

MUDMAX: A Multimodal Dataset for Multi-Purpose Autonomous Excavator Research

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Introduction



- Autonomous excavator** research is bottlenecked by the prohibitive cost and complexity of real-world experiments.
- Furthermore, the absence of **large-scale, multimodal datasets** remains a critical barrier to holistic excavator automation research.
- To break this bottleneck, we introduce **MUDMAX**, a comprehensive multimodal electric excavator dataset to enable the broader community to advance diverse excavator automation algorithms **without physical access** to heavy equipment.

Excavator Platform



- Our platform is based on HR35 (3.5-ton electric excavator)
- It is equipped with 3D LiDAR, stereo camera, inclinometer, pressure sensor, and swing sensor
- Every experiments including data acquisition was performed on ROS2 with two NVIDIA Jetson AGX Orin

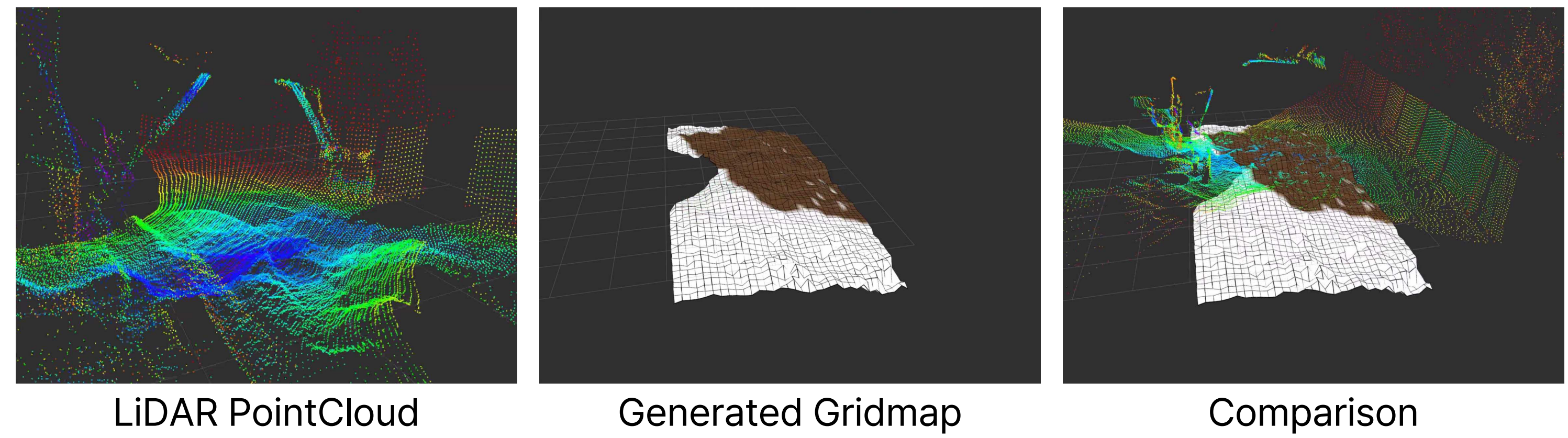
Dataset Description

- We provide the dataset as a ROS2 bag file as following:

