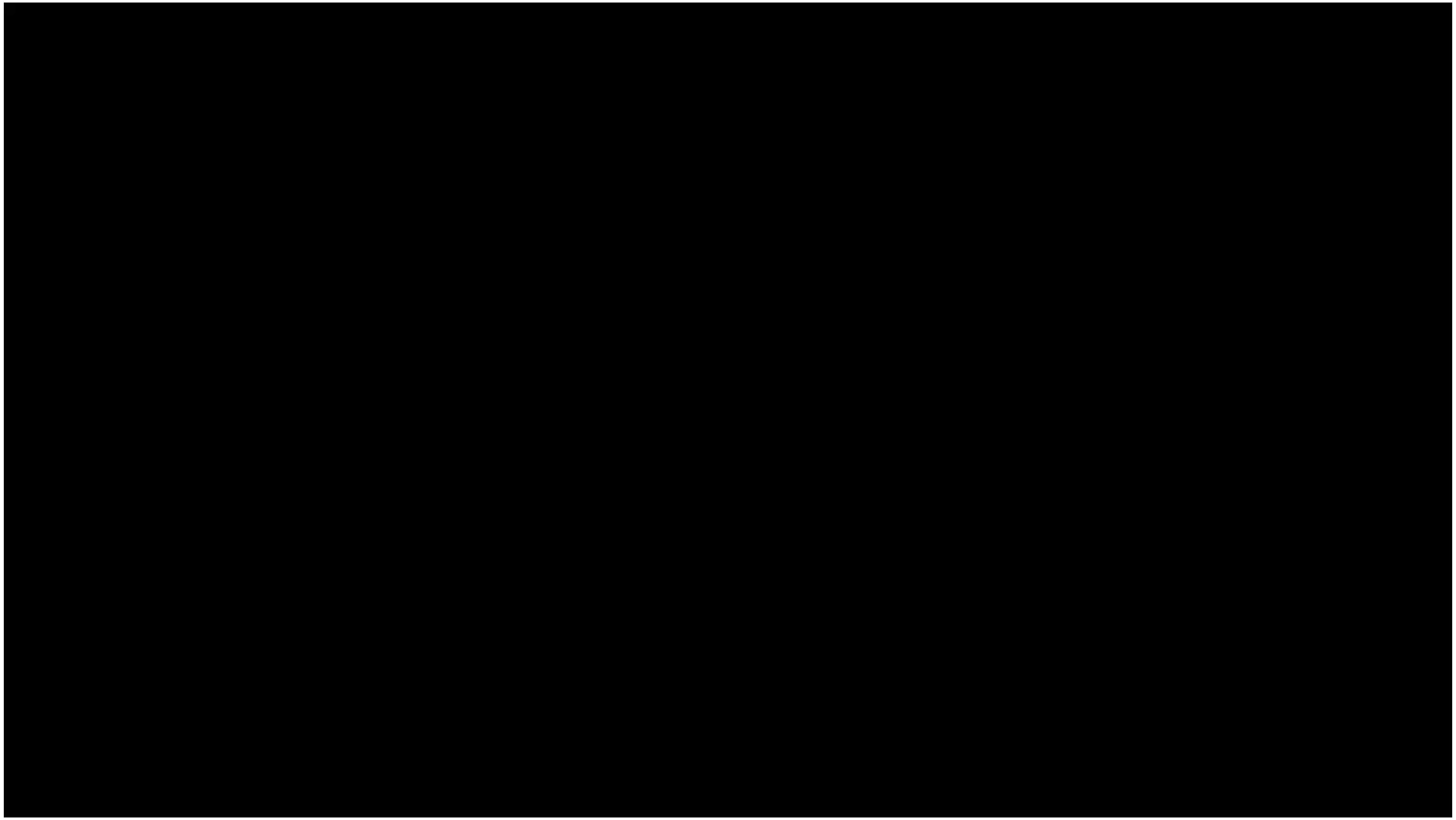
Multi-robot systems applications



Martin Saska

Multi-robot Systems group,

Czech Technical University in Prague

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Multi-Robot Systems at CTU in Prague

45 employees

> 50 MSc. & Bc. Students

> 50 AUTONOMOUS DRONES

3/2017 – MBZIRC 3rd challenge:
1st place $330.000 prize

2019-2021 - DARPA SubT: 2x 1st place among self-funded teams. 2nd place in virtual challenge finals
$200k & $500k & $500k prizes

2/2020 – MBZIRC 2rd challenge:
1st place $250.000, TOTAL WINNERS

Long-term motivation: Swarms of micro aerial vehicles in forest

- Swarming in GNSS denied space
- No direct communication
- Strictly decentralized system
- Scalable, large, anonymous groups
- Unknown environment
- Small low-cost aerial platforms
- High density of obstacles
- MAVs are well suited for such task

Petracek Bioinspiration & Biomimetics 2020, Ahmad ICRA 2021, Krizek ICUAS 2022, Saska ISRR 2017, Saska AURO 2017, Brandtner ECMR 2017, Saska JINT 2016, Saska ICUAS 2015, Saska ICRA 2014, Saska IJRR 2014

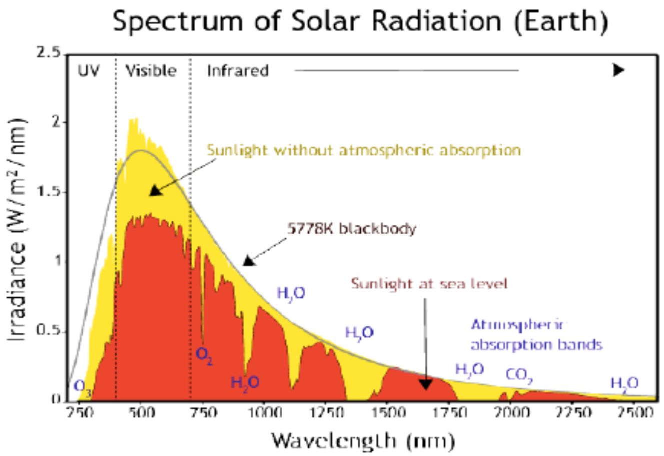
Relative Onboard Localization of Neighboring UAVs

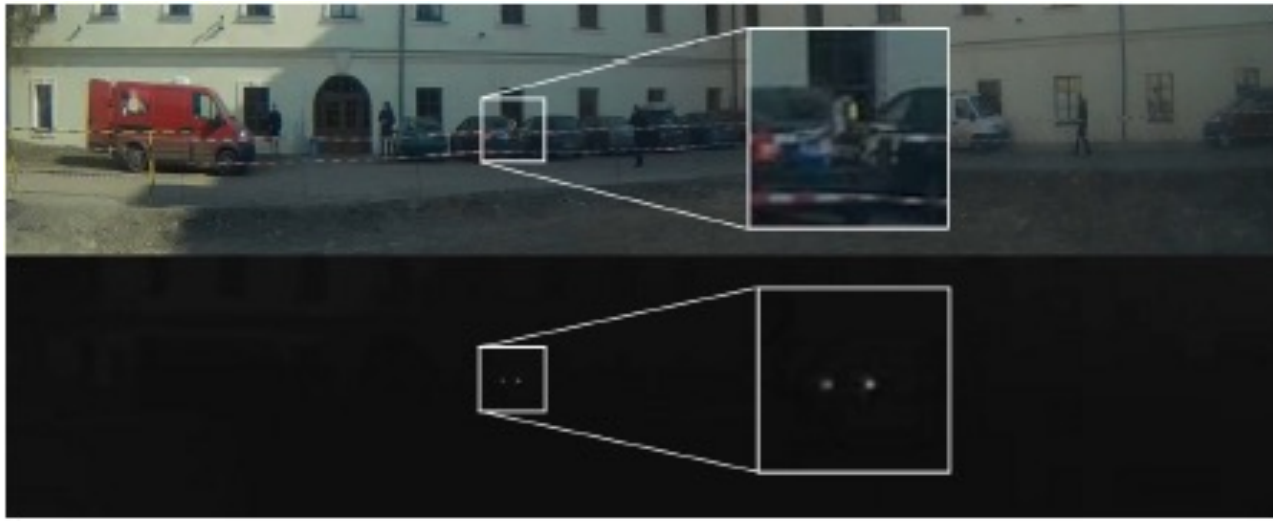
- CNN (RGB), Stereo (3D cam), 3D lidar, active RGB lights, AprilTags, UWB,…

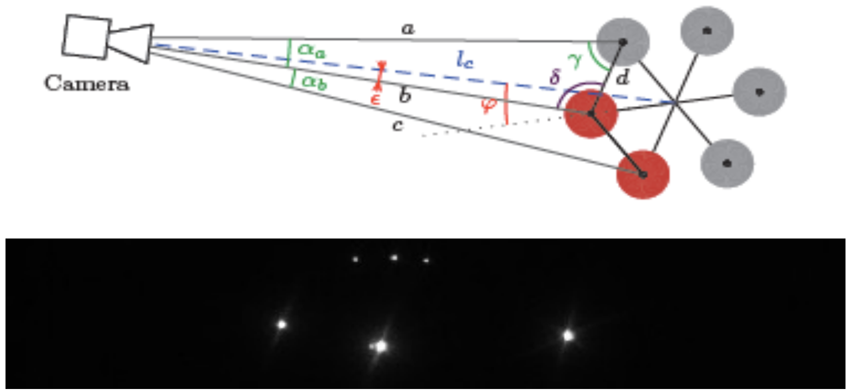
Saska IJRR 2014, Krajnik…Saska JINT 2014, Faigl…Saska ICRA 2013, Vrba…Saska RAS 2022, Vrba…Saska RAL 2020, Vrba…Saska RAL 2019, Stasinchuk…Saska Field Robotics, 2022

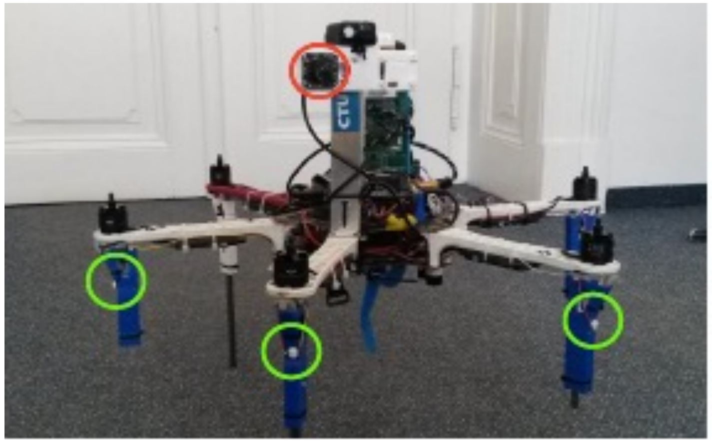
Mutual Localization of UAVs using Ultraviolet Markers

