

Enhancing human navigation ability using an active wearable exoskeleton



Scan for a video demo

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Goal of This Project

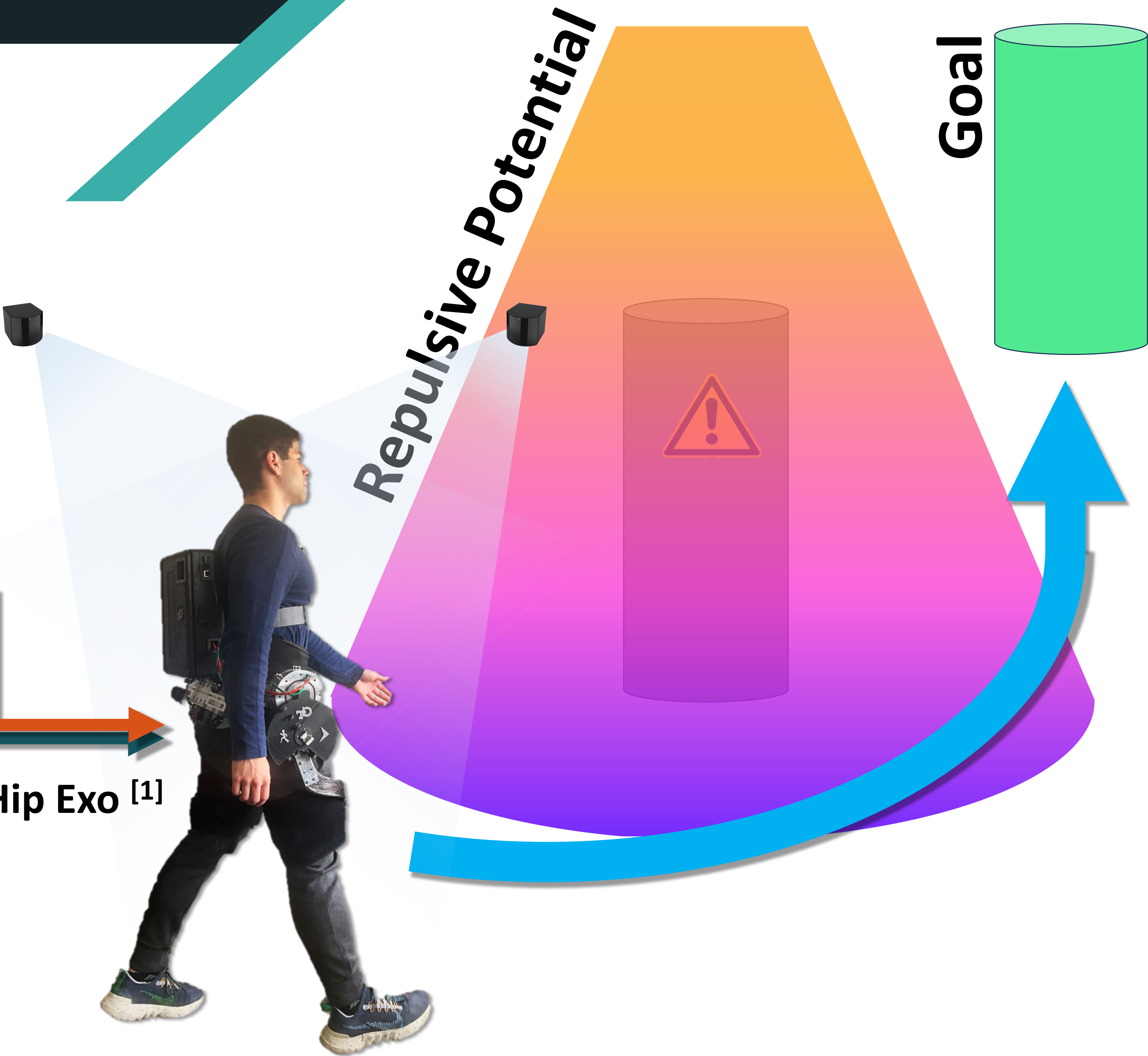
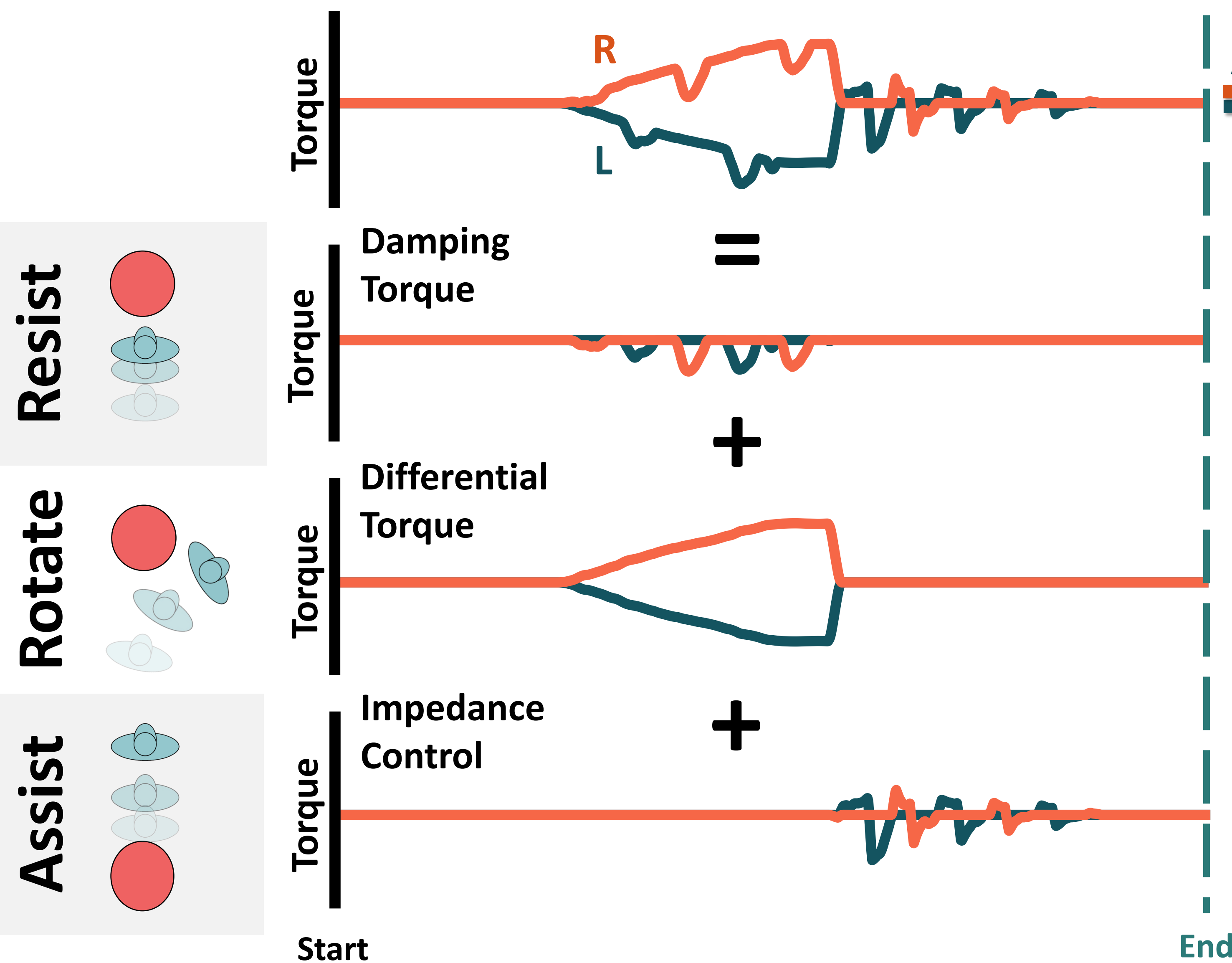
How can we promote **safe navigation** when visibility is low?