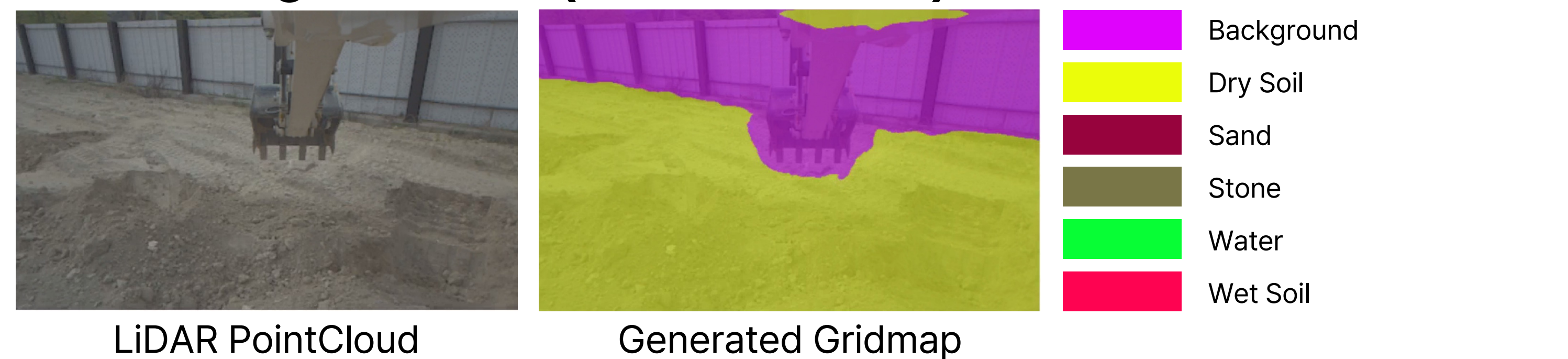
Category	Message Type	Topic Name	Data Description
On-board Sensor	<code>sensor_msgs/PointCloud2</code>	<code>/lidar_boom/points</code>	3D LiDAR point cloud
	<code>sensor_msgs/Image</code>	<code>/lidar_boom/reflec_image</code>	Reflectance image
	<code>sensor_msgs/Image</code>	<code>/lidar_boom/range_image</code>	Range image
	<code>sensor_msgs/Imu</code>	<code>/lidar_boom/imu</code>	LiDAR IMU
	<code>sensor_msgs/Image</code>	<code>/camera_boom/image</code>	RGB image
Internal Sensor	<code>msg_gps_interface/GPSMsgAtt</code>	<code>/gps_att</code>	GPS attitude info.
	<code>msg_gps_interface/GPSMsg</code>	<code>/gps_msg</code>	GPS position and status
	<code>std_msgs/Float32MultiArray</code>	<code>/excavator/sensors/boom_inclino</code>	Inclinometer data
	<code>std_msgs/Float32MultiArray</code>	<code>/excavator/sensors/arm_inclino</code>	
	<code>std_msgs/Float32MultiArray</code>	<code>/excavator/sensors/bucket_inclino</code>	
Kinematics	<code>std_msgs/Float32</code>	<code>/excavator/sensors/swing_angle</code>	Excavator swing angle
	<code>std_msgs/Float32MultiArray</code>	<code>/excavator/sensors/pressure_data</code>	6d Hydraulic pressure
	<code>msg_excavator_kine_interface/KineMsg</code>	<code>/kine_data</code>	Calculated kinematics
	<code>std_msgs/Float32MultiArray</code>	<code>/excavator/sensors/joint_boom</code>	Calculated joint angles
	<code>std_msgs/Float32MultiArray</code>	<code>/excavator/sensors/joint_arm</code>	
Kinematics	<code>std_msgs/Float32MultiArray</code>	<code>/excavator/sensors/joint_bucket</code>	
	<code>geometry_msgs/PointStamped</code>	<code>/excavator/kinematics/bucket_position</code>	Calculated bucket pose
	<code>std_msgs/Float32</code>	<code>/excavator/kinematics/bucket_orientation</code>	
	<code>std_msgs/Float32</code>	<code>/excavator/sensors/heading_track</code>	Calculated track heading
	<code>geometry_msgs/TwistWithCovariance</code>	<code>/excavator/sensors/gnss_velocity</code>	GPS velocity data

Application 1: Perception (Sensors)

Gridmap Generation (LiDAR)

