Toward Human-Like Social Robot Navigation: A Large-Scale, Multi-Modal, Social Human Navigation Dataset

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INTRODUCTION

- A novel sensor suite design to capture humans' demonstrations of social navigation.

- A large-scale dataset (MuSoHu) in a variety of public spaces which contains numerous natural social navigation interactions.

- Insights on our dataset and potential uses in the future.

TABLE I: Descriptions of Label Tags Contained in MuSoHu.

Tag	Description	# Tags
Against Traffic	Navigating against oncoming traffic	210
With Traffic	Navigating with oncoming traffic	170
Street Crossing	Crossing across a street	120
Overtaking	Overtaking a person or groups of people	100
Sidewalk	Navigating on a sidewalk	160
Passing Conversational Groups	Navigating past a group of 2 or more people that are talking amongst themselves	94
Blind Corner	Navigating past a corner where the human cannot see the other side	90
Narrow Doorway	Navigating through a doorway where the human opens or waits for others to open the door	45
Crossing Stationary Queue	Walking across a line of people	50
Stairs	Walking up and/or down stairs	30
Vehicle Interaction	Navigating around a vehicle	26
Navigating Through Large Crowds	Navigating among large unstructured crowds	45
Elevator Ride	Navigating to, waiting inside, and exiting an elevator	15
Escalator Ride	Navigating to and riding an escalator	6
Waiting in Line	Waiting in Line to enter congested areas	5
Time: Day	Navigation during day time	150
Time: Night	Navigation during night time	40

Our open-source multi-modal sensor suite allows us to collect ~100 km, 20 hours, 300 trials, 13 humans of human navigation data in natural public spaces, which robots can learn from.

360° Camera
Microphone Array
3D LiDAR
IMU
Stereo & Depth Camera
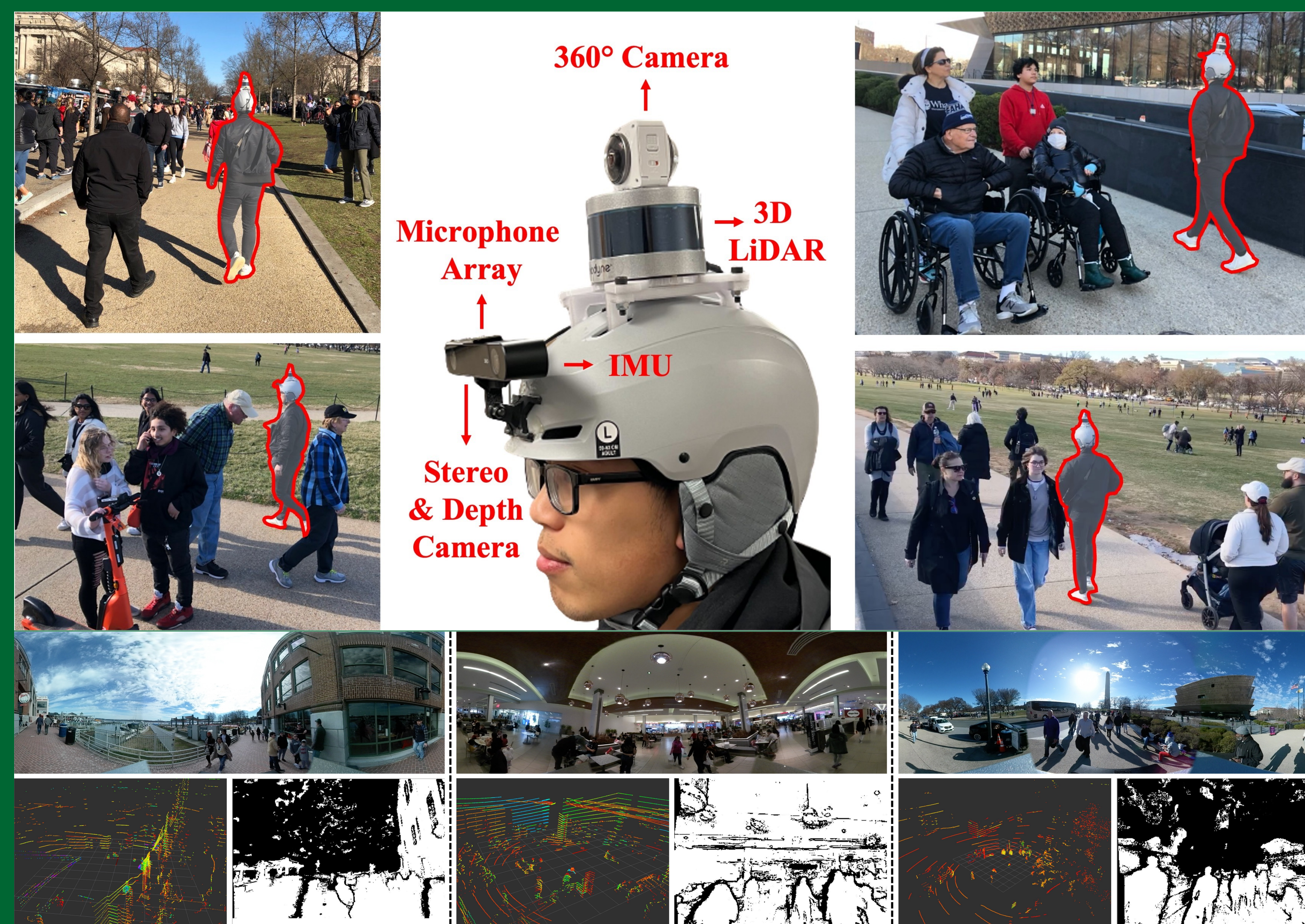
Anticipated Use Cases

