

Autonomous Robotic 3D Scanning for Smart Factory Planning

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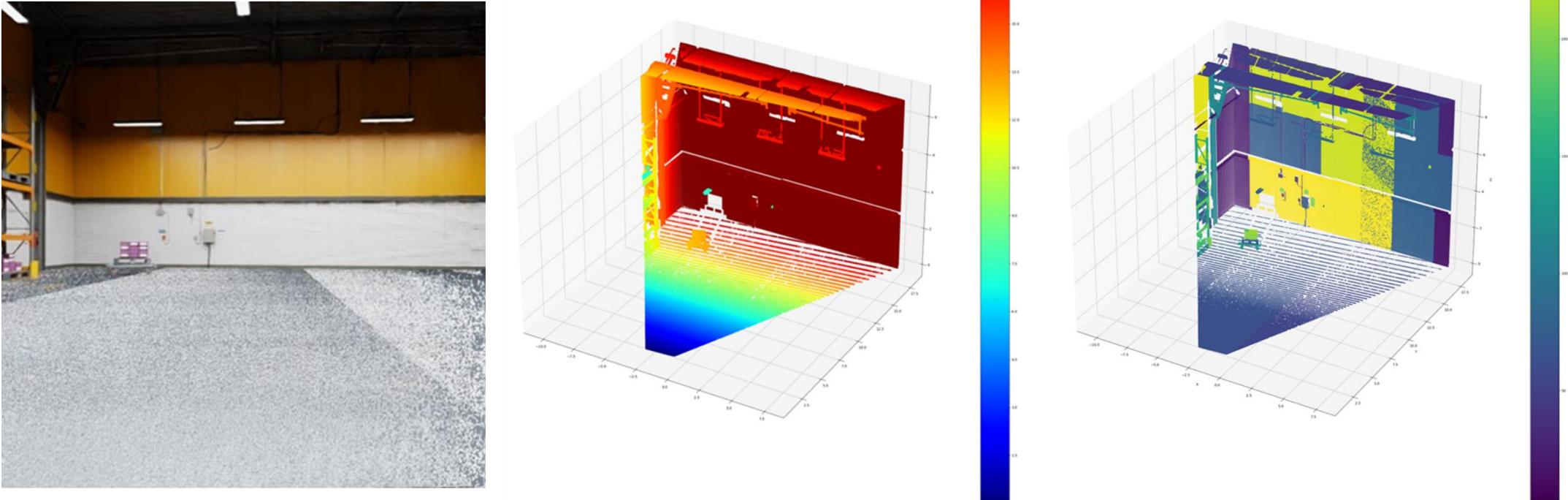
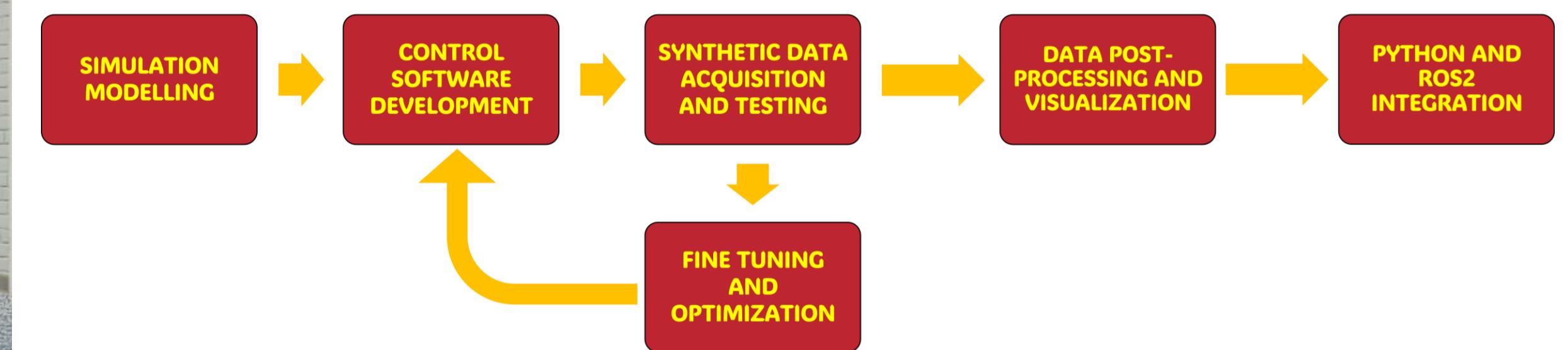
Motivation and Background

- Robotics have emerged as a critical component to industry 4.0, aiding in everything from warehouse package handling to predictive machinery maintenance with little to no human intervention [1].
- Yet, creating physical robotic systems is highly resource-intensive, requiring hundreds hours of testing to ensure their safe deployment.
- To address this, we propose the simulation of a semi-autonomous robotic system to serve as a platform for the efficient prototyping of 3D reconstruction, localization, and mapping frameworks in factory warehouse environments using NVIDIA Isaac Sim.



