Rethinking Social Robot Navigation: Leveraging the Best of Two Worlds

Sony AI

Geometric Navigation Systems

- Extensively studied and tested for decades ✓
- The "go-to solutions" for deploying robots ✓
- Reliable for most navigation scenarios ✓

- Challenging to balance the system to be both safe and efficient (e.g., Frozen robot problem) ✗
- Not scalable to deal with complex human behaviors in the wild ✗

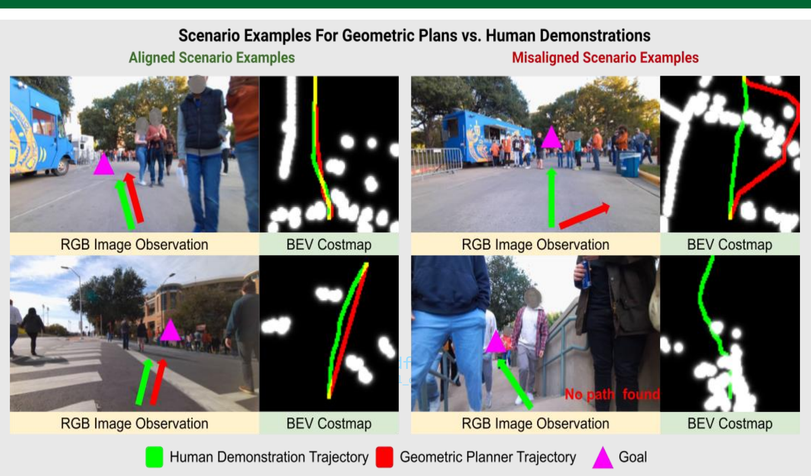
Learning-Based Navigation Systems

- Active research area ✓
- Adaptive to address complex scenarios ✓
- Scalable with the size of dataset ✓

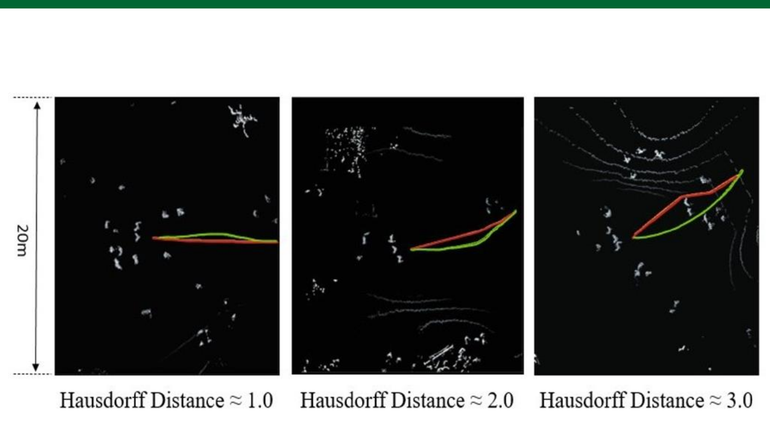
- Lack of high-quality robot navigation data ✗
- Suffer from the distribution-shift problem ✗
- Lack of safety guarantee due to the black-box nature of neural networks ✗

We propose to leverage both geometric and learning-based navigation systems to tackle the social robot navigation problem.

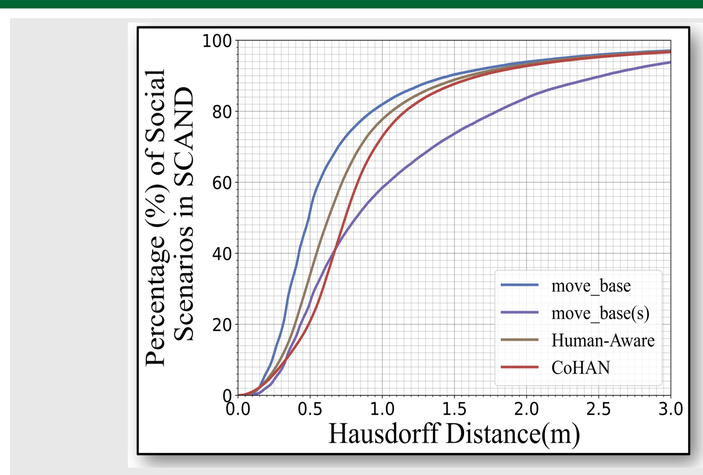
A Social Robot Navigation Case Study on SCAND



We playback ROS bags of social navigation scenarios to a geometric navigation system (e.g., *move_base*) to compare planned trajectories with human demonstrations.



