Real-time Cooperative Behavior for Tactical Mobile Robot Teams

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MissionLab Demonstrations

• “97-20” Surveillance Mission and Airfield Assessment – simulations
• Hospital Assessment – our primary emphasis now
  – Deployment and cross-country phase
    • Simulation of waypoint following with aerial photo underlay
    • Integration of DGPS on Pioneer nearly complete
    • Expect to be able to demonstrate onsite in June
  – Stair climbing phase
    • Notification of imminent robot delivery
    • Integration with MissionLab this summer
  – Interior assessment phase
    • Hospital CAD files acquired and converted
    • Room-to-room assessment exists in simulation
    • Hardware demonstration with visual servoing and obstacle avoidance
      (can also be demonstrated onsite in June)
• Real-Time Analysis (mission feasibility)
“97-20” Surveillance Mission

- Simulation complete
- Traversal of parking lot, robots seeking cover
- Street-crossing (when clear)
- Emulated self-detonation of robot inside building
Airfield Assessment

- Simulation (existing)
- Includes deployment of “Throwbots”
Hospital Assessment

- Robot deployment and cross-country traversal in formation with differential GPS
- Stair-climbing robots (awaiting delivery for integration)
- Room-to-room search on upper floor (both simulations and hardware demonstrations exist)
Hospital Assessment: Phase 1

- Deployment (optionally from Hummer), tentatively to northwest of building
- Waypoint following using DGPS, augmented by odometry going under bridge to north wing
- All to be performed with Pioneer, ending at stairs on north side
- Robot magically transforms to TMR target platform for Phase 2
- Simulation of waypoint-following is complete
- DGPS is partially integrated
  - DGPS base station set up and broadcasting data
  - Pioneer knows its position with accuracy up to 20 cm
Hospital Assessment: Phase 2

- Just received acknowledgement that we will receive TMR target platform from pool
- Integration of MissionLab expected to be similar to previous experience with other robots
  - plus side
    - more experienced students
  - minus side
    - robot dynamics could be a challenge (stair climbing)
    - 3D representation for console/simulation
Hospital Assessment: Phase 3

- Concentrating on North Wing, in area near point of entry on third floor roof
- Simulation of room-to-room assessment completed, using actual architectural CAD data from hospital
- Repositioning of Pioneer sonar sensors provides better obstacle avoidance
- Visual servoing capability now exists
- Hardware demonstration at our facility is under development
Honeywell Real-Time Analysis

• real-time performance analysis
  – to ensure processes do not overload CPU
  – to ensure tasks meet deadlines

• real-time performance guarantees
  – monitors and enforces processes
  – even in the presence of non-RT behavior (e.g. communication)

• automatic management of asynchronous sensing
Honeywell Real-Time Analysis

- **CURRENT STATUS**
  - full real-time analysis of all robot configurations
  - complete GUI integration
  - automatic robot calibration
  - execution times
  - speedup of non-RT robot executables

- **FUTURE WORK**
  - generation of real-time robot executables
  - enhance usability
Hospital Data Files

- AutoCAD files provided by Bill McBride
  - all floors, basement, and sub-basement
- Converted to various formats
  - CGM
  - Xfig
  - HPGL
  - GIF
- Available at our TMR website
  http://www.cc.gatech.edu/ai/robot-lab/tmr/ft.htm
- Some data currently in use as
  MissionLab overlay
JCATS integration option

- JCATS can simulate robots (dynamics, sensors) but does not have a behavioral model
- Without behavioral model, simulations would be scripted
- *MissionLab* to act as the behavioral simulation via either
  - existing DIS interface, or
  - upcoming HLA-compliant interface (September 1999)
- Adding Georgia Tech personnel with appropriate experience to TMR team
  - Richard Fujimoto
  - Thom McLean
Plans

• Near-term highlights (next 3-4 months)
  – Begin TMR target platform integration
  – Finalize DGPS and visual-servoing integration
  – Demonstrate cross-country traversal and room-to-room assessment at Ft. Sam Houston
  – Calibrate real-time analysis tool with actual robot runs

• Long-term
  – JCATS integration
  – Migration to Redhat Linux 5.x (6.x?)
  – Glove interface development (gesture recognition)
  – Stair-climbing demonstration (Hospital Assessment Phase 2)
  – Refine Phases 1 and 3 of Hospital Assessment demonstration
  – Integrated end-to-end Hospital Assessment demonstration
  – Real-Time Analysis with “hints” to operator
For further information . . .

• Mobile Robot Laboratory Web site
  – http://www.cc.gatech.edu/ai/robot-lab/

• PDF versions of pertinent papers
  – http://www.cc.gatech.edu/ai/robot-lab/tmr/archive.htm
    • Cooperative Multiagent Robotic Systems
    • Behavior-based Formation Control for Multi-robot Teams
    • Multiagent Teleautonomous Control
    • Communication in Reactive Multiagent Robotic Systems
    • Evaluating the Usability of Robot Programming Toolsets
    • Multiagent Mission Specification and Execution

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