- Reduced size of markers, computational complexity
- Increased reliability





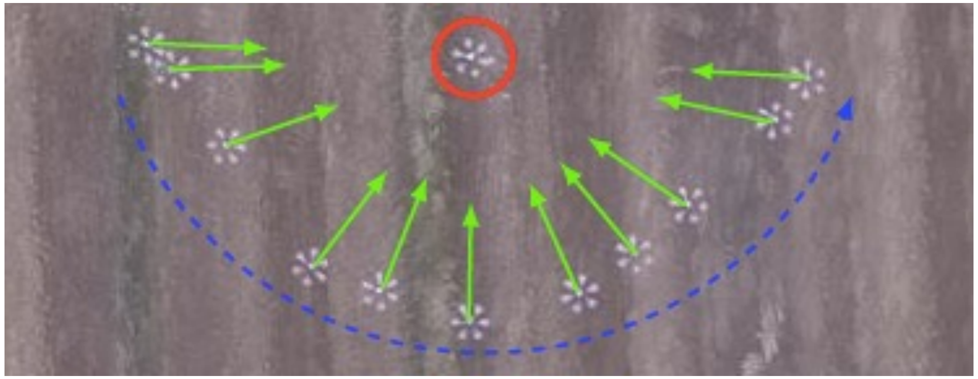


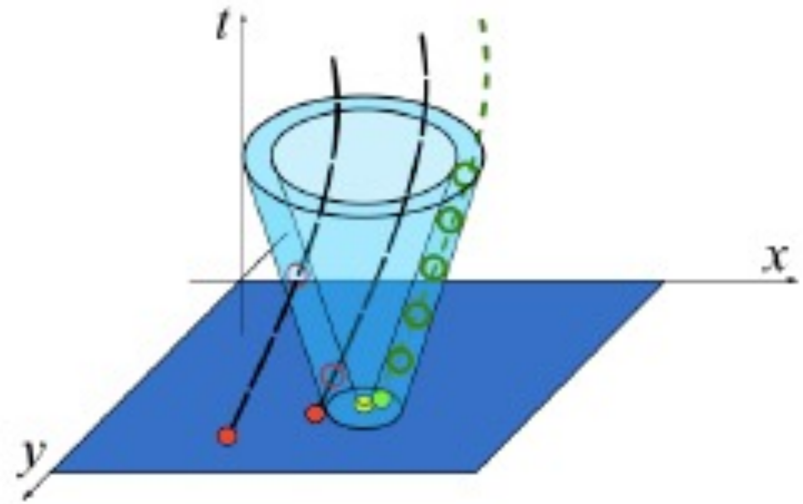


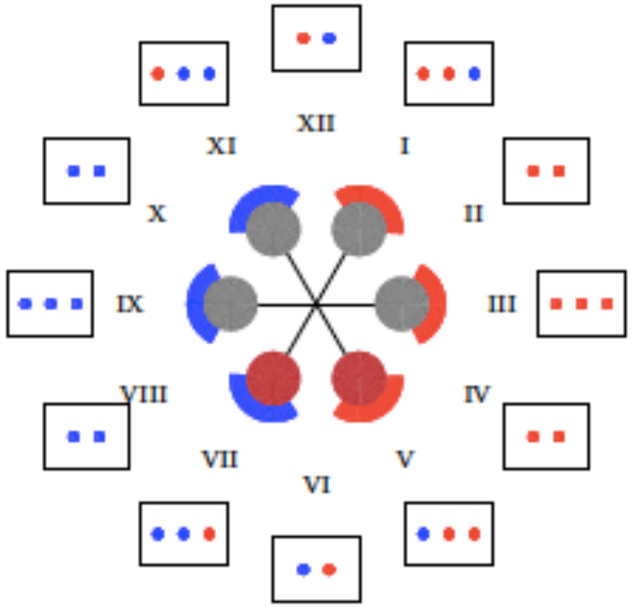
V Walter, N.Staub, M Saska and A Franchi. Mutual Localization of UAVs based on Blinking Ultraviolet Markers and 3D Time-Position Hough Transform. In IEEE CASE 2018.

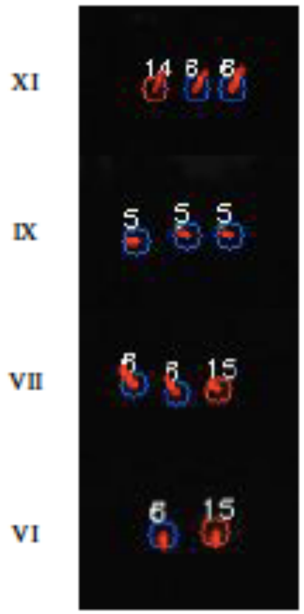
Blinking UV markers

- ID encoding and observation
- Relative orientation estimation
- Low bandwidth optical communication







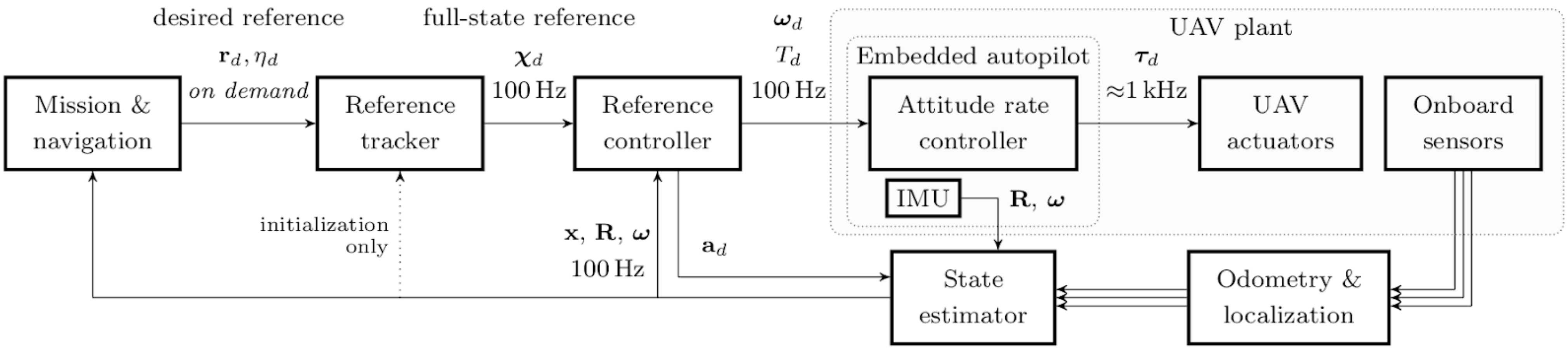


V Walter, N Staub, A Franchi and M Saska. UVDAR System for Visual Relative Localization With Application to Leader–Follower Formations of Multirotor UAVs. IEEE RAL, 4(3):2637-2644, July 2019.

MRS UAV System - Control Architecture

- Mission & Navigation - provides high-level reference (position + heading, 4D trajectory)
- Reference (MPC) tracker - feasible feedforward reference for the feedback controllers
- Reference (MPC or SE(3)) controller - estimates control disturbances and outputs attitude rate command to Pixhawk
- Attitude rate controller - PID loop on attitude rate, creates control commands to individual motors
- Odometry & Localization - UAV position (velocity) based on sensory data, examples: Laser SLAM, Visual SLAM, Optic Flow, …
- State estimator - a bank of estimators and filters produces a set of hypotheses (estimates) of the UAV state; switching between sensor configurations in flight
- Open source: >1000 registered active users

Tomas Baca, Matej Petrlik, Matous Vrba, Vojtech Spurny, Robert Penicka, Daniel Hert and Martin Saska. The MRS UAV System: Pushing the Frontiers of Reproducible Research, Real-world Deployment, and Education with Autonomous Unmanned Aerial Vehicles. JINT 102(26):1–28, May 2021.



Nature-inspired swarming - No GNSS, no communication, fully decentralized

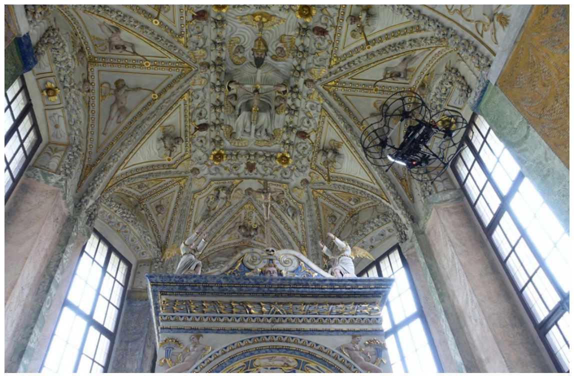
Afzal Ahmad, .. and Martin Saska. PACNav: A Collective Navigation Approach for UAV Swarms Deprived of Communication and External Localization. Bioinspiration & Biomimetics 17:1-19, 2022.

Nature-inspired swarming - No GNSS, no communication, fully decentralized

J. Horyna, … and M. Saska. Decentralized swarms of unmanned aerial vehicles for search and rescue operations without explicit communication. Autonomous Robots, pages 1-17, 2022.

Documentation of dark areas of large historical buildings by a formation of unmanned aerial vehicles

vs.