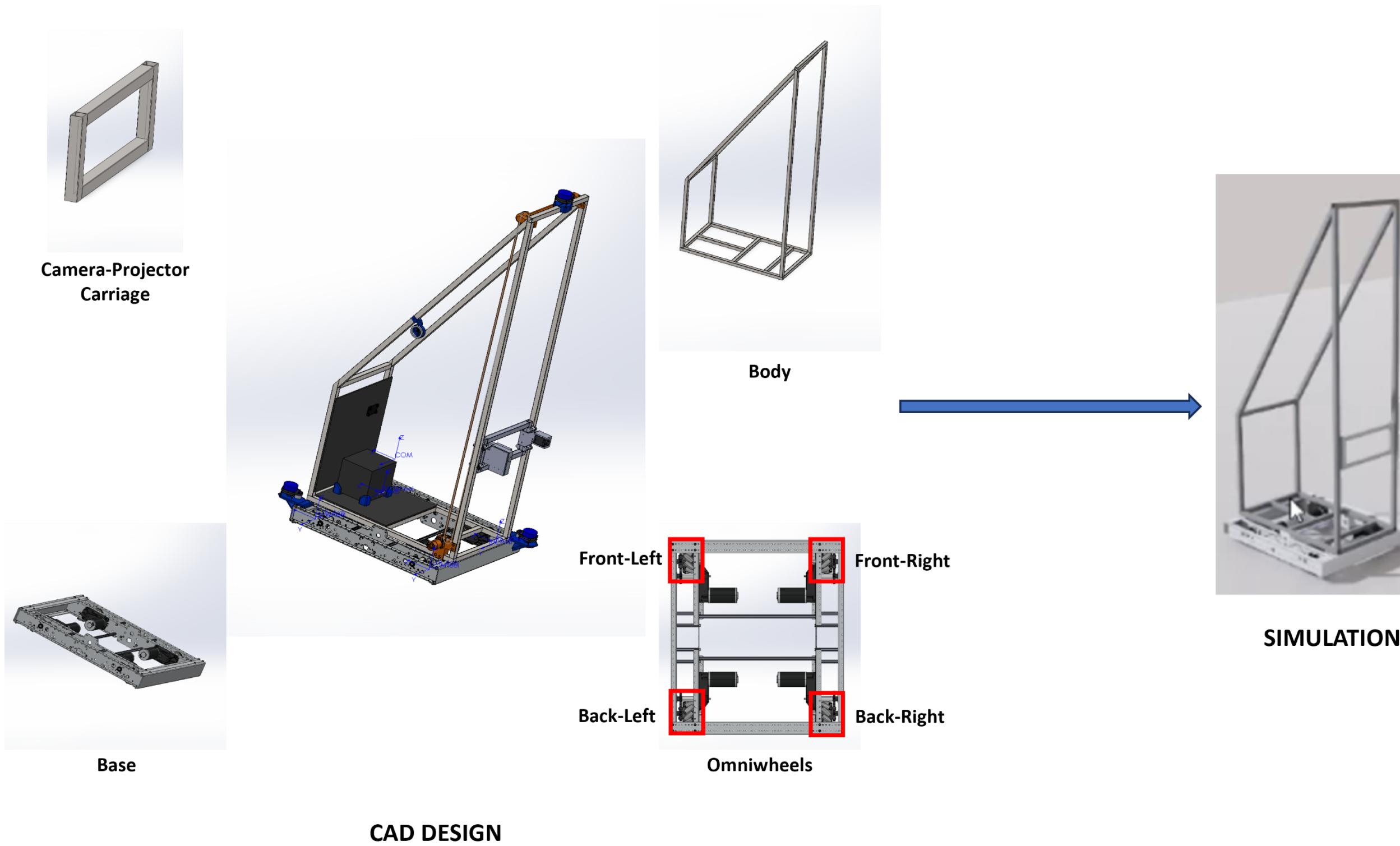
NVIDIA Isaac Sim Robotic Simulation

- Robust physics engine enables accurate modeling and simulation of various robotic behaviors and interactions with the environment.
- Visual scripting ability [2] and synthetic data generation pipeline allows for streamlined development of robot control algorithms with diverse data modalities.

