Hierarchical Cross-Modal Agent for Robotics Vision-and-Language Navigation

Muhammad Zubair Irshad, Chih-Yao Ma, Zsolt Kira

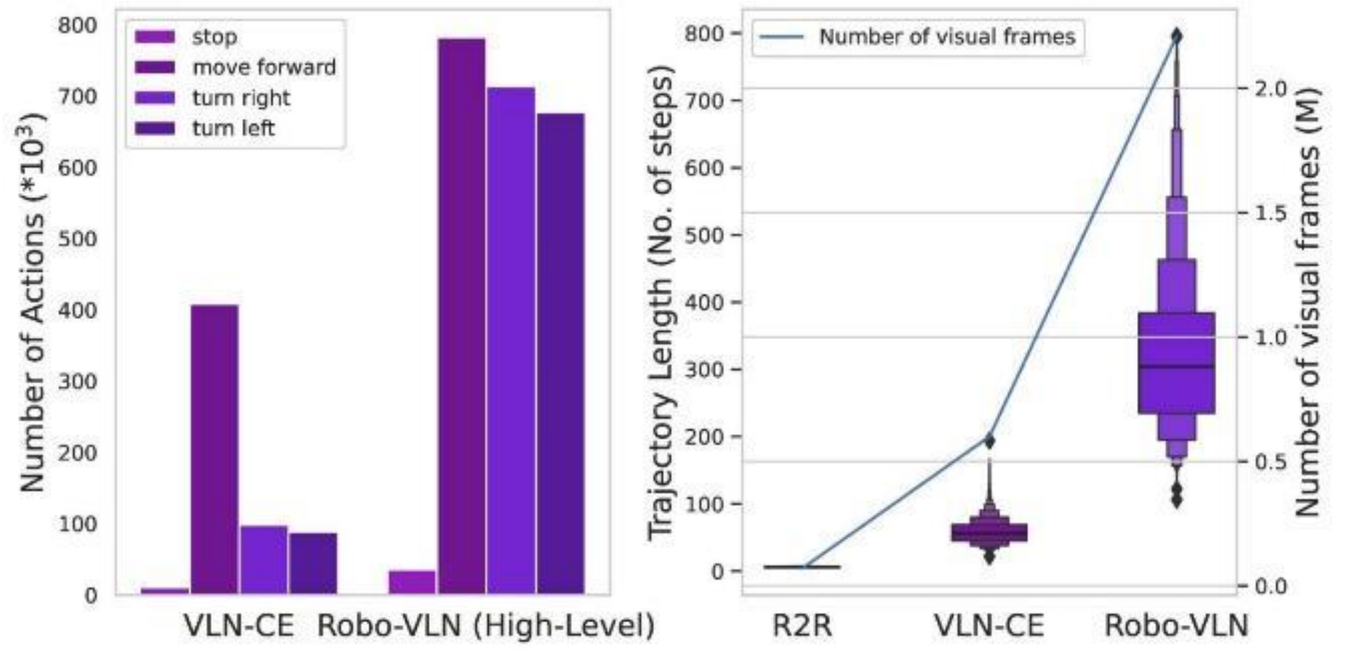
Georgia Institute of Technology

Motivation

- Vision and Language Navigation – an autonomous agent navigating to a goal location using visual inputs and provided instructions while navigating.
- Navigation without prior global maps
- Generalization to novel environments is a challenge
- Current works enforce unrealistic assumptions i.e. known topology, perfect localization and deterministic navigation

Robo-VLN Dataset

- Introduce Robo-VLN- a richer VLN formulation which is defined in continuous environments over long horizon trajectories.
- Robo-VLN provides longer horizon trajectories (4.5x times average number of steps), more visual frames and a balance high-level action distribution compared to discrete VLN settings.
- Robo-VLN computes ground truth oracle feedback controllers in 3D reconstructed environments and obtains navigable instruction-trajectory pairs in continuous environments. The dataset is an extension of VLN-CE/R2R.
- Annotated instructions in the dataset does not describe goals



Hierarchical Cross-Modal Agent

- Layered two-tiered decision making
- High-level policy performs cross modal reasoning and produces sub-goal
- Low-level policy imitates the controller and translates sub-goal to continuous actions

