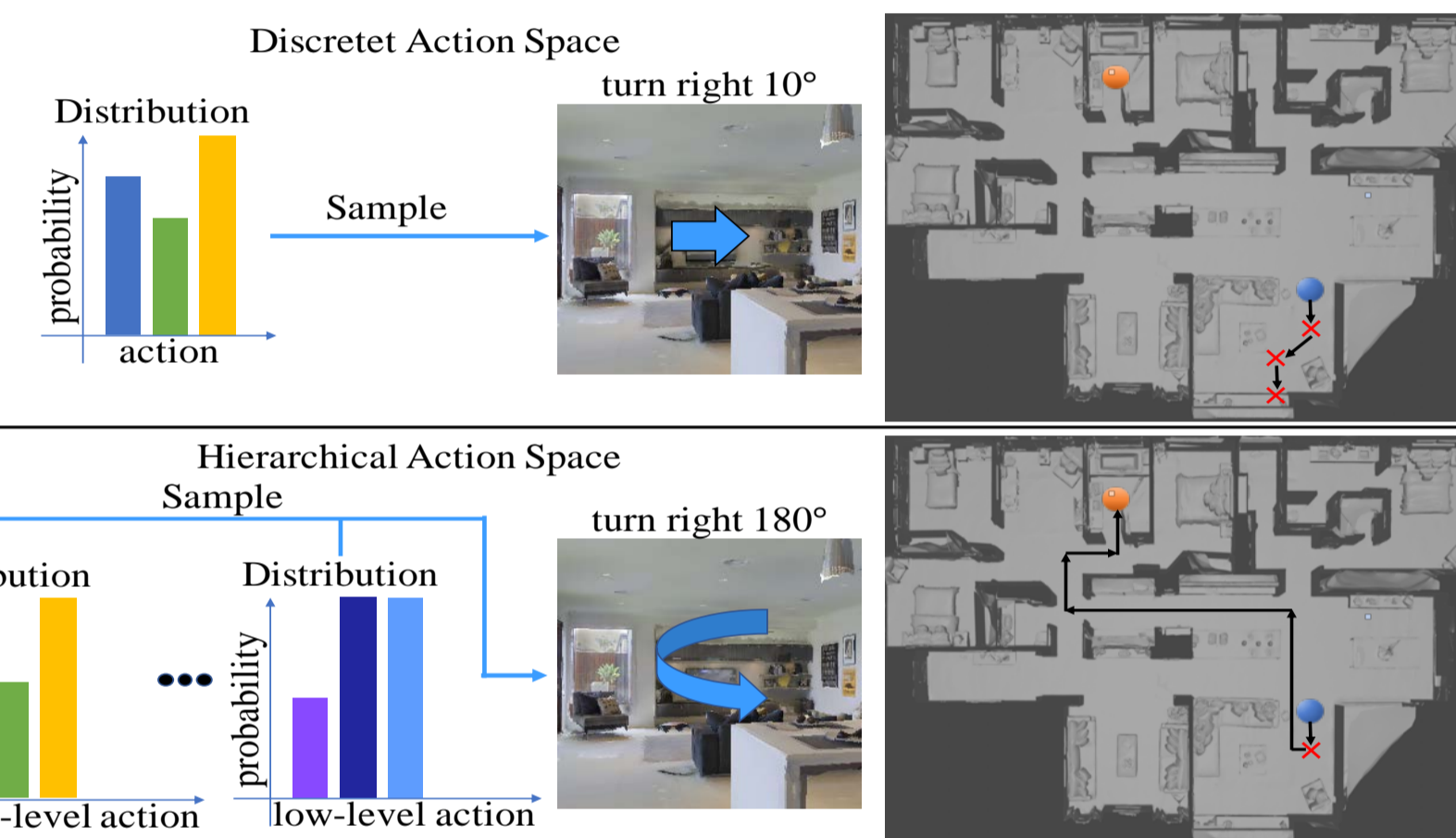


## # Motivation

In visual navigation tasks, the action space influences the efficiency of agents. Can we replace the conventional discrete action space with **hierarchical action space**?



