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جامعة الملك عبدالله للعلوم والتقنية
King Abdullah University of Science and Technology

The 3rd Saudi Aramco Digital Hackathon

Business Challenges

AI and Advanced Computing

Lightweight Multi-view 3D Scene Reconstruction

Description

- Multiple autonomous drones are deployed across large areas to perform tasks such as mapping, surveying, or inspection
- They capture RGB images from different viewpoint, containing valuable geometric information about the surroundings
- The drones observe the same locations from various angles, which naturally forms a multi-view reconstruction problem
- We want to design a lightweight 3D reconstruction pipeline capable of efficiently reconstructing the environment.

Business Impact

- Enables faster field operations, better planning, and more reliable autonomous navigation, while reducing operational cost and enhancing safety

Deliverables:

- Trained lightweight model files
- The code to reproduce the results.
- A detailed report on methods used, evaluation metrics, and challenges faced

Why 3D Reconstruction from Drones?

- Drones can capture **rich visual information** from multiple viewpoints.
- Many applications require **3D understanding**, not just 2D images:
  - Mapping & surveying
  - Infrastructure inspection
  - Smart cities
- Traditional 3D reconstruction pipelines are:
  - Computationally expensive
  - Slow
  - Not suitable for **on-board drone deployment**

There is a strong need for **fast and efficient 3D reconstruction** from drone imagery.

Business Impact

- Understand the environment using only a few RGB images.
- Reduce operational cost, speeds up mission workflows, and enhances safety.
- Enables faster field operations, better planning, and more reliable autonomous navigation.
- Does **NOT** require expensive sensors or heavy on-board computing.

Introduction to the Challenge

Task:

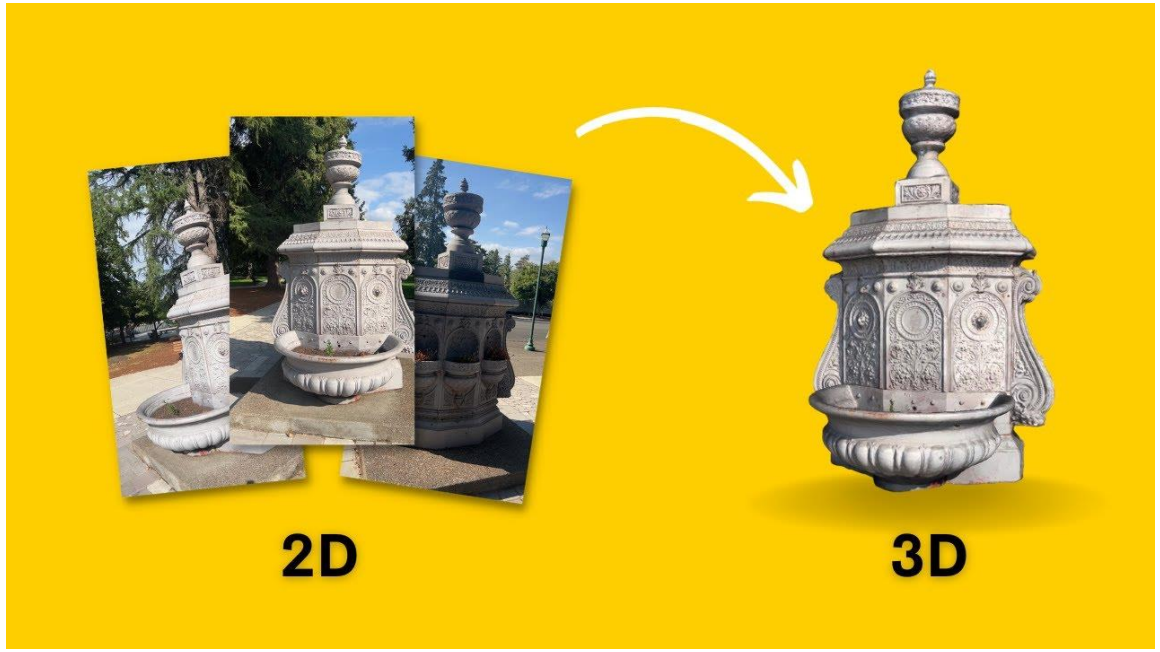
Design a **lightweight and efficient 3D reconstruction pipeline** that reconstructs a **3D scene/map** from **2D images captured by multiple drones** at different viewpoints.