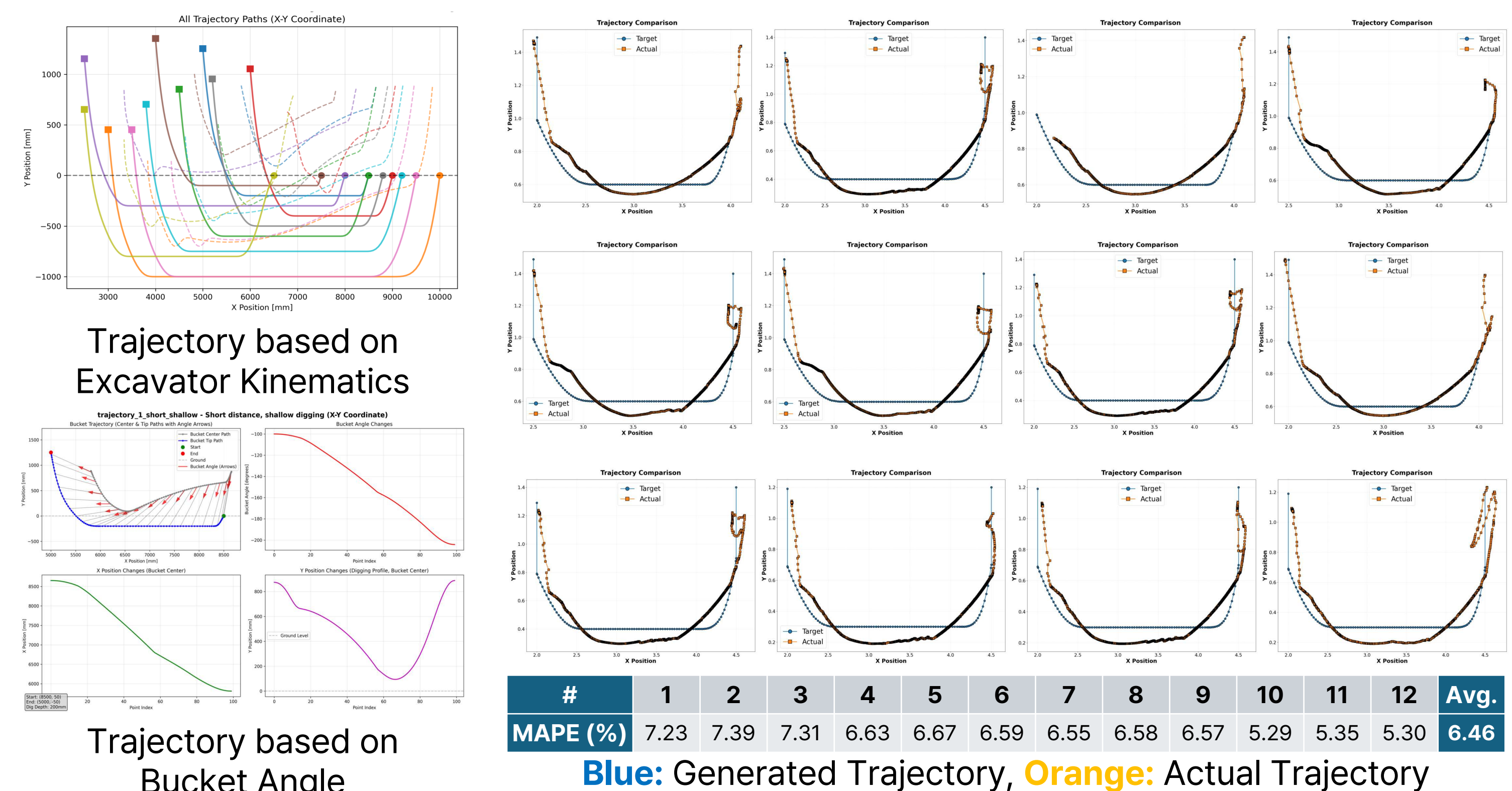


Ground Segmentation (Stereo Camera)