- Visibility may be impaired by dust, smoke, dense fog, or poor eyesight.
- Existing tactile and auditory devices require single-purpose hardware.

Hypothesis: Tactile feedback from an active exoskeleton can improve navigation ability compared to vision alone.



How the Controller Works



Experiment

- N=10
- Performed in **virtual reality**
- 7 conditions, 16 levels/condition
- 3 obstacle danger levels, d

	Exo On	Exo Off
Clear		
⋮		
Blind		

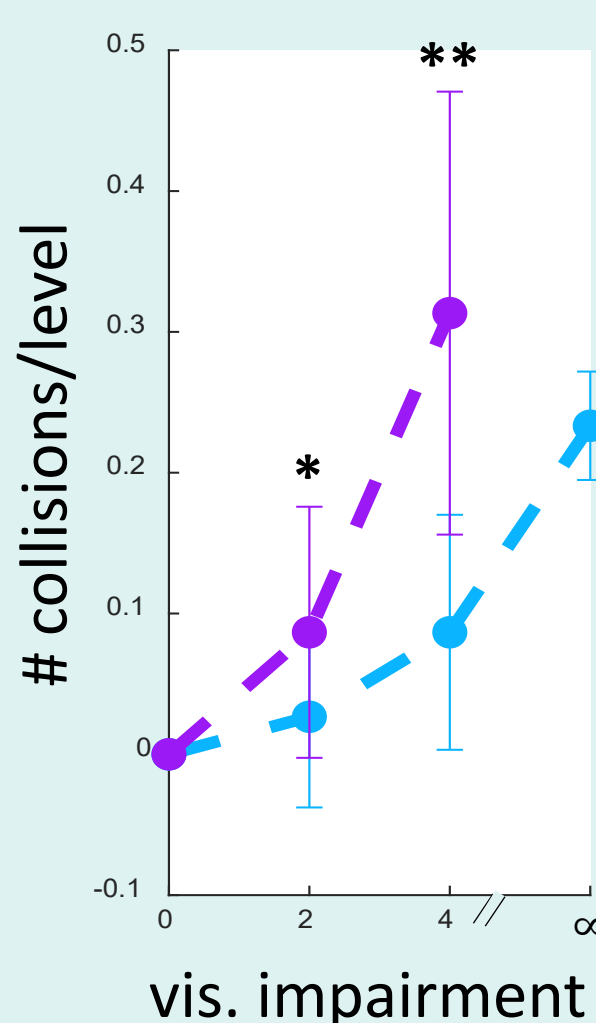


Results

Collisions

Collisions were significantly reduced with exo in all visibilities except clear.

