

Software Development for Cooperative Multi-Robot Assembly of an Airplane Wing Ladder

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Problem

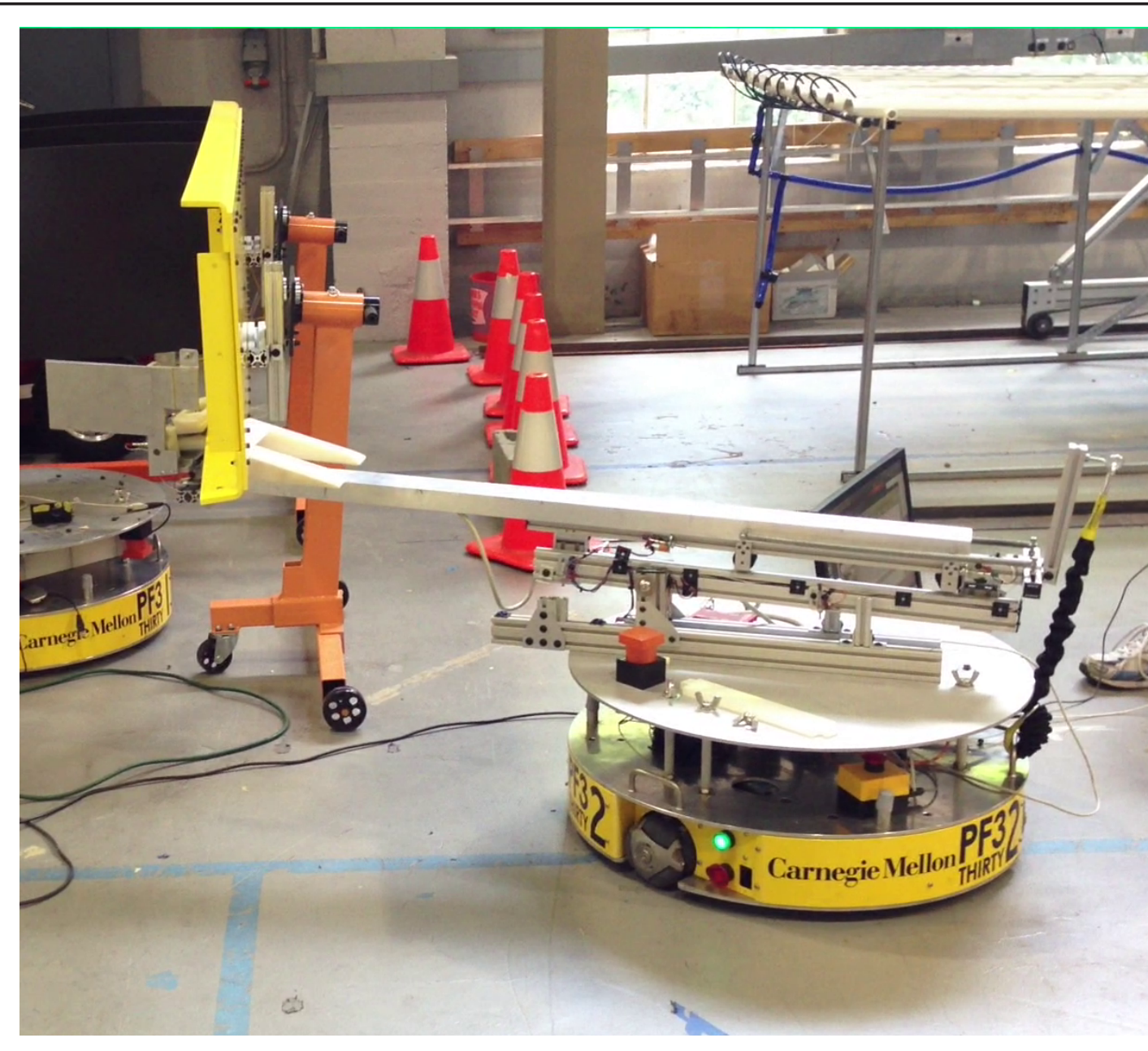
Today workers spend days assembling an airplane's wing ladder, and ribs are inserted into position by large cranes. Companies like Boeing would prefer to automate this process using modular robots with minimal lead time.

