Real-time Cooperative Behavior for Tactical Mobile Robot Teams

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Georgia Tech Robotics

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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)

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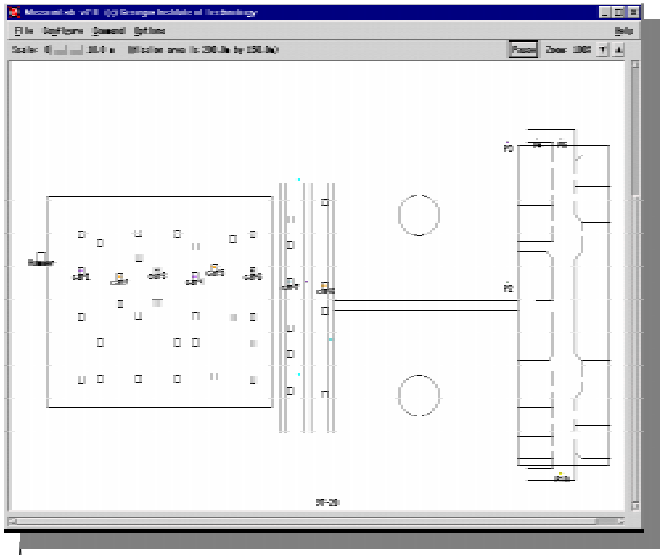
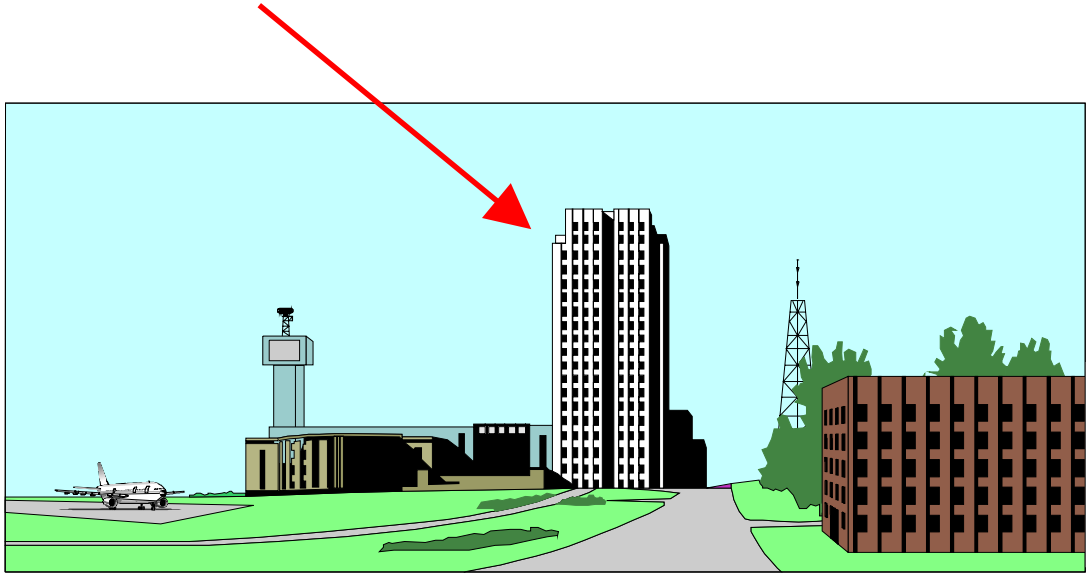
“97-20” Surveillance Mission

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





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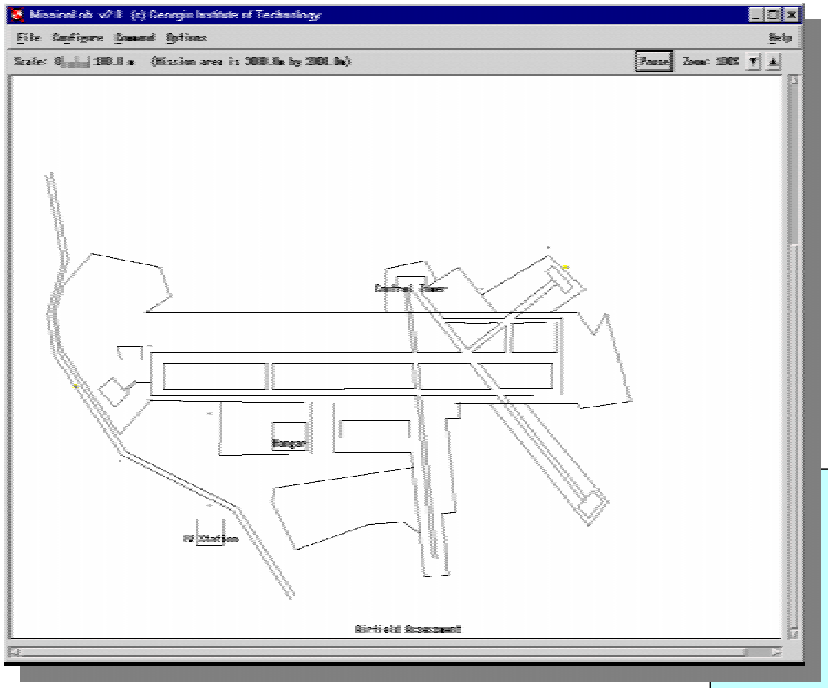
Airfield Assessment



