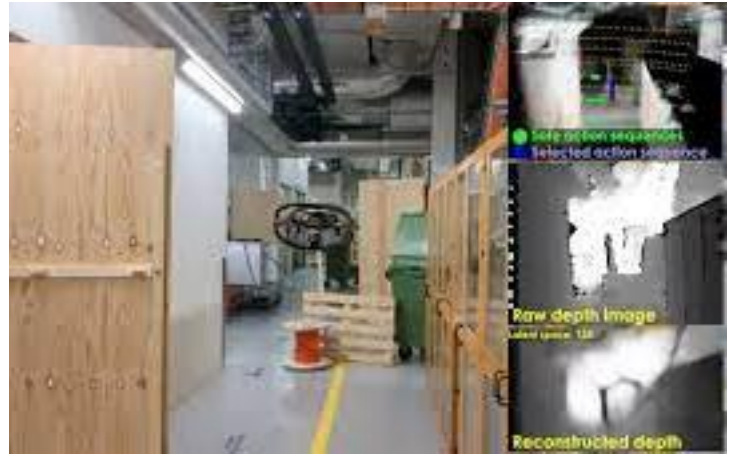# Semantic-oriented navigation of an Aerial Robot with Rotatable Camera

Abstract: Agile navigation is demonstrated using only a lightweight sensor suite like RGB-D cameras and IMU sensors. Nevertheless, existing works often utilize either visual or depth data coming from rigidly mounted cameras on the robotic platform. This data offers rich information about the surroundings in front of the robot only. Further, in most scenarios, the state-of-the-art navigation methods do not incorporate the semantic information from the RGB-D images. Thus, concerning semantic goal-oriented navigation, such a limited camera field-of-view leads to long operational time while the goal is to find a specific semantic object within the given environment. The integration of the rotatable camera within the navigation pipeline should significantly reduce the time along with the executed path by the robot. Simultaneously, it will allow for completing more missions/inspections within the given endurance time of the aerial platform. In this project, we aim to design and develop a rotatable camera and install it on the robotic system. In parallel, we strive to construct a novel semantic-oriented navigation pipeline which incorporates the rotatable camera.

Tasks:

- Study of literature in semantic-aware navigation and motion planning.
- Setup the simulation environment with an aerial robot equipped with a rotatable camera.
- Implement a novel navigation policy which benefits from the new camera setup for semantic-oriented motion planning.
- Design and fabricate the rotatable camera and mount the hardware on the existing robotic platform.
- Deployment on real hardware.

Literature:

[1] B. Zhou, P. Krähenbühl, and V. Koltun, "Does computer vision matter for action?" Sci. Robotics, vol. 4, no. 30, 2019.

[2] Gou, Siyuan, Xiaopeng Chen, and Weizhong Zhang. "Multimodal Perception based Autonomous Exploration with Active Camera Control in Unknown Environments." 2022 34th Chinese Control and Decision Conference (CCDC). IEEE, 2022.

[3] Sodano, Matteo, et al. "Open-World Semantic Segmentation Including Class Similarity." arXiv preprint arXiv:2403.07532 (2024).

[4] Chaplot, Devendra Singh, et al. "Object goal navigation using goal-oriented semantic exploration." Advances in Neural Information Processing Systems 33 (2020): 4247-4258.

[5] Bonetto, Elia, et al. "Active visual SLAM with independently rotating camera." 2021 European Conference on Mobile Robots (ECMR). IEEE, 2021.

[6] Dharmadhikari, Mihir, and Kostas Alexis. "Semantics-aware exploration and inspection path planning." 2023 IEEE International Conference on Robotics and Automation (ICRA). IEEE, 2023.

Relevant Multimedia:

- [Semantically-enhanced Deep Collision Prediction for Autonomous Navigation using Aerial Robots](#)

Relevant Funded Project:

- **Title:** ROI: RObotic Inspectors for semantic characterization of industrial facilities
- **Partners:** NTNU Adigo, Cognite
- **Funding Agency:** Research Council of Norway

Main supervisor: Kostas Alexis, Professor, NTNU | **Co-supervisor:** Grzegorz Malczyk, PhD Candidate, NTNU