Shared Autonomy

WEEK 7 OF 16-867 HUMAN-ROBOT INTERACTION

LAURA HERLANT
When is full robot autonomy not desirable?

<table>
<thead>
<tr>
<th>Safety-Critical Systems</th>
<th>Want a feeling of control</th>
<th>State-of-the-art is not yet capable</th>
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<tbody>
<tr>
<td>• Kill Decision</td>
<td>• Users with disabilities</td>
<td>• High-level decision making</td>
</tr>
<tr>
<td>• Where unreliability leads to danger</td>
<td>• Artistic Expression</td>
<td>• Not cost effective (just pay humans to do it)</td>
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<td>• When liability is important</td>
<td>• Maintain abilities (driving, rehabilitation robotics)</td>
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When is full robot autonomy not desirable?

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<td>• Military Drones</td>
<td>• Assistive robotics</td>
<td>• High-level decision making</td>
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<td>• Surgical Robots</td>
<td>• Smart wheelchairs/smart walkers</td>
<td>• Not cost effective (just pay humans to do it)</td>
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<td>• Autonomous driving?</td>
<td>• Artistic Expression: theater, dance</td>
<td>• Car panel installation</td>
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<td>• Childcare</td>
<td>• Rehabilitation robotics</td>
<td>• Garment industry</td>
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<td>• Medicine administration devices</td>
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Terminology

Supervisory Control

“one or more human operators are intermittently programming and continually receiving information from a computer that itself closes an autonomous control loop through artificial effectors to the controlled process or task environment” – Sheridan

Shared Control

“a human and an automatic controller simultaneously exert control” – Griffiths & Gillespie

Shared Autonomy

“a robot and an operator collaborate to solve a complex physical task”
Virtual Fixtures
Noise Reduction
Task-Level Shared Autonomy

End effector teleoperation - Inverse Kinematics at interactive speed renders the end configuration of the robot as the user moves the hands.
Task-Level Shared Autonomy
Shared Autonomy Spectrum

- Virtual fixtures
- Blended Policies
  - Local
  - Global
- Task-level instruction
Special Cases
Assistive Robotics –
Partial Policy Blending
CAHAI Tasks with the MICO Robot

- Pouring water
- Unscrewing a jar
- Dialing 911
Task Completion Time

- Pitcher: 600-800 seconds
- 911: 200-400 seconds
- Jar: 700-800 seconds

- User:
  - User 1: 1000-1500 seconds
  - User 2: 1500-2000 seconds
  - User 3: 1000-1500 seconds
  - User 4: 1500-2000 seconds
  - User 5: 500-1000 seconds
  - User 6: 1000-1500 seconds
Automatic Mode Switching

**Task Efficiency**

![Bar chart showing execution time, mode switching time, and number of mode switches.]

**People Prefer Assistance**

![Bar chart showing preferences for assistance.]

- Manual
- Auto
- Forced

Pretends Manual

No Preference

Prefers Assistance

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<th>1</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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Rehabilitation Robotics – Partial Input Rejection

Todd Murphey, McCormick
Rehabilitation Robotics – Partial Input Rejection

Todd Murphey, McCormick
Shared Autonomy + Mental Models (Nest Example)

Week7-2SharedAutonomyHumanFactorsBilgeMutlu.pdf