JPL / UCLA Meeting on Sensor Networks

August 12, 2003
Projects Using Distributed Computing

- Fixed topology - physically connectedness
  - I2C-based control using widget boards (e.g. Rocky 8)
  - Ethernet/FireWire FPGA-based computing and control (e.g. future rovers)
- Changing topology – wireless connectedness (Axel Concept)
  - Mobile units
  - Reconfigurable robots
  - Fault detection and recovery
- CLARAty
  - Reusable robotic software on heterogeneous platforms
Distributed Control for Rocky 8

Fixed Topology – physical connectedness

Widget Board
- 16 MHz 16xx PIC processor
- Single-axis motion controller (HCTL 1100)
- On-board analog filter
- 10 digital I/O lines
- 8 (12-bit) single-ended analog-to-digital
- 8 (8-bit) digital-to-analog conversion

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IAN
Distributed Robotic Exploration Concept

Changing Topology - wireless connectivity
Distributed Robotic Exploration Concept

Axel Concept - Wireless Connectivity

Axel2

Axel4

Axel6

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Axel Concept - Wireless Connectivity

Docking
Distributed Robotic Exploration Concept

Axel Details

Intel's Centrino Board?

Deploy sensors

Symmetric science module (operates upside down/right-side up)

Science Module covered w/ solar cells

One DOF arm

Passive Joint (constrained roll & yaw)

End effector scoops OR Science Instrument

Spring Joint

Mechanical Interface (Conical Surface)

Electrical Connections

Roll

Yaw

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Distributed Robotic Exploration Concept

• Joint proposal on Axel submitted to Mars Exploration Program
  - JPL (organizer and previous lead)
  - University of Minnesota (lead - Prof. Nikos Papanikolopoulos)
  - Intel (Jim Bulter, Myron Hattig)
  - Purdue University (lead – Prof. Ray Cipra)
  - Arkansas Tech University (Prof Murray Clark)

• Proposal includes:
  - Continuation of feasibility studies on Axel concept
  - Development of several prototypes at various universities
  - Use Intel’s Centrino boards
CLARAty – Reusable Robotic Software

DYNAMIC REPLANNING

Functional Level access through method calls at level of object hierarchy appropriate for goal.

Resource predictions and local plans during elaboration.

State values and resource usage during execution.

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Backup Slides
Intel's Initiative

• Intel is leading an open source robotic initiative under the Proactive Computing program focusing on the following areas:
  – Standardization of robotic software - RETF (robotic engineering task force)
  – Distributed sensor networks using mobile robots to support them
  – Development of common computing robotic hardware
    • Low power, small footprint Stayton board – uses 400 MHz XScale processor, flash, and runs Linux
    • Phase 2 – developing next generation Centrino board/processor which adds floating point support
JPL / Intel Interaction

- Several email exchanges and telecon with Intel and JPL:
  - Center for Integrated Space Microsystems (L. Alkalai)
  - Mars Technology Program office (R. Volpe)
  - CLARAty (JPL's robotic software for research) (I. Nesnas)
- CLARAty task manager attended the second Annual Robotic Workshop at Intel held in Portland Oregon – January 2003
- CLARAty/JPL hosted Intel for ½ a day of discussions with participation of robotic managers to explore future collaborations with the Intel open source initiative
  - Intel and JPL exchanged presentations on current robotic initiatives related to common robotic hardware and software
  - Intel is participating and sponsoring universities in the DARPA Grand Challenge (JPL not participating)
- CLARAty was invited to a special session initially organized by Intel and later by USC on robotic standardizations at the IROS conference.
Possible Areas of Collaboration JPL/Intel

- CLARAty interested in working with Intel and UCLA in defining specifications for standard robotic hardware (flexible, modular, distributed) and software
  - Low power, computational capable and low-cost motion control hardware boards that can be made available to JPL, its university partners, and the extended robotic community
  - Low-power sensor hardware boards with standard hardware/software interfaces.
- CLARAty interested in standardizing and adapting its software architecture to flexible, modular, and distributed robotic hardware components
- CLARAty with additional support can provide the Intel hardware via the CLARAty testbed which will be accessible to a number of developers within its community (JPL, ARC, CMU, and U. Minnesota)