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

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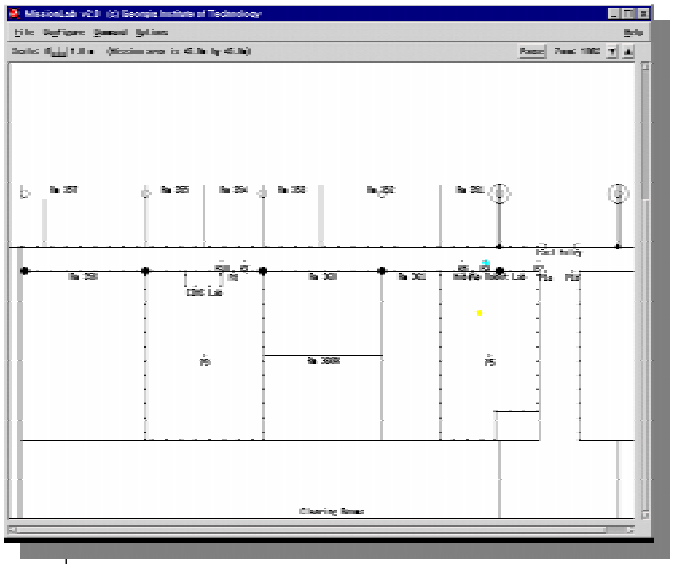
Hospital Assessment

- 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)



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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

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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

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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

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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

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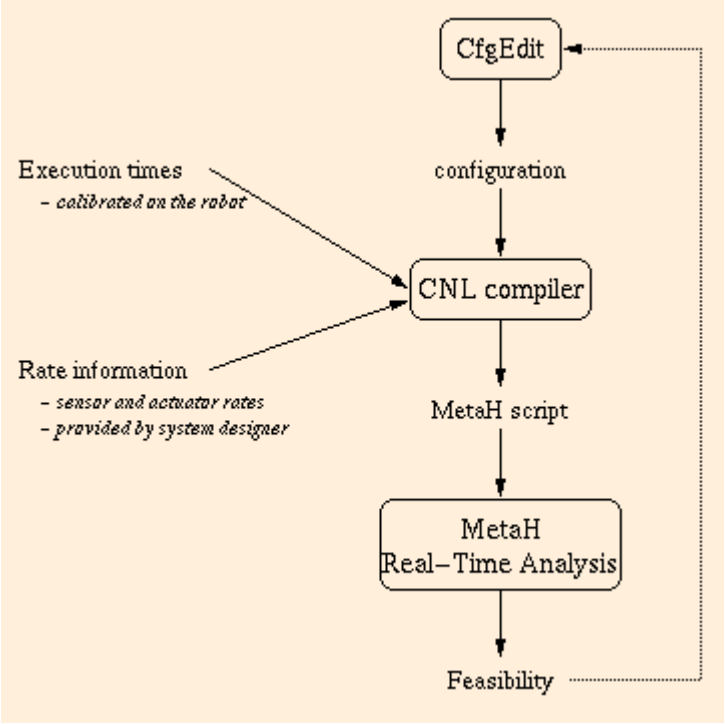
Honeywell Real-Time Analysis



- 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

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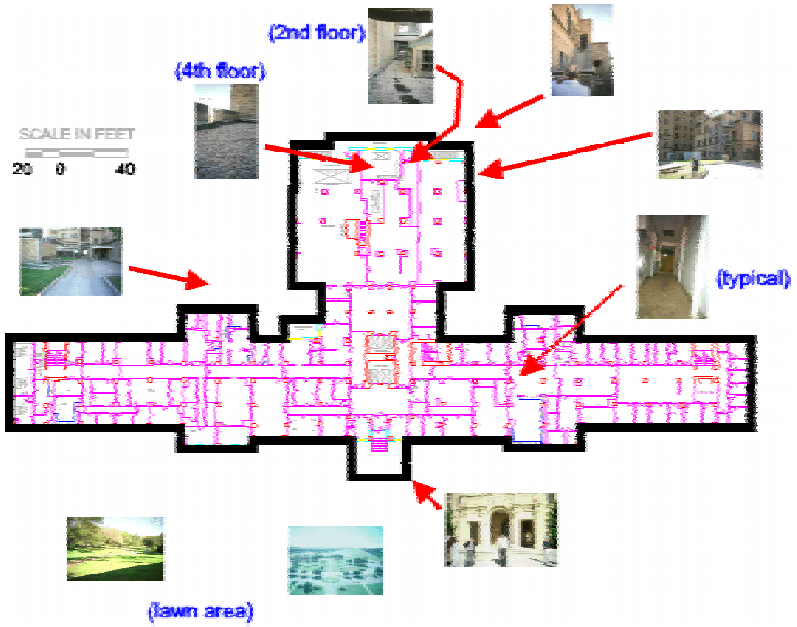
Hospital Data Files



- 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

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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

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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*
- Contact information
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