

Robotics Research at Amherst College

Mohammed Suleiman
Advised by Prof. Scott Alfeld
Computer Science

Simulation, reinforcement learning, and autonomous robotics with Boston Dynamics Spot and Crazyflie drones.

HOW IT HAPPENED · PROJECT TIMELINE

01

High level control

Learned the platform through Spot's high level API.

02

Low level ruled out

Raw joint commands risked breaking the real dog.

03

Simulate first

Risky motions had to be proven in software first.

04

Blocker: no GPU

Isaac Sim needed hardware we would have had to rent.

05

Would FrostByte take it?

Nobody had configured the cluster for Isaac Sim before.

06

I set it up

Proposed FrostByte, then got Isaac Sim running on it.

07

Three legs in sim

The simulated Spot held a stable three leg stance.

08

Sim to real pipeline

A staged path to hardware that could not damage Spot.

09

It worked for real

The real Spot held the three leg stance.

10

Two legs in Isaac Lab

Worked in simulation; summer ended before deployment.

IN PARALLEL, THROUGHOUT Crazyflie autonomous drone work: throw to hover, figure eight tracking, ping pong and dodge maneuvers, ArUco tracking, AI deck vision.

01 FrostByte HPC

Nobody knew whether **FrostByte** could be configured to run Isaac Sim. It could. I installed it on the cluster, so Spot could be simulated on Amherst's own GPUs instead of rented ones.



FROSTBYTE · AMHERST COLLEGE HPC CLUSTER

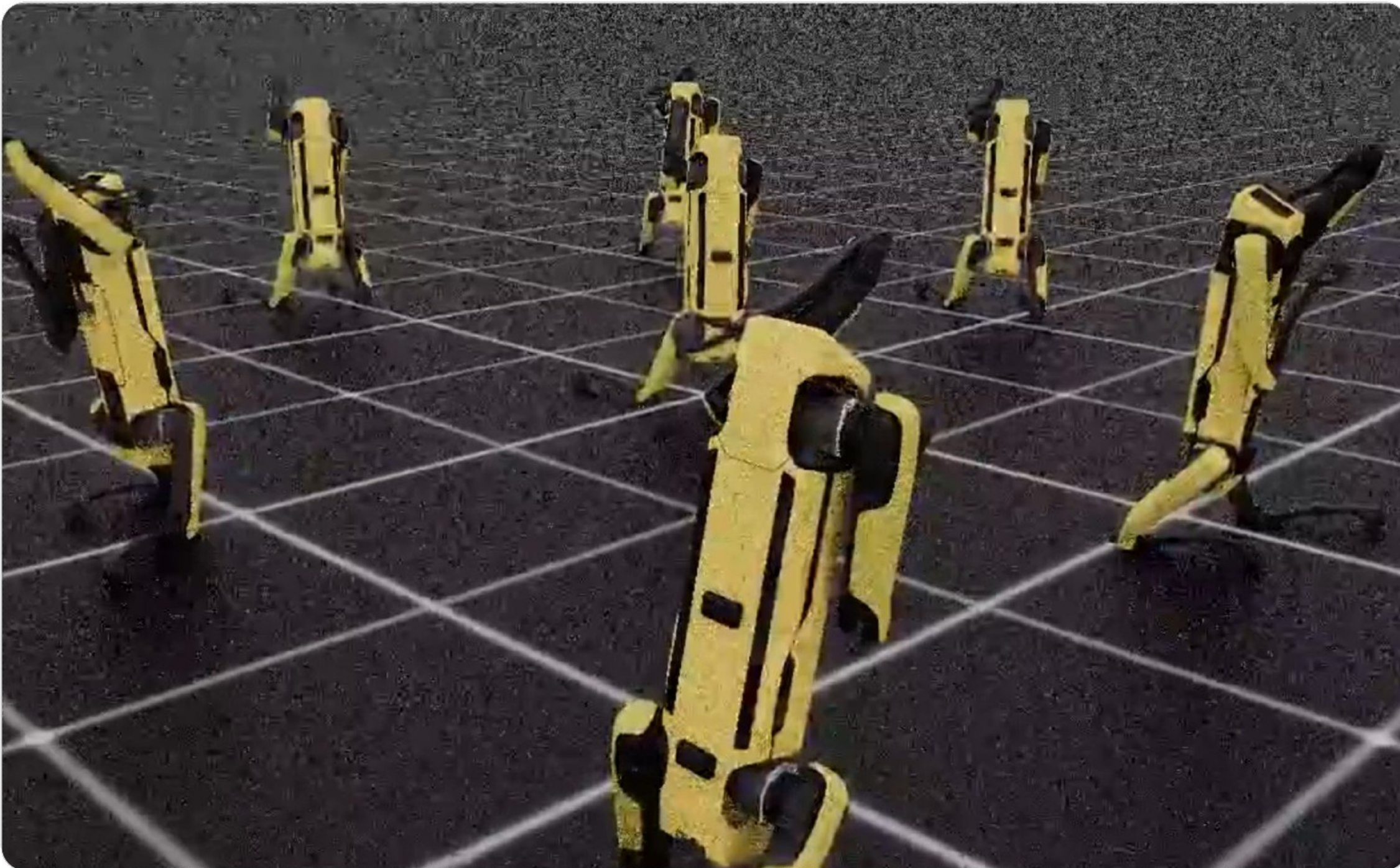
No paid GPU hosting

The cluster replaced a cloud bill we could not cover.

Reusable setup

Isaac Sim now runs on FrostByte for whoever comes next.

