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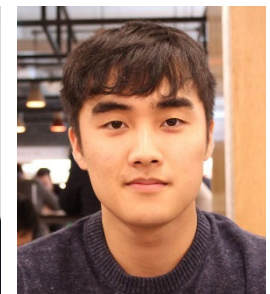
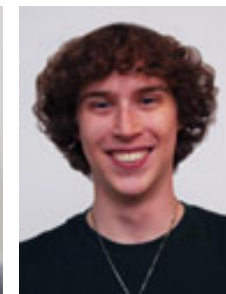
# Rethinking Multi-Legged Robots: Passive Terrain Adaptability through Underactuated Mechanisms and Exactly-Constrained Kinematics

**NRI Small (IIS-1637647), October 2016 (in NCE)**

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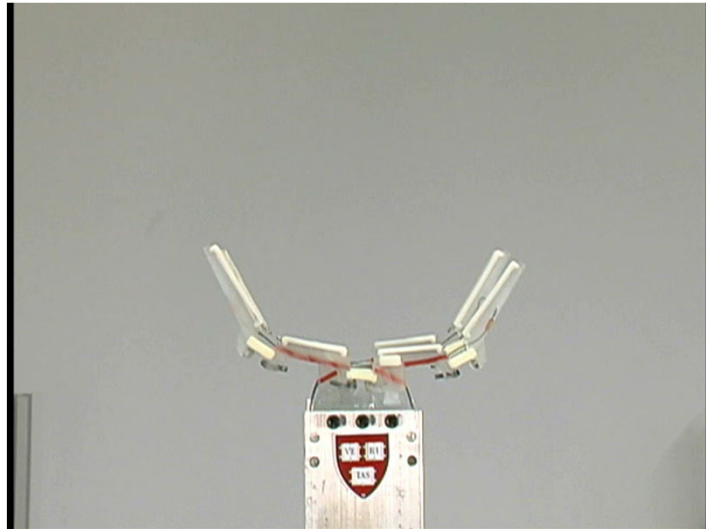


# Background

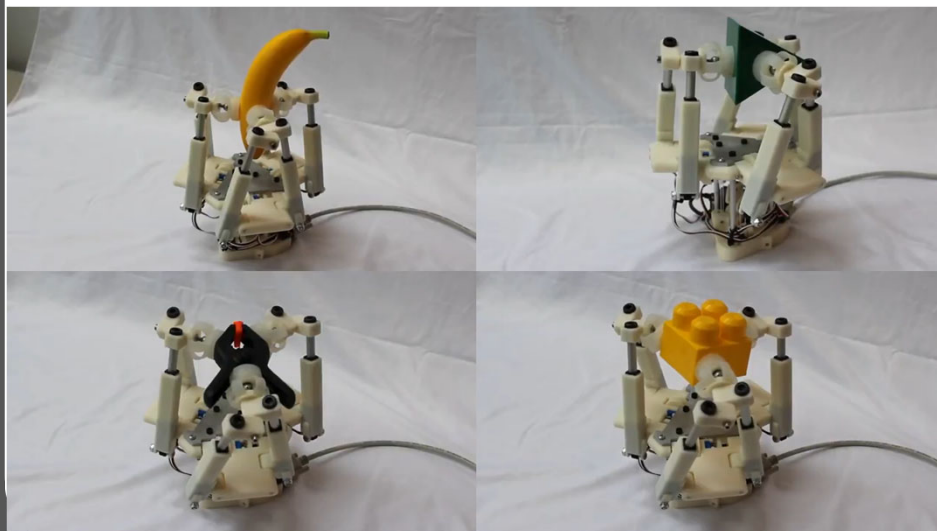
- Underactuated mechanisms
  - Fewer actuators than DOFs
  - “Differentials” split actuation
  - Unconstrained DOFs allow internal reconfiguration based on external constraints



# Background – Underactuated Hands



Eight objects from the YCB Object and Model Set are used to test the system.