- exo on
- exo off

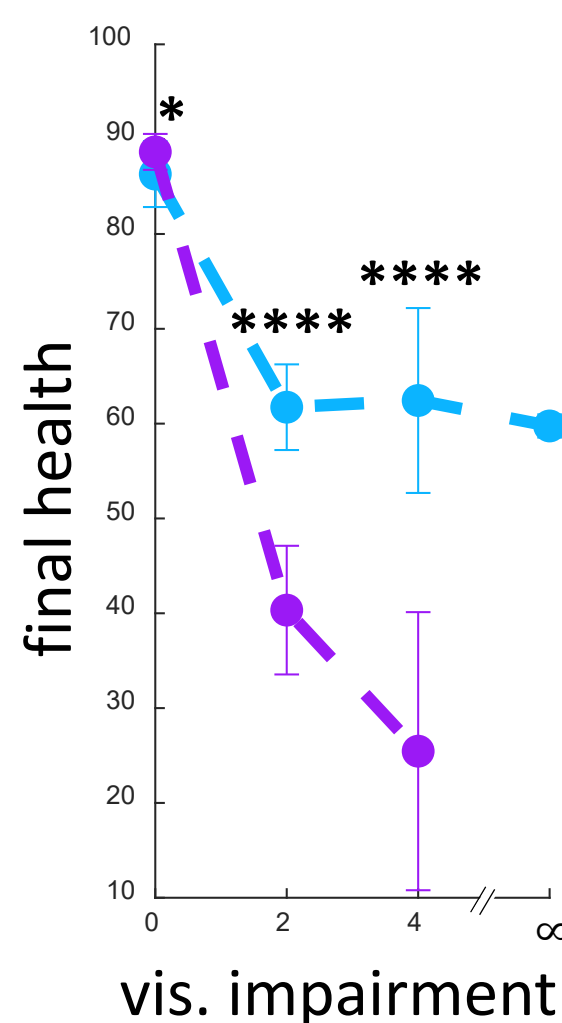


Health Metric

Performance with exo on was significantly better in all visibilities except clear.

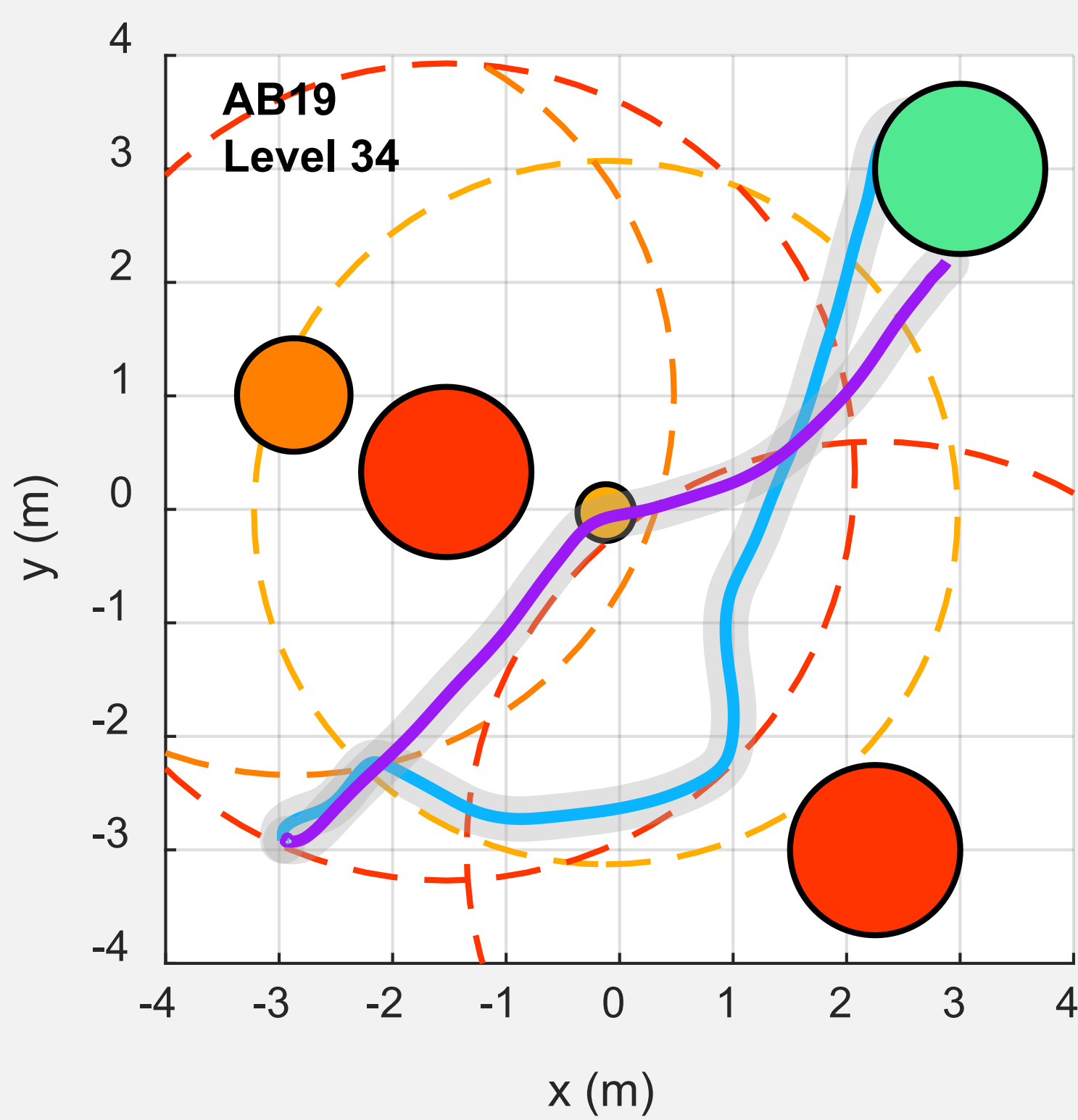
$$h_0 = 100$$
$$h_{i+1} = h_i - G \sum_{k=1}^{\text{\#obstacles}} d_k \frac{1}{r_k^2}$$

