



Frontier: Collaborative Research: Correct-by-Design Control Software Synthesis for Highly Dynamic Systems

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Caltech

UCLA

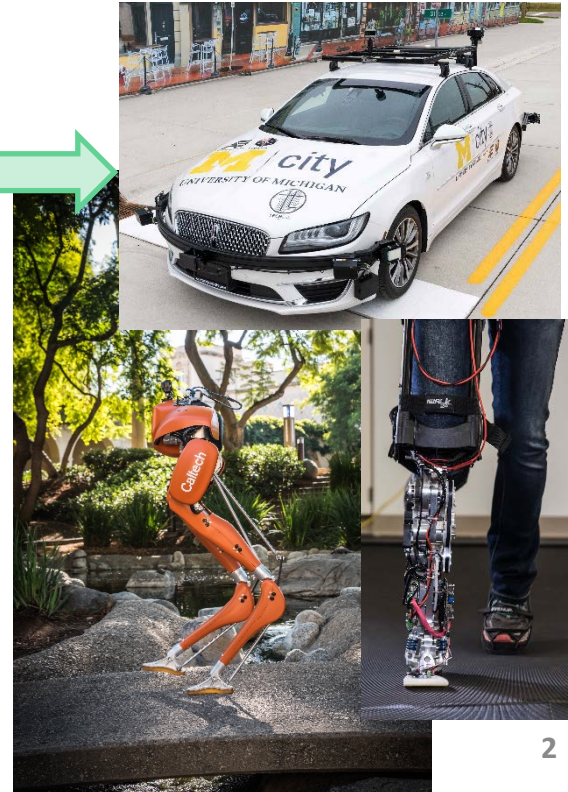
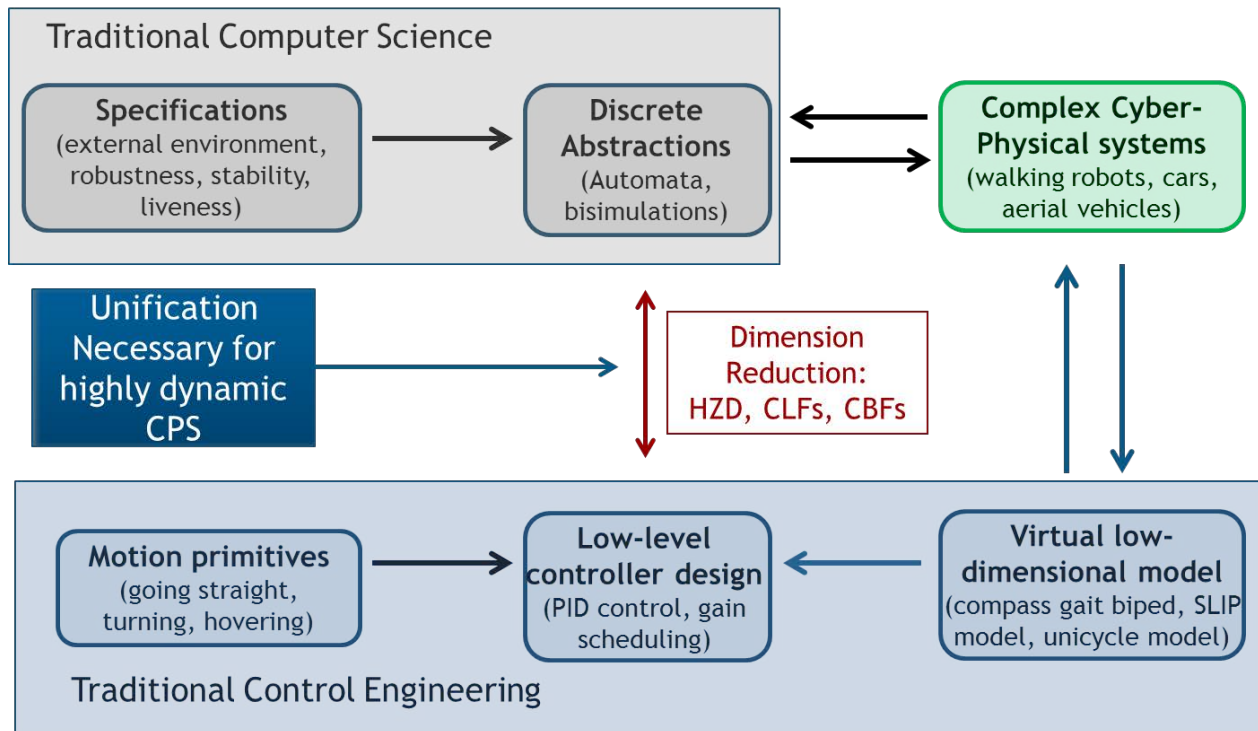
**Carnegie
Mellon
University**



Description

Overarching Goal

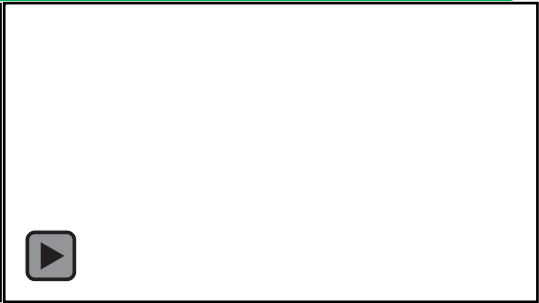
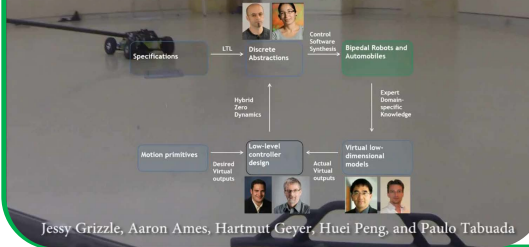
Create a formal framework for correct-by-construction control software synthesis for complex highly dynamic CPSs: where the difference between stable (safe) behavior and catastrophe (unsafe) behavior occurs in milliseconds





Findings

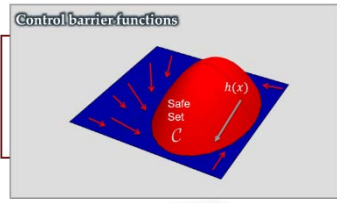
NSF Frontier: Collaborative Research: Correct-by-Design Control Software Synthesis for Highly Dynamic Systems



<p>Abstraction-based</p> <p>Gate synthesis: 6-dimensional model</p>	<p>Assume-guarantee</p> <p>First time: Correct-by-design</p>	<p>Synthesis for</p> <p>Scalability barrier: 10000-dimensional</p>	<p>Satisfiability modulo convex optimization</p> <p>Scalability barrier breached: 10000x faster than existing SMT solvers!</p>

Complex Cyber-Physical systems (walking robots, cars, aerial vehicles)

Unification Necessary for highly dynamic CPS



Motion primitives (going straight, turning, hovering)

Traditional Control Engineering

<p>Forward reachable set computation</p> <p>Real-time optimization: Theoretical guarantees + experimental results</p> $\inf_{w, \lambda, q} \int_{x \times K} w(x, k) d\lambda_{x \times K}$ <p>s.t. $-\left(\frac{dw}{dt} + \frac{dw}{dx} f\right) - q \geq 0$</p> $-v(0, x, k) \geq 0$ <p>$v(x, k, j)$ acts like a Lyapunov function (it is descending along trajectories of the system)</p>	<p>Supervised learning</p> <p>Learning with safety guarantees: Control barrier function supervises learning-based control</p>
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