MULTIPURPOSE DEXTEROUS AND CONTINUUM ARMS FOR COMPACT AGBOTS

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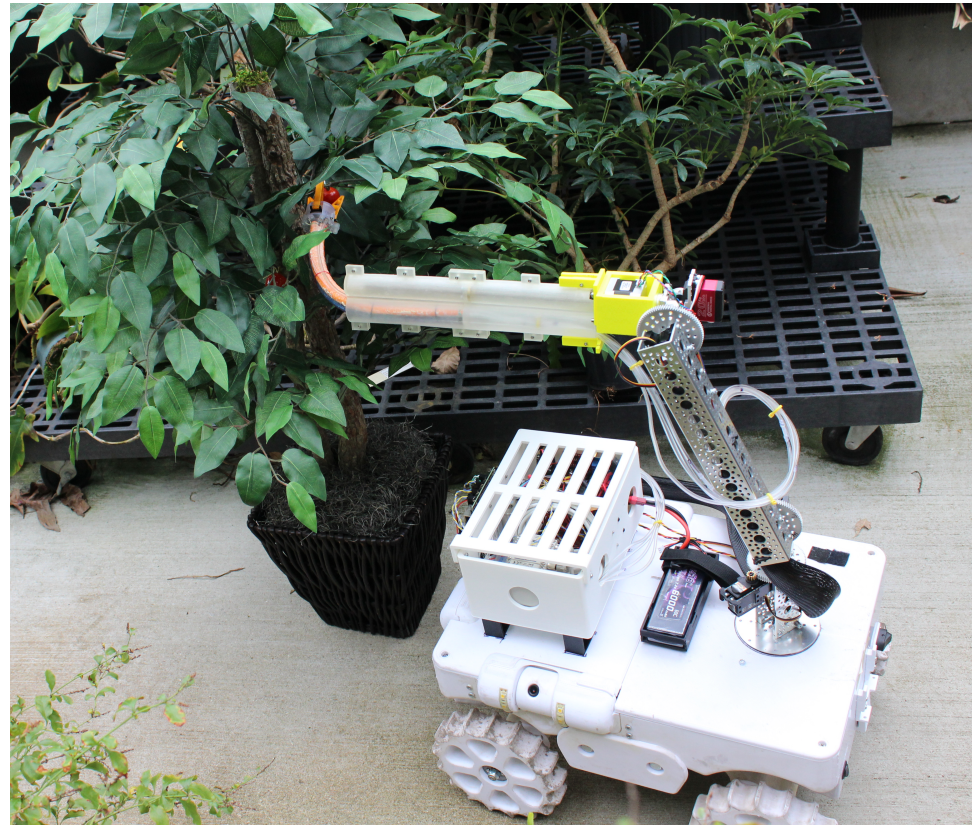
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Challenge