Input:

- 2D RGB images
- Captured by multiple drones
- Different angles, altitudes, and viewpoints
- Optional camera pose information

Output:

- A reconstructed **3D representation of the scene**
  - Point cloud
  - Mesh
  - Or other suitable 3D format



Challenges with Existing Approaches

- Classical methods (SfM + MVS):
  - Accurate but **slow**
  - Require powerful ground stations
- Neural methods (NeRF, large models):
  - High-quality but **memory-heavy**
  - Long training and inference time
- Practical drone systems require:
  - **Low latency**
  - **Low memory footprint**
  - **Energy efficiency**

! Current solutions are **not designed for real-time or near-real-time drone use**.

Vision of This Challenge

- Enable **on-drone or edge-assisted 3D reconstruction**
- Balance:
  - ✓ Accuracy
  - ✓ Speed
  - ✓ Model size
- Support **multi-drone collaboration**:
  - Multiple viewpoints
  - Different angles
  - Partial scene coverage

Goal: Practical, deployable 3D reconstruction, not just high-fidelity demos.

Datasets & Evaluation Metrics

Possible Data Sources

- Drone-captured imagery (real or simulated):
  - UAVDT
  - VisDrone
  - ETH3D
  - DTU MVS
- Google Earth Studio imagery (for inference)

Data Characteristics

- Multi-view images
- Varying lighting and viewpoints.

Evaluation Metrics

- Accuracy:
  - PSNR (↑)
  - SSIM (↑)
  - LPIPS (↓)
- Efficiency:
  - Inference time
  - Model size
  - Memory usage

$$FinalResult = w_1 * Accuracy + w_2 * Efficiency$$

Deliverables

Technical Deliverables:

- Well-organized codebase
- Clean structure
- Complete 3D reconstruction pipeline from image input to 3D output.
- Model files (e.g., .pt PyTorch checkpoints).
- Input & output example.
- Preferred framework: PyTorch.

Documentation & Visualization

- Poster
  - Visualize pipeline
  - Show quantitative & qualitative 3D results
- Technical report, including:
  - Method description
  - Architecture choices
  - Evaluation metrics & results
  - Challenges faced & solutions

Physical AI Model Development for the Seismic AGV Mission in Desert Environment

Description

- To explore and find new oil & gas reservoirs, seismic waves are utilized
- The process usually includes a lot of manpower and expenses
- Lately, a lot of effort is going into automating the process. A part of that system is the autonomous ground vehicles (AGV) which induce the seismic activity
- To automate the ground vehicles, we need an AI model that can help the rover navigate the dessert terrain