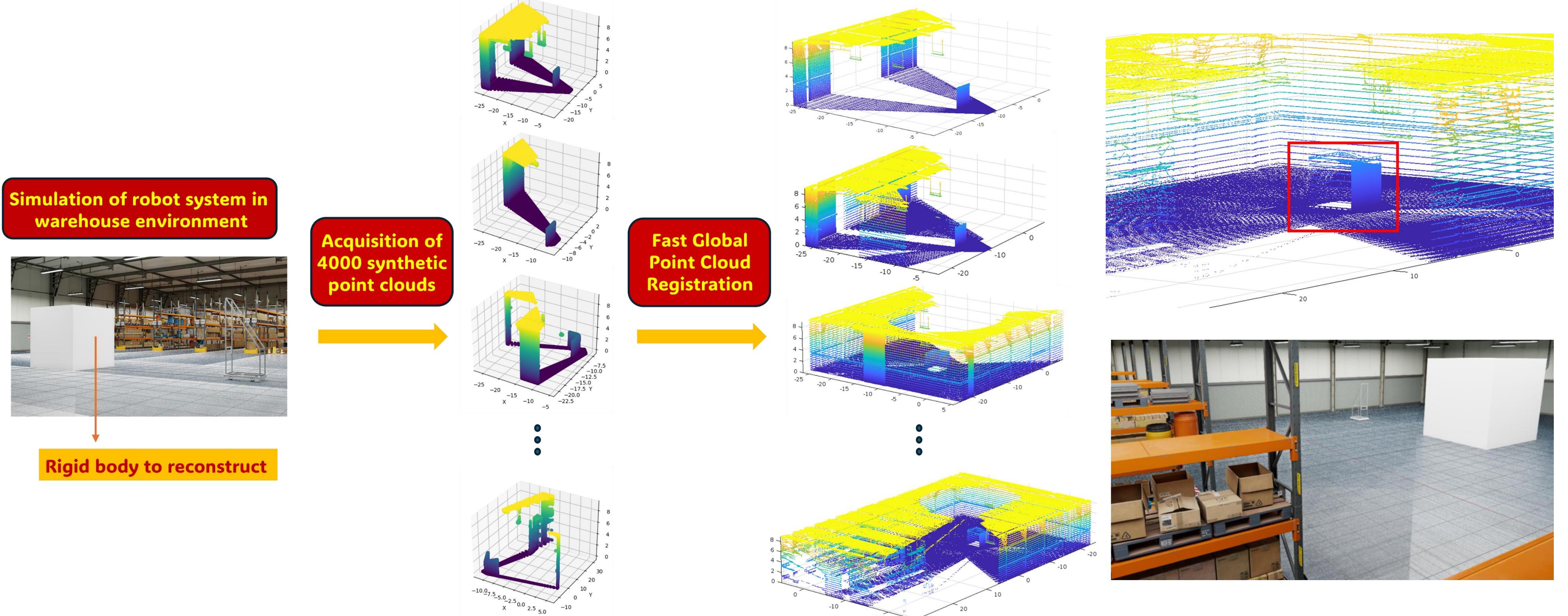


Experiment and Results

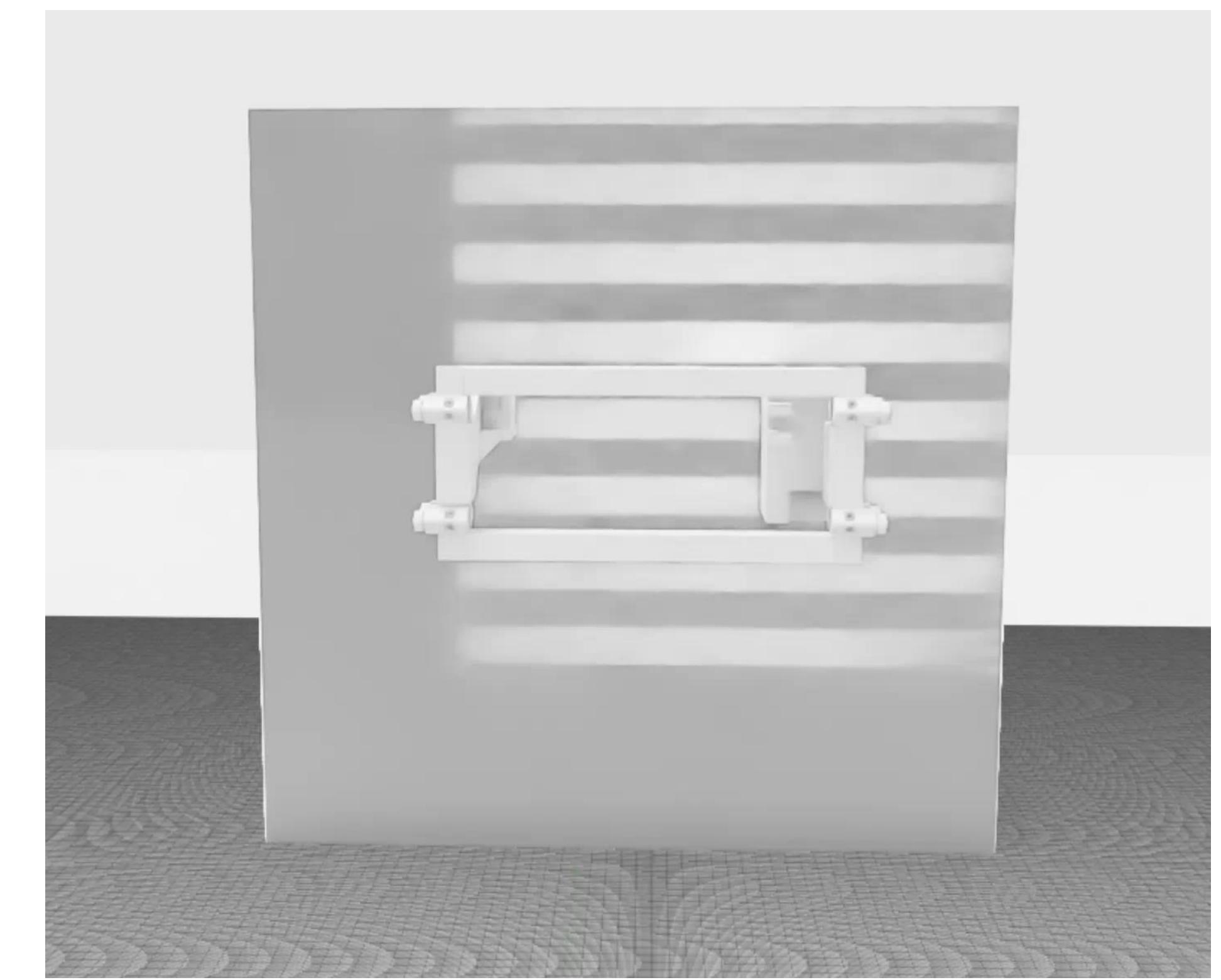
- Imported the CAD model of our existing robotic system into the simulation environment as a URDF file and developed a holonomic control policy that responds to user keyboard input to actively control the systems motion during simulation execution.
- Using the developed motion policy, we maneuvered the robot around a simulated warehouse environment to acquire 4000 point clouds of the scene to serve as input to the fast global registration method [3] resulting in a full 3D reconstruction of the warehouse.



Simulation System Modeling



Synthetic Data Acquisition, Testing, and Reconstruction of Cube



Simulated FPP System

Conclusion and Future Work

- Demonstrated potential of NVIDIA Isaac Sim as a platform for the rapid development of complex robotic frameworks for factory inspection and planning.
- Integrating autonomous navigation with VSLAM Isaac ROS and simulated FPP system for precise 3D scene reconstructions.

- [1] Abhay Kumar Grover and Muhammad Hasan Ashraf. Leveraging autonomous mobile robots for industry 4.0 warehouses: A multiple case study analysis. *The International Journal of Logistics Management*, 2023.
- [2] NVIDIA. Nvidia omniverse isaac sim glossary of terms. <https://docs.omniverse.nvidia.com/isaacsim/latest/common/glossary-of-terms.html>.
- [3] Ruiqi Lei et al. Deep global feature-based template matching for fast multi-modal image registration. In 2021 IEEE International Geoscience and Remote Sensing Symposium (IGARSS).IEEE, 2021.

References

