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Hybrid Redundancy System for Improving Reliability: A Concept

A hybrid redundancy system has been conceived to improve the reliability of fault-tolerant computers and other complex electronic equipment. The system combines two well-known concepts: triple modular redundancy (TMR), and spares (replacement system) redundancy. The system is represented as a model consisting of a TMR core of triplicated active units, with an associated bank of specifically arranged standby spare units. When one of the basic TMR units fails, a spare unit replaces it and restores the TMR core to the "all-perfect" state. The active TMR units are assumed to have a specific failure rate, while the standby spare units (which are said to be in a dormant mode) have a failure rate equal to or less than that of the TMR units.

In an actual hybrid system, a detector would compare the system output with each of the triplicated TMR units. When a disagreement occurs, a switching device would cut off the discrepant TMR unit and switch in one of the spares. If the spare fails while in the dormant mode, the disagreement will still exist and the switching device would replace it with another spare. The hybrid system reduces to a simple TMR system when all the spares have been exhausted; and the whole system fails upon the exhaustion of all the spares and the failure of any two of the basic triplicated units.

The characteristic reliability equation of the hybrid system model was derived and analyzed under the assumption that the failures of the individual units follow an exponential law and are statistically independent. Curves plotted from the characteristic equation show that the hybrid system has a significantly greater reliability than conventional TMR systems.

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:
JPL Technical Report 32-1467 (N70-28081), Reliability Modeling and Analysis of a Dynamic TMR System Using Standby Spares

Patent status:

No patent action is contemplated by NASA.

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