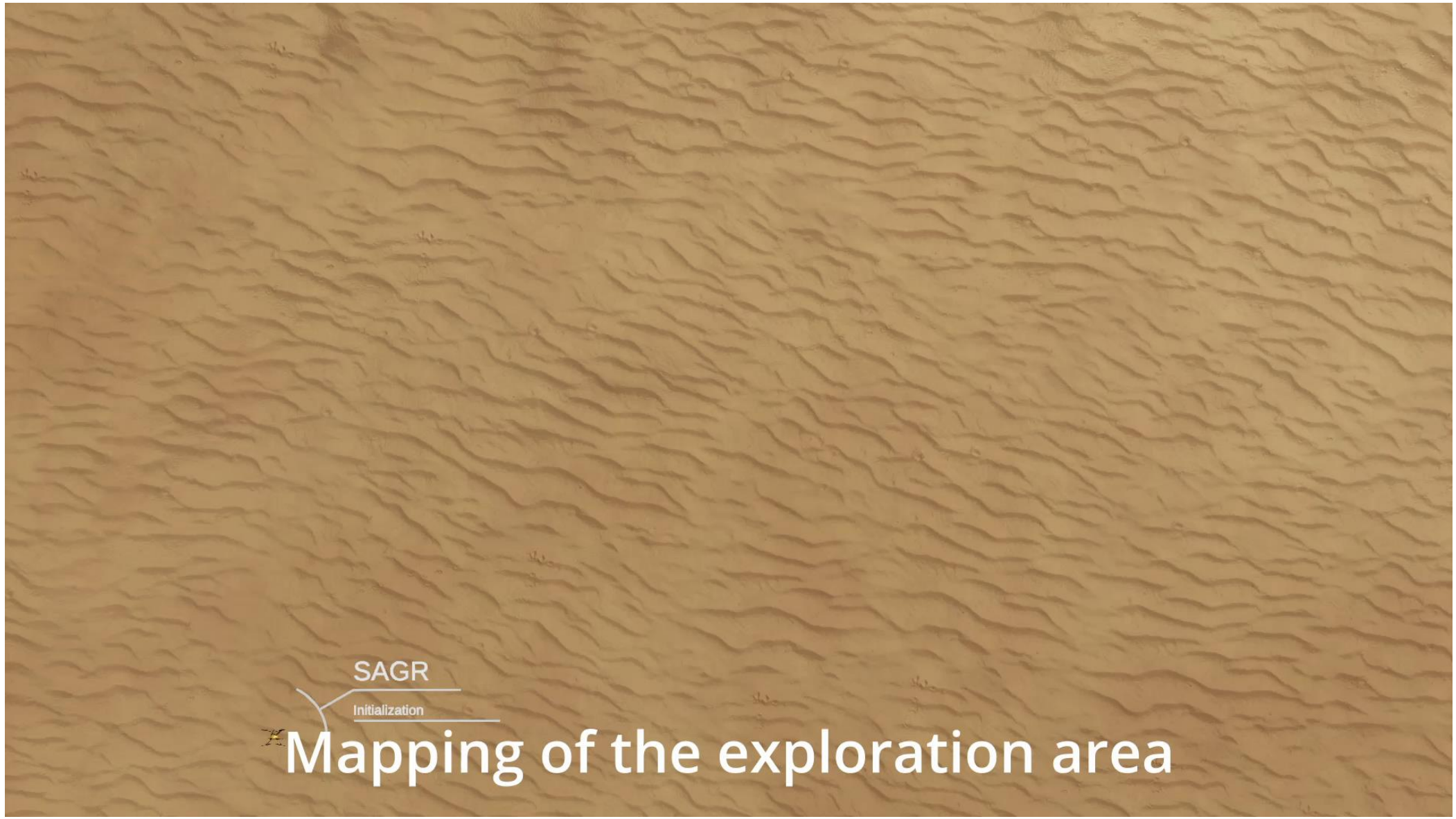
Business Impact

- Predictive navigation and adaptive control, reducing fuel, wear and crew time while increasing survey coverage; lower costs, faster delivery, and competitive edge

Deliverables:

- Project presentation
- Development report
- Docker container with simulator setup