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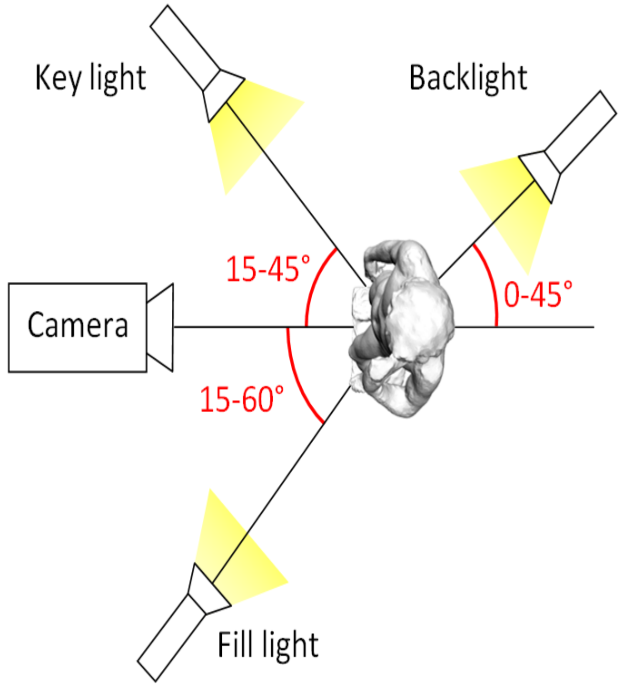
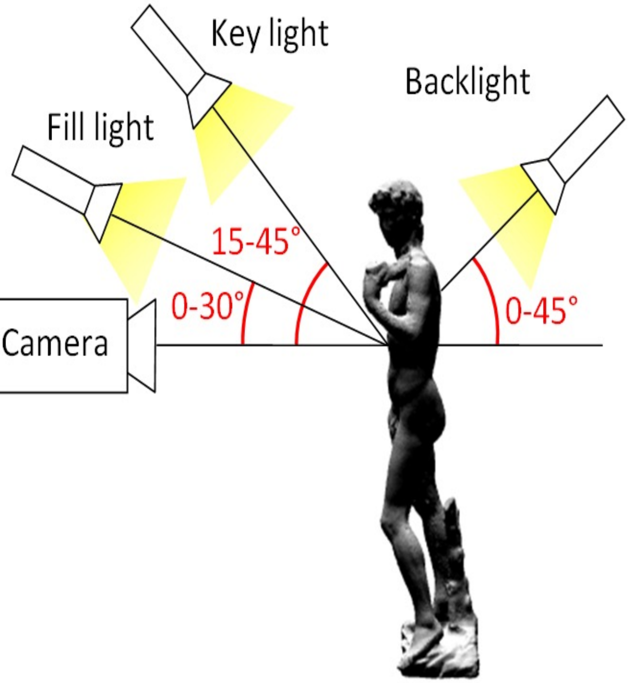
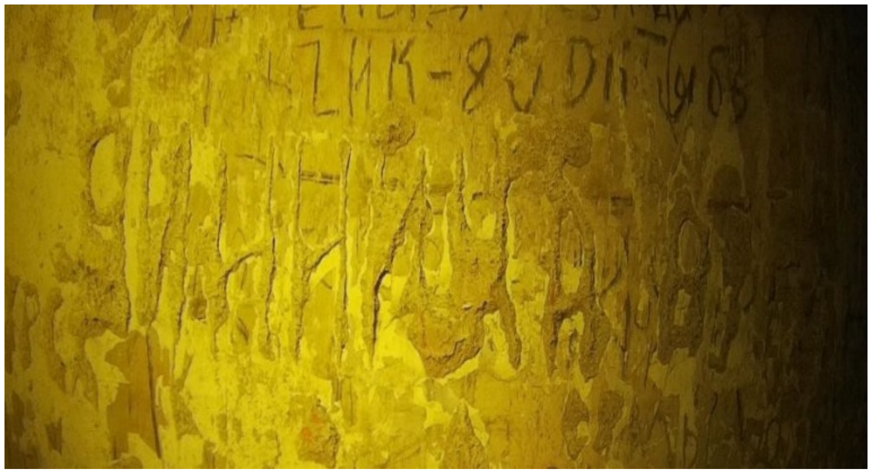
Three points lighting

- Problems with illumination in historical objects
- Cooperation of multiple UAVs







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Indoor inspection, monitoring, or documentation by teams of aerial robots

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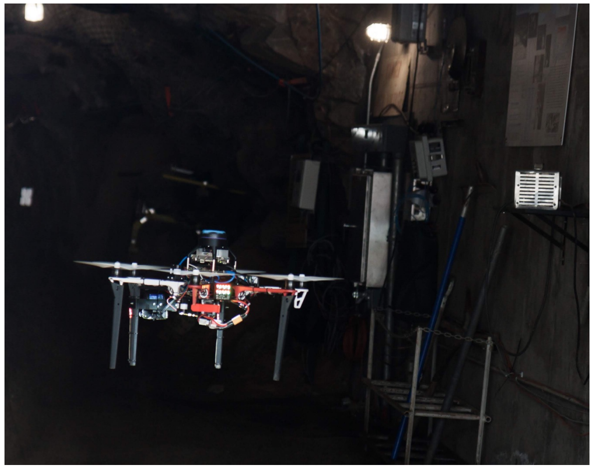
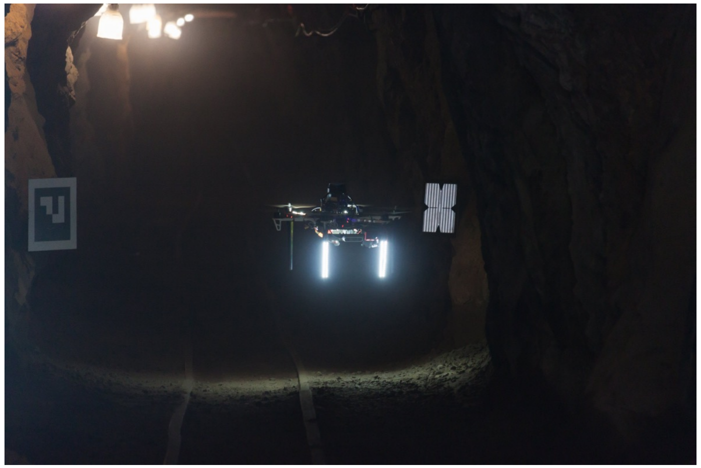
DARPA Subterranean Challenge - Tunnel Circuit

- Multi-robot team designed for exploration of underground environment
- DARPA SubT Tunnel Circuit - 8/2019: 1st place among self-funded teams, 3rd place in total. $200 000 prize





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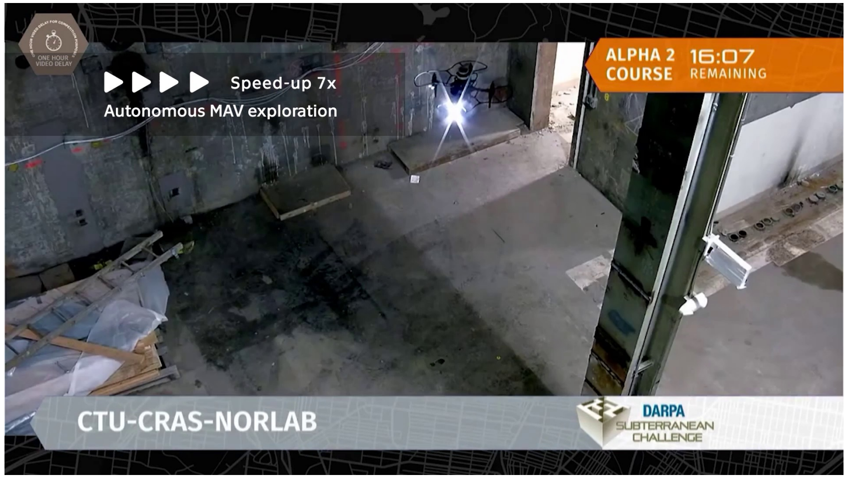
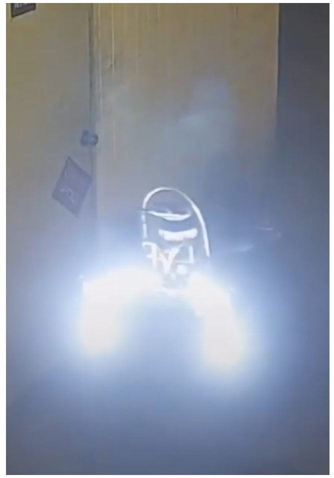
DARPA Subterranean Challenge - Urban Circuit

- Multi-robot team exploring underground urban environment
- DARPA SubT Urban Circuit - 2/2020: 1st place among self-funded teams, 3rd place in total. $500 000 prize





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CTU-CRAS-NORLAB

@DARPA Subterranean Challenge
URBAN CIRCUIT

CTU CZECH TECHNICAL UNIVERSITY IN PRAGUE

VRAS

AI CENTER

MRS

http://robotics.fel.cvut.cz/cras/darpa-subt/

http://mrs.felk.cvut.cz/projects/darpa

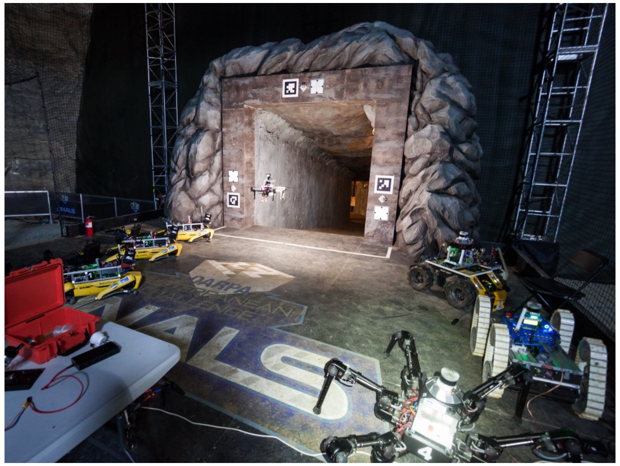
DARPA Subterranean Challenge - Cave Circuit

- Canceled due to covid
- Testing in real caves of Southern Moravia Karst

DARPA Subterranean Challenge – Final Event

- A combination of Cave, Urban, and Tunnel Circuits. Virtual and system tracks
- DARPA SubT Final Event - 9/2021: 2nd place in the virtual track. $500 000 prize. 6 best teams were using MRS-CTU X500 platform in the virtual track.