damage gain
radius/danger level of obstacle k
distance to obstacle k

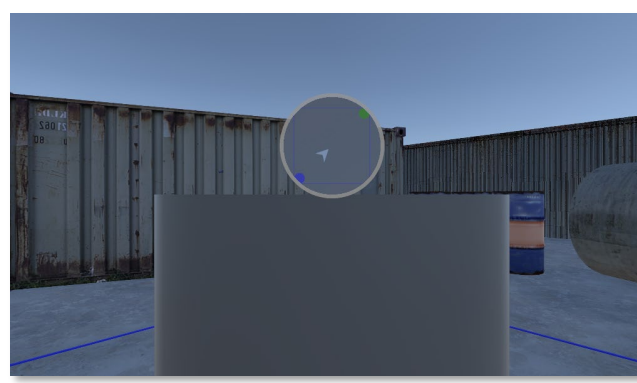
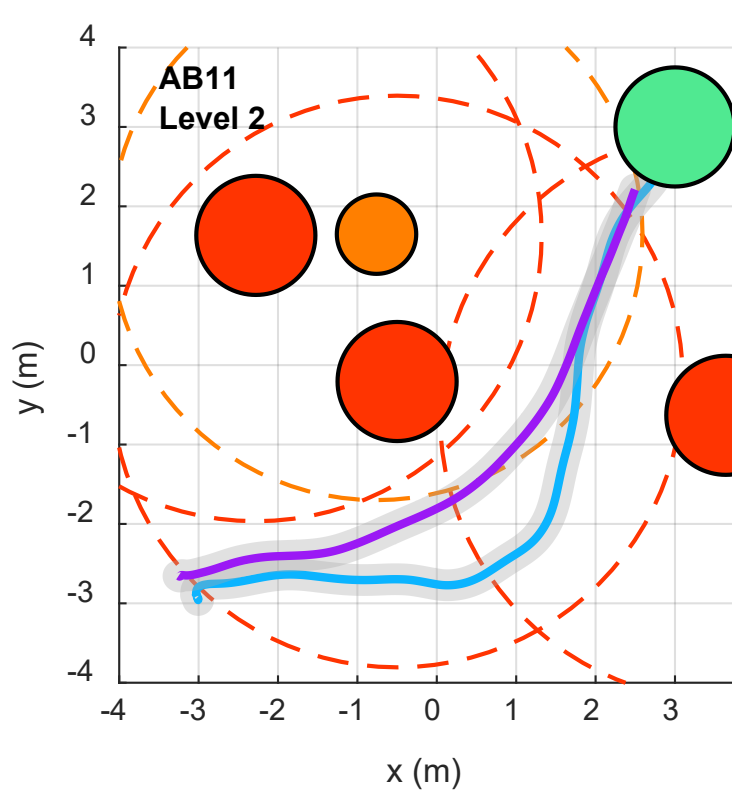
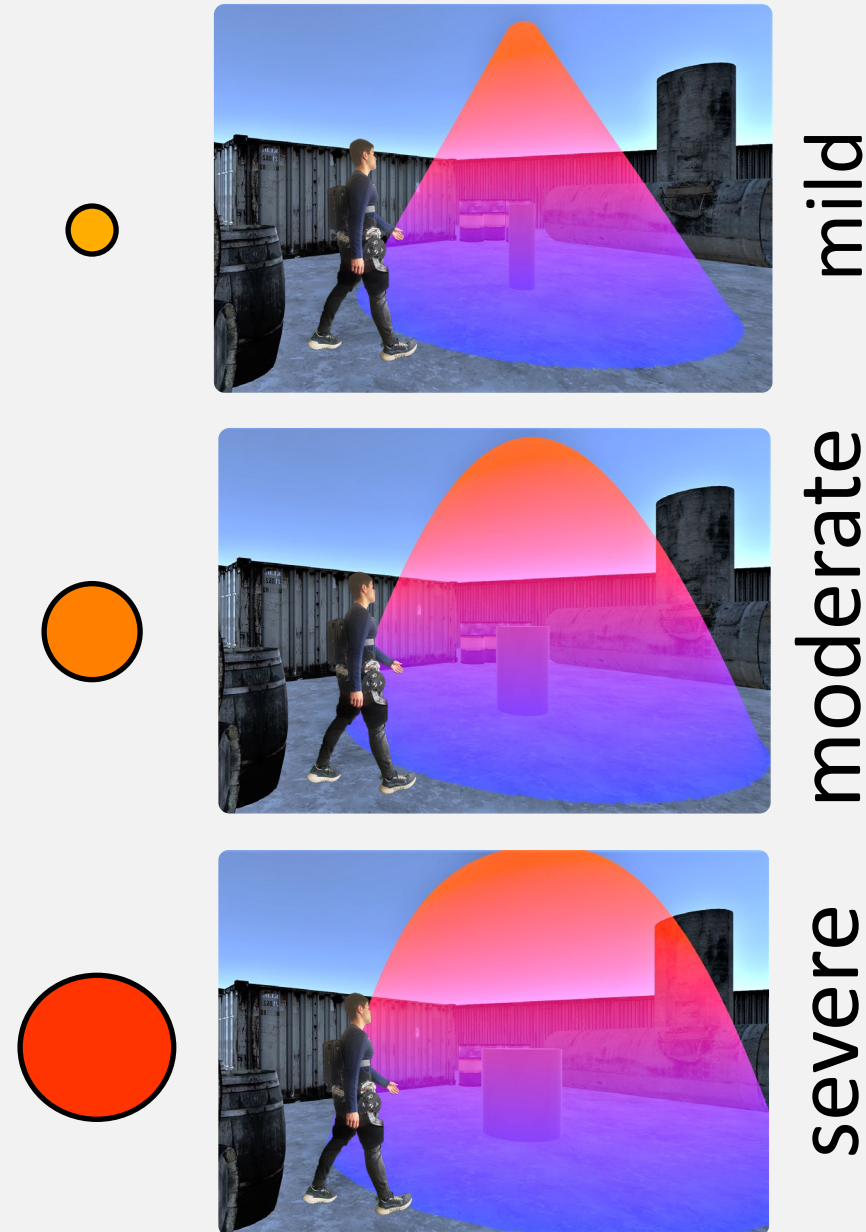