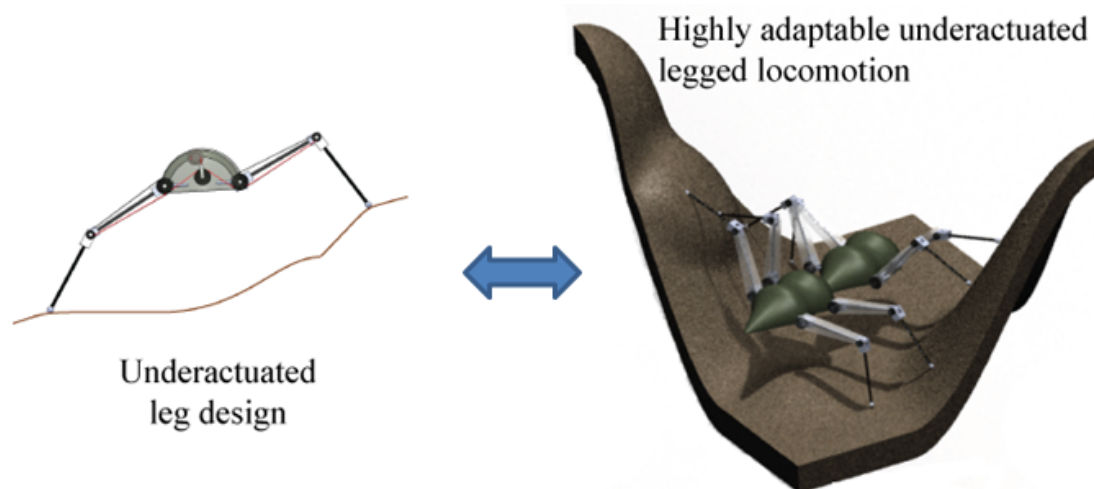
Yale  
2x

Without  
In-Hand Manipulation



# Background

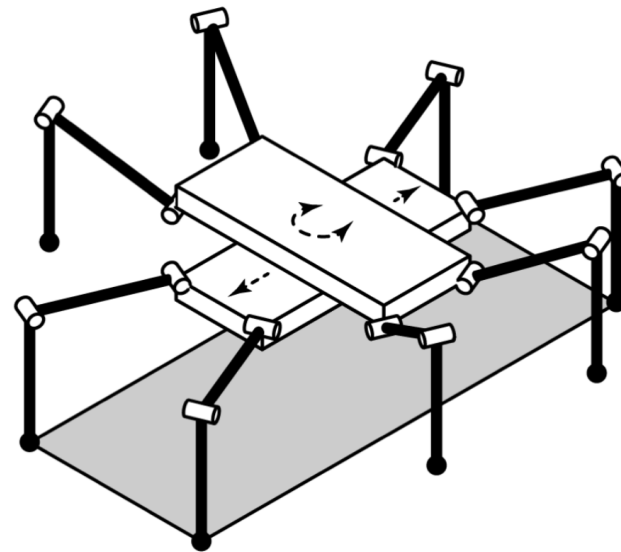
- Overall idea:
  - Impart similar large-scale passive adaptability on multi-legged robots for stable open-loop locomotion on rough terrains





