

Quantum Search in Hilbert Space

A large database would be searched in one quantum computing operation.

A proposed quantum-computing algorithm would perform a search for an item of information in a database stored in a Hilbert-space memory structure. The algorithm is intended to make it possible to search relatively quickly through a large database under conditions in which available computing resources would otherwise be considered inadequate to perform such a task.

The algorithm would apply, more specifically, to a relational database in which information would be stored in a set of N complex orthonormal vectors, each of N dimensions (where N can be exponentially large). Each vector would constitute one row of a

unitary matrix, from which one would derive the Hamiltonian operator (and hence the evolutionary operator) of a quantum system. In other words, all the stored information would be mapped onto a unitary operator acting on a quantum state that would represent the item of information to be retrieved. Then one could exploit quantum parallelism: one could pose all search queries simultaneously by performing a quantum measurement on the system. In so doing, one would effectively solve the search problem in one computational step.

One could exploit the direct- and inner-product decomposability of the unitary matrix to make the dimensionality of the

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memory space exponentially large by use of only linear resources. However, inasmuch as the necessary preprocessing (the mapping of the stored information into a Hilbert space) could be exponentially expensive, the proposed algorithm would likely be most beneficial in applications in which the resources available for preprocessing were much greater than those available for searching.

This work was done by Michail Zak of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free on-line at www.nasatech.com.
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Analytic Method for Computing Instrument Pointing Jitter

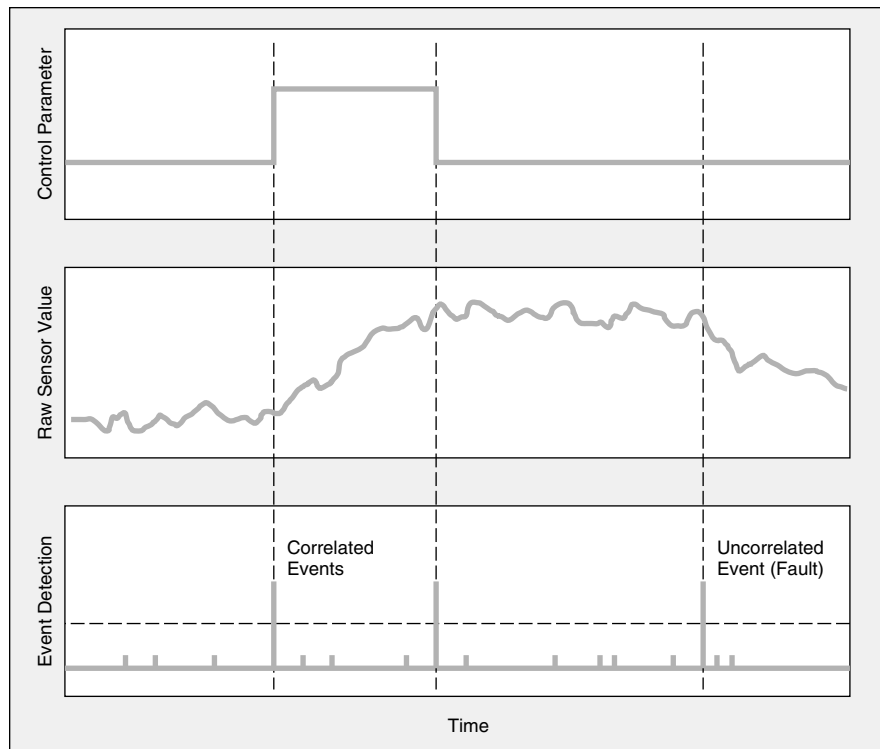
Jitter can be computed more efficiently.

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A new method of calculating the root-mean-square (rms) pointing jitter of a scientific instrument (e.g., a camera, radar antenna, or telescope) is introduced based on a state-space concept. In comparison with the prior method of calculating the rms pointing jitter, the present method involves significantly less computation.

The rms pointing jitter of an instrument (the square root of the jitter variance shown in the figure) is an important physical quantity which impacts the design of the instrument, its actuators, controls, sensory components, and sensor-output-sampling circuitry. Using the Sirlin, San Martin, and Lucke definition of pointing jitter, the prior method of computing the rms pointing jitter involves a frequency-domain integral of a rational polynomial multiplied by a transcendental weighting function, necessitating the use of numerical-integration techniques. In practice, numerical integration complicates the problem of calculating the rms pointing error. In contrast, the state-space method provides exact analytic expressions that can be evaluated without numerical integration.

The theoretical foundation of the state-space method includes a representation of the pointing process as a stationary process generated by a state-space model driven by white noise. The



Instantaneous and Statistical Quantities are used to characterize the pointing of an instrument (that is, rotation of the instrument about an axis). The quantities shown here pertain to a pointing process $y(t)$ at instant of time t during an observation interval (window) of duration T that starts at time τ , $E[\]$ is an expectation operator denoting the ensemble average of the bracketed term, $n(t)$ is a zero-mean white-noise process, and $Cov[\]$ is an ensemble-average covariance operator.

state-space formulation results in the replacement of the aforementioned weighted frequency integral with the cal-

culational of a matrix exponential. Additional simplifications may be possible in certain applications by taking

advantage of well-known matrix exponential expressions and/or inverse Laplace transform relationships. Two useful examples of such simplifications are given in the report. In addition to

simplifying the calculations, the closed-form expressions provide insight into physical mechanisms of jitter.

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Laboratory. *For further information, access the Technical Support Package (TSP) **free on-line at www.nasatech.com**. NPO-30525*