- Learning Social Robot Navigation
- Imitation Learning with Various Constraints
- Studying Social Human and Robot Navigation
- Real-to-Sim Transfer for Social Navigation
- Investigating Robot Morphology for Social Navigation
- And more…

DATASET

The figure shows filtered velocities and the human demonstrator's navigation path in three example scenarios.

Linear Velocity (m/s) Angular Velocity (rad/s) Navigation Path
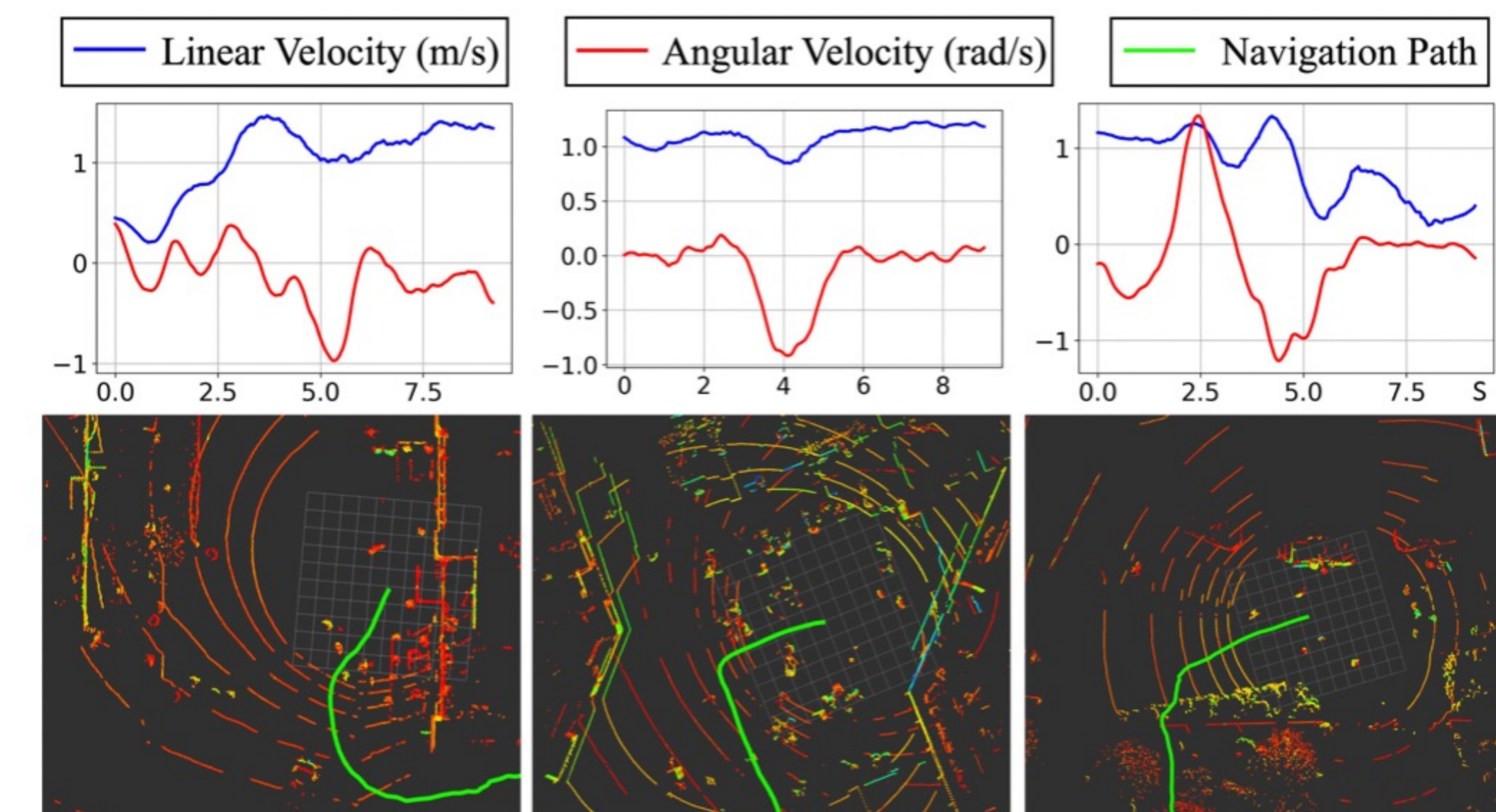
Linear (Blue) and Angular (Red) Velocities and Navigation Path (Green) Taken by the Human Demonstrator

BEHAVIOR CLONING FROM MUSOHU

The learned policies from MuSoHu are implemented on two physical robots, a wheeled and a legged robots. Both robots demonstrate collision avoidance behavior based on the policy learned from MuSoHu.

Learned Obstacle Avoidance Behavior from MuSoHu