U.S. Automated Rendezvous and Capture Capabilities Review
Category 1- Hardware Systems

595-18
N93-22821
146805
P-2

Abstract Title: AR&D Image Processing System

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Technical Details:

General Dynamics has developed advanced hardware, software, and algorithms for use with the Tomahawk cruise missile and other unmanned vehicles. We have applied this technology to the problem of locating and determining the orientation of the docking port of a target vehicle with respect to an approaching spacecraft. The system described in this presentation utilizes a multi-processor based computer to digitize and process television imagery and extract parameters such as range to the target vehicle, approach velocity, and pitch and yaw angles. The processor is based on the Inmos T-800 Transputer, and is configured as a loosely coupled array. Each processor operates asynchronously and has its own local memory. This allows additional processors to be easily added if additional processing power is required for more complex tasks. Total system throughput is approximately 100 MIPS (scalar) and 60 MFLOPS and can be expanded as desired. The algorithm implemented on the system uses a unique adaptive thresholding technique to locate the target vehicle and determine the approximate position of the docking port. A target pattern surrounding the port is than analyzed in the imagery to determine the range and orientation of the target. This information is passed to an autopilot which uses it to perform course and speed corrections. Future upgrades to the processor are described which will enhance its capabilities for a variety of missions.

Historical Background:

For several years we have persued the development of systems to perform target detection and recognition, autonomous navigation, and other advanced imaging guidance functions for cruise missiles and other unmanned vehicles. Limitations in available power and volume as well as the need for significant data processing throughput has caused us to develop a family of powerful compact multiprocessor systems. These systems are based on the Inmos Transputer, a 32 bit microprocessor designed for use in multi-processor systems. Transputers can be used to create loosely coupled arrays with each processor having its own local memory and communicating with other processors via high speed serial links. The loosely coupled nature of the array allows it to be easily reconfigured and extended to provide increased processing throughput if required. This allows a flexibility not generally available with bus-based or traditional tightly coupled multi-processor systems.

We have developed several systems based on the above technology. These include our Combat Vehicle VHSIC Integrated System (CVIS) processor designed to meet military temperature and vibration requirements for tanks and other armored vehicles,

flight ready image processing and data collection systems for our Advanced Technology Laser Radar (ATLAS) program, and various other desktop and hardened processors. We have also developed software packages for our processors. These include operating systems and run-time kernals customized for each processor's particular needs. Finally, we have implemented a wide variety of algorithms in several higher order languages. The algorithms perform target detection and recognition as well as guidance, navigation and control functions.

System Testing and Demonstration. All three components of the systems (hardware, software, and algorithms) have been demonstrated and tested in both laboratory and field test environments. Our ATLAS processors, for example, are presently undergoing preliminary flight test evaluation. The CVIS processor was delivered to the Army in 1990 and is being used to develop advanced target tracking and fire control software.

Program Sponsorship. Work on the CVIS processor is sponsored by the Army Research Development and Engineering Center (ARDEC) in Dover, New Jersey. ATLAS work is sponsored by the Armament Directorate of the Air Force Wright Laboratory in Eglin, Fla.