Motivation: Robotization of the seismic exploration in desert

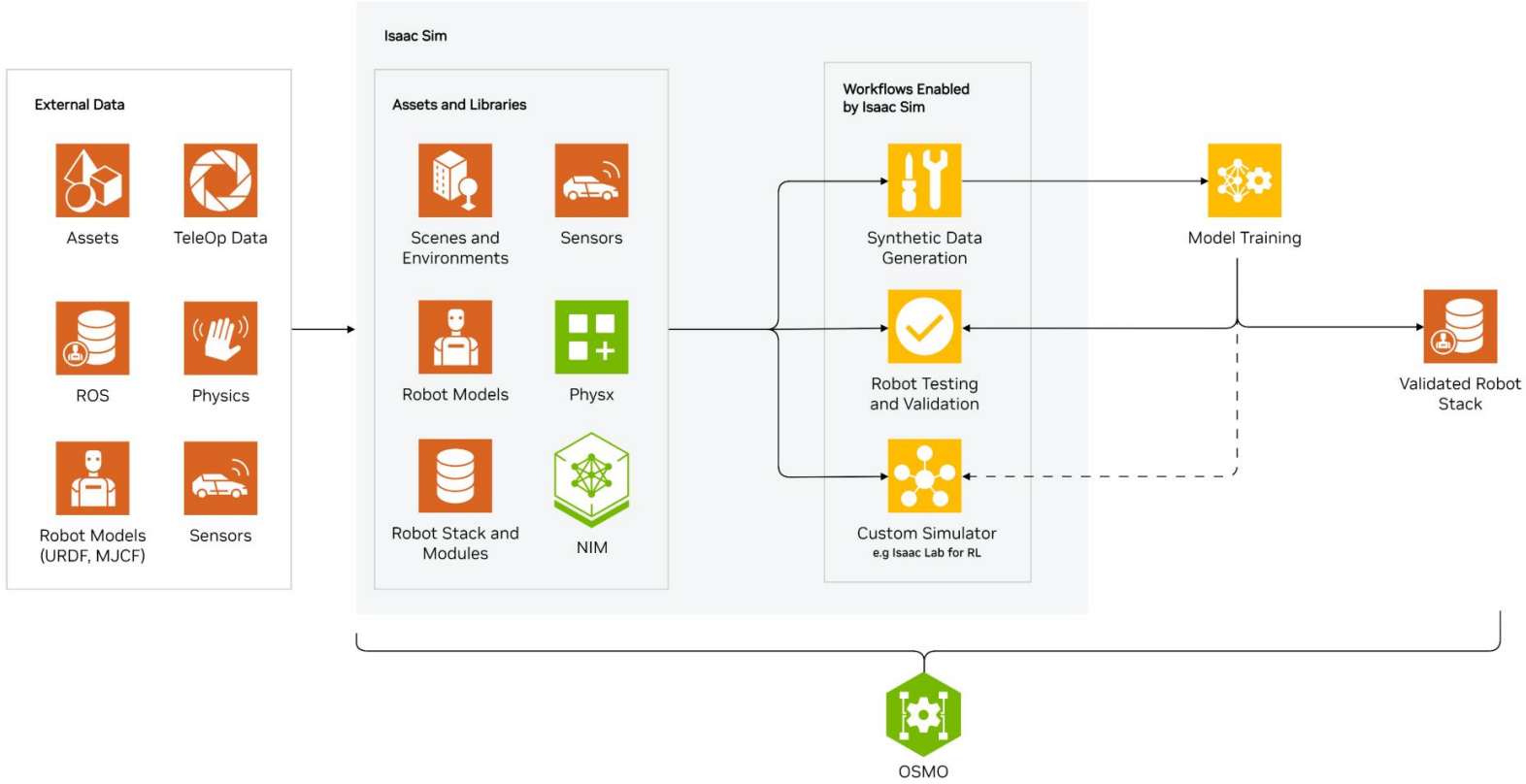


Physics based simulation environment

NVIDIA Isaac Sim

Open-source reference framework built on NVIDIA Omniverse™ that enables developers to simulate and test AI-driven robotics solutions in physically based virtual environments.

