NRI: FND: Robust and Scalable Planning for Agile and Collaborative Robot Teammates in Complex Environments

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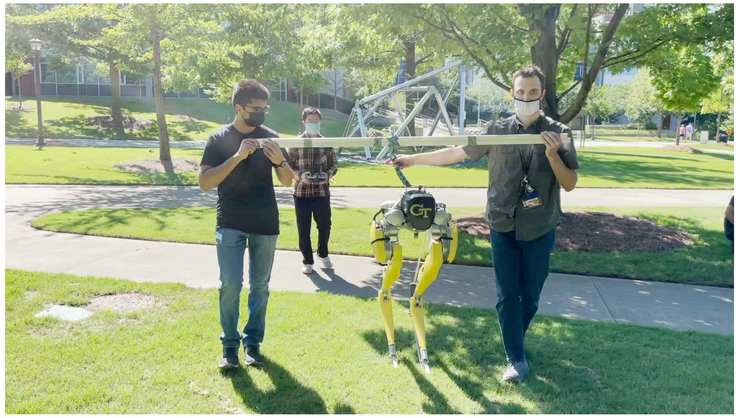
http://lab-idar.gatech.edu/planning-collaborative-robots/

Goal: Robust task and motion planning for unified locomotion and aerial mobility.

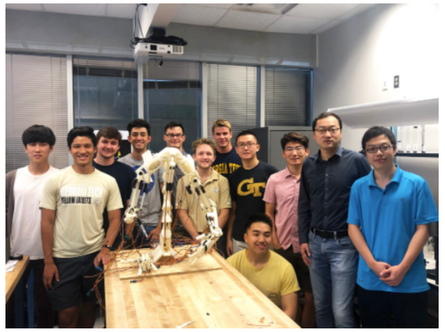
Proposed Approach

- Robust phase-space planning and control barrier certificates for versatile terrestrial and aerial maneuvering.
- Sequential composition of template models via game-based reactive synthesis.
- A multi-agent decision-making approach with formal guarantees on achieving team goals.



Scientific and Broader Impact

- Our Vertically Integrated Project (VIP) team at Georgia Tech won **2020 AIM Best Late Breaking Results Poster Award**.
- The VIP team won 2021 **First place in the Hardware, Devices & Robotics Track of the GaTech VIP Innovation Competition**.
- ENGAGES students won **Outstanding Exhibit Award** in STEM at the YSEA Science Fair.
- 13 Students won Georgia Tech **President's Undergraduate Research Awards**.



2022 NRI & FRR Principal Investigators' Meeting
April 19-22, 2022

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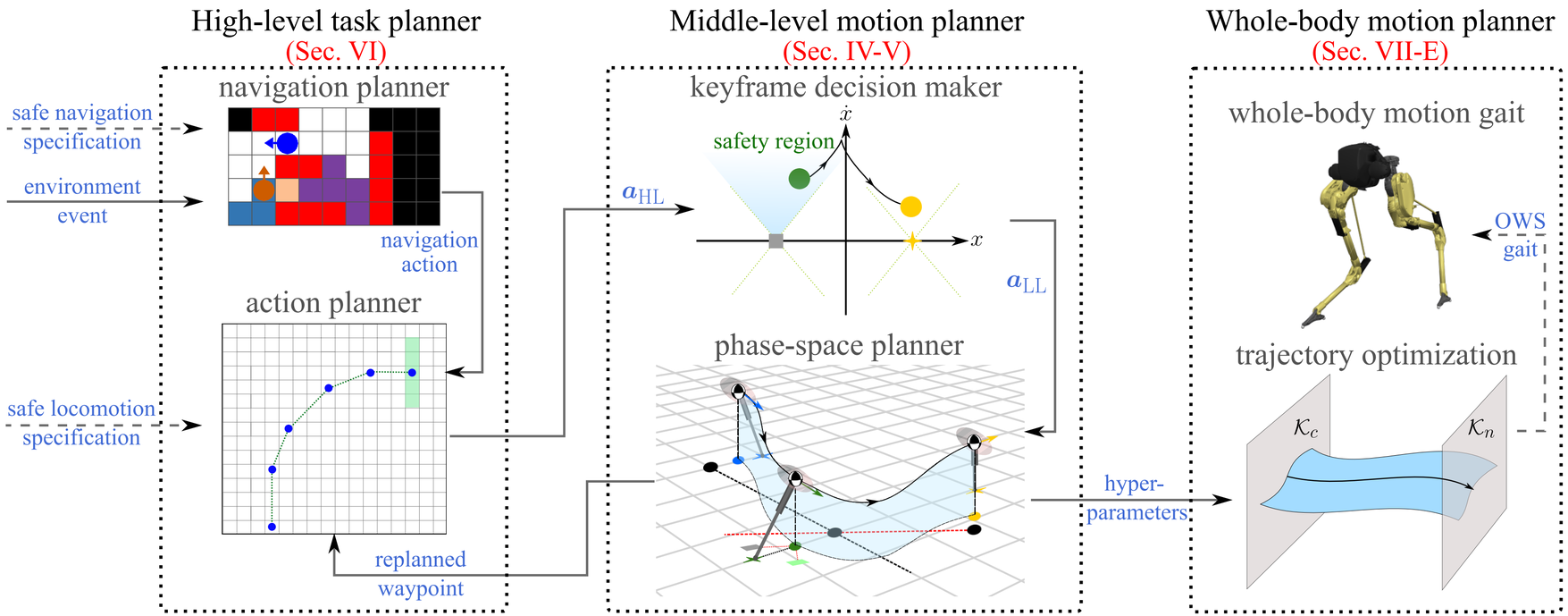
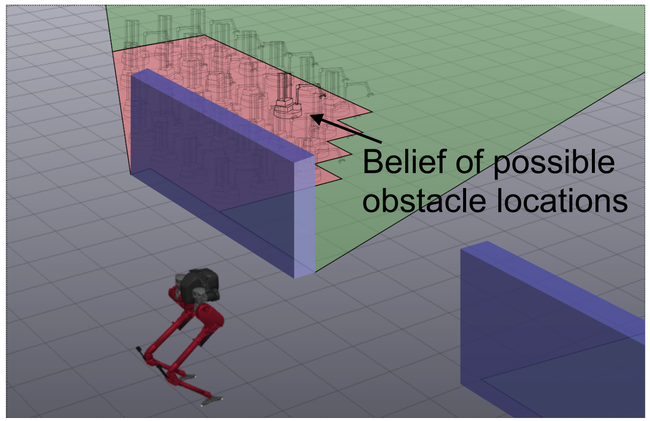
Safe Locomotion in Partially Observable Environments