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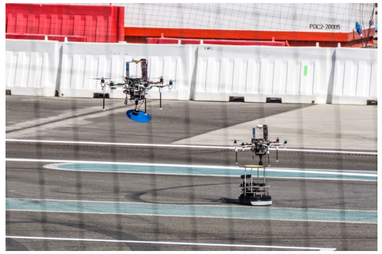
Publications

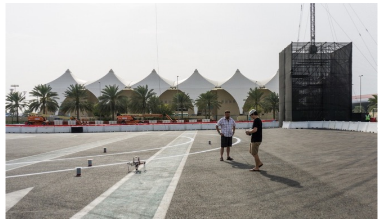
- *Matej Petrlik, Pavel Petracek, Vit Kratky, Tomas Musil, Yurii Stasinchuk, Matous Vrba, Tomas Baca, Daniel Hert, Martin Pecka, Tomas Svoboda and Martin Saska. UAVs Beneath the Surface: Cooperative Autonomy for Subterranean Search and Rescue in DARPA SubT. Field Robotics 3:1–68, January 2023.*
- *T Musil, Matej Petrlik and Martin Saska. SphereMap: Dynamic Multi-Layer Graph Structure for Rapid Safety-Aware UAV Planning. IEEE Robotics and Automation Letters 7(4):11007-11014, 2022.*
- *T Roucek, M Pecka, P Cizek, T Petricek, J Bayer, V Salansky, T Azayev, D Hert, M Petrlik, T Baca, V Spurny, V Kratky, P Petracek, D Baril, M Vaidis, V Kubelka, F Pomerleau, J Faigl, K Zimmermann, M Saska, T Svoboda and T Krajnik. System for multi-robotic exploration of underground environments CTU-CRAS-NORLAB in the DARPA Subterranean Challenge. Field Robotics 2:1779–1818, 2022.*
- *Kamak Ebadi, Lukas Bernreiter, Harel Biggie, Gavin Catt, Yun Chang, Arghya Chatterjee, Christopher E Denniston, Simon-Pierre Deschênes, Kyle Harlow, Shehryar Khattak, Lucas Nogueira, Matteo Palieri, Pavel Petráček, Matěj Petrlík, Andrzej Reinke, Vít Krátký, Shibo Zhao, Ali-akbar Agha-mohammadi, Kostas Alexis, Christoffer Heckman, Kasra Khosoussi, Navinda Kottege, Benjamin Morrell, Marco Hutter, Fred Pauling, François Pomerleau, Martin Saska, Sebastian Scherer, Roland Siegwart, Jason L Williams and Luca Carlone. Present and Future of SLAM in Extreme Underground Environments. IEEE Transactions on Robotics (revision), 2022.*
- *Pavel Petracek, Vit Kratky, Matej Petrlik, Tomas Baca, Radim Kratochvil and Martin Saska. Large-Scale Exploration of Cave Environments by Unmanned Aerial Vehicles. IEEE Robotics and Automation Letters 6(4):7596-7603, October 2021.*
- *Vít Krátký, Pavel Petráček, Tomáš Báča and Martin Saska. An autonomous unmanned aerial vehicle system for fast exploration of large complex indoor environments. Journal of Field Robotics 38(8):1036-1058, May 2021.*
- *M Petrlík, T Báča, D Heřt, M Vrba, T Krajník and M Saska. A Robust UAV System for Operations in a Constrained Environment. IEEE Robotics and Automation Letters (RAL) 5(2):2169-2176, 2020.*
- *T Rouček, M Pecka, P Čížek, T Petříček, J Bayer, V Šalanský, D Heřt, M Petrlík, T Báča, V Spurný, F Pomerleau, V Kubelka, J Faigl, K Zimmermann, M Saska, T Svoboda and T Krajník. DARPA Subterranean Challenge: Multi-robotic Exploration of Underground Environments. In Modelling and Simulation for Autonomous Systems. 2020, 274–290.*

MBZIRC 2017 competition:

3rd challenge: 1st place $330.000, 1st challenge: 2nd place, TOTAL: 3rd place

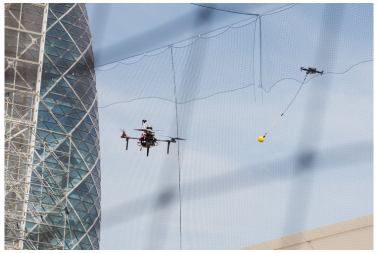
- **1. challenge: to autonomously land on a moving car**
- **2. challenge: to operate a control station by UGV**
- **3. challenge: to localize and collect static and moving metal objects with unknown position**





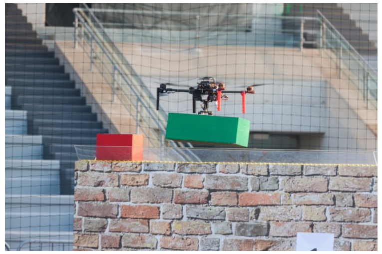
MBZIRC 2020 competition:

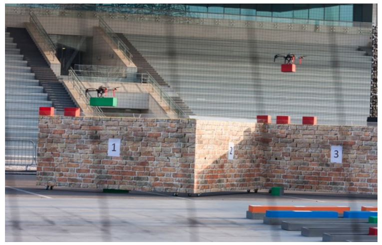
2nd challenge: 1st place $330.000, 1st challenge: 2nd place, TOTAL: 1st place





- 1. challenge: to capture and neutralize intruder UAVs
- 2. challenge: to autonomously locate, pick, transport and assemble different types of brick-shaped objects to build pre-defined structures
- 3. challenge: to autonomously extinguish a series of simulated fires in an urban high rise building




CTU

CZECH TECHNICAL UNIVERSITY IN PRAGUE

FACULTY OF ELECTRICAL ENGINEERING CTU IN PRAGUE

MBZIRC
مسابقة محمد بن زايد العالمية للروبوت
Mohamed Bin Zayed International Robotics Challenge
inspiring the future of Robotics صياغة مستقبل الروبوتات

Publications

- *V Walter, V Spurny, M Petrlik, T Baca, D Zaitlík, L Demkiv and M Saska. Extinguishing real fires by fully autonomous multirotor UAVs in the MBZIRC 2020 competition. Field Robotics 2:406–436, April 2022.*
- *Matouš Vrba, Yurii Stasinchuk, Tomáš Báča, Vojtěch Spurný, Matěj Petrlík, Daniel Heřt, David Žaitlík and Martin Saska. Autonomous capture of agile flying objects using UAVs: The MBZIRC 2020 challenge. Robotics and Autonomous Systems 149:103970, March 2022.*
- *Yurii Stasinchuk, Matous Vrba, T Baca, Vojtech Spurny, M Petrlik, Daniel Hert, D Zaitlik and M Saska. A Multi-MAV System for the Autonomous Elimination of Multiple Targets in the MBZIRC 2020 Competition. Field Robotics 2:17988–1720, 2022.*
- *P Štibinger, G Broughton, F Majer, Z Rozsypálek, A Wang, K Jindal, A Zhou, D Thakur, G Loianno, T Krajník and M Saska. Towards new frontiers in mobile manipulation: Team CTU-UPenn-NYU at MBZIRC 2020. Field Robotics 2:75–106, March 2022.*
- *Jiri Horyna, Tomas Baca and Martin Saska. Autonomous Collaborative Transport of a Beam-Type Payload by a Pair of Multi-rotor Helicopters. In 2021 International Conference on Unmanned Aircraft Systems (ICUAS). June 2021, 1139–1147.*
- *Viktor Walter, Vojtěch Spurný, Matěj Petrlík, Tomáš Báča, David Žaitlík and Martin Saska. Extinguishing of Ground Fires by Fully Autonomous UAVs Motivated by the MBZIRC 2020 Competition. In ICUAS. June 2021, 787–793.*
- *V Pritzl, P Stepan and M Saska. Autonomous Flying into Buildings in a Firefighting Scenario. In 2021 IEEE International Conference on Robotics and Automation (ICRA). May 2021, 239–245.*
- *P Štibinger, G Broughton, F Majer, Z Rozsypálek, A Wang, K Jindal, A Zhou, D Thakur, G Loianno, T Krajník and M Saska. Mobile Manipulator for Autonomous Localization, Grasping and Precise Placement of Construction Material in a Semi-structured Environment. IEEE Robotics and Automation Letters 6(2):2595–2602, April 2021.*
- *Vojetech Spurny, Vaclav Pritzl, Viktor Walter, Matej Petrlik, Tomas Baca, Petr Stepan, David Zaitlik and Martin Saska. Autonomous Firefighting Inside Buildings by an Unmanned Aerial Vehicle. IEEE Access 9:15872-15890, January 2021.*
- *Yurii Stasinchuk, Matouš Vrba, Matěj Petrlík, Tomáš Báča, Vojtěch Spurný, Daniel Hert, David Žaitlík, Tiago Nascimento and Martin Saska. A Multi-UAV System for Detection and Elimination of Multiple Targets. In 2021 IEEE International Conference on Robotics and Automation (ICRA). 2021, 555-561.*
- *Tomas Baca, Robert Penicka, Petr Stepan, Matej Petrlik, Vojtech Spurny, Daniel Hert and Martin Saska. Autonomous Cooperative Wall Building by a Team of Unmanned Aerial Vehicles in the MBZIRC 2020 Competition. Minor revision in Robotics and Autonomous Systems, December 2020.*

- Close collaboration with MRS group at CTU in Prague (s
- 35 R&D engineers for technology transfer from research to produ
- 12 new positions starting 12/2024

F4F RoboFly: Universal robot with on-board AI for swarming

- fully autonomous flying robot ready for use in real conditions
- user-friendly, easy to program
- € 2,999 per unit

- Raspberry PI as main computer
- ROS-based and various simulators
- open source software
- suitable for multirobot swarm applications
- UVDAR and UWB relative localization

F4F FLY4FUTURE

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F4F modular robots: research platforms for indoor and outdoor

