CAREER: Interactive Decision-making and Resilient Planning for Safe Legged Locomotion and Navigation

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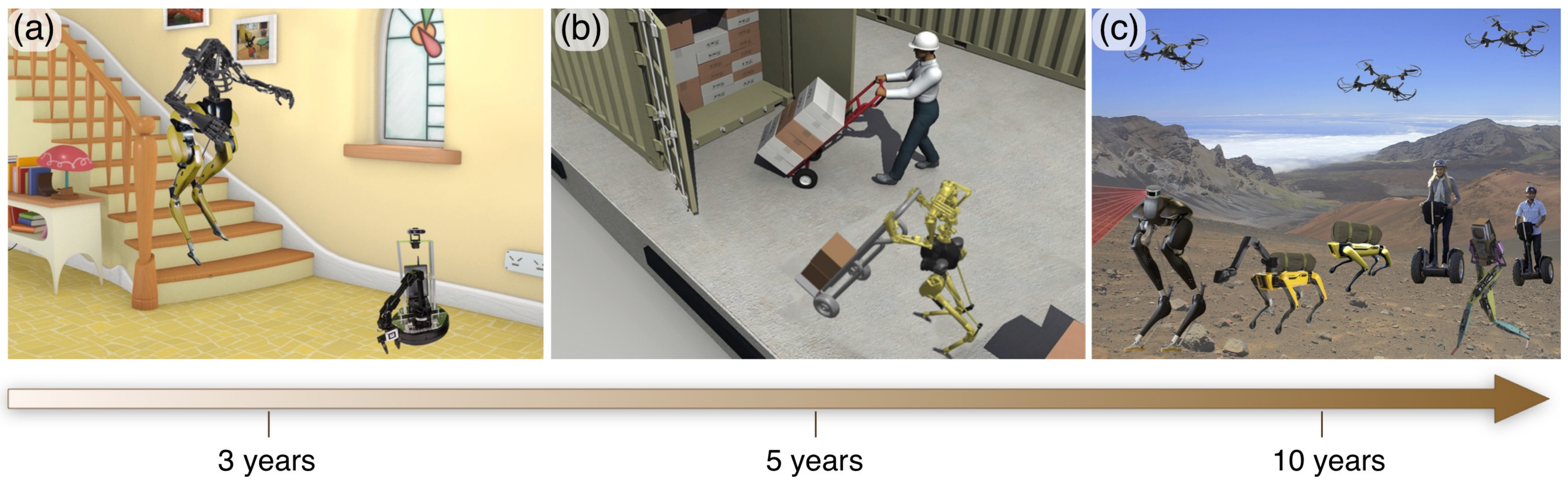

