Using a simulated user to explore human-robot interfaces

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Simulated user to test interfaces

- Glean, EPIC, ACT-R/PM, APEX
- Interact indirectly with interface
  - Abstract copy (GLEAN, EPIC)
  - Special UIMS (ACT-R/PM, APEX)
- Results in part determined by accuracy of simulation of interface

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Direct access to interface

- Cognitive model - ACT-R 5
- Eyes & hands - SEGMAN
- Allows direct interaction between cognitive model and interface
Segman v3.1

Sensor module & Effector module
- takes pixel-level input
- runs data through processing algorithms
- builds a structured representation
- generates mouse and keyboard gestures

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Segman v3.1 Diagram

Scripts

Planners

Cognitive Models

Controller interface

SegMan substrate (lisp)

foreign-interface.lisp
wrappers.lisp
segmentation.lisp

segman.lisp
objectory.lisp

segman.dll (C++)

pixel-groups

pixels

Buttons, windows, string, etc.

Windows

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ACT-R 5 and Segman demo 1

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ACT-R 5 and Segman demo 2

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Introducing a simulated user

Quantitative tool to guide the design process of human-robot interfaces

Urban Search and Rescue robots (USR)

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Urban Search and Rescue - 1

Teleoperated robots
Mixed-initiative HRI
3D Driving Game

- Direct interface
  - “Inside-out” driving
- Driving behavior
  - Real-time
  - Interactive environment
- Extensible code
  - Environment
  - Interface
- Works with unmodified 3D Driving

www.theebest.com/games/3ddriver/3ddriver.shtml

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Segman and ACT-R 5 integration

**Segman**
- position-in-lane information
- left lane + right edge of the road
- midpoint at 5.5 degrees below the horizon

**ACT-R 5**
- Takes Midpoint
- Steers right or left
- Brakes, accelerates

**Buffer stuffing galore**

[link](ritter.ist.psu.edu/acs-lab/)
DUMAS

- Driver User Model in Act-r&Segman
- About 30 production rules
- Restricted model of driving behavior
  - Does not use PM fully
  - Does not learn yet
  - ……
DUMAS demo

Click mouse to restart

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Two demonstrations

✦ Speed and multi-tasking

✦ Speed
  – Three sets of 10 runs
  – High, medium and slow speed

✦ Multi-tasking
  – Standard condition = Slow speed
  – Worried condition

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Figure 4. Speed Demonstration: Lane deviation (in degrees) and total driving time (in minutes) of DUMAS in function of speed. Slow corresponds to a driving speed within the range of 15-20, medium 20-25, and fast 30-35 as measured on the spedometer in the simulation.
Multi-tasking

Figure 5: Lane deviation (in degrees) and total driving time (in minutes) of DUMAS in the Standard and Worried condition.
Conclusions

- Quantitative tool for HRI
- USR tasks are difficult because
  - Multi-tasking, interference
  - Hard vision problems
  - Noisy, ambiguous, poor quality display
- Surprising parallels
  - Course corrections

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Future

- Extend DUMAS
  - To include more PM theory
  - To include more HRI subtasks
  - Multi-tasking (multiple robots)
- Apply to actual HRI’s
- Develop theory of HRI development

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Thank you

More on this can be found at ritter.ist.psu.edu/acs-lab/

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