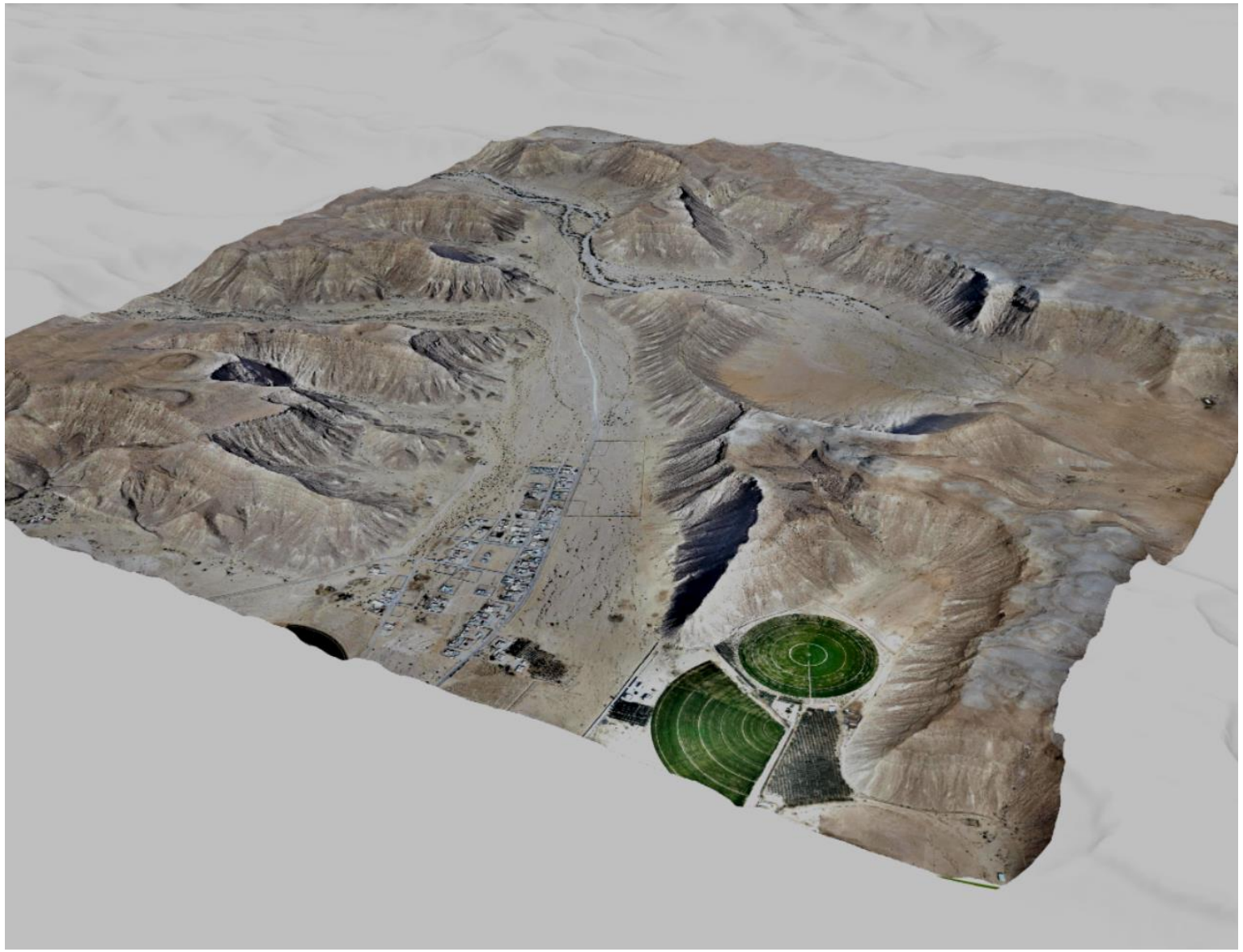
https://developer.nvidia.com/isaac/sim



Mission description

- Install all prerequisites and get access to Isaac Sim
- Add topography surface
- Design new AGV or modify existing one
- Program autonomous mission to survey points from the input list

