Ansys + Navantia

"Through the collaboration with Ansys, we could explore new ways to tackle the challenges of data availability for future new capabilities development."

— **Aitor Facio Valero**
AI Technical Architect **/** Navantia, COEX Naval Systems

Navantia Generates Synthetic Datasets for Machine Learning-based Algorithms Using Ansys Sensor Simulation Software

The historical lack of data governance in real naval systems, the failure to unify and centralize the sources of this information, and the lack of a standard in this regard has led to a shortage of images of naval environments. Given the confidentiality associated with this type of data, it has been difficult to create a dataset suitable for training high-quality machine learning (ML)-based visual models for the sensing, recognition, and identification of ships at sea. This makes it difficult for naval commanders to make timely decisions as to whether an approaching ship is friendly or an enemy. Innovative naval cognitive systems are needed to discover alternative sources of high-quantity and high-quality naval images.

Navantia has demonstrated how simulation can create synthetic environments for generation of images for naval cognitive systems, thereby improving the recognition of naval objects through training of visual sensing models. The company was tasked to develop an automated system for visual detection and identification of threats in a maritime environment. The system's purpose is to help the naval ship crew identify warships, aircraft carriers, cruise ships, and other vessels, especially at long distances. Early detection can help initiate appropriate responses in a timely manner. They used Ansys AVxcelerate Sensors™ sensor simulation software to generate images and scenarios to train ML-based systems for automated identification of naval vessels.

Challenges

The main challenges faced by Navantia included:

- Unavailability of adequate data for training ML-based computer vision systems
- Unpredictability of actual operations at sea, which implies that the trained model must be prepared with maximum generalization capabilities
- Correlation of real and simulated images of naval vessel scenarios from three cameras (short, medium, and long range)
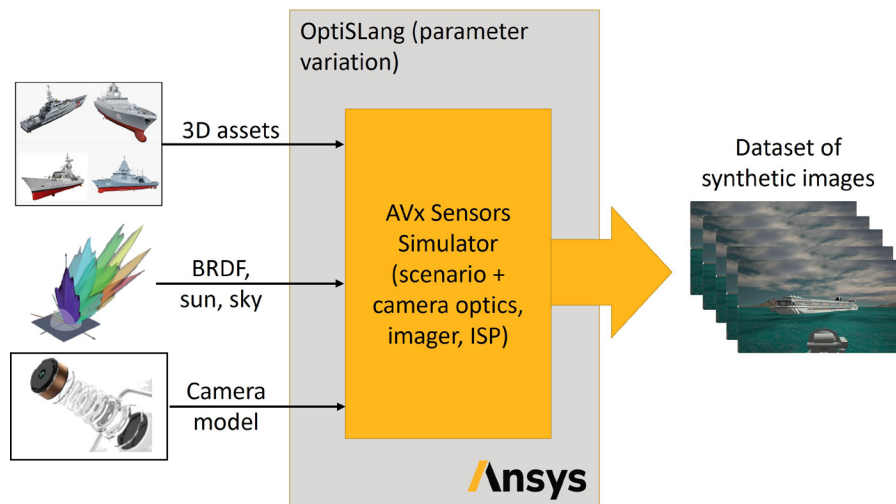
Generating synthetic camera data using Ansys AVxcelerate software and the Ansys optiSLang tool

Technology Used

- Ansys AVxcelerate Sensors software
- Ansys optiSLang™ software

Input to Ansys AVxcelerate Sensors simulation: a 3D model of
a carrier ship in a marine environment with sunset lighting

Simulated image from a wide-field-of-view
surveillance camera in a maritime environment

Engineering Solutions

Navantia engineers:

- Utilized AVxcelerate Sensors software to simulate camera sensors with diverse characteristics (e.g., optics, resolution, etc.) and Ansys optiSLang process integration and design optimization software for scenario variation and orchestration, enabling generation of thousands of images with the high variability needed to train a deep learning algorithm

- Generated synthetic camera images to train a deep neural network (DNN) to recognize objects in a naval environment. The DNN trained with synthetic images outperformed the DNN trained only on real data. Working with synthetic images and real data to create a hybrid dataset showed high levels of accuracy.

- Greatly improved the performance of the video detection system compared to previous non-physics-based synthetic data approaches

Detection results with the models trained on synthetic AVxcelerate Sensors images (left) and real images (right)

Detection results with the models trained on synthetic AVxcelerate Sensors images (left) and on the hybrid dataset (synthetic and real images, right)

/ Benefits

- Solved the problem of a lack of data by generating simulated images to train deep learning algorithms in heterogenous environments such as naval theaters of operations using physics-based simulation

- Lifted limitations in data acquisition associated with military environments such as image confidentiality, security concerns, unpredictability of actual operations at sea, difficulty in organizing real measurement campaigns on navy ships, and the availability of such ships

- Used simulation to better understand the operational design domain and expand the automatic decision process even to previously unseen situations

- Reduced the costs of creating realistic virtual environments, optimizing budget, and allocating resources through collaborative efforts with Ansys

- Published a paper with Ansys for the 2023 National Congress on Defense and Security R&D (DESEi+d 2023) titled "Datasets híbridos mediante entornos de simulación en sistemas navales."
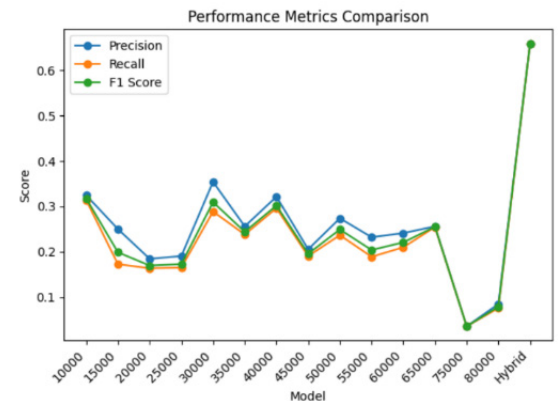
Metrics of hybrid datasets

/ Company Description

Navantia is a state-owned company (SEPI Group) that designs and builds high-technology ships for the Spanish Navy and other navies. It integrates systems and provides life cycle support, repairs, modernization, and technology transfer services in 20 countries. Navantia's activity focuses on three areas: shipbuilding and ship repairs, systems and services, and green energy, where we are an international benchmark in offshore wind energy.

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