# Previous Results

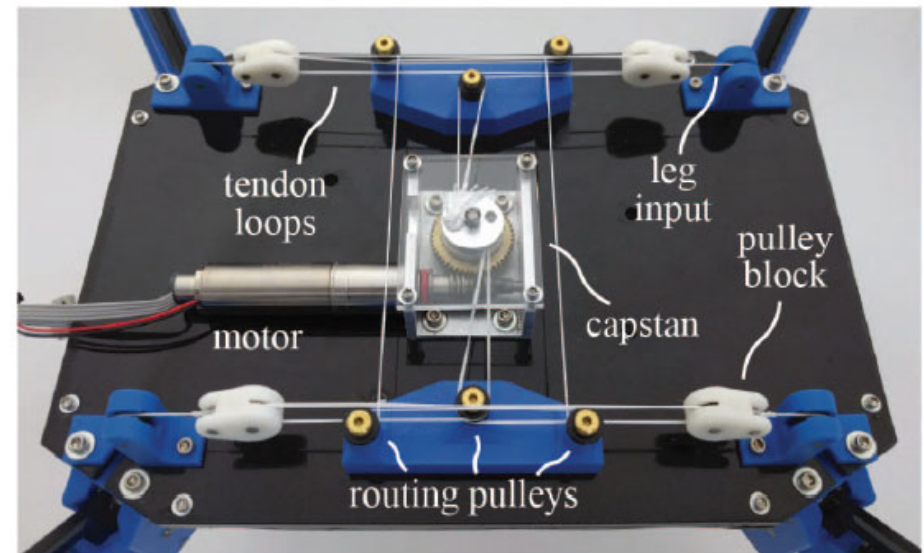
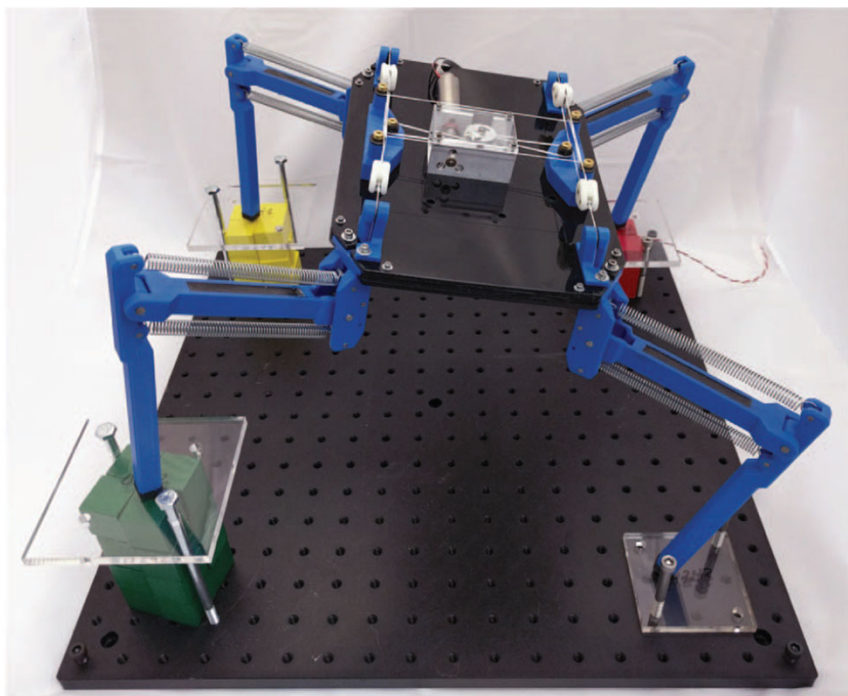
- Started with rotational joints





