

ACCELERATED WAREHOUSE AUTOMATION

Case Study

with Digital Twins and Synthetic Data

Learn how Toyota Material Handling Europe and SoftServe leveraged NVIDIA Omniverse™ to harness AI simulation and digital twins for safe and efficient autonomous forklifts.



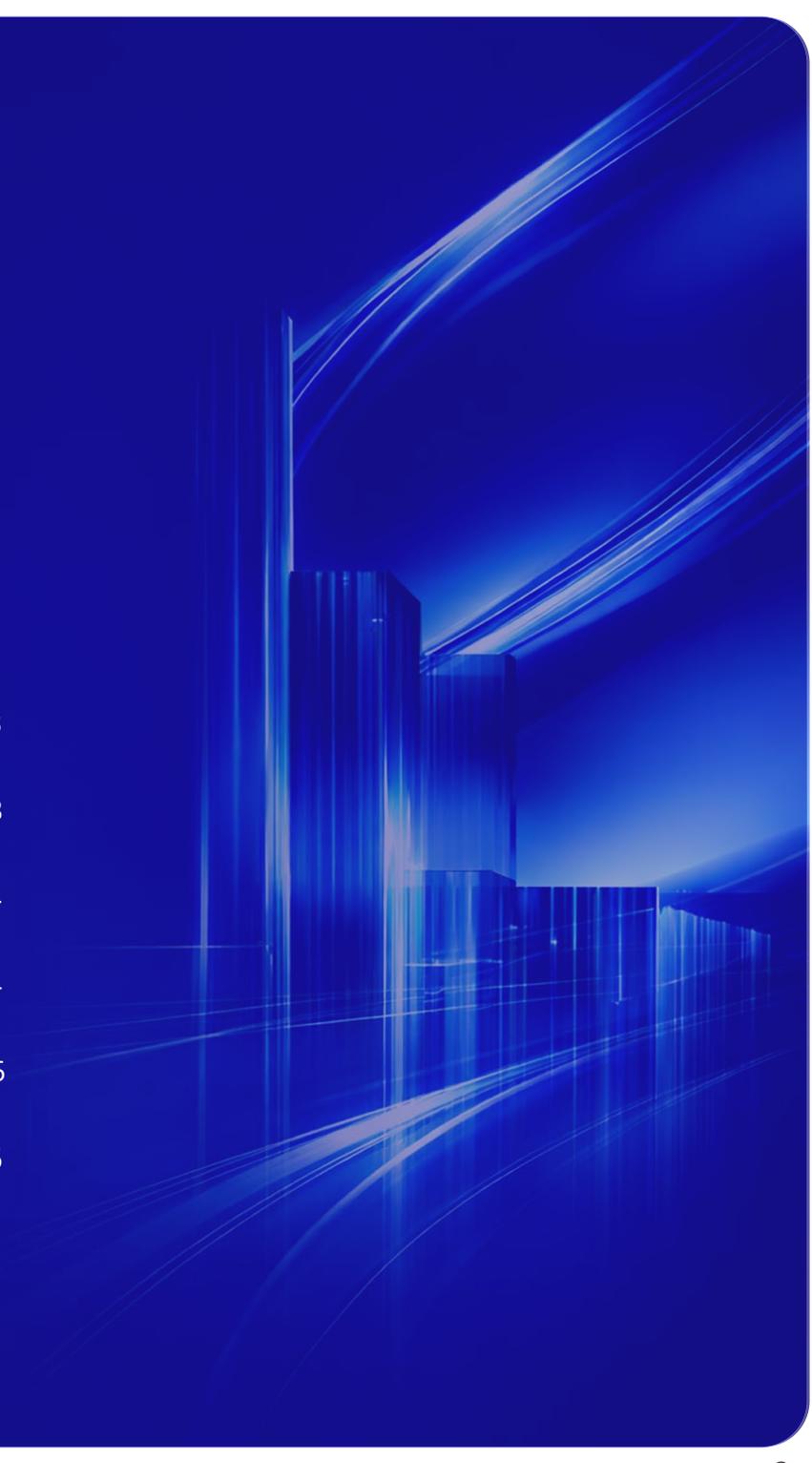
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MATERIAL HANDLING

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Executive Summary

Toyota Material Handling Europe is a leader in the material handling business, offering AGVs (automated guided vehicles) in addition to other logistics solutions and services. As a premier manufacturer and distributor in the sector, Toyota recognized the urgency to enhance its warehouse automation processes amidst evolving market demands. To address this challenge, Toyota sought to leverage cutting-edge technology through a collaboration with NVIDIA and SoftServe, focusing on an innovative digital twin initiative that promises to revolutionize material handling.