F450

Compact

Flights close to obstacles

Stereo vision and simple collision avoidance

Outdoor and indoor inspection and monitoring

X500

Universal Drone

DARPA SUB-T VIRTUAL CHALLENGE WINNER SYSTEM

Collision avoidance

Dense, complex GNSS-denied environments

Indoors, forests, caves

M650B

Long Flights

Long operational time

3D lidar, stereo camera, or a special gimbal camera

Outdoor inspection and monitoring

T650

Heavy Loads

Capacity for carrying heavy payloads

Grasping objects from the ground

Outdoor environments with GNSS

fly4future.com/custom-drones

F4F FLY4FUTURE

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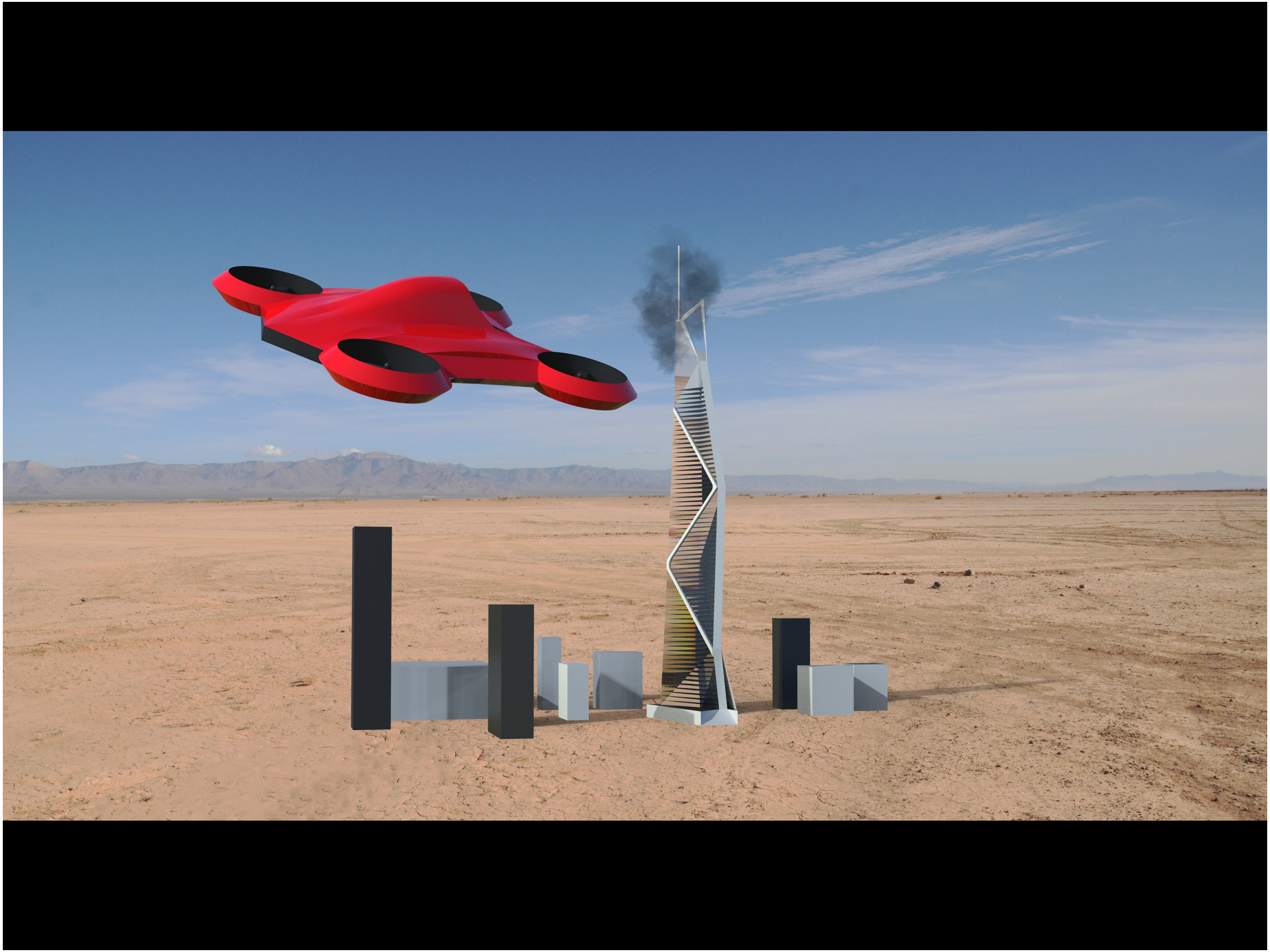
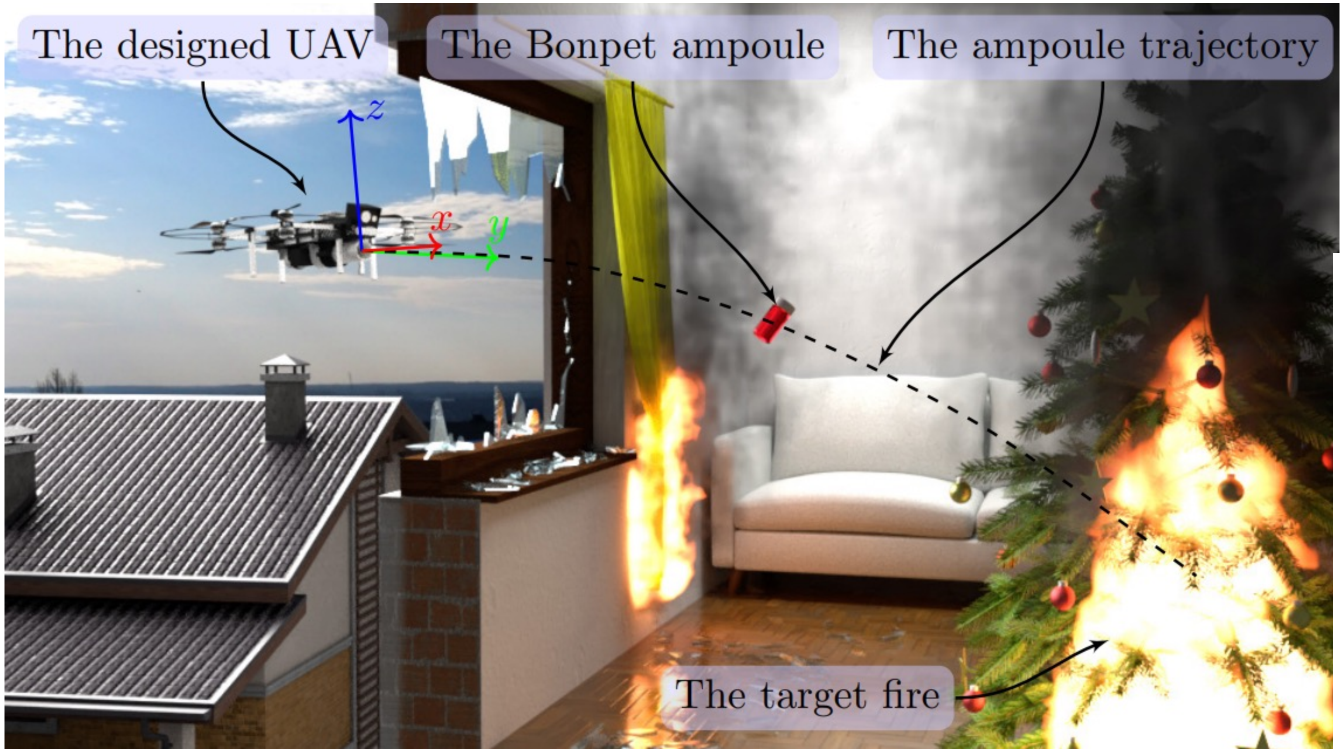


DOFEC – Discharging Of Fire Extinguishing Capsules

- Autonomous fast fire extinguishment in aboveground floors
- Fire detection using an onboard thermal camera and its localization by a depth camera
- Precise discharge of ampoules with a fire extinguisher from an onboard launcher

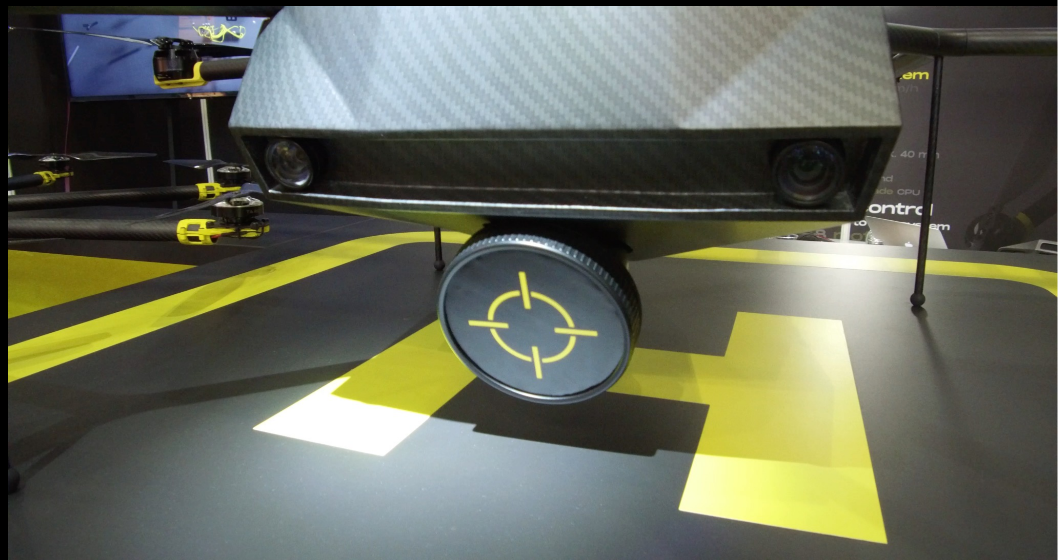


DOFEC: Discharging Of Fire Extinguishing Capsules

http://mrs.felk.cvut.cz/ *martin.saska@fel.cvut.cz*

Autonomous drone hunting flying robot to catch none- authorized UAVs

MARK II April 2019



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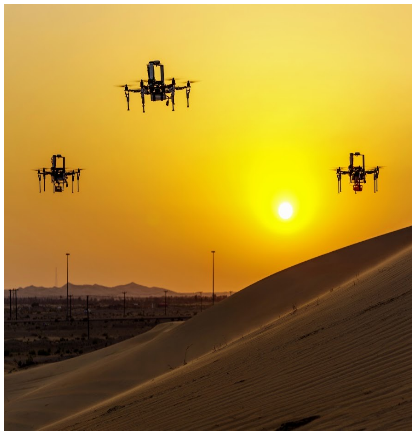
Publications

