Automated Monitoring With a BCP Fault-Decision Test

Fault-detection events are evaluated to reduce the incidence of false alarms.

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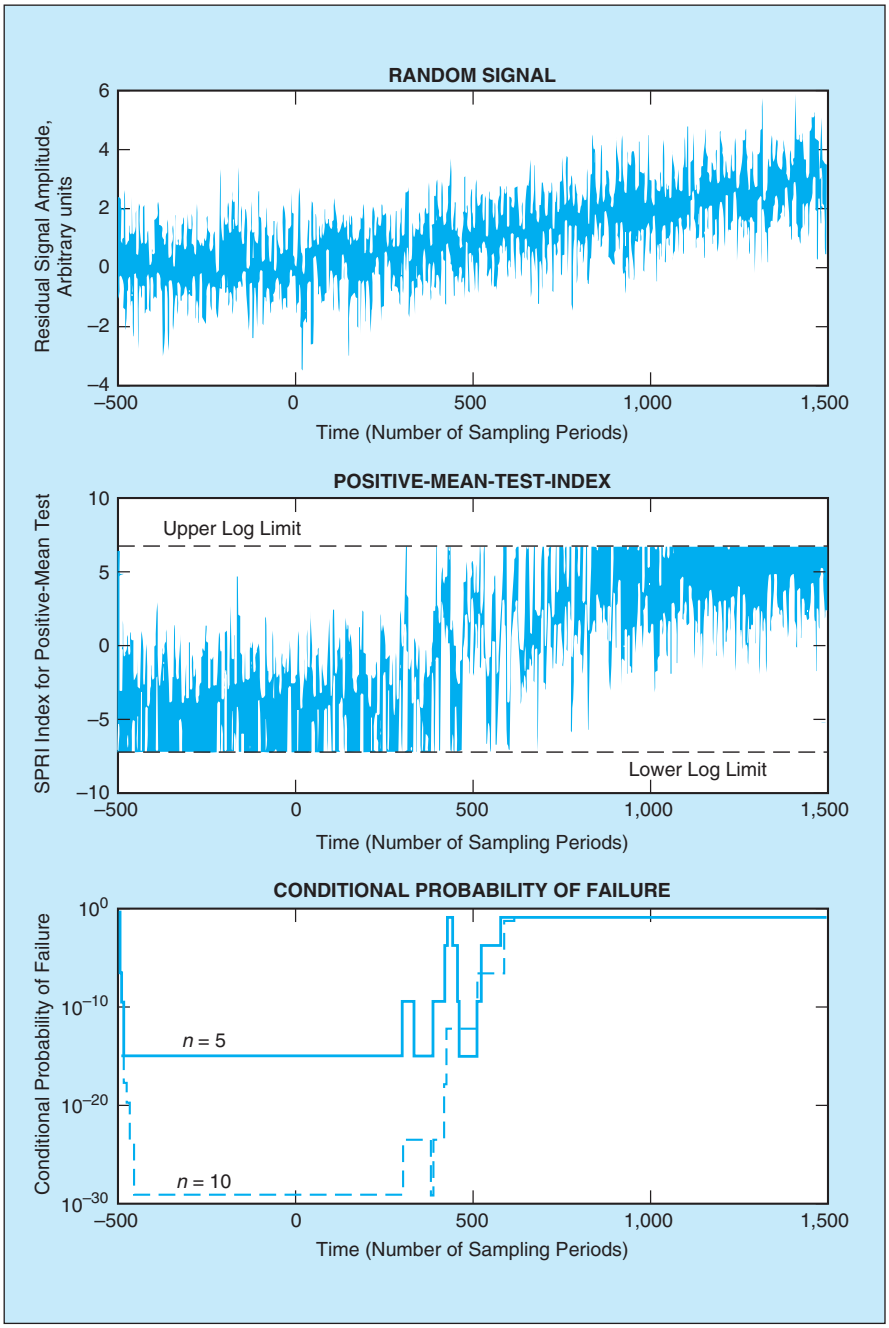
The Bayesian conditional probability (BCP) technique is a statistical fault-decision technique that is suitable as the mathematical basis of the fault-manager module in the automated-monitoring system and method described in the immediately preceding article. Within the automated-monitoring system, the fault-manager module operates in conjunction with the fault-detector module, which can be based on any one of several fault-detection techniques; examples include a threshold-limit-comparison technique or the BSP or SPRT technique mentioned in the preceding article. The present BCP technique is used to evaluate a series of one or more fault-detection events for the purpose of filtering out occasional false alarms produced by many types of statistical fault-detection procedures. The BCP technique increases the probability that an automated monitoring system produces a correct decision regarding the presence or absence of a fault.



These **Plots Were Generated** in an application of the BCP technique, in conjunction with the SPRT technique, to data from a simulated sensor failure that manifested itself in a slow drift of the sensor output. As soon as the number of "fault" decisions reached by the SPRT exceeded the number of "normal" decisions, the conditional probability exceeded a confidence level, causing the BCP test to conclude that a failure had occurred.

Because occasional false alarms are an inevitable consequence of the SPRT, BSP, or any other statistically based fault-detection test, there is a need for a logical procedure to distinguish between true and false alarms. Heretofore, it has been common practice to make a fault decision on an *ad hoc* basis — for example, by following a multiple-observation voting strategy in which a signal is declared to be indicative of a fault if m of the last n observations produced a fault-detection alarm. The BCP technique was developed to obtain results more reliable than those afforded by a voting strategy.

The BCP technique involves a test in which one applies Bayesian inference techniques to a series of one or more single-observation alarms produced by a fault-detection test. One considers the last n decisions generated by a fault-detection test in order to evaluate the conditional probability that a failure is indicated (see figure). Each new decision reached by a fault-detection test is treated as a new piece of evidence about the state of the monitored asset, and the conditional probability of failure for the system is updated on the basis of this new evidence. The conditional probability of failure is compared with a predefined limit. For a probability below the limit, the asset is declared to be healthy. For a probability above the limit, the asset is declared to be faulty.

This work was done by Randall L. Bickford of Expert Microsystems, Inc., and James P. Herzog of Argonne National Laboratory for **Marshall Space Flight Center.** *This technology is immediately available using the SureSense™ Signal Validation System software produced by Expert Microsystems, Inc. For more information, contact the company at (916) 989-2018 or at expert@expmicrosys.com.*
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