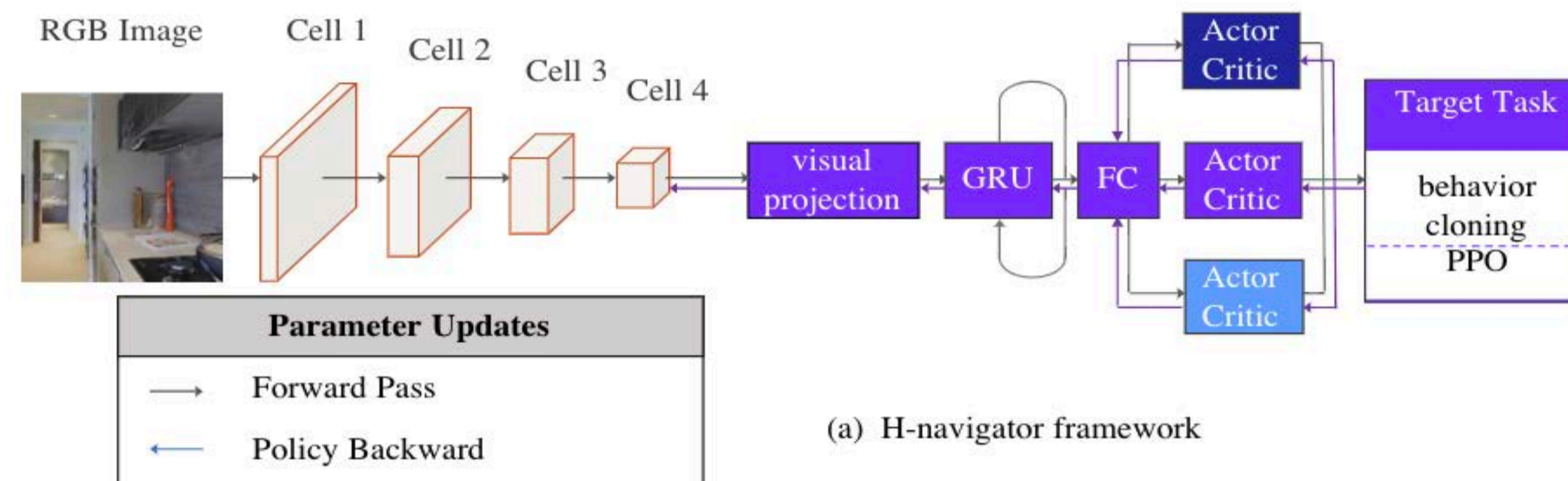
## # Contribution

1. We propose a **hierarchical navigation network**. The network divides the action space into hierarchical levels, including atomic-level actions (e.g. turn right  $10^\circ$ ) and composite-level actions (e.g. turn right  $180^\circ$ )
2. Our network achieves **superior performance** than our baseline methods on the widely-used large-scale Gibson navigation benchmark