“Developing digital twin applications with Omniverse allows us to replicate and explore various testing environments in a way that is very hard to do in the real world, without actually going to the customer’s site.”

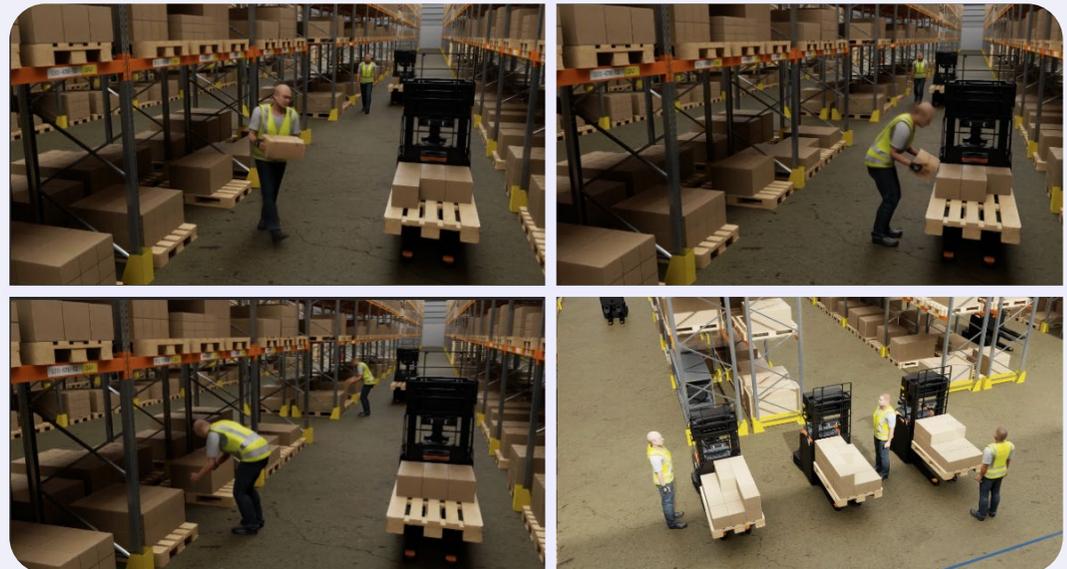
— Johan Brynås,

Director Head of Research & Innovation at Toyota Material Handling Europe

To begin, Toyota Material Handling Europe selected a transformative aspect of warehouse logistics for simulation: collaborative case picking. As automation increases, the workflows involving interactions between pickers and AGVs have grown increasingly important. Simulating the complex interactions took two parallel streams of work:

- 1 A digital twin built using the NVIDIA Omniverse to simulate real-world scenarios**
- 2 Training of AI models on synthetic data enhanced with NVIDIA Cosmos-Transfer**

Together, these two initiatives have accelerated Toyota’s ability to develop safe automated guided vehicles for warehouse operations and positioned the company at the forefront of warehouse automation.



Stream 1: High-Fidelity Digital Twin for Forklift Simulations

In collaboration with SoftServe and NVIDIA, Toyota Material Handling launched a digital twin initiative that leverages physical AI and synthetic data generation (SDG) to simulate, validate, and optimize autonomous forklift operations within high-fidelity virtual replicas of warehouses and production environments. This system utilizes AI to detect pallet components, interpret depth information from labels, and orchestrate the full manipulation sequence — including precise fork positioning and the complete movement required to safely pick up or place down pallets with payloads.

By doing so, it significantly reduces the risk of damage and enhances operational efficiency in dynamic, real-world logistics scenarios.



Results:

At the core of this solution is the NVIDIA Omniverse platform, a real-time simulation and collaboration framework for creating high-fidelity, physics-accurate digital twins. SoftServe collaborated with Toyota Material Handling to develop and integrate:



Digital Replicas of Autonomous Forklifts

High-fidelity digital twins of Toyota's forklift models were created to mirror real-world physics and operational timelines.



AI-Driven Simulations

The initiative integrated real software-in-the-loop capabilities, enabling AI systems to simulate actual operational conditions and assess the forking and material handling tasks.