Input data

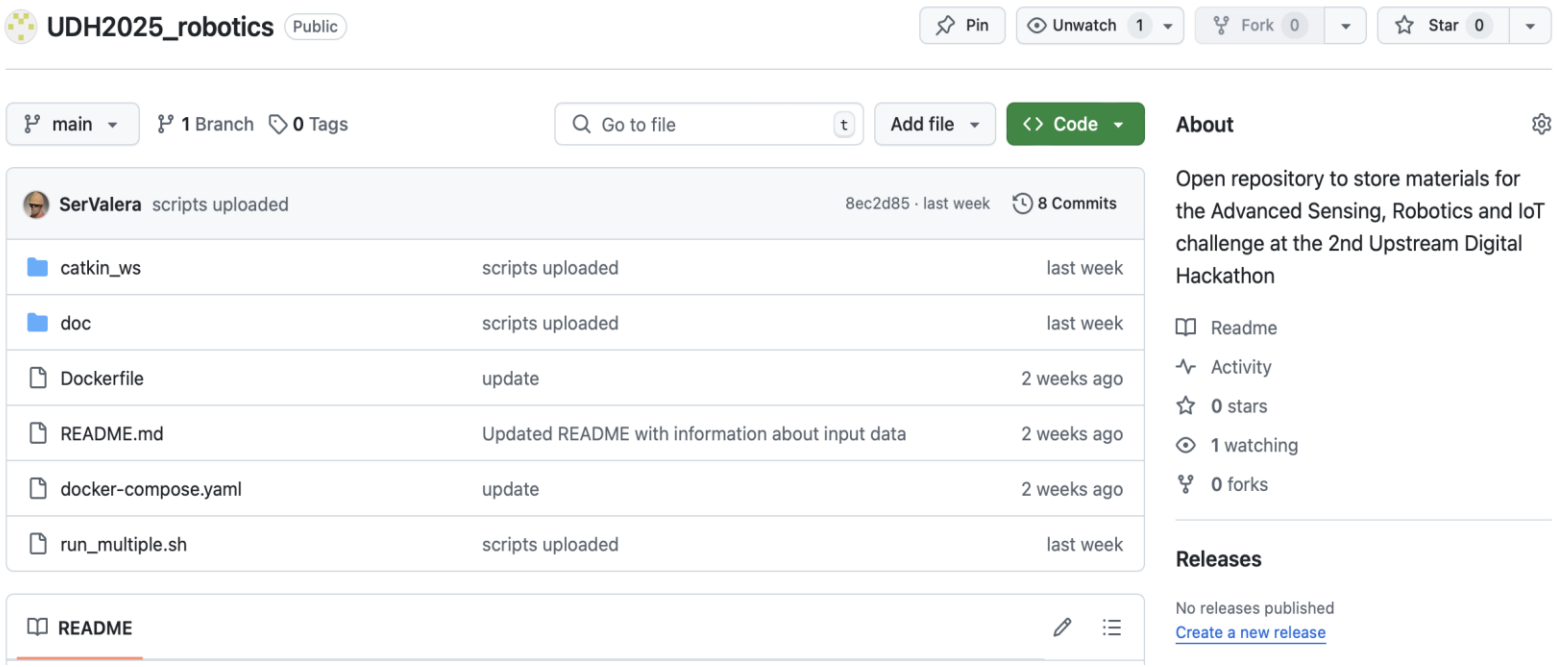


- **Realisitic terrain** in STL format
- List of **acquisition points**
- **AGV parameters**: ground speed, autonomy, payload

Expected deliverables

- **Algorithm/System Implementation:** simulation setup as Docker container.
- **Simulation:** A demo video showing the AGV navigating the map, avoiding obstacles, and collecting data.
- **Documentation:** A detailed report or presentation describing your approach, methods, and any assumptions.
- **Bonus Points:**
  - Uzing ChatGPT or other LLM chats to generate flight missions and commands for swarm operations.
  - Creative use of AI/ML models, RL, heuristics, or other techniques to solve complex challenges in mission planning.

Github repository



https://github.com/pgolikov/UDH2026_robotics

Register Your Team

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Physical AI Model Development for the Seismic AGV Mission in Desert Environment

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