## # Method

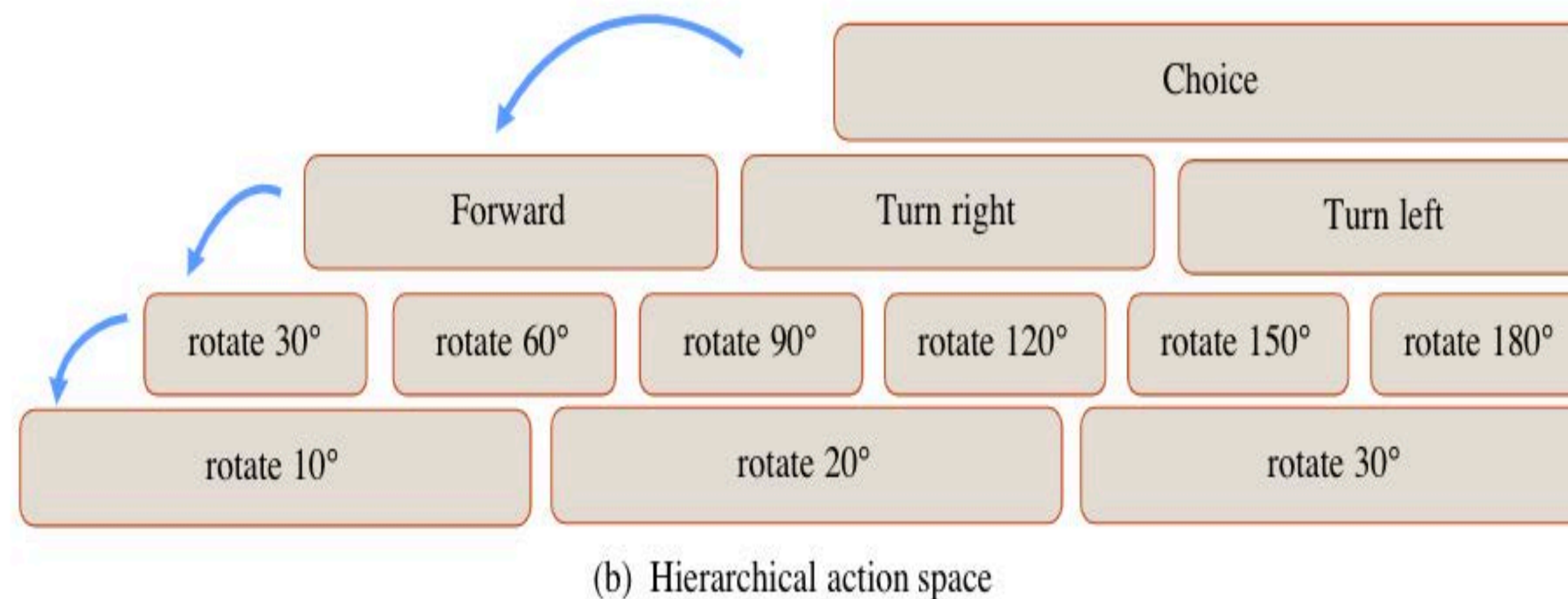
### Pipeline Overview

Our pipeline employ a three-stage training schedule: (1) pre-training visual encoder with auxiliary tasks; (2) training policy decoder via behavior cloning (3) fine-tuning policy decoder via proximal policy optimization (PPO).



### Hierarchical Action Space

We design an ordered tree structure as hierarchical action space. To be specific, the output of policy is a probability distribution over the action space. We propose three policy decoders to predict different levels of actions.



## # Experiments and Results

### Result on Gibson

Method	Rewards	Steps	SPL (%)	Success (%)
SplitNet[7]	-	-	58.40	86.50
H-Navigator	5.52	113.29	68.67	89.24
Hseq-Navigator	5.73	105.32	70.23	90.74

### State-of-the-art comparison

Method	backbone	RGB	RGBD	mapper	SPL (%)	Success (%)
Habitat [18]	ShallowNetf	✓			46.0	64.0
Habitat [18]	ShallowNetf		✓		70.0	80.0
SLAM [15]	-			✓	51.0	62.0
SplitNet [7]	ShallowNetf	✓			70.10	85.50
DDPPO [22]	SE-ResNeXt101		✓		96.9	-
ANM [3]	ResNet-18			✓	84.6	95.0
H-Navigator	ShallowNetf	✓			74.15	89.74