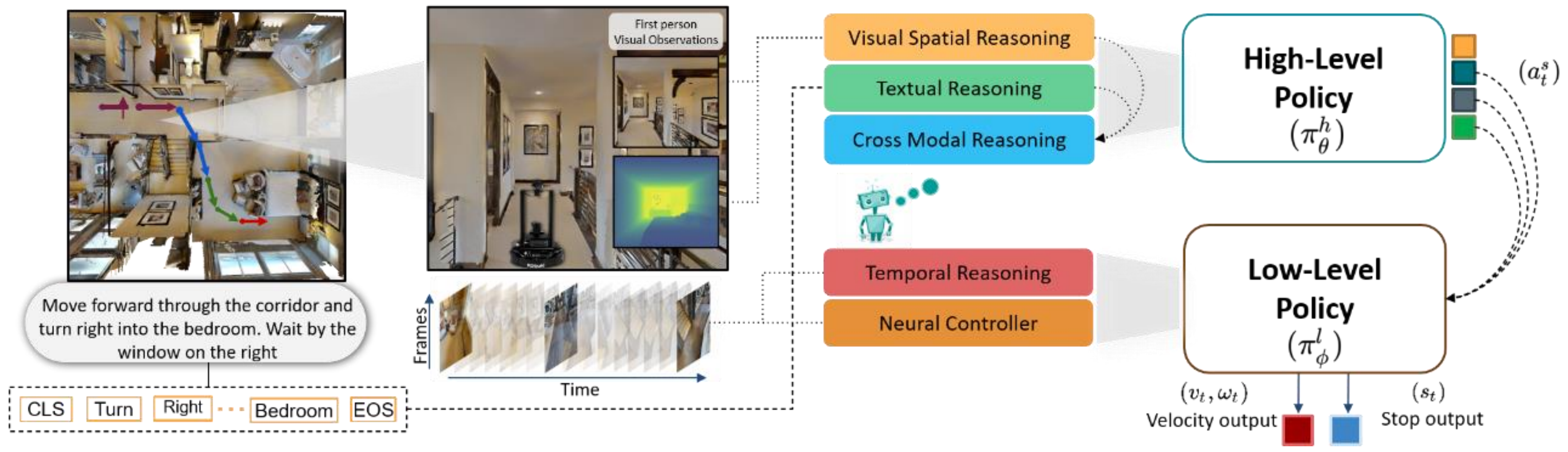
Overview

a. Continuous VLN

b. Visual observations

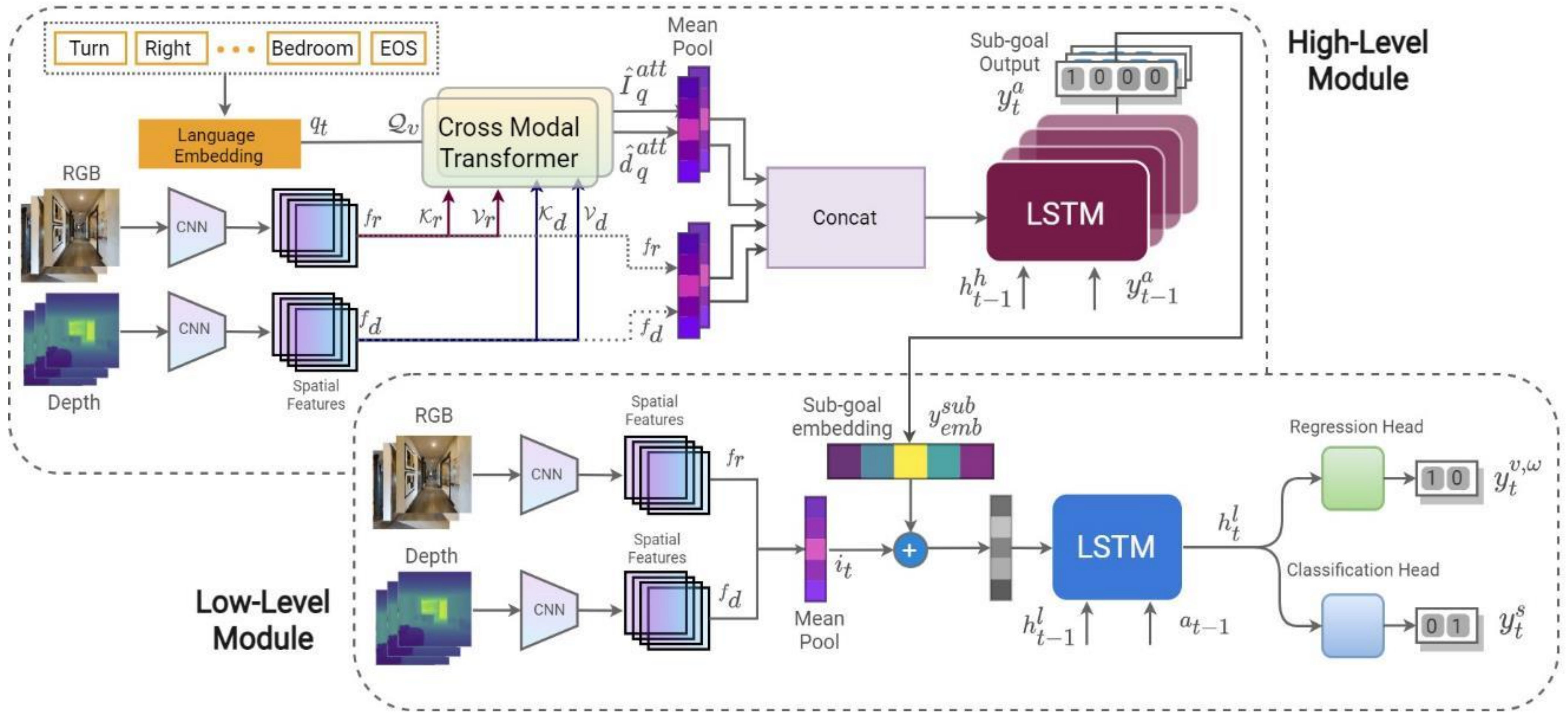
c. Decoupled reasoning

d. Hierarchical Imitation



Architecture

- The Agent is comprised of a high-level policy and a low-level policy. A layered decision making allows spatially different reasoning at different levels in the hierarchy, hence specializing each policy with a different reasoning abstraction level.