04 Two legs, trained in parallel



Isaac Lab is the reinforcement learning layer on top of Isaac Sim. The policy trained continuously across 2,400 simulated Spots. The nine shown are the finished product, each with its own payload and floor friction.

Stood on two legs in simulation

The trained policy held a two leg stance in Isaac Lab.

Not yet on hardware

Summer ended before it reached the real Spot.

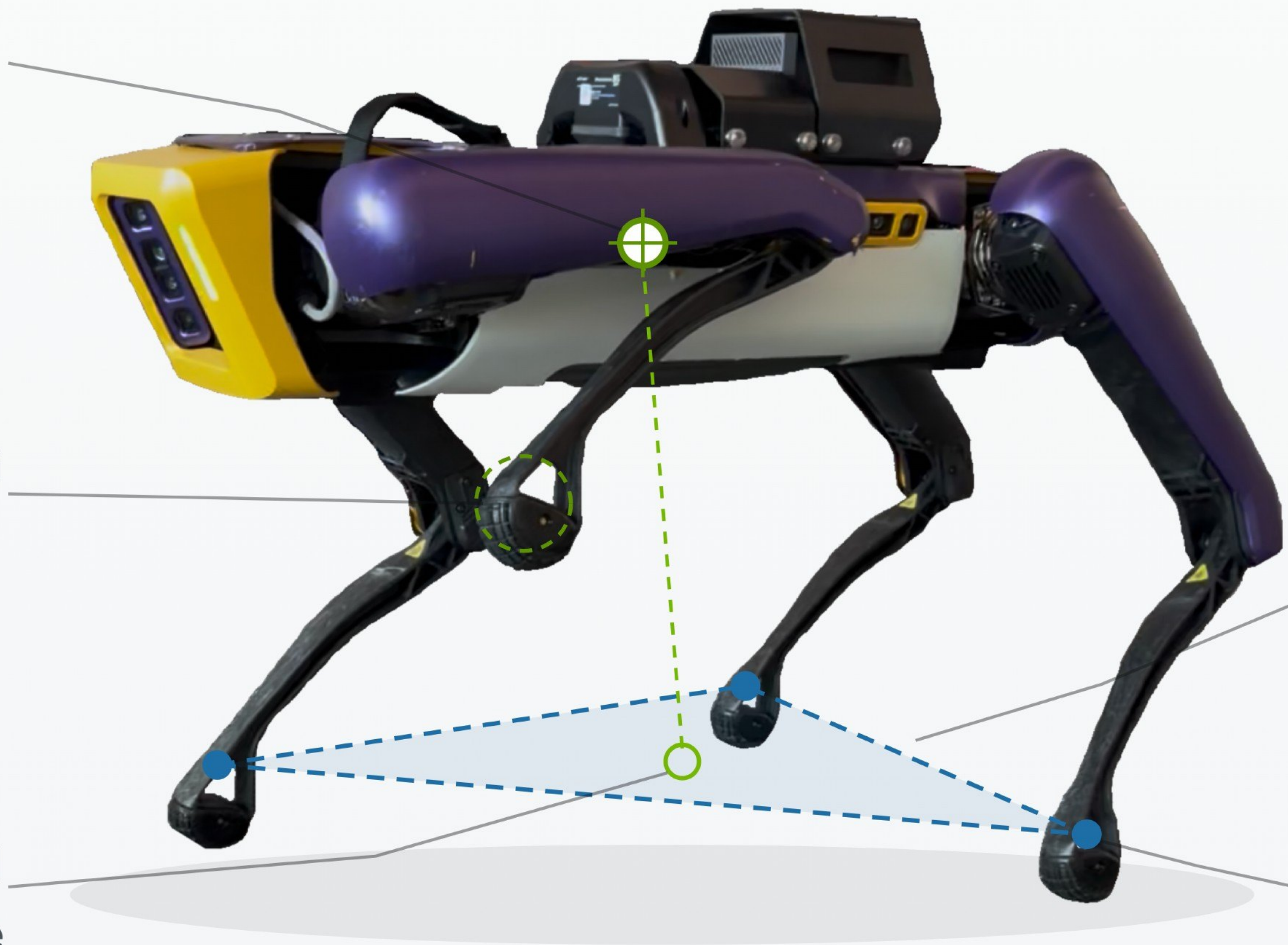
02 THREE LEG BALANCE

One front leg lifted, with the center of mass driven inside the triangle the other three feet make.

CENTER OF MASS
held inside the support triangle

LIFTED FRONT LEG
front left leg clear of the ground

STABILITY MARGIN
room left before the stance tips



SUPPORT TRIANGLE
three contact points on the floor

LOADED FEET
carrying the whole robot

03 Spot: sim to real

Isaac Sim is a physics simulator: a virtual copy of Spot and the ground it stands on, where a motion can fail hundreds of times before it touches real hardware.



THREE LEG STANCE IN ISAAC SIM

Nothing Breaks

Every failed attempt hit the simulated Spot, never the real one.

Staged Deployment

Then pushed to hardware over the Spot SDK, one guarded step at a time.

05 Crazyflie autonomous drone

Autonomy at the opposite scale: a palm sized quadrotor, cheap to crash and fully programmable. Every flight ran on its own sensing, with no pilot and no tracking rig.



Throw to Hover

Thrown by hand, it senses free fall and catches its hover.

Dodge

Senses something near, backs off to the gap I set.

ArUco Tracking

Reads markers to work out where it is in the room.

Figure Eight

Flies a continuous figure eight, tight at the crossover.

Ping Pong

Never settles: runs from each new object, on all four sides.

AI Deck Vision

Camera perception runs onboard the drone itself.