Navigation specifications

avoid collisions
visit location infinitely often
collaborate with other robots

+

Locomotion safety

foot placement
CoM apex velocity
CoM surface
…

[Warnke, Shamsah, Li, and Zhao, CDC 2020]

[Warnke, Shamsah, Li, Coogan, and Zhao, RSS Workshop 2020]

[Shamsah, Warnke, Gu, and Zhao, TRO, in revision, 2022]

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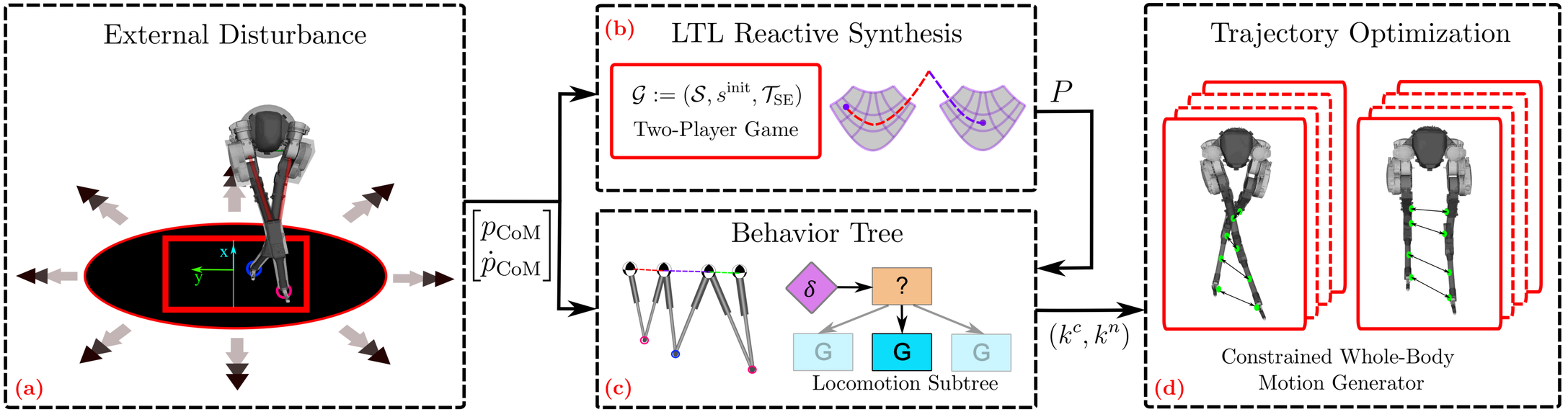
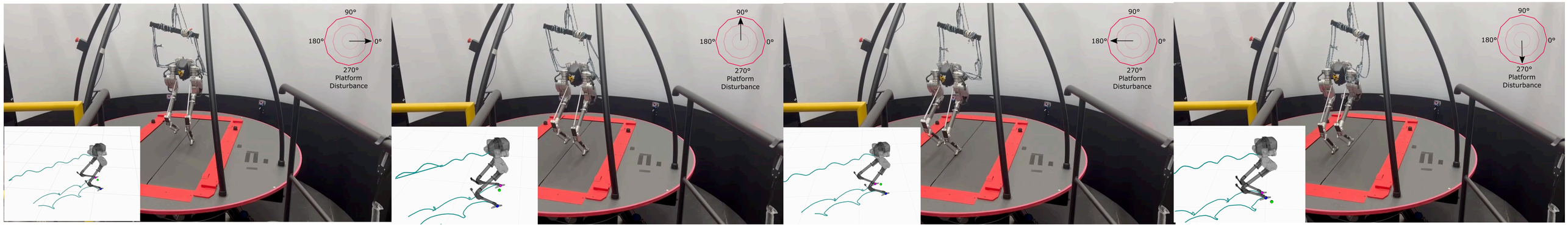
Real-time Locomotion Planning Resilient to Anytime Perturbations