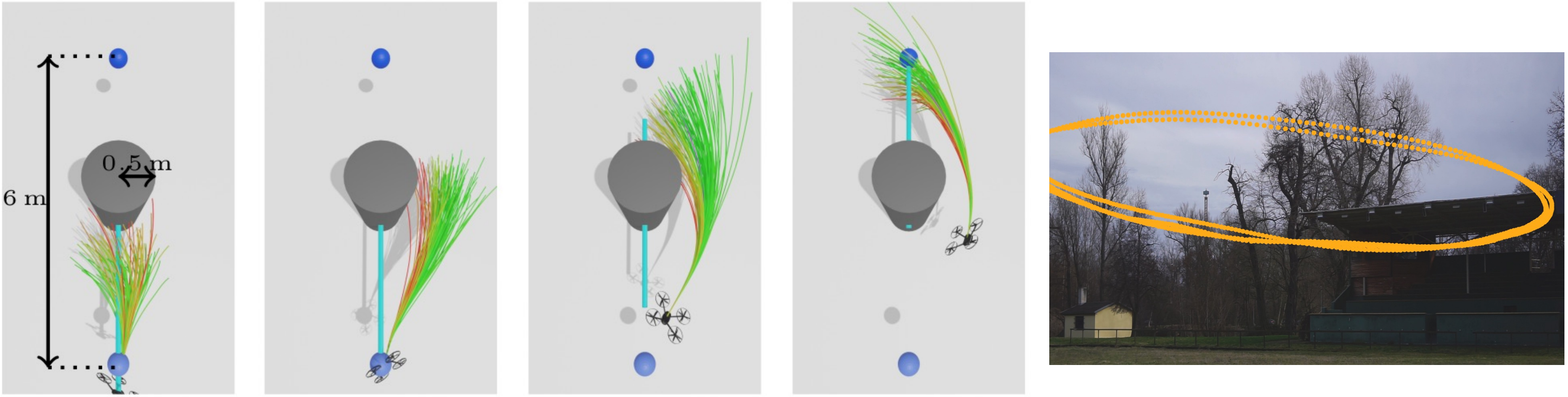
- *M Vrba and M Saska. Marker-Less Micro Aerial Vehicle Detection and Localization Using Convolutional Neural Networks. IEEE Robotics and Automation Letters 5(2):2459-2466, April 2020.*
- *M Vrba, D Heřt and M Saska. Onboard Marker-Less Detection and Localization of Non-Cooperating Drones for Their Safe Interception by an Autonomous Aerial System. IEEE Robotics and Automation Letters 4(4):3402-3409, October 2019.*
- *Matouš Vrba, Yurii Stasinchuk, Tomáš Báča, Vojtěch Spurný, Matěj Petrlík, Daniel Heřt, David Žaitlík and Martin Saska. Autonomous capture of agile flying objects using UAVs: The MBZIRC 2020 challenge. Robotics and Autonomous Systems 149:103970, March 2022.*
- *Yurii Stasinchuk, Matous Vrba, T Baca, Vojtech Spurny, M Petrlik, Daniel Hert, D Zaitlik and M Saska. A Multi-MAV System for the Autonomous Elimination of Multiple Targets in the MBZIRC 2020 Competition. Field Robotics 2:17988–1720, 2022.*
- *Martin Křížek, Matouš Vrba, Antonella Barišić Kulaš, Stjepan Bogdan and Martin Saska. Bio-inspired visual relative localization for large swarms of UAVs. In International Conference on Robotics and Automation (ICRA). 2024.*
- *Yurii Stasinchuk, Matous Vrba, Matej Petrlik, Tomas Baca, Vojtech Spurny, Daniel Hert, David Zaitlik, Tiago Nascimento and Martin Saska. A Multi-UAV System for Detection and Elimination of Multiple Targets. In 2021 IEEE International Conference on Robotics and Automation (ICRA). May 2021, 555–561.*

Further challenges of closely cooperating UAV-teams in the wild

- Agility – current swarms are slow
  - nonlinear control
  - fast perception (ego navigation & relative localization)
- Reliability of GNSS-denied localization
  - Degraded environment (no features)
  - Sensors depend on the environment (multi-modal perception required)
- Applications require also global localization
  - Long-range missions (huge maps)
- Scalability in real world (perception)
  - Scalable and secured mesh communication
- Heterogenous systems with different dynamics



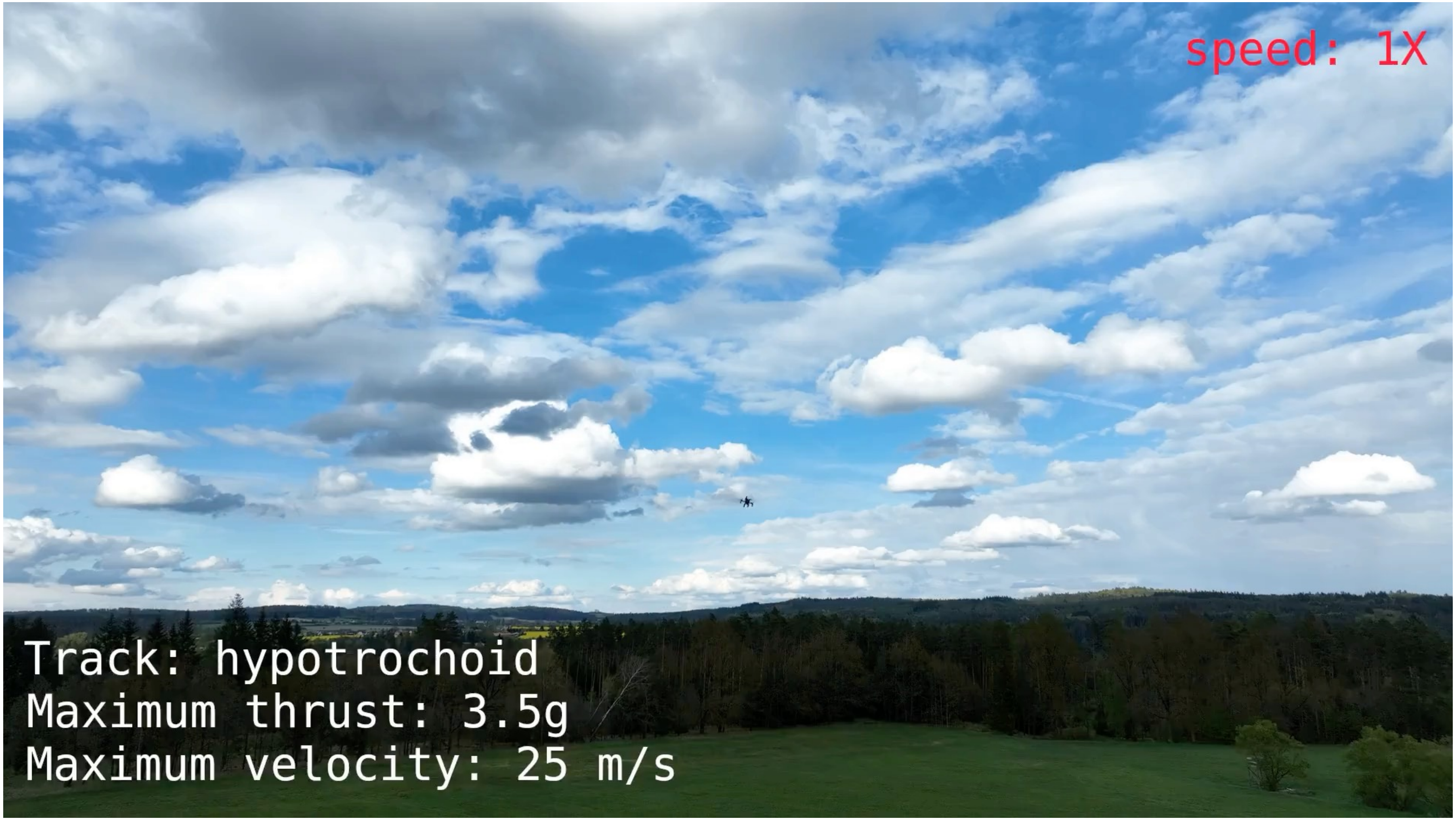
Model Predictive Path Integral Control for Agile UAVs



- Real-time control and dynamic obstacle avoidance for UAVs entirely onboard, leveraging parallelized GPU optimization
- Unlike NMPC, MPPI handles non-convex and non-differentiable cost functions, operates at higher frequencies (100 Hz vs. 10-20 Hz of SOTA MPPI planners), and effectively manages complex, non-convex obstacles.
- For unpredictable outdoor conditions, relying on onboard sensors and GPS for localization, complex tasks in dynamic, cluttered environments.

Michal Minařík, Robert Penicka, Vojtech Vonasek, Martin Saska. Model Predictive Path Integral Control for Agile Unmanned Aerial Vehicles. In IEEE IROS, 2024.

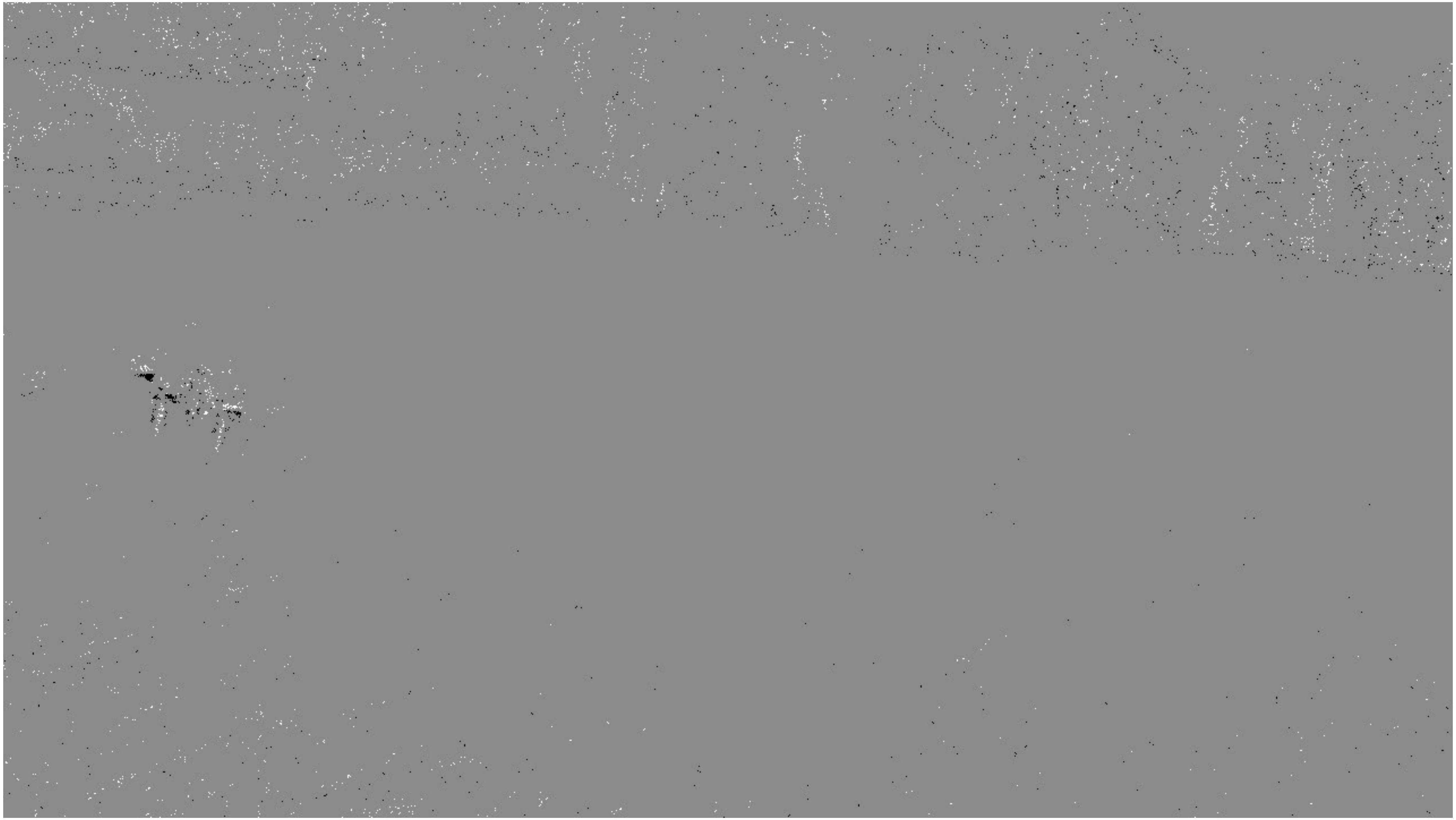
Model Predictive Path Integral Control for Agile UAVs