Human-Robot Interaction Scenarios

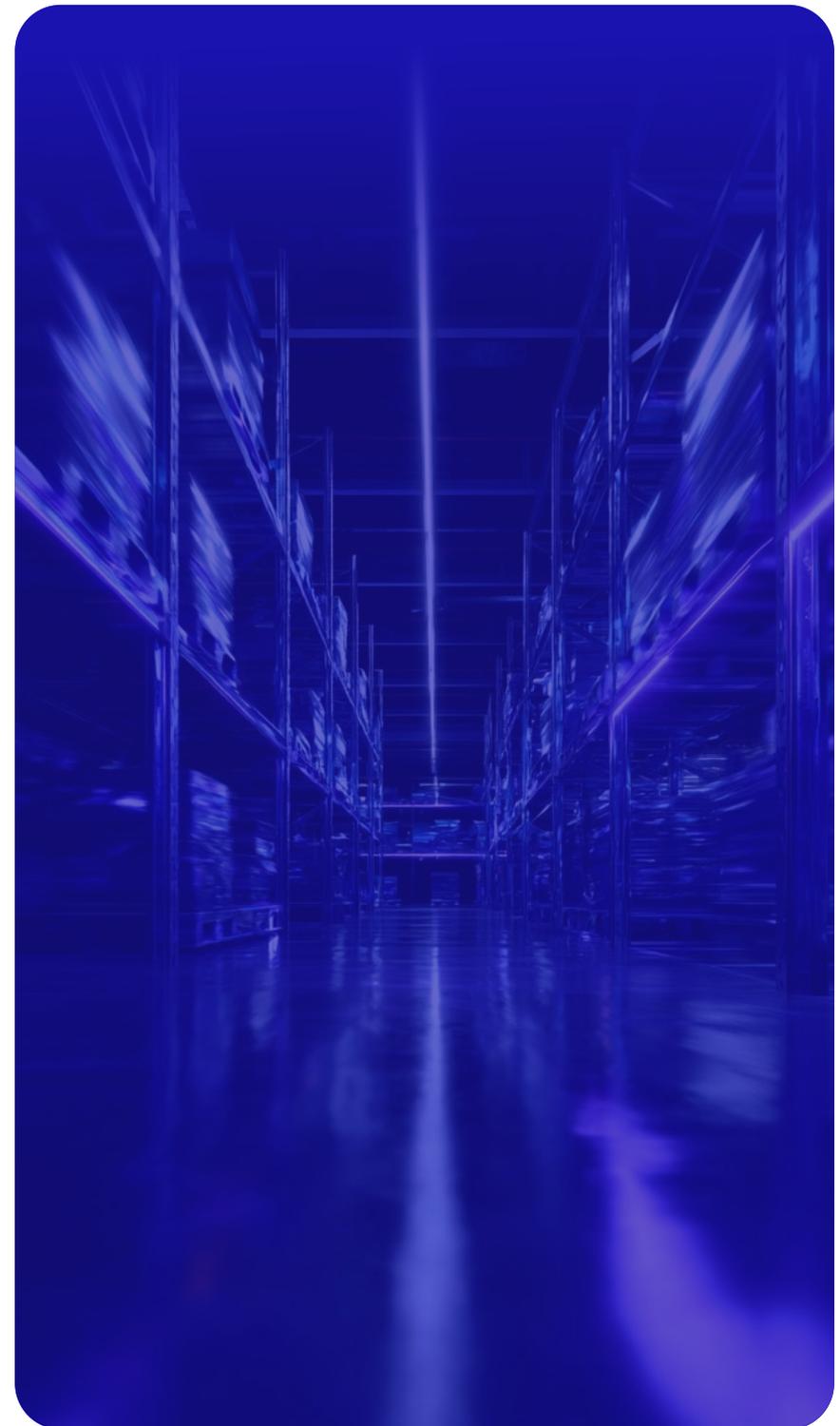
Collaborative scenarios, such as case picking, were tested to ensure safe and efficient interactions between human operatives and robotic systems.

Stream 2: AI Model Improvement With Enhanced Synthetic Data

The AI models at the heart of AGVs must be trained to enhance their precision (percentage of correct positive predictions a model makes) and recall (percentage of the actual positive instances the model correctly identifies). To minimize cost and time spent on gathering scarce real-world data, Toyota Material Handling worked with SoftServe to enhance synthetic training data for warehouse object detection tasks. Leveraging NVIDIA Cosmos-Transfer, the teams demonstrated that AI models trained on Cosmos-processed data significantly outperform simulator-trained models on real-world data while maintaining comparable performance on synthetic datasets.

The project contained two steps:

- 1 NVIDIA Cosmos-Transfer:**
Deployed NVIDIA Cosmos-Transfer on OVX systems to generate ultra-realistic synthetic data, bridging the simulation-to-reality gap for Toyota's autonomous forklifts.
- 2 NVIDIA Cosmos Post-Training:**
Further bridged the sim-to-real gap by post-training the Cosmos model with just 15 minutes of client warehouse videos on the NVIDIA DGX Cloud Lepton platform.