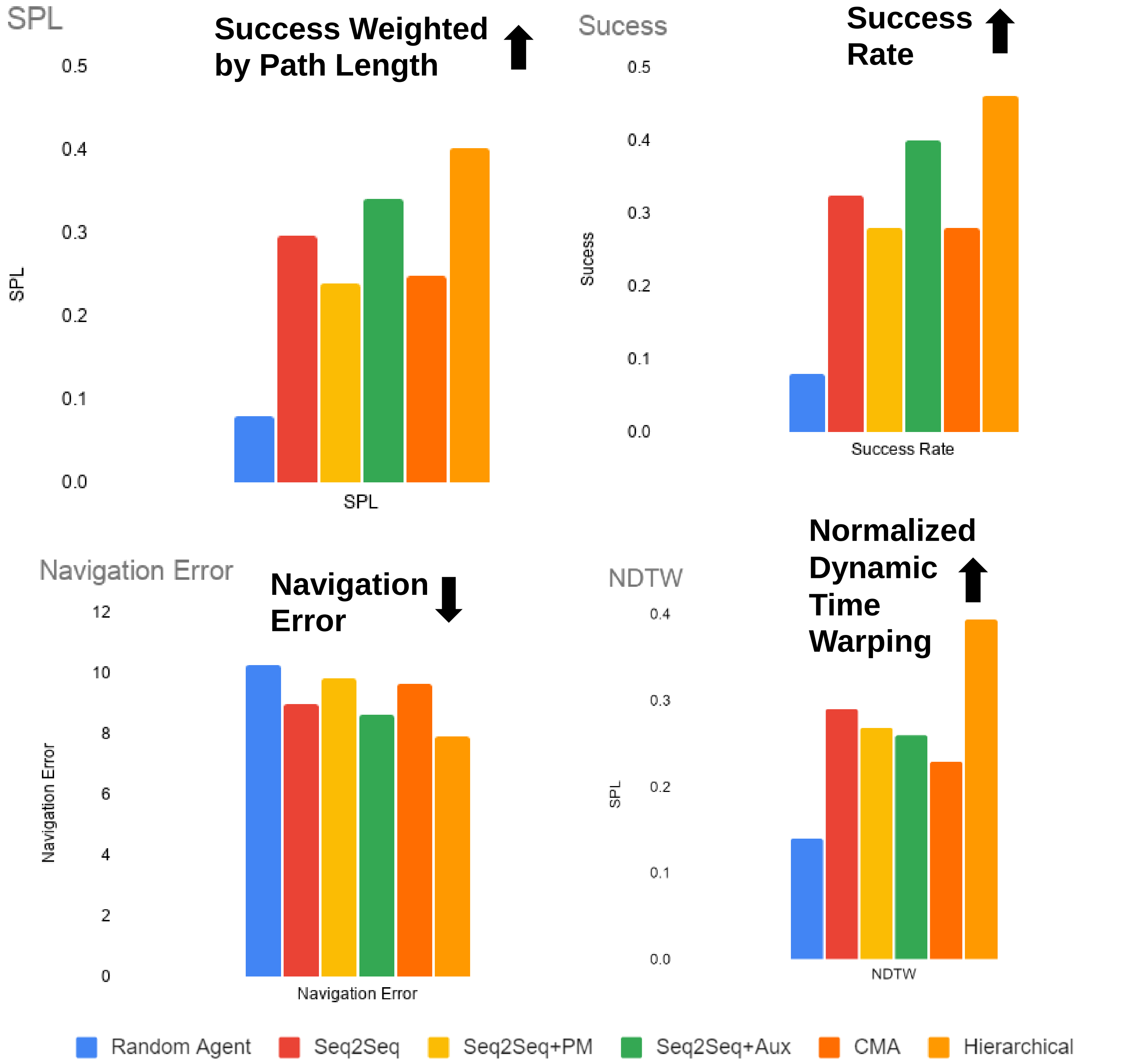


Experiments

- We introduced a suit of flat baselines similar to ones used in VLN-CE.
- Sequence to Sequence (**Seq2Seq**): Encoder-Decoder Architecture
- Cross-Modal Attention (**CMA**): Aligning instructions with images
- **Progress Monitor** [1]: Adding auxiliary losses to aid learning
- **Flattened hierarchical**: Provide sub-goal supervision to flat model

[1] Chih-Yao Ma, Jiasen Lu, Zuxuan Wu, Ghassan Al-Regib, Zsolt Kira, Richard Socher, and Caiming Xiong. Self-monitoring navigation agent via auxiliary progress estimation.

Results



Conclusion

- We lift the agent off the assumptions enforced by discrete action spaces and navigation graph based VLN formulation.
- Provide a suit of baselines in Robo-VLN inspired by recent state of the works in VLN.
- Show that hierarchical approach performs better across all key standard metrics in Robo-VLN.