Michal Minařík, Robert Penicka, Vojtech Vonasek, Martin Saska. Model Predictive Path Integral Control for Agile Unmanned Aerial Vehicles. In IEEE IROS, 2024.

http://mrs.felk.cvut.cz/ martin.saska@fel.cvut.cz

Agile swarms: super fast onboard relative localization



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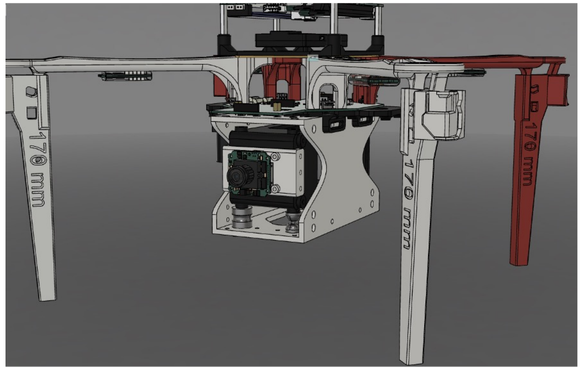
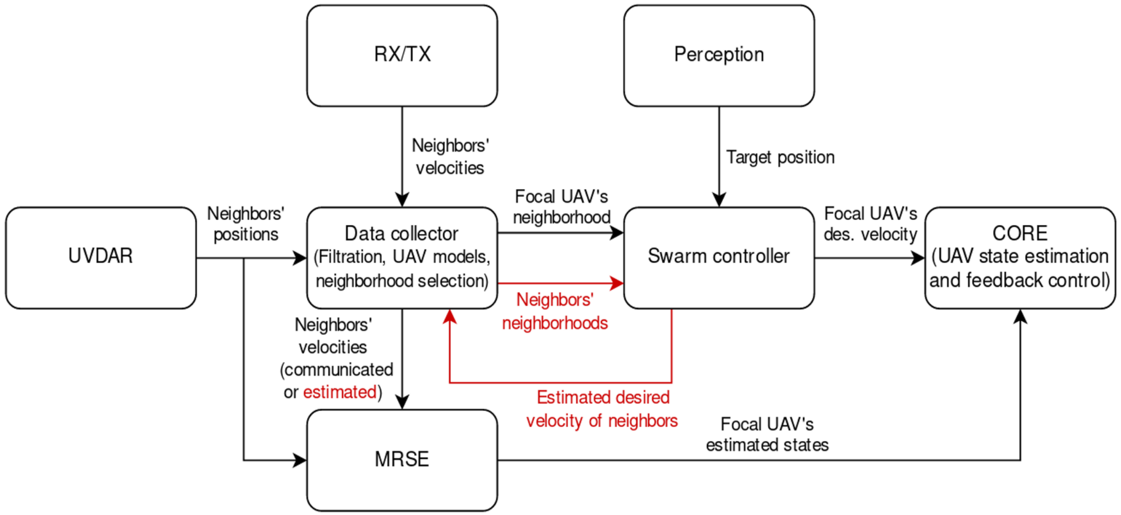
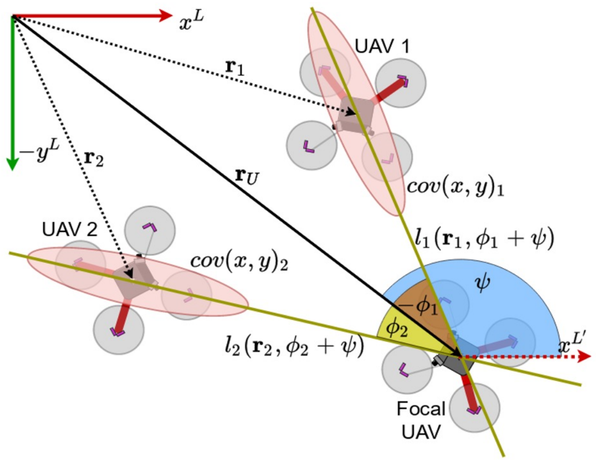
Increasing Reliability: Fast swarming in plain GNSS-denied environment

- Precise onboard only localization and neighbor perception
- VIO for self localization with improved dampening and IMU filtration
- Multi-robot state estimator (MRSE) in case of decrease of localization features
- Model of neighbors fusing UVDAR + velocities





Red parts shows the system used in the case of loss of communication.



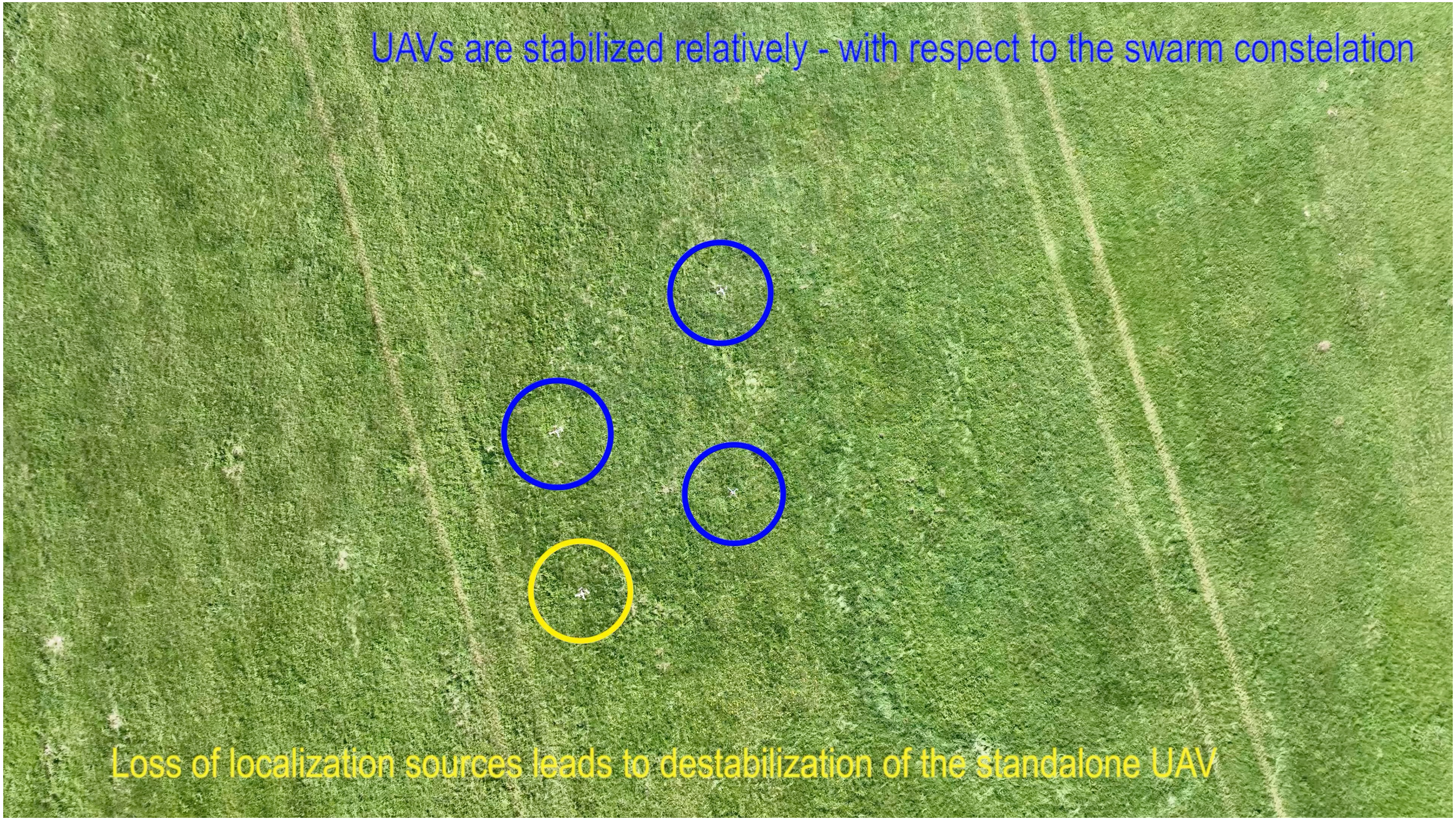
MRSE: UVDAR used for self-localization in the case of decrease of localization features of VIO

Jiri Horyna, Vit Kratky, Vaclav Pritzl, Tomas Baca, Eliseo Ferrante and Martin Saska. Fast Swarming of UAVs in GNSS-denied Feature-Poor Environments without Explicit Communication. IEEE RAL 9(6):5284-5291, April 2024.

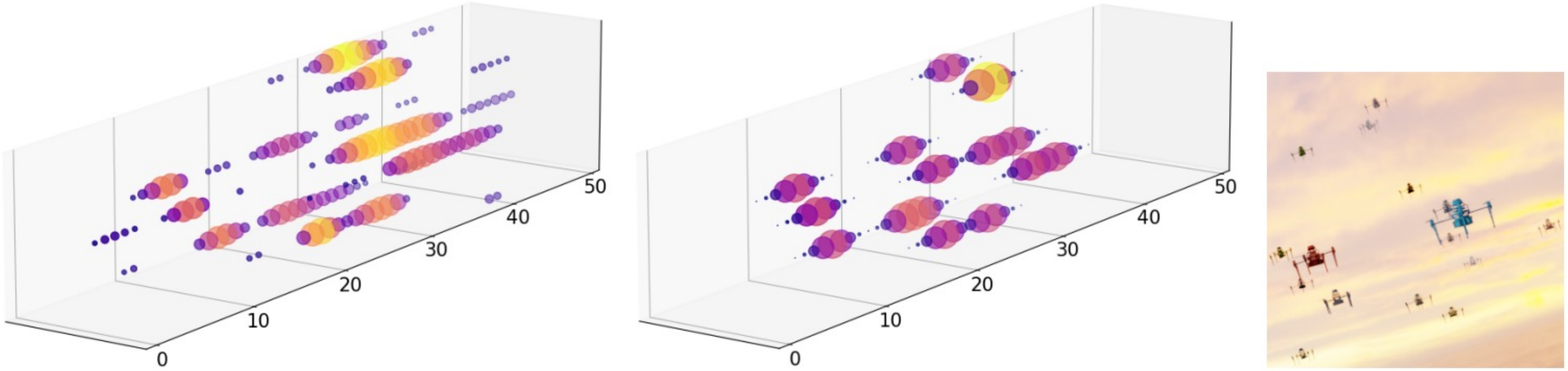
No GNSS. Some UAVs with no velocity measurements.