Training and Evaluation on Three Datasets

Toyota Material Handling Europe and SoftServe used specific datasets to evaluate the models' performance.



Simulated dataset

Generated using the NVIDIA Isaac Sim™ simulator. It consisted of 50 videos showing raw, unwrapped boxes. This dataset served as a baseline for synthetic training, offering perfect labeling in a controlled environment.



Cosmos-enhanced dataset

Created by processing the original 50 videos through Cosmos-Transfer. Each video was processed three times, producing 150 videos that simulated realistic stretch film and foil wrappings to mimic real-world conditions.



Real-world dataset

Compiled from client-provided warehouse footage. This dataset included 137 hand-labeled images of actual boxes with stretch wrap, capturing authentic lighting and genuine warehouse environments.



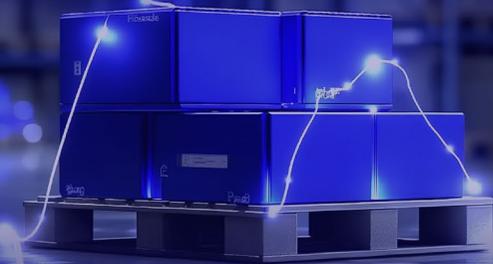
Cosmos-Transfer1 post-training dataset

Contained 141 videos (5 seconds each) captured directly from the actual warehouse environment. The dataset improved label accuracy, color fidelity, floor characteristics, and shadow rendering.

Results:

The NVIDIA Cosmos™-trained model achieved **89.6% precision** and **84.7% recall** on real-world datasets on the DGX Cloud Lepton platform with Cosmos-trained models, compared to just 49.4% recall for simulator-only models. Moreover, the post-trained Cosmos model demonstrated dramatic gains — achieving **99.5% precision** and **92.8% recall** on **real-world data** by adapting visuals such as labels, colors, flooring, and shadows to match the client's environment.

This advanced customization resulted in superior detection quality and alignment — outperforming both simulator-only and standard Cosmos-trained models. **Thanks to the initiative, Toyota is now in the position to leverage AI models in its AGVs with demonstrably greater ability to perform critical tasks in AGV-human interactions.**



Impact: Rapid and Affordable AGV Commissioning



Toyota Material Handling's achievement clearly demonstrates how advanced simulation and synthetic data propels autonomous systems to new heights. At SoftServe, we are passionate about sharing this expertise and fueling innovation for our partners.

— **Lyubomyr Demkiv**,
Director, Robotics & Advanced Automation, SoftServe

The implementation of this advanced simulation framework will yield considerable benefits for Toyota:



Enhanced operational efficiency

The predictive simulations will greatly reduce the risks of damage during forklift operations, increasing overall safety and workflow efficiency.



Faster time-to-market

By simulating complex scenarios in a virtual environment, Toyota will accelerate the development cycle of autonomous forklifts, allowing them to respond swiftly to market demands.



Cost reductions

The digital twin initiative will allow Toyota to minimize costs associated with physical testing, failures, and damages by testing in a risk-free environment before deployment.

Tech Stack

Technologies:

- Physical AI
- Generative AI
- Synthetic data generation (SDG)
- Digital twins
- AI-driven driver assistance system
- Computer vision

Tech stack:

- NVIDIA Omniverse™
- NVIDIA Isaac Sim™
- NVIDIA Cosmos-Transfer
- ROS/ROS2
- C++
- Python



This collaboration marks a turning point for manufacturing in EMEA. By leveraging NVIDIA's digital twin technology, Toyota Material Handling delivered proven, virtual-tested automation. For Toyota's clients, this means safer, more efficient operations and a faster path to innovation — before any system is deployed on the factory floor.

— **Olha Moroz**,
Executive Vice President EMEA, SoftServe

Conclusion

With the help of NVIDIA's innovative technologies and SoftServe's expertise, Toyota will position itself as a leader in warehouse automation, ready to tackle the dynamics of modern logistics. Through the strategic collaboration with SoftServe and NVIDIA, Toyota Material Handling Europe has not only addressed its initial operational challenges but has also set a new benchmark in the field of warehouse automation.

The digital twin initiative illustrates the potential of combining innovative technologies with operational expertise, while the enhancement of AI models with SDG demonstrates the possibilities to bridge the gap between the virtual and physical world — paving the way for a future of automated logistics that is more efficient, safe, and responsive to market needs.