0° perturbation (leg crossing) 90° perturbation 180° perturbation 270° perturbation



[Gu, Boyd, and Zhao, ICRA, 2022] [Zhao, Li, Sentis, Topcu, and Jun, IJRR, 2022]

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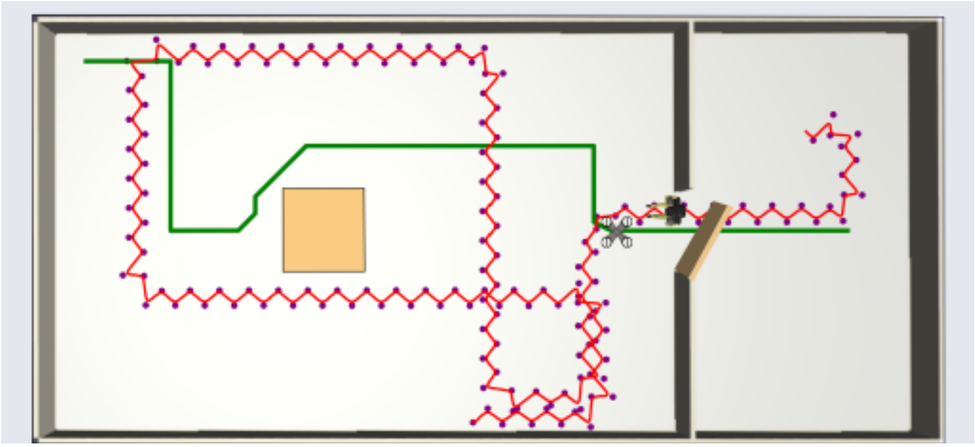
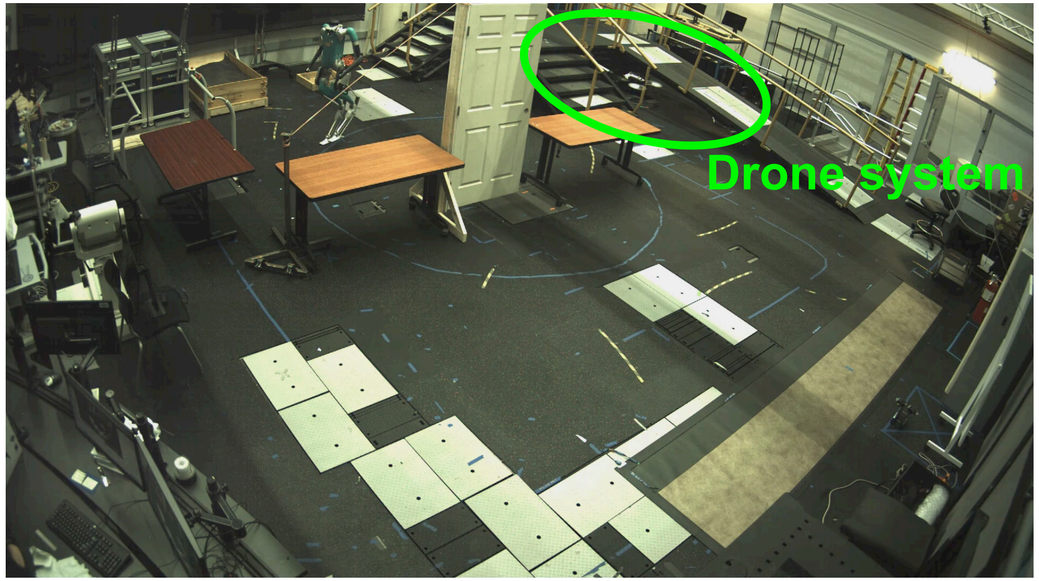
Terrestrial and Aerial Coordination for Resolving Runtime Conflict