# Previous Results

- Started with rotational joints





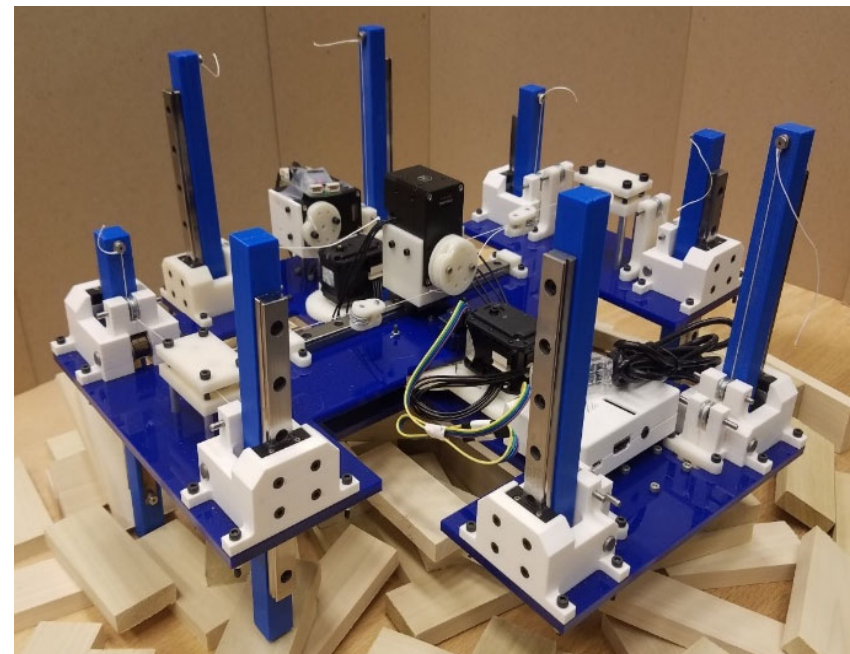
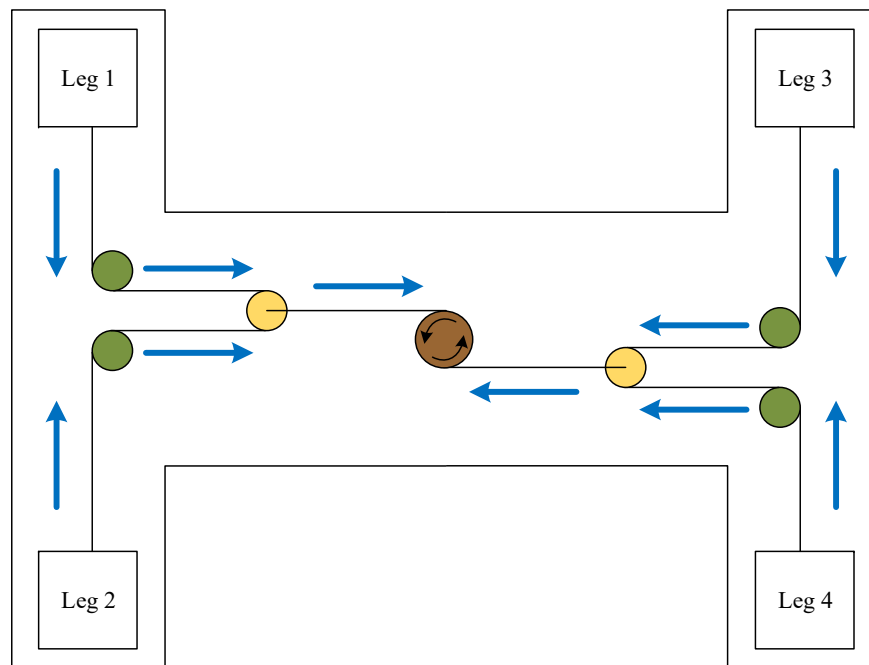
# Previous Results

- Purely vertical forces are generally optimum
  - Suggested a shift to prismatic legs



