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**CATEGORY 2 - SOFTWARE SYSTEMS**

**Intelligent Systems Technology Infrastructure for Integrated Systems**  
by Dr. Henry Lum, ARC

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A system infrastructure must be properly designed and integrated from the conceptual development phase to accommodate evolutionary intelligent technologies. Several technology development activities were identified that may have application to rendezvous and capture systems. Optical correlators in conjunction with fuzzy logic control might be used for the identification, tracking, and capture of either cooperative or non-cooperative targets without the intensive computational requirements associated with vision processing. A hybrid digital/analog system has been developed and tested with a robotic arm. An aircraft refueling application demonstration is planned within two years. Initially this demonstration will be ground based with a follow-on air based demonstration. System dependability measurement and modeling techniques are being developed for fault management applications. This involves usage of incremental solution/evaluation techniques and modularized systems to facilitate reuse and to take advantage of natural partitions in system models. Though not yet commercially available and currently subject to accuracy limitations, technology is being developed to perform optical matrix operations to enhance computational speed. Optical terrain recognition using camera image sequencing processed with optical correlators is being developed to determine position and velocity in support of lander guidance. The system is planned for testing in conjunction with Dryden Flight Research Facility. Advanced architecture technology is defining open architecture design constraints, test bed concepts (processors, multiple hardware/software and multi-dimensional user support, knowledge/tool sharing infrastructure) and software engineering interface issues.

**Results of Prototype Software Development for Automation of Shuttle Proximity Operations**

by H. Hiers, JSC and  
O. Olszewski, Lockheed Engineering and Sciences Company

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The effort involves demonstration of expert system technology application to Shuttle rendezvous operations in a high-fidelity, real-time simulation environment. The JSC Systems Engineering Simulator (SES) served as the test bed for the demonstration. Rendezvous applications were focused on crew procedures and monitoring of sensor health and trajectory status. Proximity operations applications were focused on monitoring, crew advisory, and control of the approach trajectory. Guidance, Navigation and Control areas of emphasis included the approach, transition and stationkeeping guidance and laser docking sensor navigation. Operator interface displays for monitor and control functions were developed. A rule-based expert system was developed to manage the relative navigation system/sensors for nominal operations and simple failure contingencies. Testing resulted in the following findings: 1) the developed guidance is applicable for operations with LVLH stabilized targets; 2) closing rates less than 0.05 feet per second are difficult to maintain due to the Shuttle translational/rotational cross-coupling; 3) automated operations result in reduced propellant consumption and plume impingement effects on the target as compared to manual operations; and 4) braking gates are beneficial for trajectory management. A versatile guidance design has been demonstrated. An accurate proximity operations sensor/navigation system to provide relative attitude information within 30 feet is required and redesign of the existing Shuttle digital autopilot should be considered to reduce the cross-coupling effects. This activity has demonstrated the feasibility of automated Shuttle proximity operations with the Space Station Freedom. Indications are that berthing operations as well as docking can be supported.

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