RobustNav: Towards Benchmarking Robustness in Embodied Navigation

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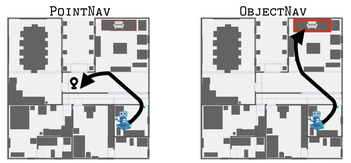
1 Highlights

- **RobustNav:** Benchmark to assess robustness of embodied navigation agents
- Navigation agents ***underperform or fail*** in the presence of **visual (affecting RGB)** and **dynamics (affecting motion) corruptions**
- Unsupervised methods to resist or improve under corruptions offer ***little to no improvements***
- **Project Page:** prior.allenai.org/projects/robustnav

2 Motivation

- **Task of interest:** Visual Navigation
- Navigate to target based on RGB(D) sensors

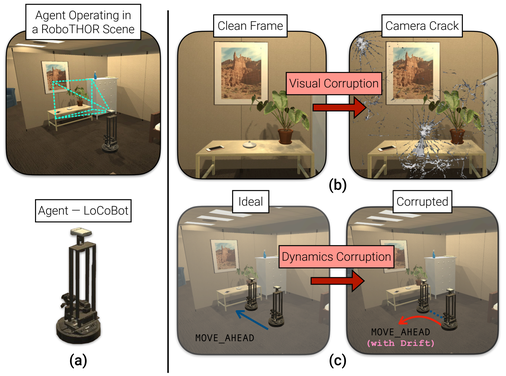


- Current generalization pipeline

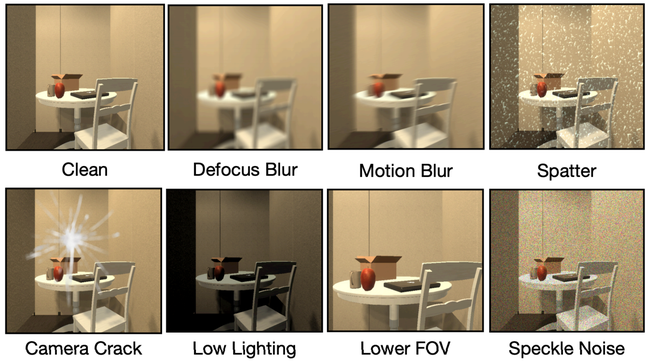
- Significant discrepancy in appearance and dynamics characteristics not considered

RobustNav

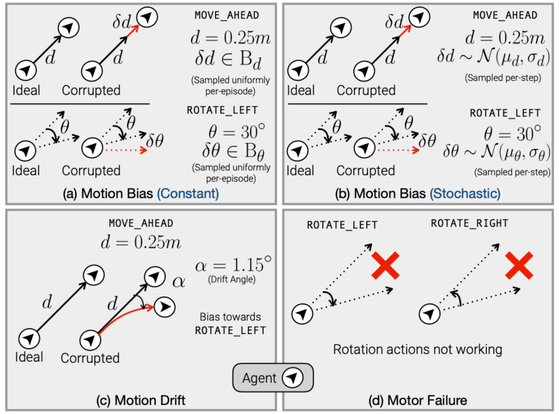
In addition to changes in floorplan, also evaluate under changing appearance and dyanmics



3 RobustNav



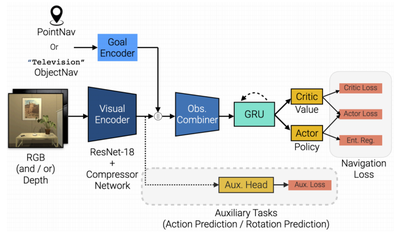
- **Visual Corruptions** affect the agent's **ego-centric RGB observation**
- Can be due to poor lighting conditions, noise, particles deposited on camera lens, blur, etc.
- 7 visual corruptions at 5 progressively increasing levels of severity



- **Dynamics Corruptions** affect **transition dynamics** in the target environment
- Motion Bias (Constant & Stochastic) mimics friction
- Motion Drift mimics drift in translation
- Motor Failure involves actions not working

4 Findings

- **Agent Architecture:** Vanilla Neural (CNN + GRU) Policy Architectures
- Trained via RL from scratch using DD-PPO
- PointNav & ObjectNav



	Corruption ↓	V	D	PointNav RGB SR ↑	PointNav RGB SPL ↑	PointNav RGB-D SR ↑	PointNav RGB-D SPL ↑
	Clean			98.82	83.13	98.54	84.60
Visual Corruptions	Low Lighting	✓		94.36	75.15	99.45	84.97
	Motion Blur	✓		95.72	73.37	99.36	85.36
	Camera Crack	✓		82.07	63.83	95.72	81.21
	Defocus Blur	✓		75.89	53.55	99.09	85.54
	Speckle Noise	✓		67.42	48.57	98.73	84.66
	Lower-FOV	✓		42.49	31.73	89.08	73.59
	Spatter	✓		33.58	24.72	98.91	84.81
Dynamics Corruptions	Motion Bias (C)		✓	92.81	77.83	93.36	79.46
	Motion Bias (S)		✓	94.72	76.95	96.72	79.08
	Motion Drift		✓	95.72	76.19	93.36	75.08
	PyRobot [41] (ILQR) Mul. = 1.0		✓	96.00	67.79	95.45	69.27
	Motor Failure		✓	20.56	17.63	20.56	17.62
Visual + Dynamics Corruptions	Defocus Blur + Motion Bias (S)	✓	✓	76.52	51.08	97.18	79.46
	Speckle Noise + Motion Bias (S)	✓	✓	62.69	43.31	95.81	78.27
	Spatter + Motion Bias (S)	✓	✓	33.30	23.33	95.81	78.85
	Defocus Blur + Motion Drift	✓	✓	74.25	50.99	95.54	76.66
	Speckle Noise + Motion Drift	✓	✓	64.42	44.73	94.36	75.23
	Spatter + Motion Drift	✓	✓	32.94	23.44	95.45	76.61

- Unlike "clean" settings, agents under corruptions underperform or fail
- Drop in performance is accompanied by idiosyncrasies like inability to terminate, uptick in collisions, being farther from the target
- Methods to provide zero-shot resistance (data-augmentation) or adapt to visual corruptions offer little improvements
- **Future Work:** Develop robust navigation agents via iterative evaluation under RobustNav
- **Future Work:** Extend to more tasks involving navigation