Curriculum Learning for GPS-Free Indoor Social Navigation

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TL;DR 📄

Problem ⚠️: Indoor human-robot interaction requiring GPS is impractical due to unreliable indoor GPS systems.

Solution 🧠: Introduce curriculum learning to train RL policies for social navigation with minimal human GPS data.

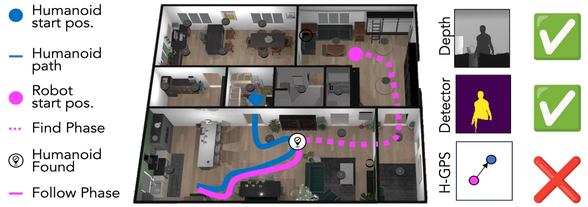
Result 🏆: Comparable performance to GPS-dependent methods with fewer samples, using only initial GPS observations.

Introduction 👋

Challenge 🏋️: Embodied Social Navigation in indoor scenes with unreliable or unavailable GPS data.

Current Ideas 💡: Over-reliance on GPS, impractical in real-life.

Objective 🎯: A policy robust to limited/no GPS availability.



Task Details 📝

Task: Habitat 3.0 SocialNav: agent finds and follows a human while avoiding collisions, humans follows random path.

Metrics: Finding Success (FS), Following Rate (FR), FS weighted by Past Steps (SPS), Collision Rate (CR), Reward (R);

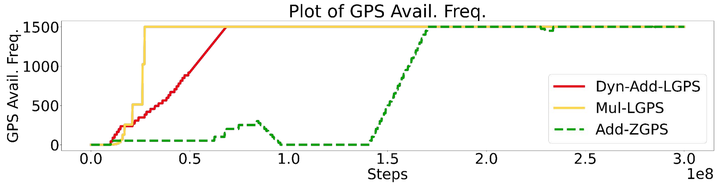
Methodology ⚙️

Approach: Curriculum for training FS to reduce GPS availability.

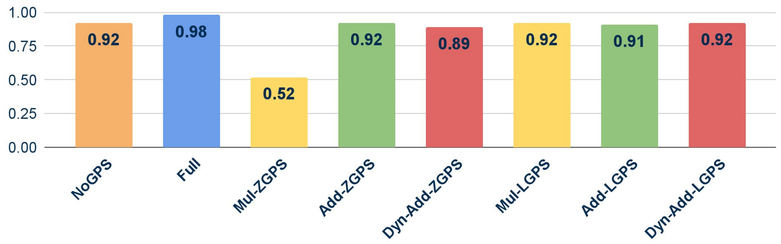
Curriculum Learning:
- **Levels:** 1 to 1500, determining interval of availability.
- **Training Steps:** 300M, with level update every 10M steps.
- **Thresholds:** Train FS to adjust curriculum difficulty.

GPS Representation Strategies:
- **ZeroGPS 0️⃣:** Use (0,0) when GPS is unavailable.
- **LastGPS 🔄:** Use last known GPS location.

Curriculum Update Strategies:
- **Additive➕ :** Fixed increment/decrement based on FS.
- **Multiplicative✖️ :** Frequency doubles/halves based on FS.
- **Dynamic Additive 🔧 :** Variable additive scaled with FS.



Best Eval FS

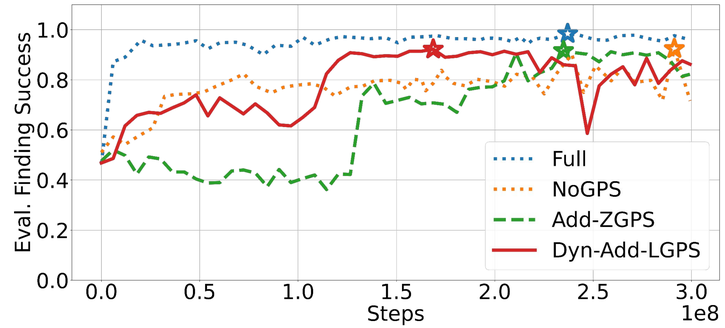


Results 📊

Performance Comparison:
- **Full (all sensors):** FS = 0.98, stable performance.
- **NoGPS (no GPS):** FS = 0.92, variable performance.
- **Curriculum:** Achieve similar FS as NoGPS with better stability and fewer samples.

Top Performing Strategies:
- **Dyn-Add-LGPS:** High FS, fewer iterations.
- **Add-ZGPS:** High FS but requires more iterations.

Summary:
- **Mul-ZGPS:** Poor with ZeroGPS, good with LastGPS
- **Add-ZGPS/Dyn-Add-ZGPS:** Good FS, stable performance.
- **Dyn-Add-LGPS:** Best overall performance, stable FS.



Conclusion and Future Work 🔍🔮

This Work: Curriculum matches the performance of NoGPS baseline with fewer samples. 🎉

Next: Focus on reducing CR, improving SPS, active exploration.