supervisor intentionally or unintentionally deviates from activities previously planned in coordination with robot activities directed toward a goal, (2) the robot fails to execute a command as directed or fails to do anything else required of it within a maximum allowable time, or (3) the robot environment changes or is progressively revealed to be significantly different from what was previously assumed.

The planner part of the intelligent assistant must respond gracefully to such violations and notify the human supervisor. Graceful response must include replanning, for which it is necessary to cause the state model to revert to the most recent known state of the robot. In re-planning, it is also necessary to recognize which goals have been reached so as not to again expand and schedule the constituent tasks involved in reaching those goals.

The purpose served by the assistant is to provide advice to the human supervisor about current and future activities, derived from a sequence of high-level goals to be achieved. To do this, the assistant must simultaneously monitor and react to various data sources, including (1) actions taken by the supervisor, including commands being issued by the supervisor to the robot; (2) actions taken by the robot as reported with delay; (3) the environment of the robot as currently perceived with time delay; and (4) the current sequence of goals. As any of these change, the assistant must respond appropriately, detecting both normal completion of tasks and exceptional conditions.

This work was done by Mark Johnston and Kenneth Rabe of Caltech for NASA's Jet Propulsion Laboratory.

The software used in this innovation is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-43520.

Minimizing Input-to-Output Latency in Virtual Environment

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A method and apparatus were developed to minimize latency (time delay) in virtual environment (VE) and other discrete-time computer-based systems that require real-time display in response to sensor inputs. Latency in such systems is due to the sum of the finite time required for information processing and communication within and between sensors, software, and displays. Even though the latencies intrinsic to each individual hardware, software, and communication component can be minimized (or theoretically eliminated) by speeding up internal computation and transmission speeds, time delays due to the integration of the overall system will persist. These "integration" delays arise when data produced or processed by earlier components or stages in a system pathway sit idle, waiting to be accessed by subsequent components. Such idle times can be sizeable when compared with latency of individual system components and can also be variable in duration because of insufficient synchrony between events in the data path. This development is intended specifically to reduce the magnitude and variability of idle-time type delays and thus enable the minimization and stabilization of overall latency in the complete VE (or other computer) system.

This work was done by Bernard D. Adelstein and Stephen R. Ellis of Ames Research Center and Michael I. Hill of San Jose State University Foundation. Further information is contained in a TSP (see page 1).

This invention is owned by NASA and a patent application has been filed. Inquiries concerning rights for the commercial use of this invention should be addressed to the Ames Technology Partnerships Division at (650) 604-5761. Refer to ARC-15102-1.