Open-Source Robotic Manipulation and Benchmarking: Current Gaps and Future Solutions

ROS-Industrial Consortium Americas 2023 Annual Meeting
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https://www.robot-manipulation.org/

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How to Enhance the Open-Source Ecosystem?

- For Better Performance Benchmarking in Robotics
- For Better Comparison Between Methods
- Boosting Use of Datasets and Open-Source Tools
- Enhance Communication Between Researchers
Open-Source Ecosystem
Ecosystem

Open-Source Assets

- **Physical**: Sets of objects, experiment set-ups, and hardware designs
- **Digital**: Datasets generated from physical assets and benchmarking
- **Instructional**: Task protocols for benchmarking that utilize physical and digital assets
- **Functional**: Software that can be benchmarked using instructional assets

Development and Benchmarking

- **Experiments**: In simulation and using physical robot systems available within the ecosystem
- **Competitions**: Engaging the community with challenges that use open-source assets
- **Publications**: Collaborative research papers and organizing special issue journals

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robot-manipulation.org
Survey on Open-Source and Benchmarking for Robotics

- Feedback on the current landscape
  - Benchmarking
  - Open-source
  - Simulation and hardware
  - Limitations and barriers

- Feedback on proposed solutions

- Open response for suggestions
# Open-Source Robotic Manipulation and Benchmarking: Current Gaps

## Barriers (highest to lowest frequency)

1. My research is limited by a lack of relevant comparable benchmarks in the field
2. My research is limited by current robot simulation capabilities
3. I face barriers when attempting to integrate open-source assets into my research
4. My research is limited by a lack of relevant open-source assets in the field
5. My research is limited by access to robotic hardware

## Activity (highest to lowest frequency)

1. I learn about the availability of new open-source assets
2. I utilize open-source assets (e.g., YCB Object Set, Cornell Grasp Dataset, GPD) in my research
3. I benchmark my robotic manipulation research to others in the field
4. I contribute to open-source for robotic manipulation
Open-Source Robotic Manipulation and Benchmarking: Future Solutions

- Modular Benchmarking Software Pipelines
- Distributed Physical Benchmarking Facilities
- Online Community Resources
- Working Groups and Advocacy
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Perception → Grasp Detection* → Motion Planning ← Robot Control

*Example application
Future Solution:
Distributed Physical Benchmarking Facilities

Global Leaderboard

“Benchmarking with a Twist” Paper
## Future Solution: Online Community Resources

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<tr>
<td>1) Organized repositories of open-source assets</td>
<td>E.g., object sets, 3D models, datasets, hardware designs</td>
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<td>2) Organized repositories of benchmarking results of robotic manipulation solutions</td>
<td>E.g., similar to Papers with Code</td>
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<td>3) Online forums for discussion and coordination of community efforts</td>
<td>E.g., ROS Discourse, Reddit upvote/downvote for prioritization</td>
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<td>4) Organize efforts to integrate benchmarking results into existing resources</td>
<td>E.g., ROS Enhancement Proposal (REP) for coupling performance data with packages</td>
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### Future Solution: Working Groups and Advocacy

| 1) Establishing advisory committees and working groups | E.g., reviewing contributed open-source assets and benchmarks to meet community standards |
| 2) Advocacy of open-source and benchmarking best practices into existing working groups | E.g., IEEE technical committees, ASTM standards committees |
| 3) Advocating for conference/journal submission acceptance criteria to favor best practices | E.g., criteria including comparative benchmarking and leveraging of open-source assets |