- Agricultural robots requires dexterity and reach

Solution

- New Soft+Hard: Hybrid robots
- New design tools with coserat rod models
- Control of continuum arms with reinforcement learning
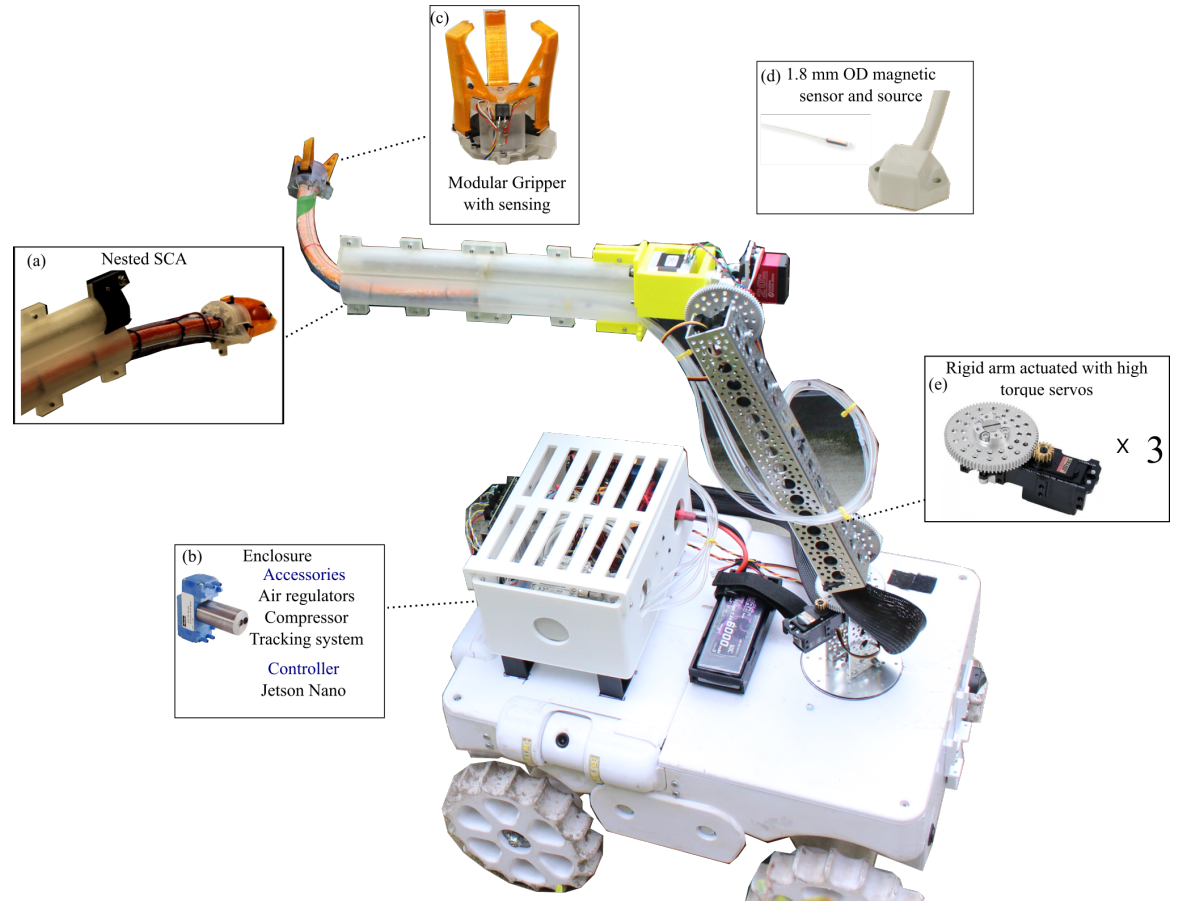

Scientific Impact

- Advancing the science of dexterous robotics
- Advancing control and modeling

Broader Impact

- Solutions for the agricultural labor crisis!
- Far cheaper soft-arms for the same level of reach and dexterity
- K-12 outreach through Not Your Old McDonald's Farm

Hybrid Hard - Soft arm

(a) Nested SCA

(b) Enclosure
Accessories
Air regulators
Compressor
Tracking system
Controller
Jetson Nano