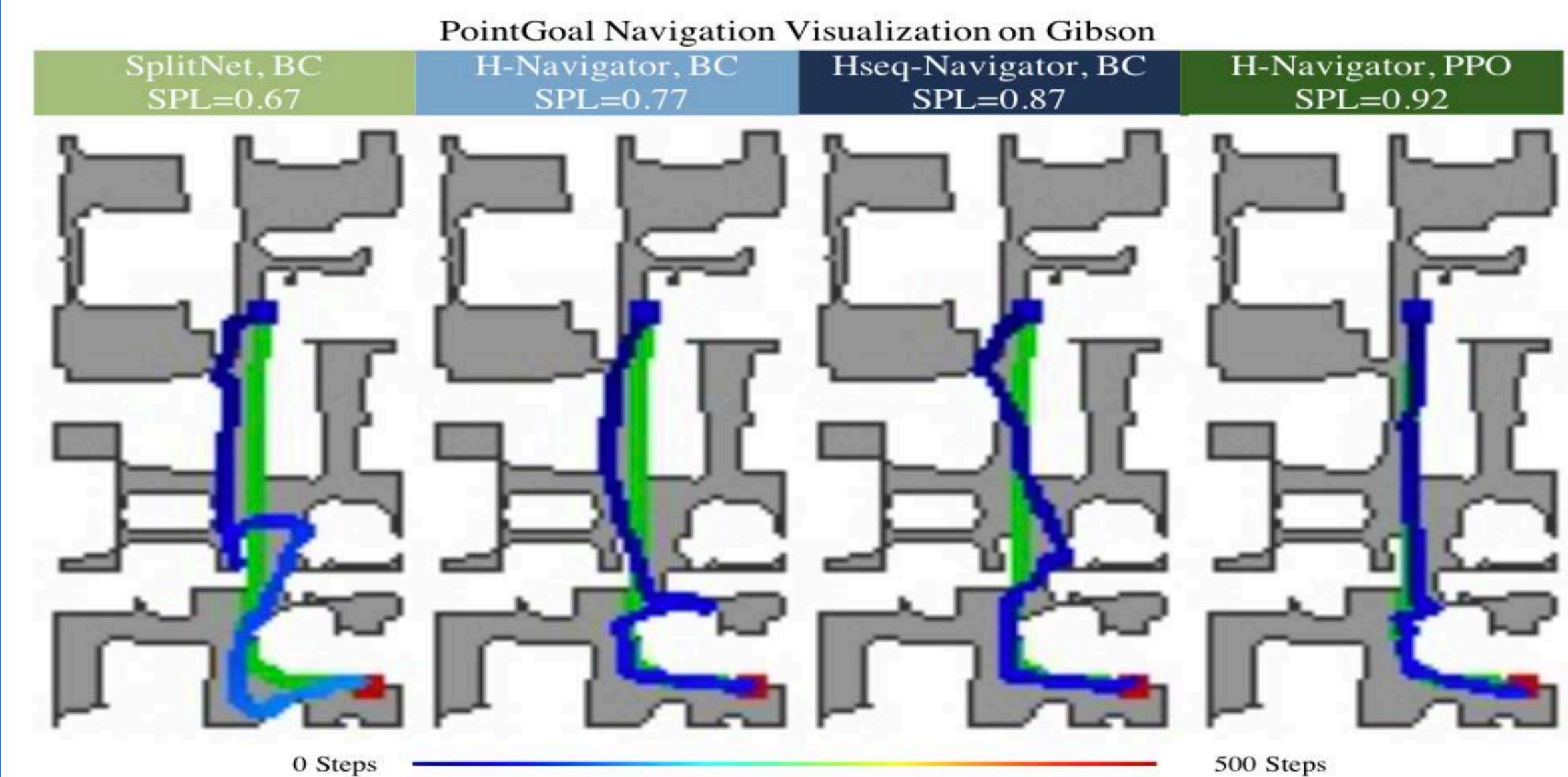
### Result on MP3D

Method	BC	PPO	Rewards	Steps	SPL (%)	Success (%)
Baseline	✓		4.29	317.92	39.74	60.81
H-Navigator	✓		4.37	300.19	37.96	58.79
H-Navigator	✓	✓	4.42	279.19	41.17	60.00
Hseq-Navigator	✓		2.87	347.18	28.91	48.89

### Ablation Study on Gibson

Method	BC	PPO	Rewards	Steps	SPL (%)	Success (%)
H-Navigator	✓		5.52	113.29	68.67	89.24
Hseq-Navigator	✓		5.73	105.32	70.23	90.74
H-Navigator	✓	✓	5.60	106.60	74.15	89.74
Random [7]			-	-	4.60	2.80
SplitNet [7]	✓		-	-	58.40	86.50
SplitNet [7]	✓	✓	-	-	70.10	85.50

### Visualization Results



## # Conclusion

We propose a hierarchical action policy navigation network, called H-Navigator. H-Navigator divides the action space into hierarchical actions with three-stage levels. Our H-Navigator achieves superior performance than our baseline methods.