Defense Science Board

Task Force on Supercomputer Applications

Meeting Minutes

Date/Place

9:30 a.m. - 5:30 p.m. 13 July 1983
9:00 a.m. - 3:00 p.m. 14 July 1983
DARPA Headquarters, Rosslyn, Va.

Attendees
Task Force Members:
Dr. Joshua Lederberg, Chairman
CDR Ronald B. Ohlander, Executive Secretary
Lt. Gen. John H. Cushman USA (ret)
Adm. Bobby Inman, USN (ret)
Dr. Frederick P. Brooks
Dr. Charles M. Herzfeld

Invited Guest Participants:
James Painter, USMC HQ
Joseph Batz OUSDRE

Business

The fourth meeting of the DSB Task Force on Supercomputer Applications was opened by the Chairman, Dr. Joshua Lederberg. The primary objectives of this meeting were to gain additional familiarity with military defense systems requirements and artificial intelligence (AI) technology and converge on the identification of candidate applications for super intelligent computers. After the brief introductory remarks, the task force then received additional inputs in the series of briefings on military applications and AI technology. Copies of briefing charts are appended to these minutes.

The first presentation was provided by Harvey Cragon of Texas Instruments and concerned Lisp machine technology. He traced the history of Lisp machine development starting with the first implementations of Lisp on the general purpose DEC computers. The features that made this machine amenable to Lisp implementation were primarily its stack capabilities and half-word address operations. The DEC-10 and Dec-20 machines were for many years the primary Lisp engines of the AI scientific community. These machines, however, suffered from two shortcomings. They were address limited and were also relatively expensive in terms of the computing power needed to solve major AI problems. To address these problems, the MIT AI Lab commenced the development of a specialized Lisp architecture. Among its features it included, specialized memory instructions, increased addressability, tag architecture, special data operations, optimized garbage collection, stack features, and microcoded Lisp instructions. The machine was a personal workstation and offered powerful computing resources at low cost. It set the standard for the current set of Lisp architectures and was picked up for commercial development by two startup companies. Currently, the distinguishing feature of Lisp machines is that they are specialized to offer symbolic computing at low cost. Many of the more general machine architectures could host Lisp but could not achieve the same performance/cost ratio.

The second presentation concerned autonomous underwater vehicles. The first part of the briefing centered around an actual vehicle being built by Lincoln Laboratories for the Strategic Technology Office of DARPA. The vehicle would have the endurance, sensing, and control capabilities to perform the minimal task of transiting to a point and returning. In order to perform additional tasks such as complex navigation, surveillance and avoidance operations, the vehicle would have to incorporate reasoning and planning capabilities. The second part of the briefing by David McKeown from Carnegie-Mellon University covered some of the issues concerning underwater navigation and the task of constructing a feature map of an ocean or bay bottom. The conceptual approach proposed a knowledge-based control system that could plan a mission and also alter actions during the course of the pre-planned mission. the system had been simulated on a VAX computer. On the basis of the briefing, it was apparent that considerable computing power in a relatively small package would be required for the autonomous underwater vehicle problem to do anything interesting.

There was some discussion concerning the current limitations of rule-based systems and the most appropriate environment for research in the autonomous vehicle domain. It was felt that current technology limited systems to about 1500 rules. It was also conjectured that future limitations of systems might not be based on computational limitations but the sheer difficulty in gathering rules from experts.

The underwater environment was contrasted with that of the air and ground vehicle environments. It was agreed that the ground environment was the most difficult because of the constant need to avoid obstacles in the simplest movement scenarios. A ground vehicle was in constant danger of running into a tree or rock or going into a ditch. Both the air and underwater environments were considerably less cluttered. The air environment offered much better visual perception for a vehicle but the real-time reaction requirements were conjectured to be much more severe. While an underwater vehicle was essentially limited to acoustic sensing, it would have relatively much more time to reason about its necessary functions before action had to be taken.

The third briefing was on autonomous terminal homing presented by the TASC Corporation. Their approach utilized point-to-point navigation and used scene matching in both midcourse and terminal guidance. IR and coherent radar sensors were available. The ability of a missile to fly a given path is highly dependent on pre-stored models and the capacity to match sensory data to these stored models. There is very little capability to maneuver freely for threat avoidance. Future research would concentrate on instilling the capability to update data in flight in order to avoid threats. Much of the computation for current systems is done on the ground. It would be much better to move it to the missile. The process of setting up reference data and models was essentially manual in nature and very laborious. It was felt that expert system technology could be of great assistance in this area. A good terminal homing capability also required damage assessment. This is currently an unsolved problem.

The task force next went into some discussion on the utility of speech applications. It was readily agreed that speech understanding had application in an office environment and for intelligence gathering. There was more critical discussion of the role of automatically recognized speech as an input medium in command and control systems. It might have some application in situations where the operator's movements were constrained such as for a pilot in the cockpit of a sophisticated fighter aircraft. In such a situation, however, was speech understanding necessary or only speech recognition, i.e. of a limited vocabulary? The task force would try to pursue this topic further at a later date by obtaining a briefing from knowledgeable sources such as the Air Force laboratories.

There was also some discussion on distributed wargaming and simulation. The point was made that the military had little opportunity to understand their craft by participation in its practice. Simulation was important to understand war. Wargaming simulations should be both people and computer intensive. Computers should provide the scenarios and keep the events proceeding while people would react to the situations. It was decided that Gen. Cushman would brief the task force on this subject at the next meeting date in Washington D.C.

The last order of business for the task force involved future meetings. It was decided to hold the next meeting at Stanford in Palo Alto on the 16th and 17th of August and the one subsequent to that at Carnegie-Mellon University in Pittsburgh. For Stanford, we would try to get briefings from Tom Binford on computer vision, Rick Hayes-Roth on Expert System technology, and Doug Lenat and Al Clarkson on computer learning and the application of the discovery process to military applications.

Certified: ________________
Joshua Lederberg,
Chairman