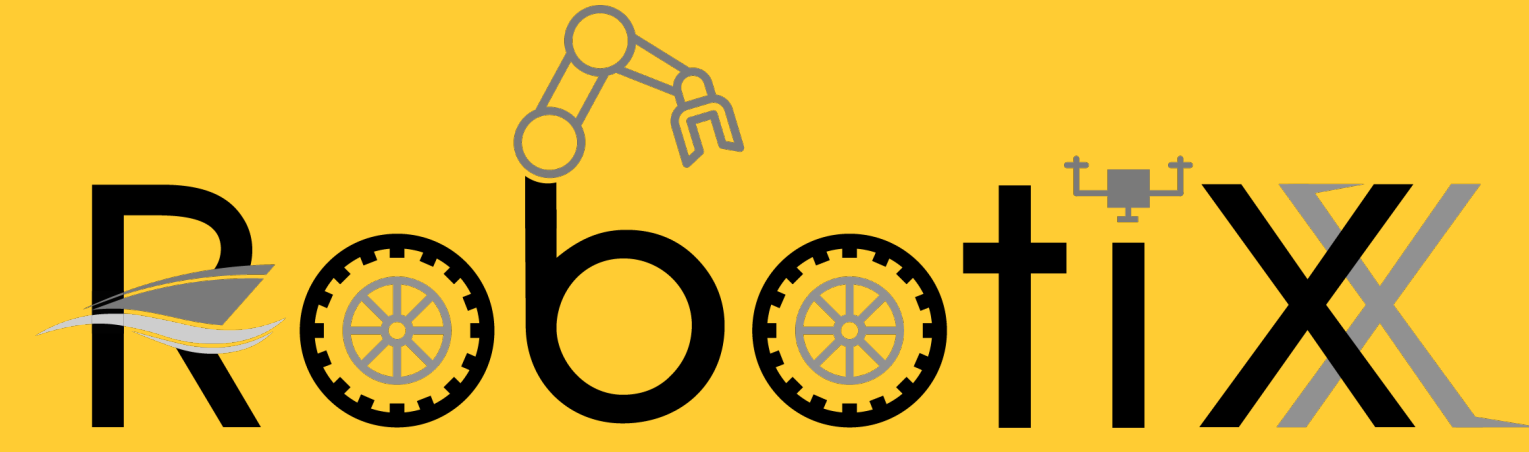# Toward Wheeled Mobility on Vertically Challenging Terrain: Platforms, Datasets, and Algorithms

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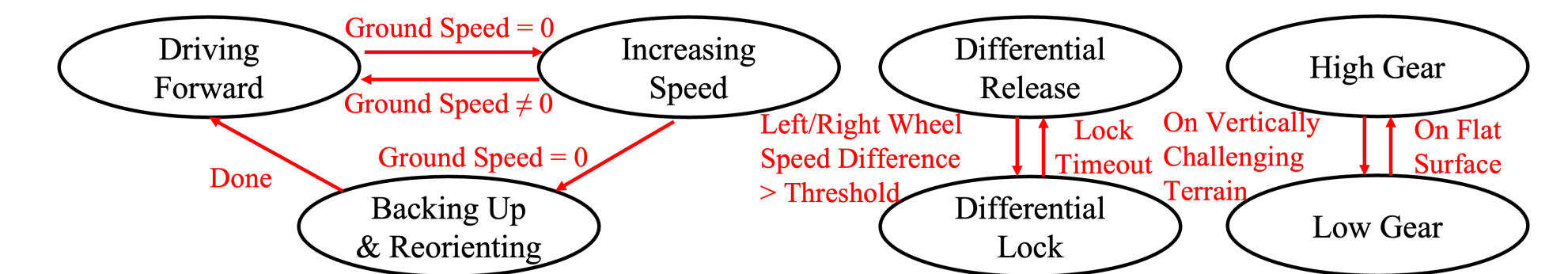
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INTRODUCTION

- Conventional wheeled robots are normally designed for on-road navigation.

- Off-road navigation extends robots' reachability into many unstructured, hard-to-reach environments.

- Off-road mobility in vertically challenging terrain has been made possible mainly through advancement in hardware.

PLATFORMS

DATASET

- We collect the following data streams from the onboard sensors and human teleoperation commands: RGB ($1280 \times 720 \times 3$) and depth (512×512) images, wheel speed (4D float vector for four wheels), and ground speed (relative movement indicators along Δx and Δy and displacement along z).