Are you interested in developing advanced automation solutions? SoftServe can help you use advanced digital twin technology and AI-driven simulations to set a new standard for safety and productivity — before deploying a single robot.

BOOK A MEETING FOR A CONSULTATION



About SoftServe

SoftServe brings Physical and Agentic AI to life by leveraging the full breadth of NVIDIA's technology stack, enabling enterprises to move beyond AI experimentation and into production with scalable, outcome-driven solutions. As **NVIDIA's 2025 Service Delivery Partner of the Year** and an **Advanced Technology Partner**, SoftServe delivers real-world impact through high-fidelity simulation, robotics and automation, intelligent collaborative agents, and computer vision at scale. As AI complexity grows across technologies and use cases, our value lies in helping customers prioritize and integrate the right capabilities into end-to-end architectures.



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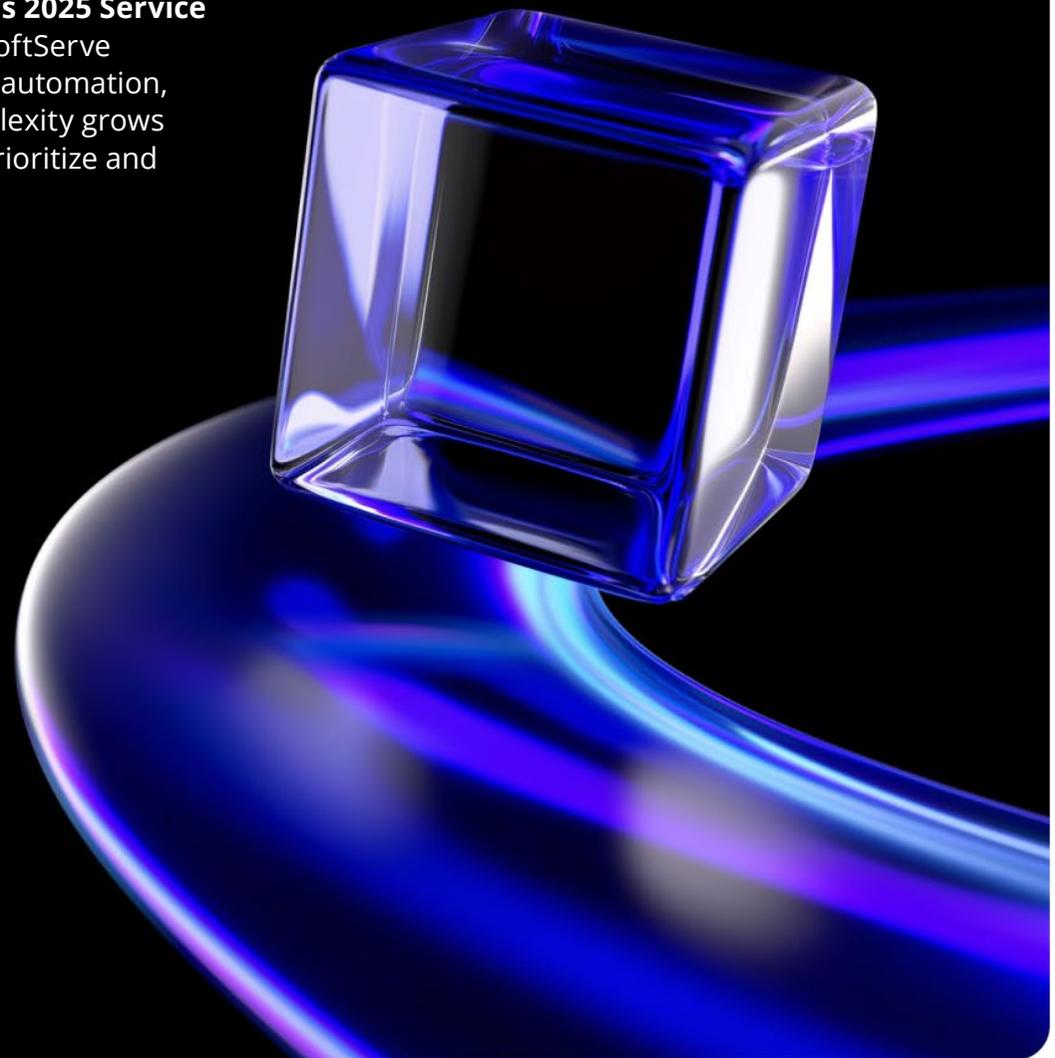
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