This project addresses the following issues:

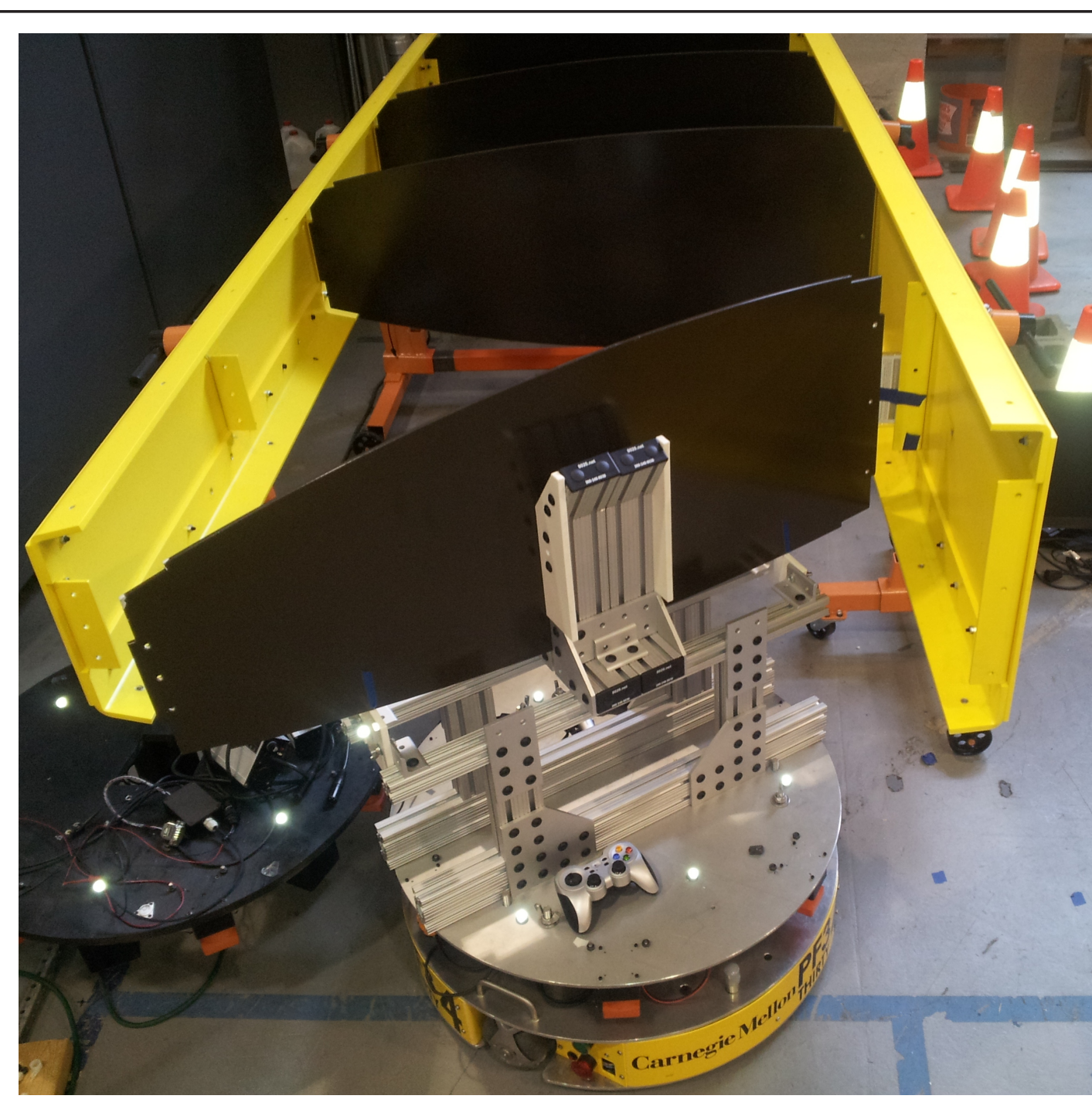
1. Fixtureless manufacturing
2. Inherently inaccurate mobile robots
3. Cooperative manufacturing

The Robots

• Rib-Catcher:

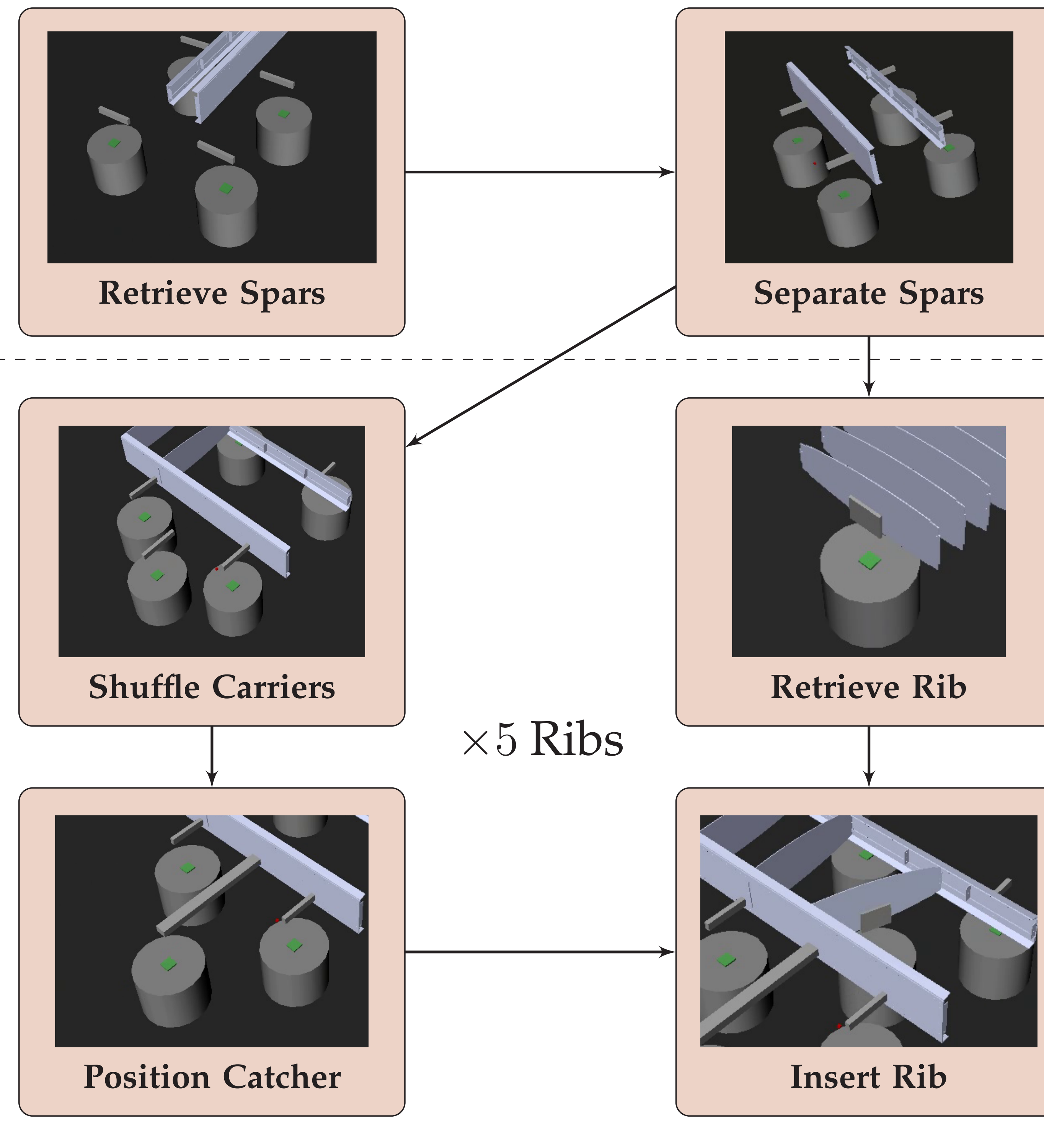


• Rib-Carrier:



• Spar-Carrier: (simulation only)

