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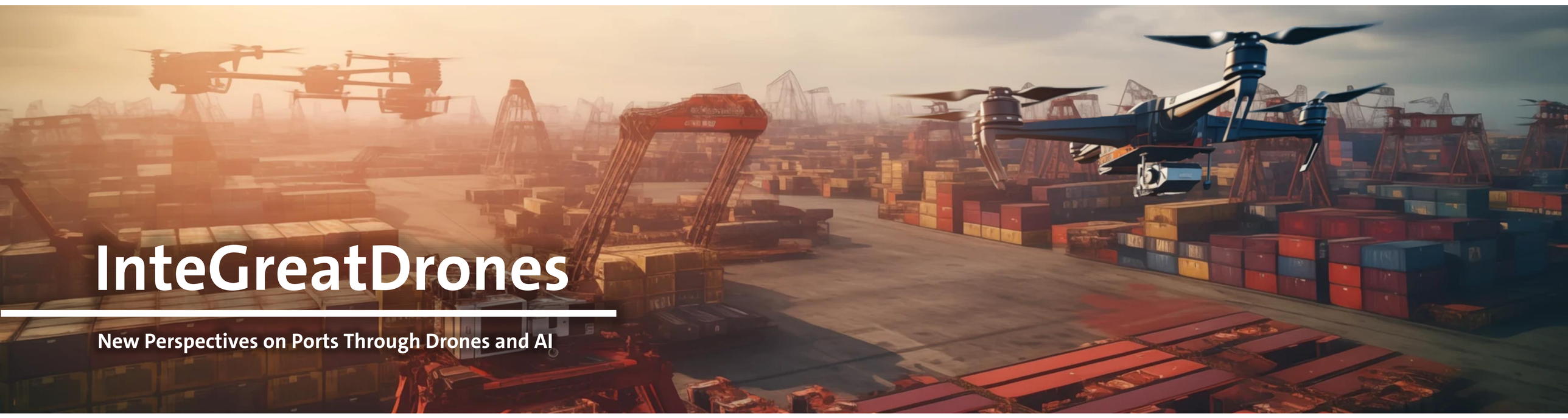
Department of Informatics
Distributed Operating Systems



InteGreatDrones

New Perspectives on Ports Through Drones and AI

General Project Information

The rise in production of cost-efficient unmanned aerial vehicles ("UAVs" or "drones") opens up new possibilities for process optimizations in industrial settings. The InteGreatDrones project focuses on the use of drone swarms for data collection in dynamic inland terminals, addressing challenges of changing cargo types and stakeholder interactions.
The project's goal is to employ autonomous drones to capture terminal activities, ensuring privacy through local data processing and selective sharing. With the help of computer vision algorithms, a digital twin of the port is created. A central middleware connects drones and existing systems, supporting terminal-specific applications like route optimization and predictive maintenance. The project seeks to provide real-time data for informed operational and strategic decisions. Thus, InteGreatDrones aims to enable comprehensive process and activity monitoring in inland terminals without relying on expensive fixed infrastructures.

Areas of Innovation

(1) Autonomously operating drone fleet

(3) Modular, distributed middleware

(5) Active drone integration in port processes

(2) Image processing with privacy in mind

(4) Development of port-specific applications

Project Members

InteGreatDrones is coordinated by the Sächsische Binnenhäfen Oberelbe GmbH (SBO) and is a cooperation with the research groups Distributed Operating Systems (DOS) and Computer Vision (CV) of the Universität Hamburg, the research group for Marine Logistics (MLS) of the TU Hamburg (TUHH) as well as Syntax Systems GmbH & Co. KG.

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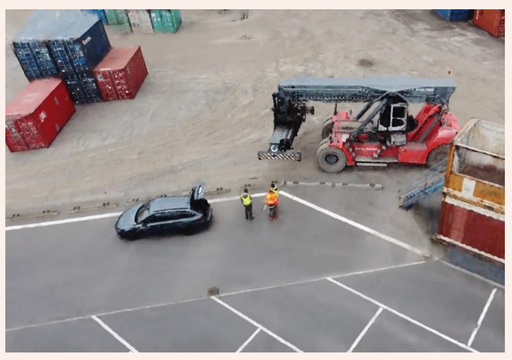
IHATEC Innovative Hafentechnologien

