in the alphabet was transmitted. Each other computer calculates the alternative probabilities that the other digits in the alphabet were transmitted. These calculations are made each time a data sample is processed. The probability numbers are updated each time a data sample is processed. At the end of the time period allotted to the transmitted message digit after the last data sample has been processed, the updated probability numbers are compared in amplitude in the comparator. The message digit which yields the highest probability is produced at the output.

At the beginning of the next message digit period, the estimates in the filters which were operating under the "wrong" assumptions during the previous period are reset to equal the last estimates of the "correct" filter, as determined by the decision on which digit was transmitted. In this manner, the detector proceeds to reconstruct each digit in the received message sequence.

Note:

Requests for further information, including computational algorithmic descriptions of the operations performed during each message period by any one of the filter-probability computer branches, may be directed to:

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Patent status:

Inquiries concerning rights for the commercial use of this invention should be addressed to:

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