Sample Trials

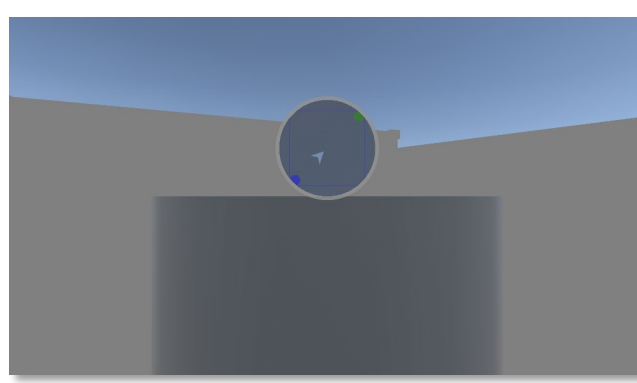
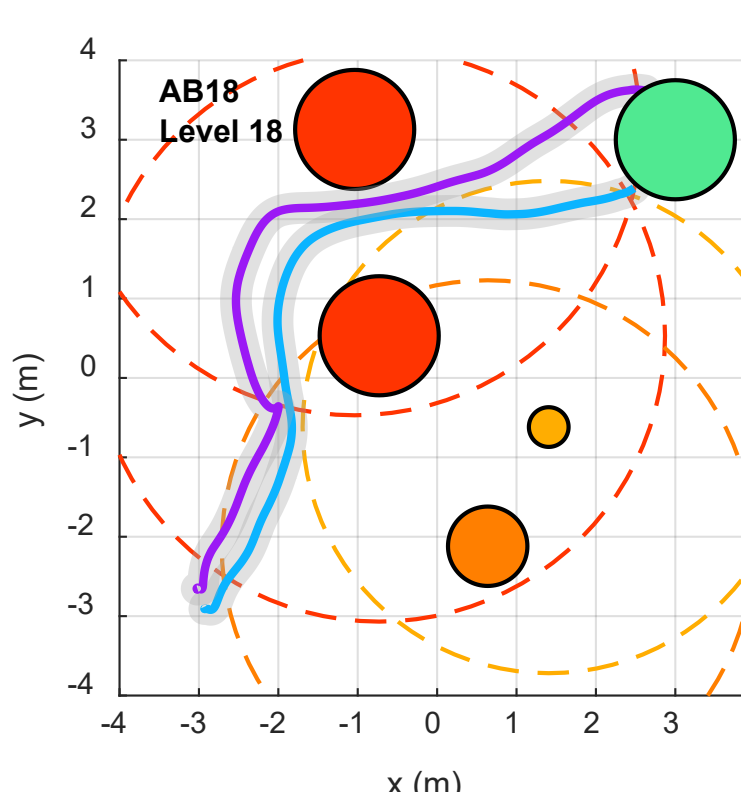
- exo on
- exo off