We provide platforms, datasets, and algorithms to tackle vertically challenging terrain with minimal hardware modification to conventional wheeled robots.

ALGORITHMS

- Open-Loop (OL): Drive with a constant velocity of 0.5m/s.
- Rule-Based (RB):

- End-to-End Behavior Cloning (BC): Trained with the collected datasets. We also cross deploy the trained models on both platforms.

RESULTS

- For each test course, we run four different approaches, i.e., OL, RB, BC, and BC with cross-deployment (we denote the model trained on the V6W and V4W dataset as BC6 and BC4 respectively), each ten attempts, running from both directions of the course.

- We report both number of successful trials (out of 10 attempts) and mean traversal time (for the successful trials in seconds) with variance of all 240 experiment trials. A failure trial can either be the vehicle getting stuck or tipping over on the test course.
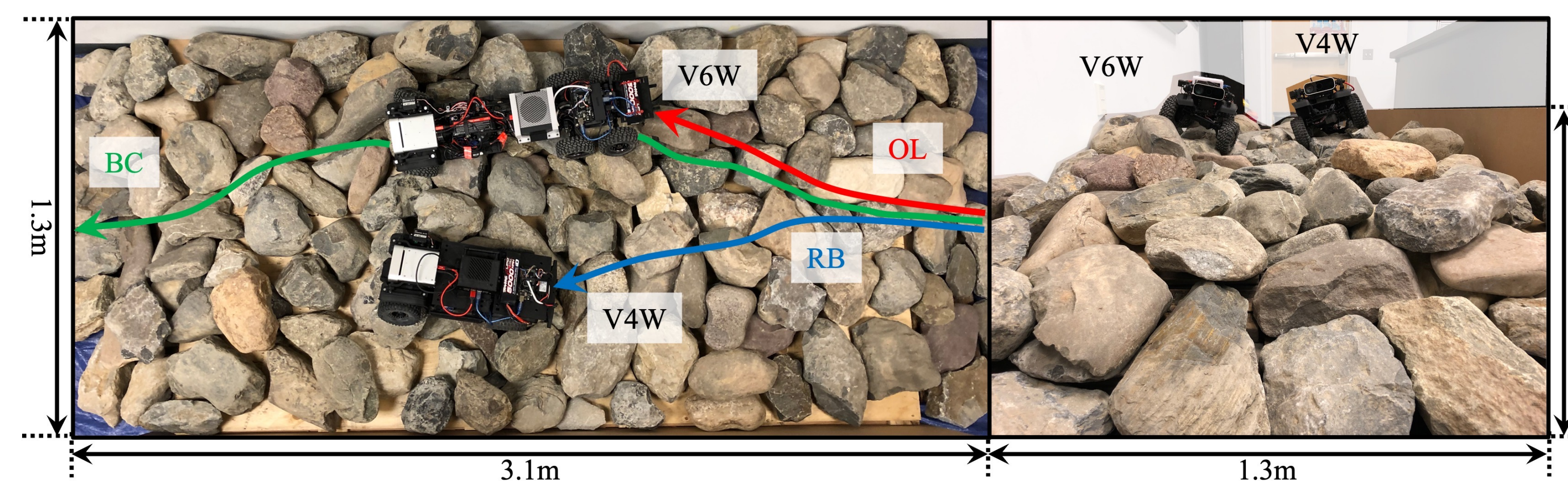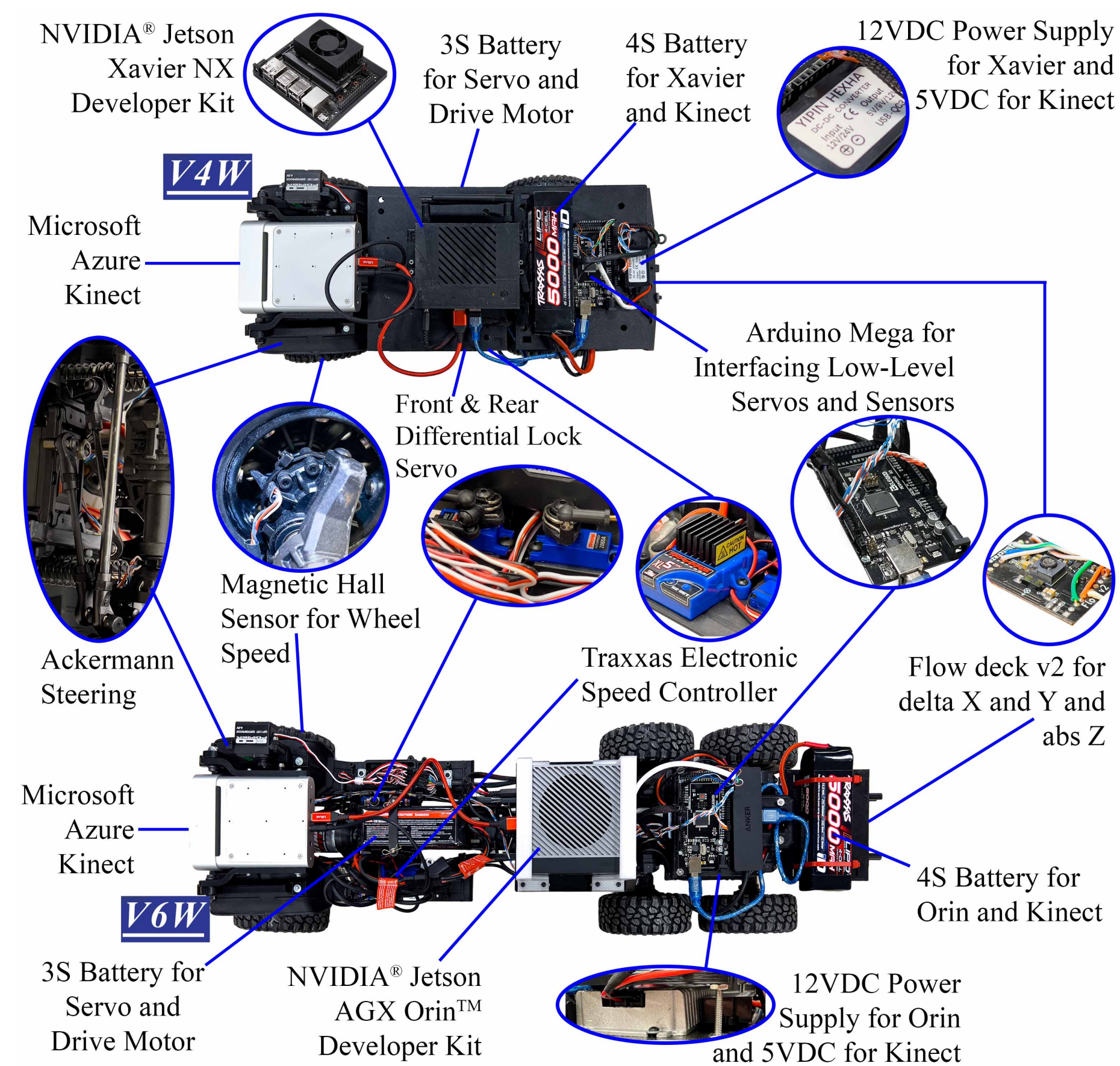
Experiment Results for V6W:

	V6W			
	OL	RB	BC6	BC4
Easy	$5\,(20.7 \pm 1.7)$	$8\,(19.2 \pm 3.9)$	$9\,(13.8 \pm 8.2)$	$\mathbf{10}\,(11.6 \pm 1.9)$
Medium	$6\,(15.4 \pm 0.9)$	$9\,(14.8 \pm 2.2)$	$9\,(14.6 \pm 11.2)$	$\mathbf{10}\,(13.6 \pm 2.3)$
Difficult	$3\,(24.1 \pm 2.6)$	$6\,(14.3 \pm 1.9)$	$6\,(15.7 \pm 18.5)$	$\mathbf{9}\,(14.9 \pm 2.9)$

Experiment Results for V4W:

V4W			
OL	RB	BC6	BC4
$6\,(17.7 \pm 3.8)$	$6\,(13.4 \pm 2.5)$	$7\,(17.2 \pm 6.7)$	$\mathbf{9}\,(14.1 \pm 7.7)$
$4\,(15.6 \pm 14.2)$	$6\,(12.9 \pm 1.8)$	$3\,(19.2 \pm 10.6)$	$\mathbf{8}\,(13.7 \pm 1.6)$
$3\,(19.7 \pm 29.4)$	$5\,(16.8 \pm 20.5)$	$3\,(23.3 \pm 43.4)$	$7\,(14.9 \pm 8.2)$