(c) Modular Gripper with sensing

(d) 1.8 mm OD magnetic sensor and source

(e) Rigid arm actuated with high torque servos   x 3

End effector position sensing
With electromagnetic tracking

TerraSentia 2018 robot

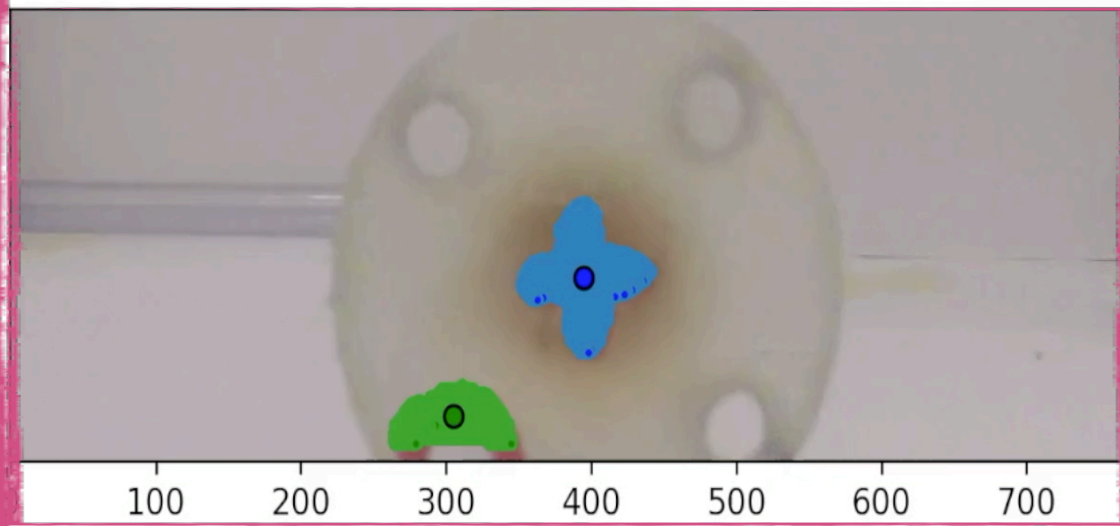**Berry on the periphery**
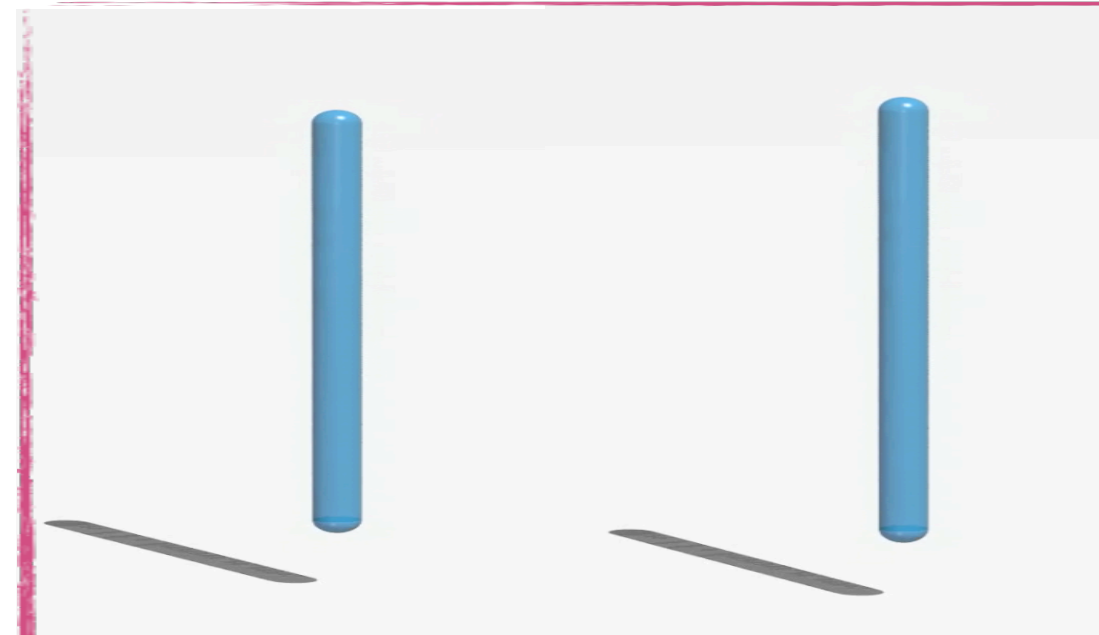
Berry in the interior

Satheeshbabu, Sreeshankar, et al. "Open loop position control of soft continuum arm using deep reinforcement learning." *2019 International Conference on Robotics and Automation (ICRA)*. IEEE, 2019.

Calibrated models of soft arms using real data

Zhang, Xiaotian, et al. "Modeling and simulation of complex dynamic musculoskeletal architectures." *Nature communications* 10.1 (2019): 1-12.

1) Zhang, Xiaotian, et al. "Modeling and simulation of complex dynamic musculoskeletal architectures." *Nature communications* 10.1 (2019): 1-12.

2) Satheeshbabu, Sreeshankar, et al. "Open loop position control of soft continuum arm using deep reinforcement learning." *2019 International Conference on Robotics and Automation (ICRA)*. IEEE, 2019.

3) Uppalapati, Naveen Kumar, and Girish Krishnan. "VaLeNS: Design of a Novel Variable Length Nested Soft Arm." *IEEE Robotics and Automation Letters (RAL)* 5.2 (2020): 1135-1142.

4) Uppalapati, Naveen Kumar, and Girish Krishnan. "Design of soft continuum manipulators using parallel asymmetric combination of fiber reinforced elastomers." *ASME Journal of Mechanisms and Robotics* (Accepted).

5) Satheeshbabu, Sreeshankar, et al. "Continuous Control of a Soft Continuum Arm using Deep Reinforcement Learning ." *2020 IEEE International Conference on Soft Robotics (RoboSoft)*. IEEE.(Accepted)

7) Chowdhary, Girish, et al. "Soft Robotics as an Enabling Technology for Agroforestry Practice and Research." *Sustainability* 11.23 (2019): 6751.

The New York Times
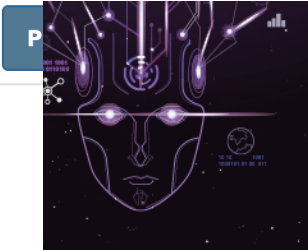
A Growing Presence on the Farm: Robots

A new generation of autonomous robots is helping plant breeders shape the crops of tomorrow.