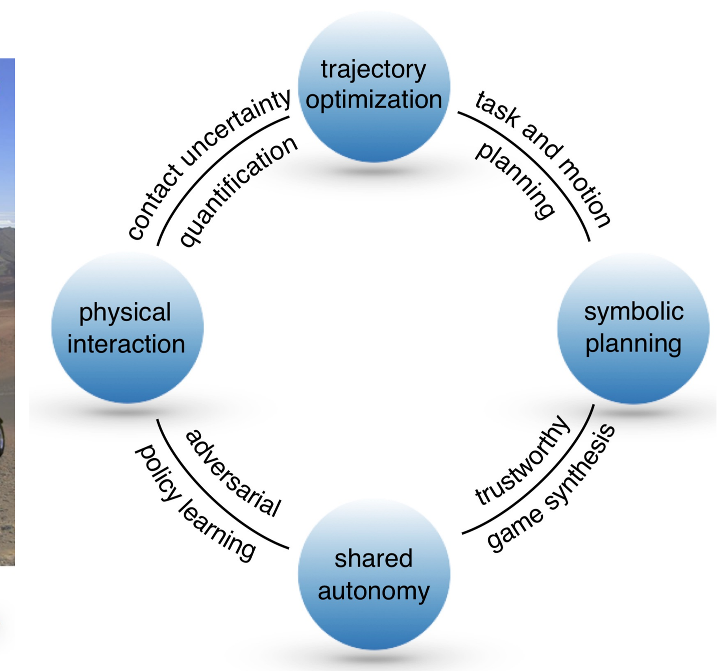

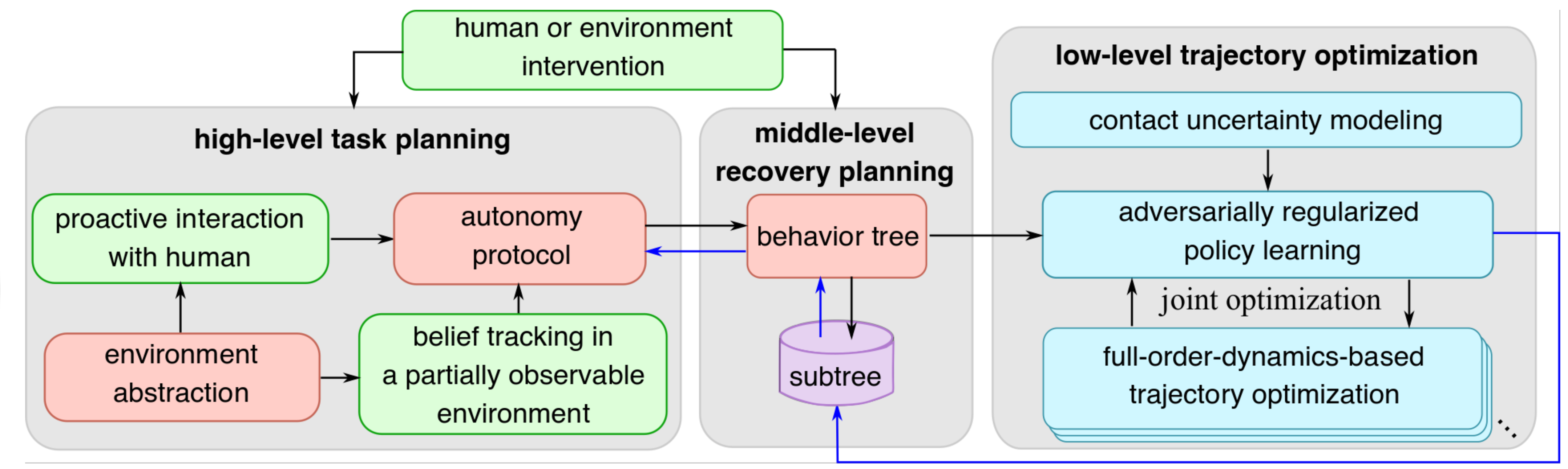

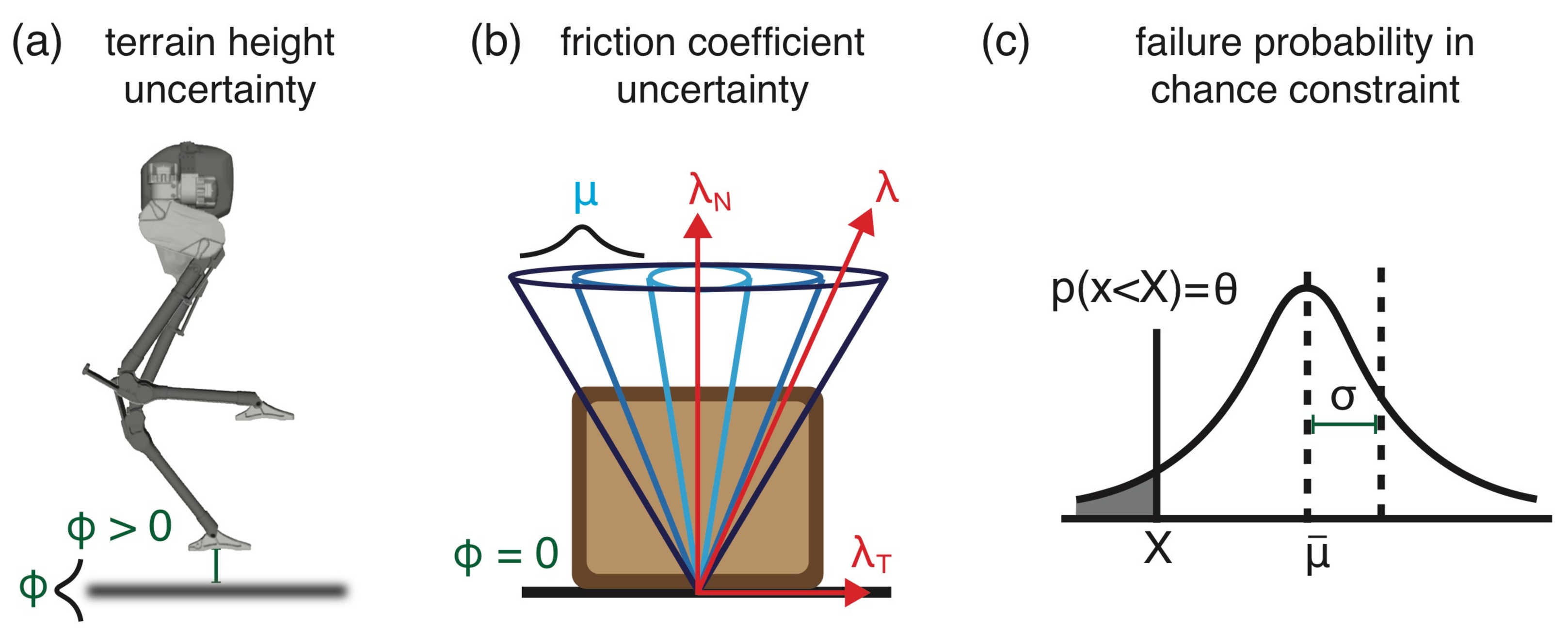

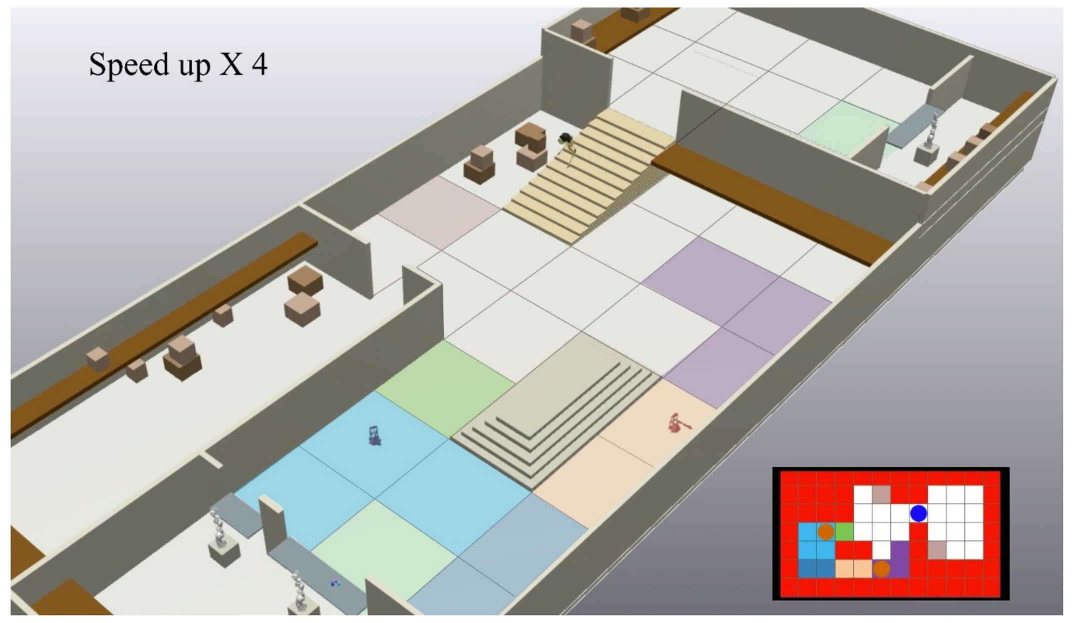

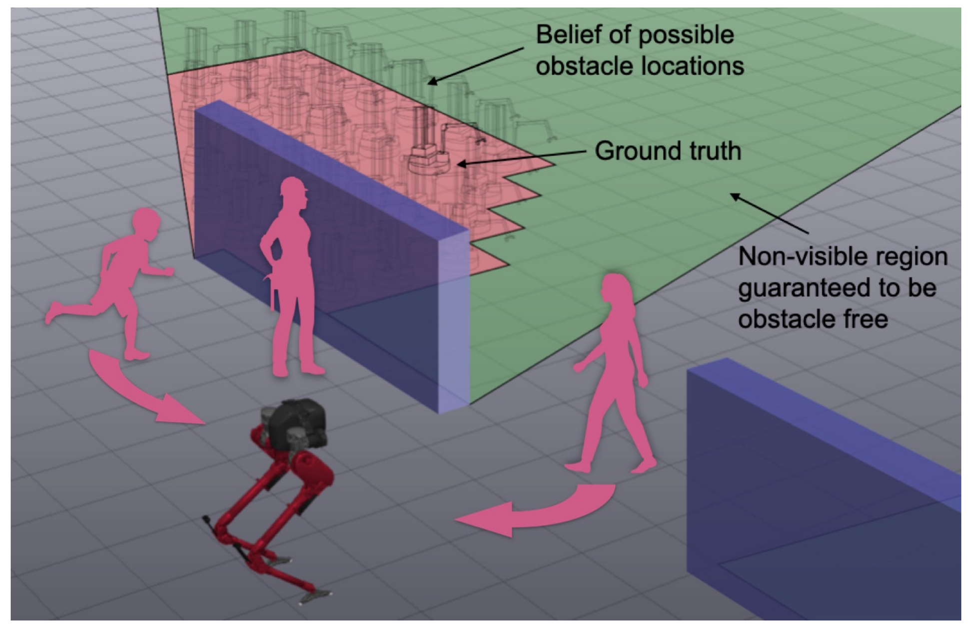

Aim 1: Risk-sensitive trajectory optimization with chance constraints for robust locomotion

Challenge: Reasoning about contact uncertainties and generalizing trajectory optimization (TO) to a variety of robot tasks is challenging.
Proposed approach: (i) Design chance complementarity constraints to parameterize contact uncertainties; (ii) Devise TO-guided policy learning through adversarial regularization for contact modeling.

Aim 2: Hierarchically integrated task and motion planning with multi-level safety guarantee

Challenge: Legged navigation in complex environments while incorporating safety-critical locomotion dynamics is yet a largely open research question.