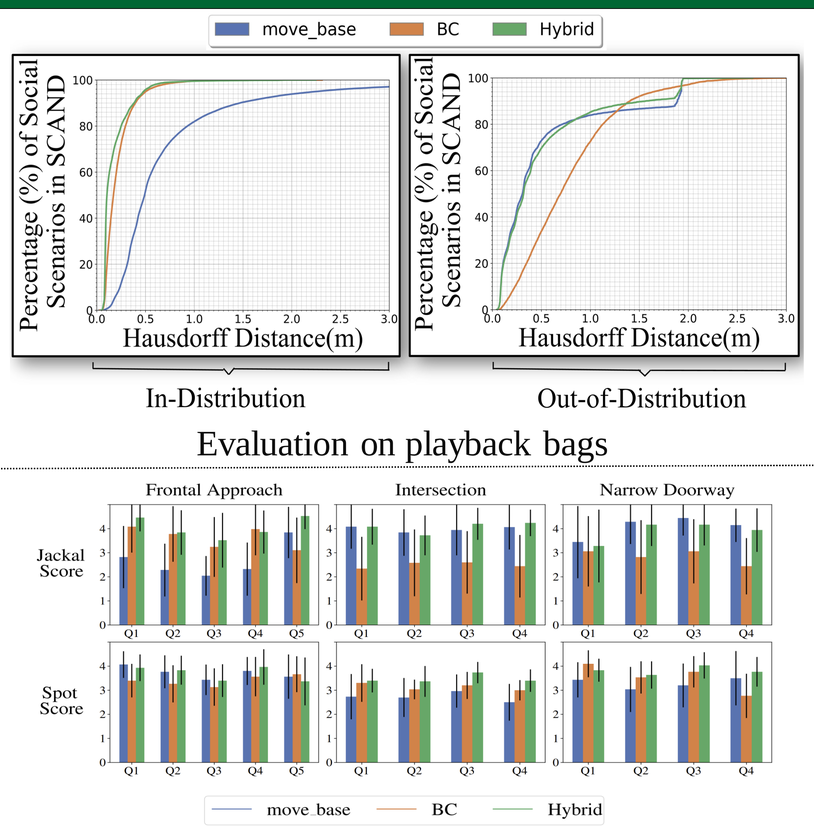
We propose a definition of social compliance based on how well a navigation behavior produced by a navigation system aligns with the human demonstration.



We benchmark the social compliance of four public geometric navigation systems, finding that they often produce trajectories aligned with human demonstrations in social navigation scenarios.

Rethinking Social Robot Navigation to Leverage Both

We develop a hybrid planner that uses a geometric navigation system as the backbone and complements it with a learned model (BC) for handling difficult social navigation scenarios.



Social Compliance Questionnaire

For Frontal Approach, the five questions are :

1) *The robot moved to avoid me.*
2) *The robot obstructed my path*.*
3) *The robot maintained a safe and comfortable distance at all times.*
4) *The robot nearly collided with me*.*
5) *It was clear what the robot wanted to do.*

For Intersection, the four questions are:

1) *The robot let me cross the intersection by maintaining a safe and comfortable distance.*
2) *The robot changed course to let me pass.*
3) *The robot paid attention to what I was doing.*
4) *The robot slowed down and stopped to let me pass.*

For Narrow Doorway, the four questions are:

1) *The robot got in my way*.*
2) *The robot moved to avoid me.*
3) *The robot made room for me to enter or exit.*
4) *It was clear what the robot wanted to do.*

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