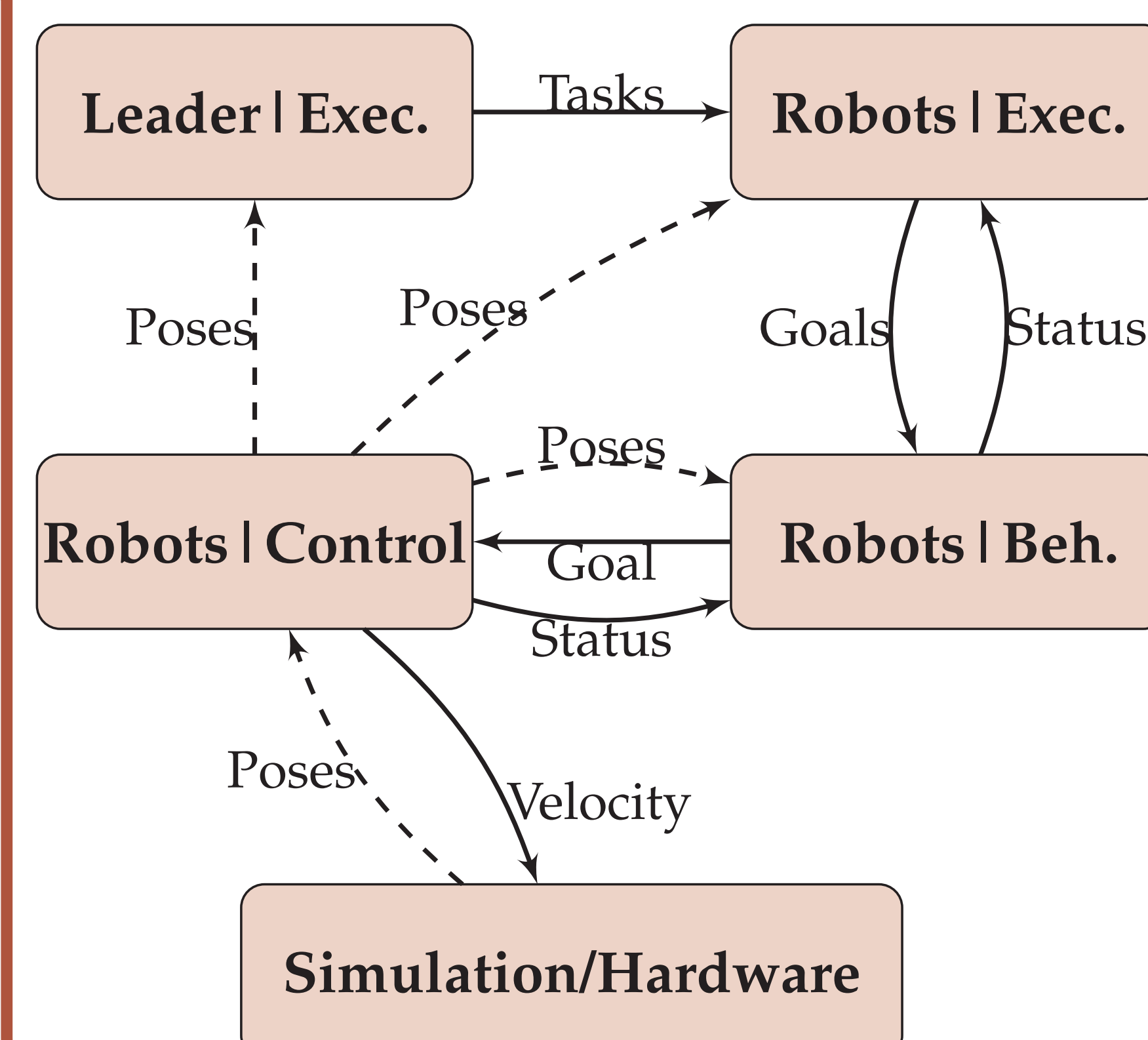
The Assembly Process



Assembly Details

1. **Retrieve Spars:**
Initial spar position is known, but relative position of carriers is unpredictable. The exact relative position is then updated after grabbing.
2. **Separate Spars:**
Carriers move slowly and to maintain tight tolerances. This is an open problem for actual assembly.
3. **Shuffle Carriers:**
Spar-carriers may block the catcher. New position are found, and a free carrier fills in.
4. **Position Catcher:**
The catcher provides features to align the rib to the post.
5. **Retrieve Rib:**
Ribs are located in a nearby depot. There is a different rib for each step of assembly
6. **Insert Rib:**
The rib-carrier enters the spar at an angle. Once the rib contacts the catcher's target it may be rotated to the final position.

Diagram of the System



Motion Tasks

- **Rotation about a fixed point:**
 - Uses such as rotating while maintaining contact during rib insertion
- **Group rotation and translation:**
 - Uses rotation about point tasks
 - Velocities are set to maintain the positions relative the group
 - Used when carrying the spar
- **Post attachment behavior:**
 - Direct velocity control
 - The catcher aligns by rotating about the end of the arm

In Progress

1. Integrate with existing task planning work
2. Demonstrate a hybrid simulation with real and simulated robots
3. Test curved motion tasks on fully equipped robots

Acknowledgements

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