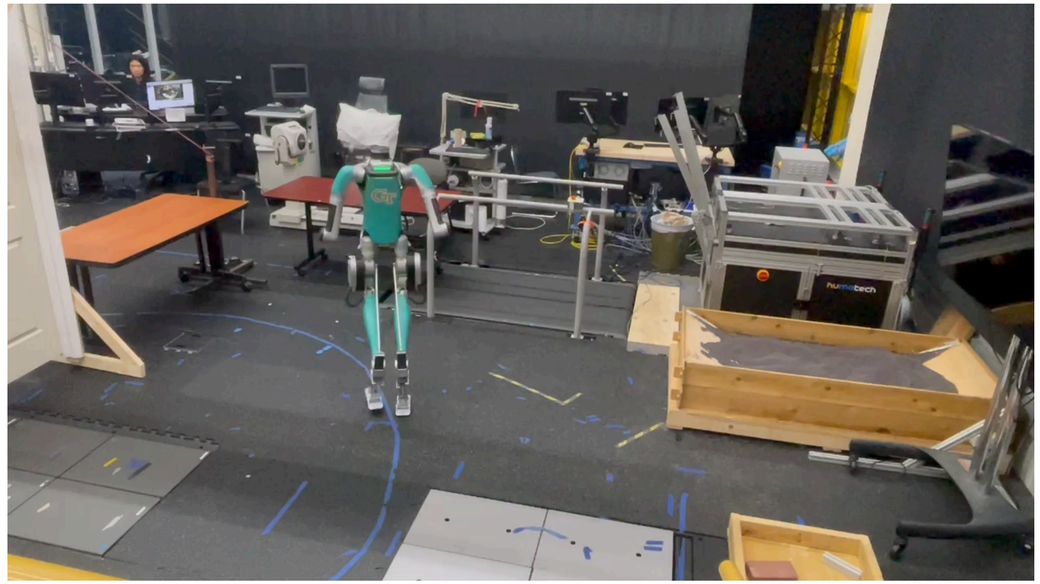


- Problem: Temporal-logic-based reactive synthesis often **predefines** allowable environment events.
- An agent may encounter **un-modeled failures** that is ignored by offline synthesis approaches.
- Resolve unexpected failures through leveraging **other agent's assistance at runtime**

[Cao, Warnke, Zhao, and Coogan, under review, 2022]



Top view



Side view

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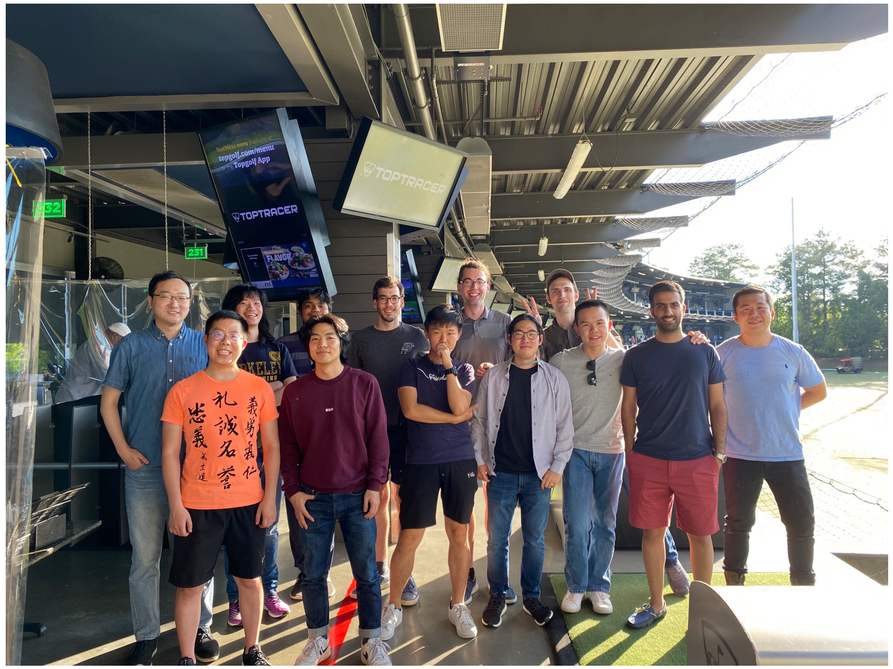
Acknowledgement



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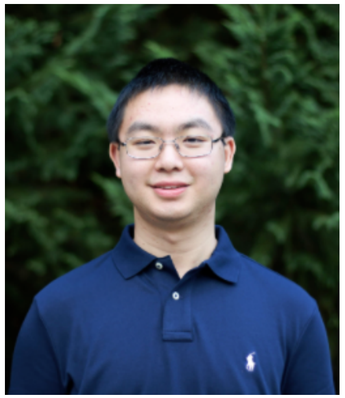

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