# Previous Results

- Built Prototype Prismatic walker

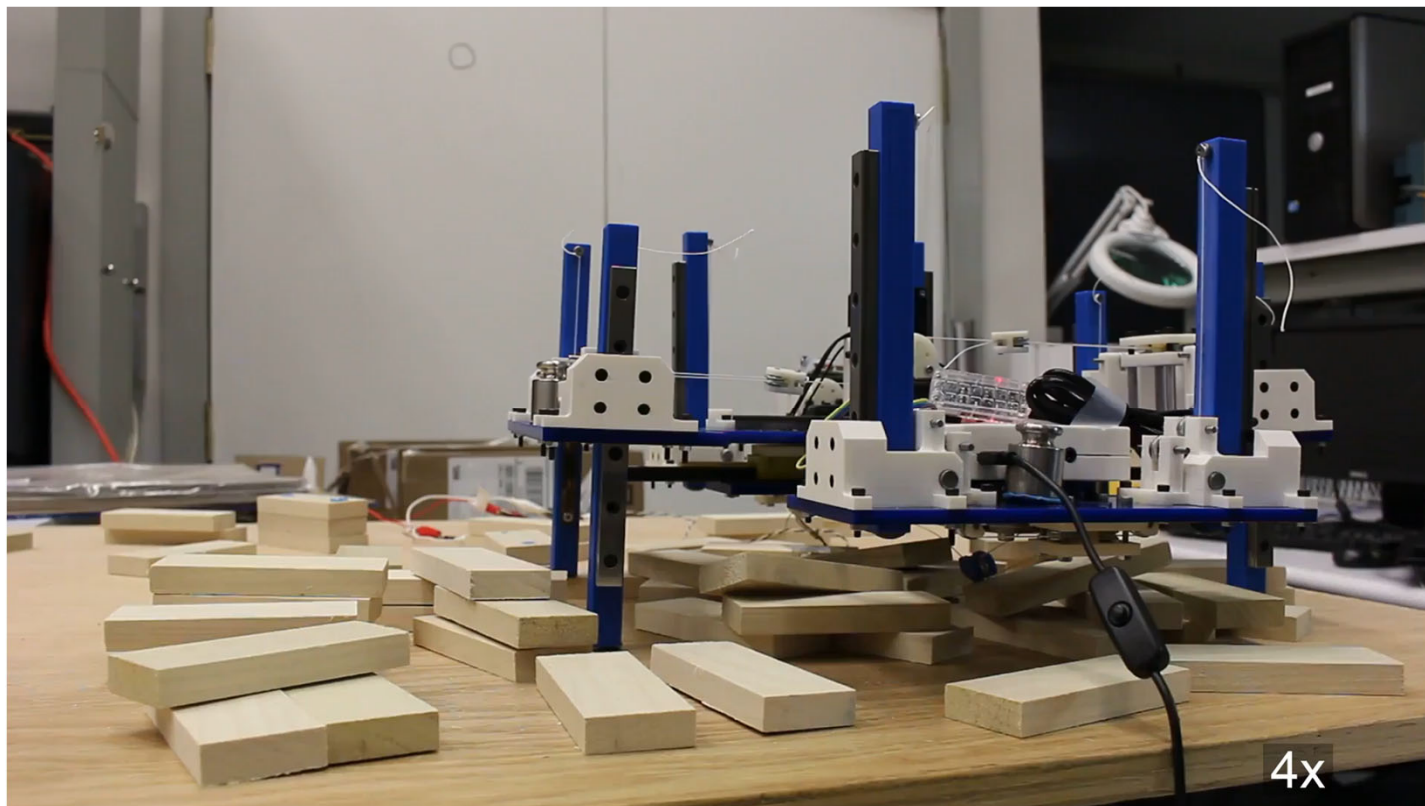






# Previous Results

- Built Prototype Prismatic walker



4x



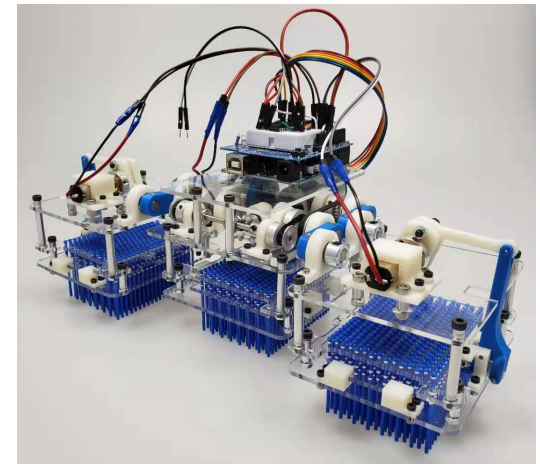
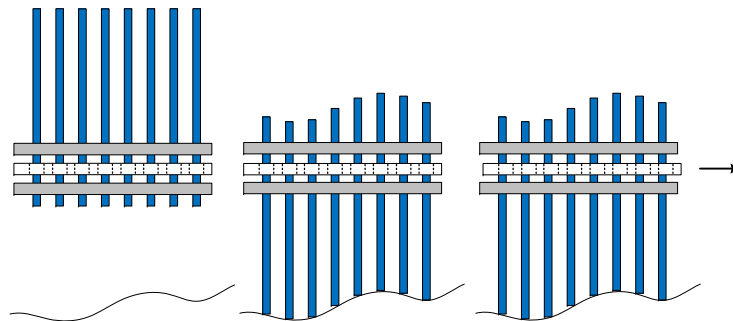
## Previous Results

- Some issues with antagonist springs that led to asymmetries and poorer stability
  - Difficult to get spring forces to balance
- Try it without springs
  - Use gravity to drop legs, actuation to raise them



