

Marsupial Walking and Flying Robotic Systems



Abstract: Ground and aerial systems, in particular walking and multirotor robots present unique advantages and disadvantages. Our experience in the DARPA Subterranean Challenge demonstrated that none of them was able to undertake the full exploration mission on their own. Simultaneously, beyond classical multi-robot teams where systems are deployed separately there is unique value in the ability to deploy the complementary navigation modality “on demand”. A solution is that of “marsupial” robotic system-of-systems, meaning in this case the ferrying of one or more small flying robots onboard the legged system. In this project you are invited to develop a comprehensive mechatronic-and-autonomy solution for the integration of an RMF-Owl flying robot onboard the ANYmal D legged robot. A first solution will be outlined by our team (depicted in the Figure above with an earlier version of RMF and the ANYmal C system). The goal is that the marsupial set of robots can share maps, plan in a combinatorial manner to inspect complex structures, while the flying robot can also safely land onboard ANYmal after the completion of its mission.

Tasks:

- Study of literature on system-of-systems design of aerial and ground robots.
- Develop an optimized solution for the mechatronic integration of RMF on ANYmal.
- Optimized map sharing among the robots.
- Optimized collective inspection path planning.
- Automated landing back on ANYmal.

Literature (indicative):

- [1] De Petris, P., Khattak, S., Dharmadhikari, M., Waibel, G., Nguyen, H., Montenegro, M., Khedekar, N., Alexis, K. and Hutter, M., 2022. Marsupial Walking-and-Flying Robotic Deployment for Collaborative Exploration of Unknown Environments. arXiv preprint arXiv:2205.05477.
- [2] Tranzatto, M., Miki, T., Dharmadhikari, M., Bernreiter, L., Kulkarni, M., Mascari, F., Andersson, O., Khattak, S., Hutter, M., Siegwart, R. and Alexis, K., 2022. CERBERUS in the DARPA Subterranean Challenge. Science Robotics, 7(66), p.eabp9742.
- [3] Kottege, N., Williams, J., Tidd, B., Talbot, F., Steindl, R., Cox, M., Frousteger, D., Hines, T., Pitt, A., Tam, B. and Wood, B., 2023. Heterogeneous robot teams with unified perception and autonomy: How Team CSIRO Data61 tied for the top score at the DARPA Subterranean Challenge. arXiv preprint arXiv:2302.13230.

Relevant Project Information

- **ROI Project - Funding Agency:** Research Council of Norway

Main supervisor: Kostas Alexis, Professor, NTNU