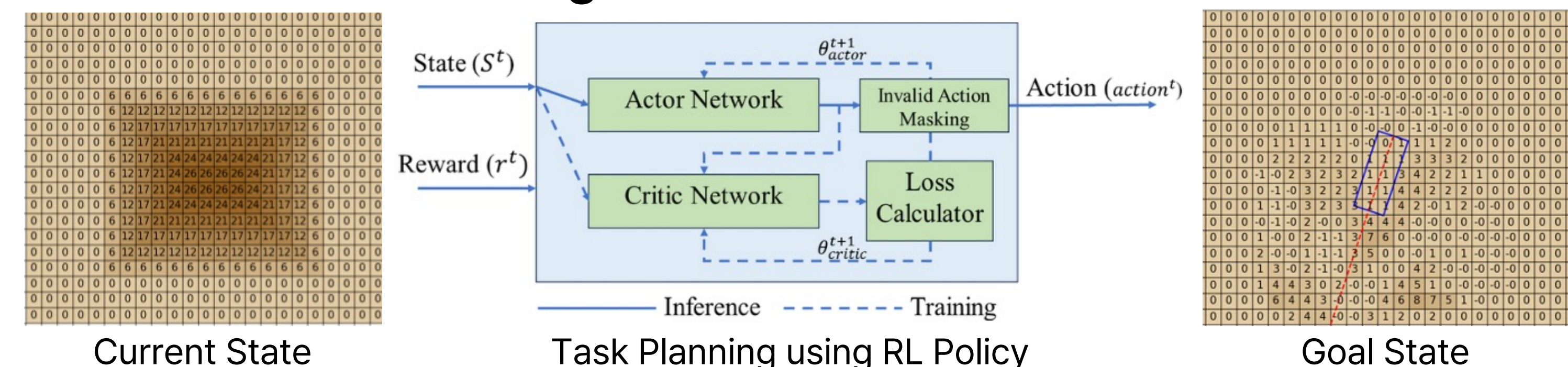


Application 2: Task/Trajectory Planning

Expert Data-based Bucket Trajectory Generation

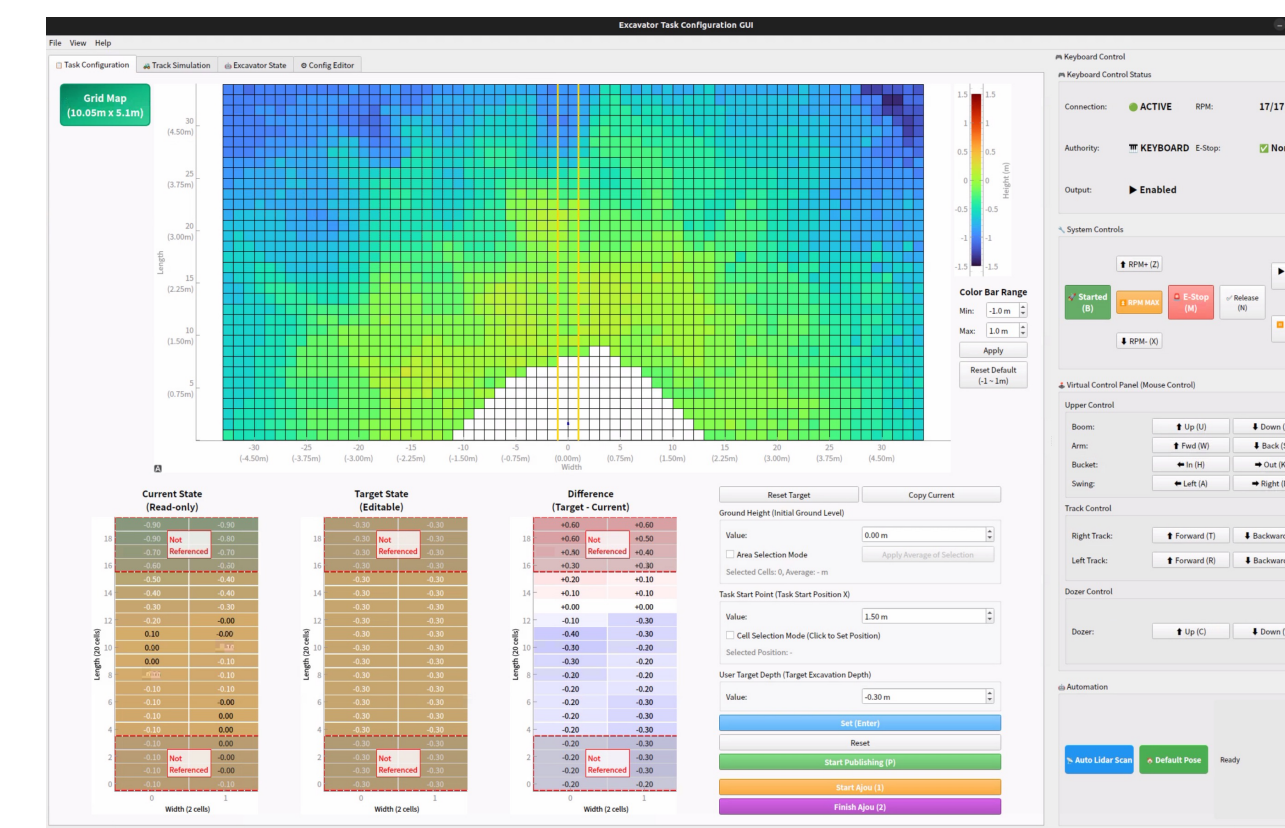


RL-based Task Planning



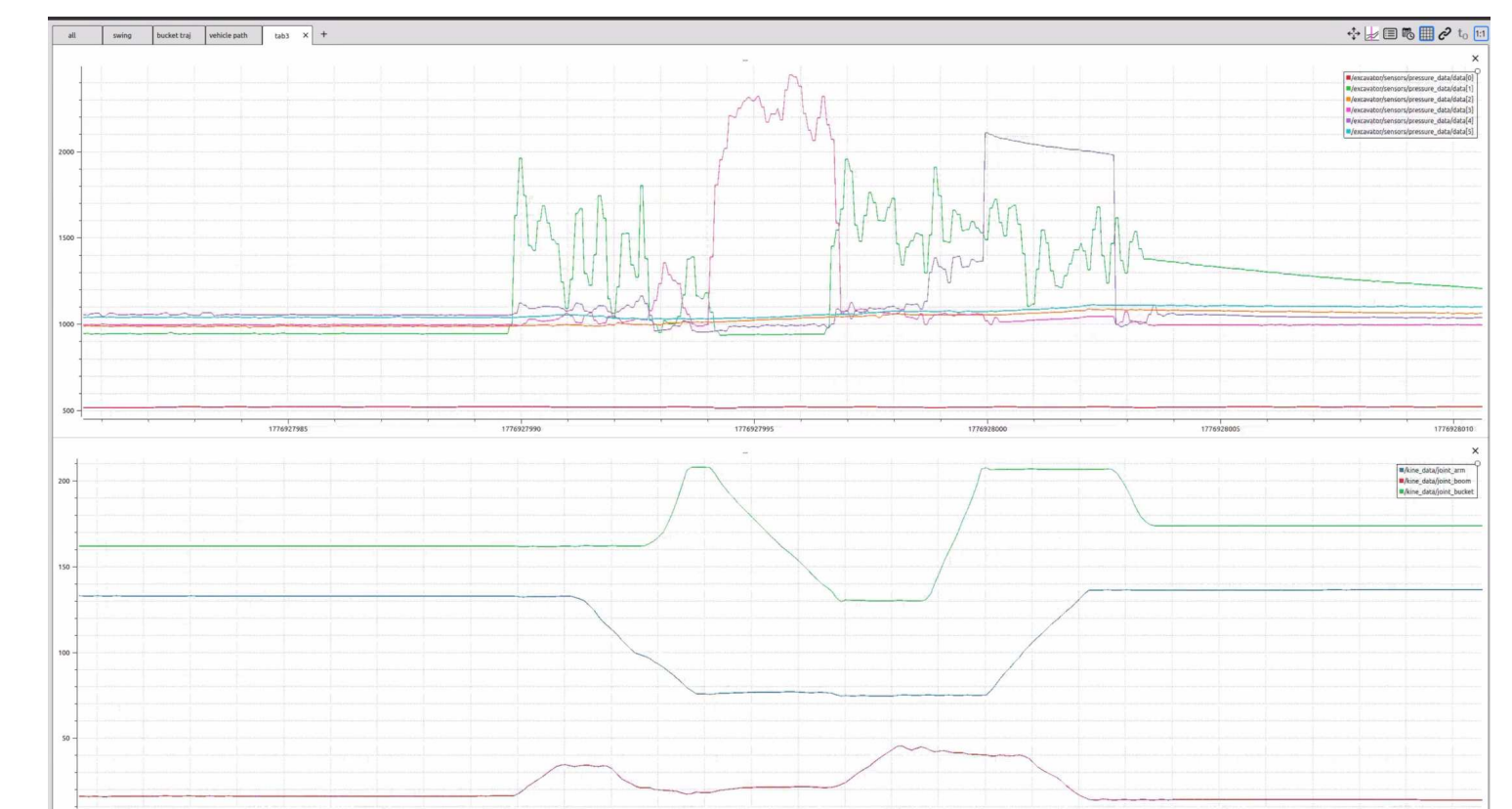
Application 3: Excavator Control

Control Panel



- Monitor status: gridmap, excavator status
- Issue excavator work commands

Pressure Sensor Data



- Upper: hydraulic pressure of each boom, arm, bucket
- Lower: joint angle of each boom, arm, bucket

Trenching Excavation Demonstration