Proposed approach: (i) Design multi-level environmental abstraction; (ii) Encode locomotion-dynamics-aware safety criteria into high-level task specification; (iii) Design real-time recovery planning via behavior trees.

Aim 3: Proactive and safe navigation in partially observable environments

Challenge: Tracking dynamic obstacles in a long horizon and predicting future behaviors of pedestrians is essential for legged navigation in human-crowded environments.
Proposed approach: (i) Devise belief tracking of dynamic obstacles in partially observable environments; (ii) Make proactive navigation decisions for pedestrian collision avoidance.

Project goal: bridge fundamental gaps between state-of-the-art robot task and motion planning and the ultimate goals of safe and autonomous robot locomotion

Broader impact on research

The PI expects the proposed algorithms, methods, and tools to cut across the spectrum of robotics systems that physically interact with the environment, dexterously manipulate objects, or work in the vicinity of humans. This capability has the potential to advance diverse real-world applications such as first-responders to provide medical care during a national crisis, monitoring a controlled-environment in civil or mechanical infrastructures, and planting crop products in agricultural environments.

Broader impact on education and outreach

The PI will lead these educational initiatives through collaborations with Georgia Tech's Center for Education Integrating Science, Mathematics, and Computing (CEISMC), multiple Georgia Tech educational and outreach programs, Interdisciplinary Research Centers, and Atlanta's local high schools. Such collaborations will not only disseminate the PI's robotics research to a broader community but also benefit the K-12 STEM workforce.

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