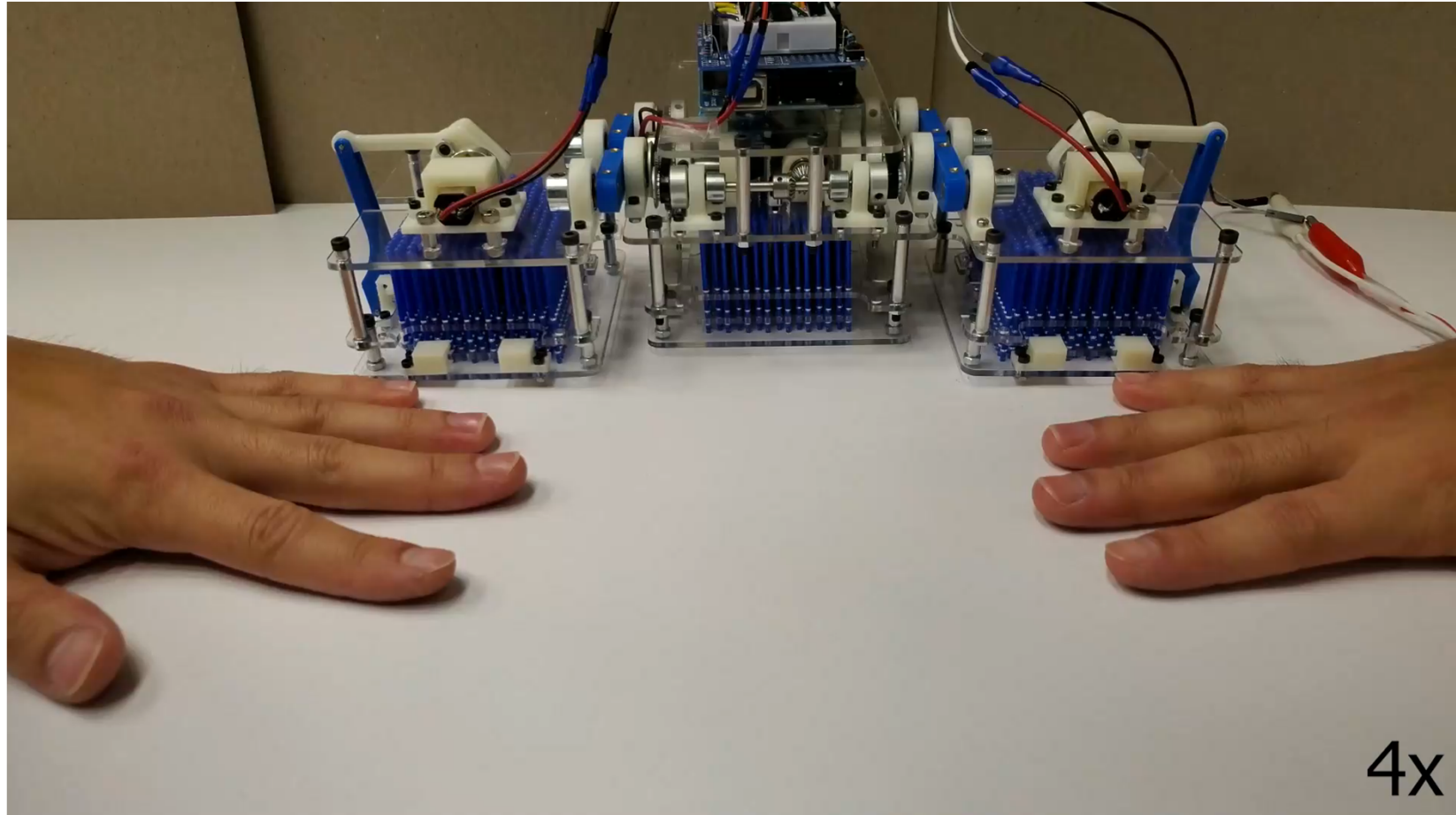
# Previous Results

- Consider a “toy problem”
  - Pin array toy with additional locking feature



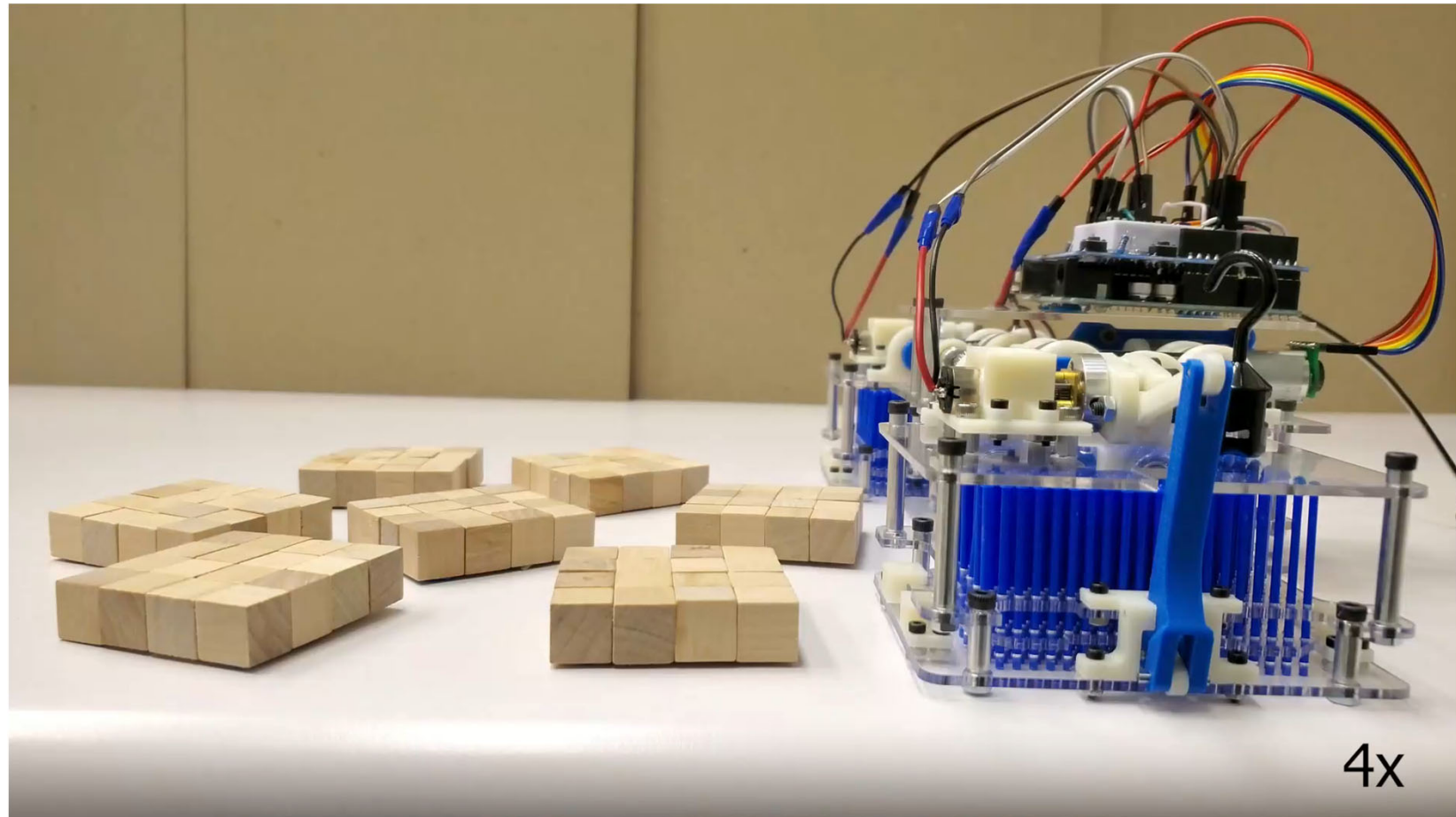


# Previous Results





# Previous Results





## Ongoing/Next Steps

- Currently working on a new prototype extending the “drop and lock” leg design
- Scaling it up for practical missions in rough outdoor terrain