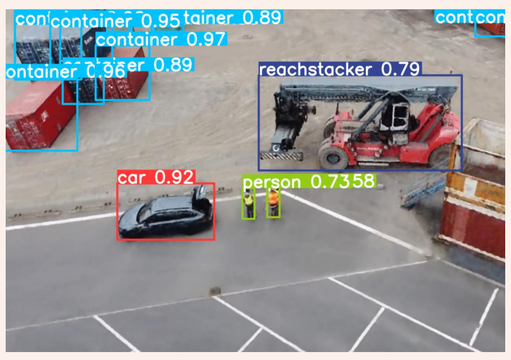
www.integreatdrones.de

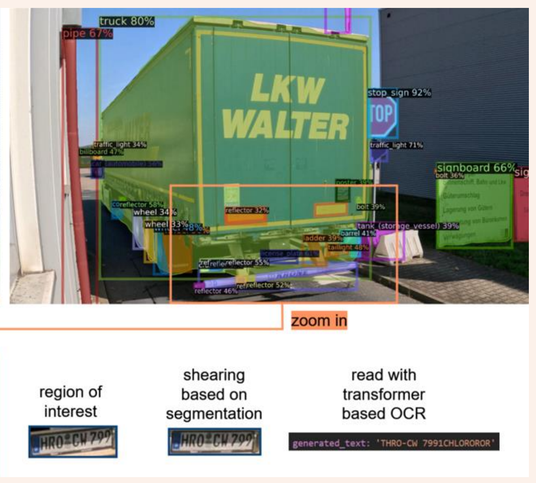
Research Projects and Theses

Neural Radiance Fields (NeRFs)

NeRFs allow to synthesize new views of complex environments from a small set of input views. This means that a few two-dimensional images captured from distinct vantage points can provide all the information needed to virtually explore and observe the environment from any possible angle. We use NeRFs to create digital representa-tives of terminals that serve as environments for virtual drone flights to collect image data.





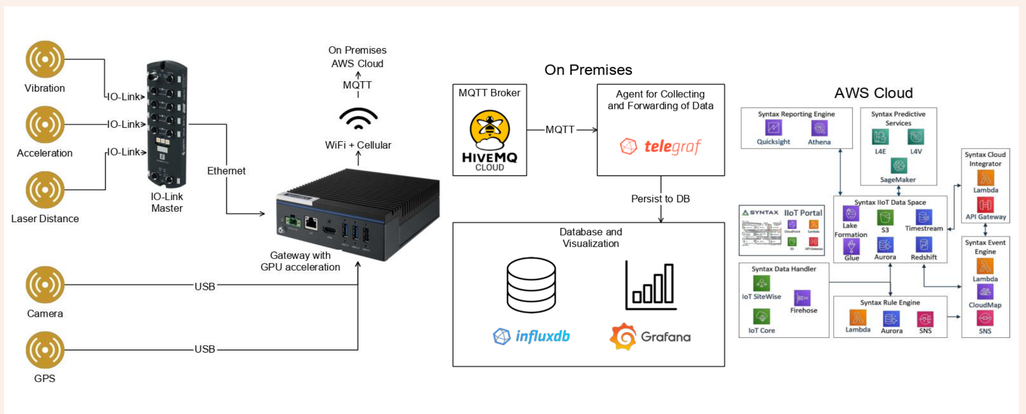


Optical Character Recognition

Abbreviated as OCR, it can be used to extract text from images. InteGreatDrones deals not only with containers, but also with truck trailers. Their license plates are useful for identification. Object detection of rare classes can be used to extract the region of interest of a 4K-image that contain the license plate. A segmentation mask can be used to calculate the orientation of the plate so that it can be straightened using a shearing process. Finally, OCR determines the actual characters. This information is used to gain an understanding of which vehicles are currently located inside the terminal.

Container Identification

Containers can be uniquely identified by an 11-digit code. We use sensors attached to terminal equipment in combination with OCR to auto-matically read this identifier. However, visual recognition is challenging and requires high-resolution image material. Thus, in a subproject, we also aim to find out whether it is possible to recognize containers once they have been identified on the basis of their characteristic patterns in order to save resources in data collection and processing.



Cloud Environment

By leveraging AWS (Amazon Web Services), Syntax orchestrates a seamless transition to the cloud and unlocks advanced analytics and machine learning capabilities through SYNSIGHTS resource components. AWS' robust cloud infrastructure enables real-time monitoring and analysis of key performance indicators (KPIs), providing actionable insights for improved operational efficiency. We use edge and cloud resources to place computational workload under quality of service constraints.

Autonomous UAVs

Drones can be used as dynamic sensors that do not need a fixed infrastructure. They take over routine tasks or spontaneously complete flight missions. In the container terminal, a base station (BS) will be setup where the UAVs can reload their batteries. The drone swarm is deployed to fly missions to scan the current state of the container stacks. Those missions might be triggered by events of the sensory infrastructure installed in the terminal gear.