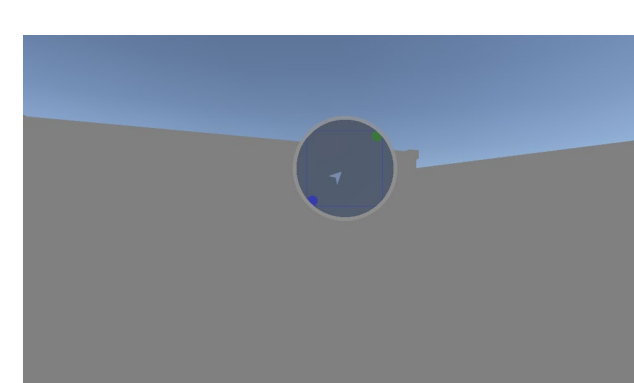
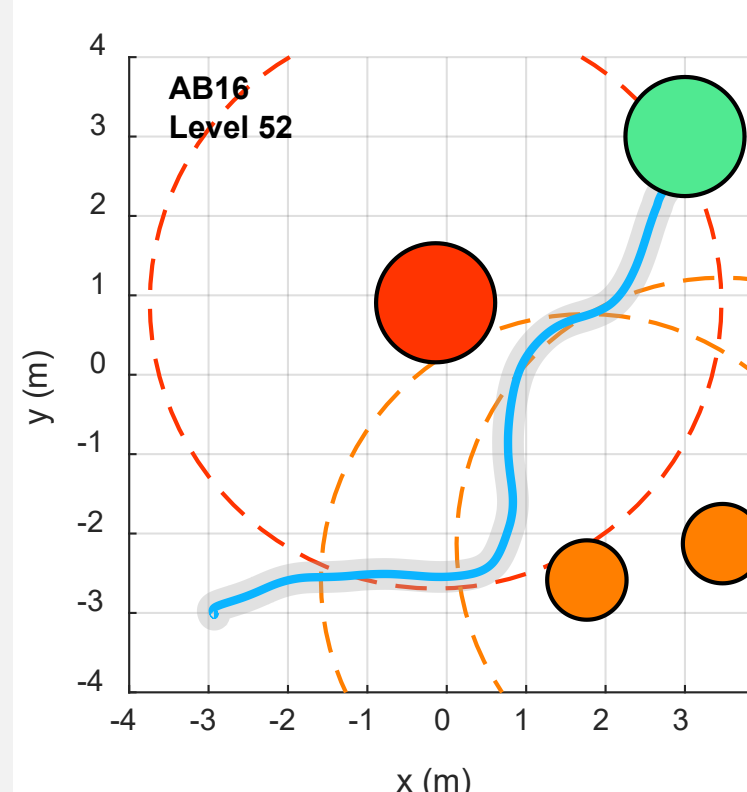
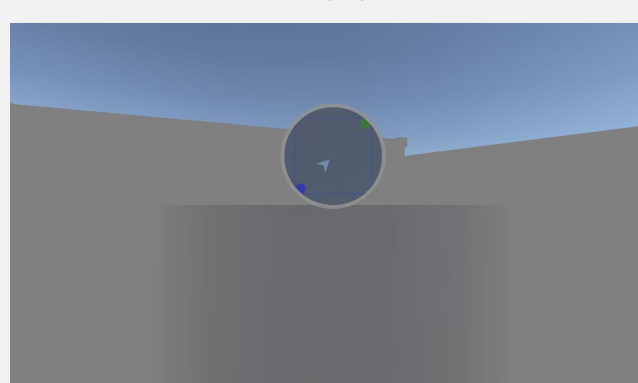
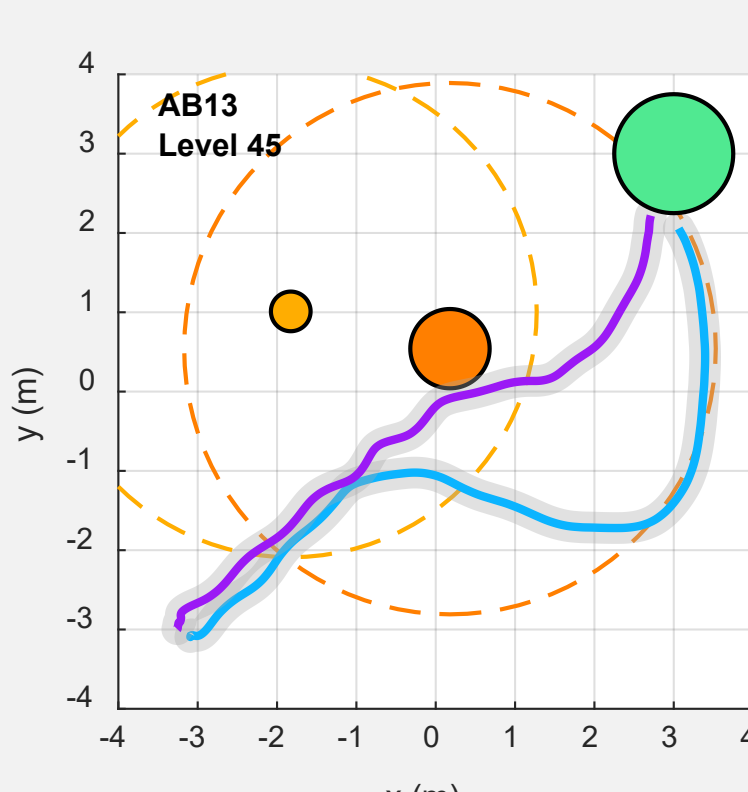
Obstacle Danger Levels



Clear



Decreased Visibility



Blind

References & Acknowledgements

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[1] A. Bajpai *et al.*, "Design and Validation of a Versatile High Torque Quasi-Direct Drive Hip Exoskeleton," 2023.