Jiri Horyna, Vit Kratky, Vaclav Pritzl, Tomas Baca, Eliseo Ferrante and Martin Saska. Fast Swarming of UAVs in GNSS-denied Feature-Poor Environments without Explicit Communication. IEEE RAL 9(6):5284-5291, April 2024.

No GNSS. ALL UAVs without velocity measurements.



Towards scalability in wild: relative localization of hundreds



(a) Prediction (b) Ground truth (c) Input

- Inspired by large flocks of birds
- Not relying on detecting of individual neighbors
- Regressing a neighbor density over distance

Martin Křížek, Matouš Vrba, Antonella Barišić Kulaš, Stjepan Bogdan and Martin Saska. Bio-inspired visual relative localization for large swarms of UAVs. In IEEE ICRA, 2024.

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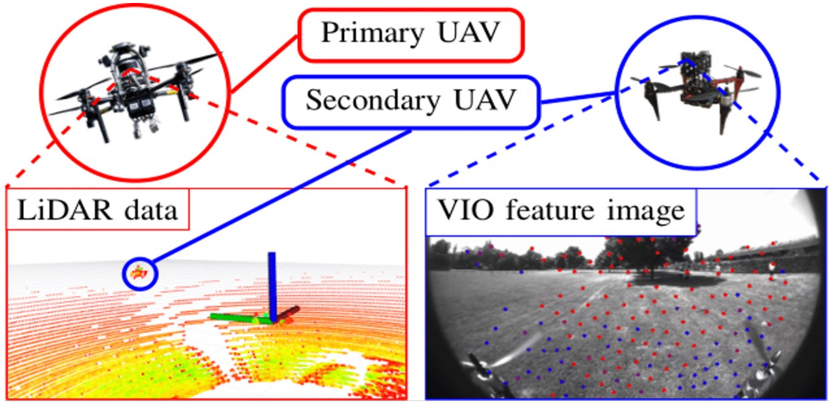
Cooperative navigation of a less-equipped UAV by an accompanying UAV

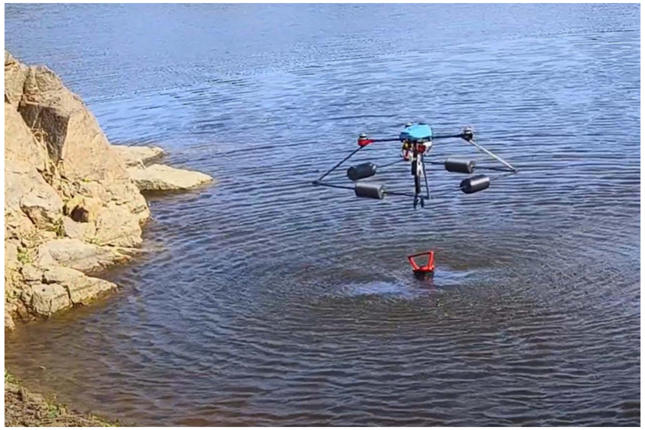
- Primary LiDAR-equipped UAV
- Secondary camera-equipped UAV
- Relative localization using fusion of LiDAR detections and VIO odometry data

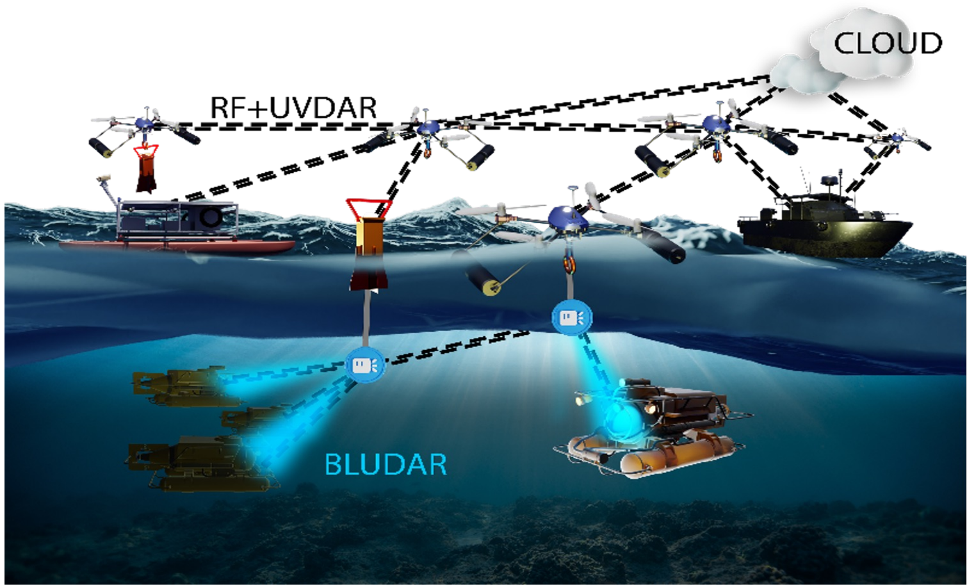


- *Vaclav Pritzl, Matous Vrba, Vit Kratky, Jiri Horyna, Petr Stepan, Martin Saska. Drones Guiding Drones: Cooperative Navigation of a Less-Equipped Micro Aerial Vehicle in Cluttered Environments. In IROS 2024.*
- *Václav Pritzl, Matouš Vrba, Claudio Tortorici, Reem Ashour and Martin Saska. Adaptive estimation of UAV altitude in complex indoor environments using degraded and time-delayed measurements with time-varying uncertainties. Robotics and Autonomous Systems 160:104315, 2023.*

Teams of Cooperating UAVs and autonomous boats (USVs)

Marine operations: cargo delivering to ships, autonomous monitoring and surveillance (on the surface and under water), inspection of ships, water surface monitoring and cleaning



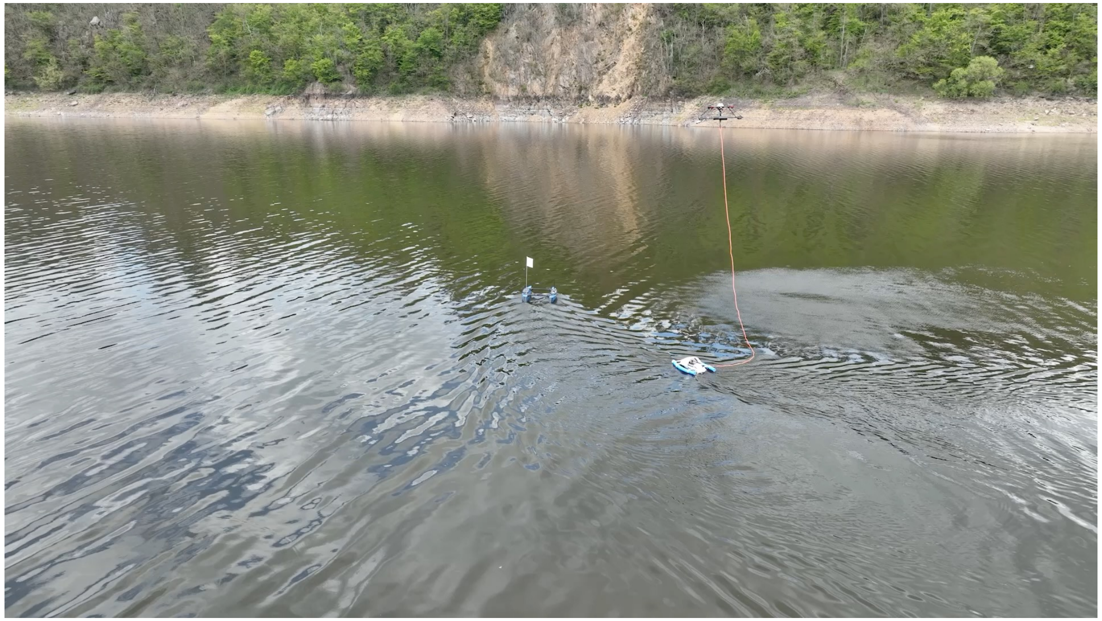


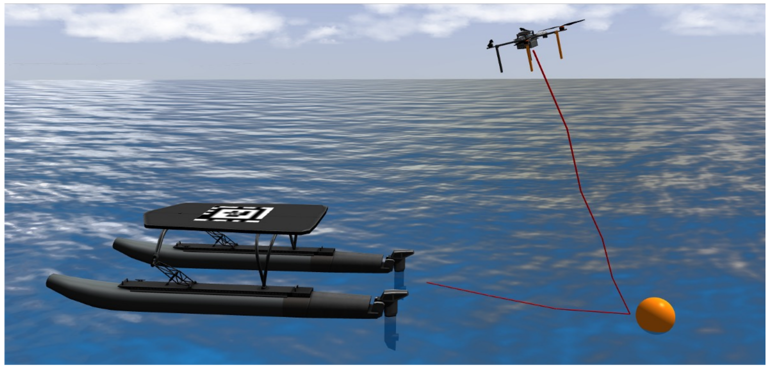
Coordination of robots with different dynamics

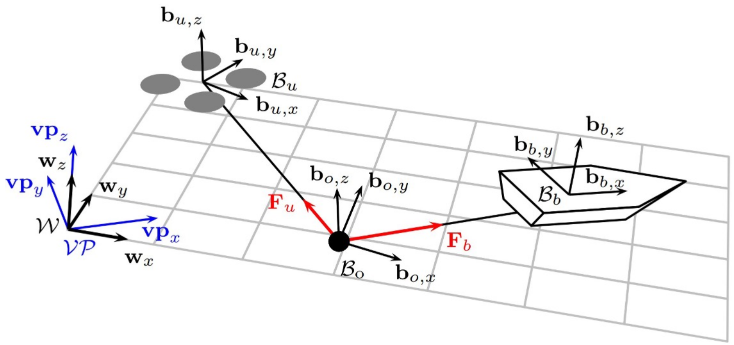
Parakh M Gupta, Èric Pairet, Tiago Nascimento and Martin Saska. Landing a UAV in Harsh Winds and Turbulent Open Waters. IEEE Robotics and Automation Letters 8(2):744-751, 2023.

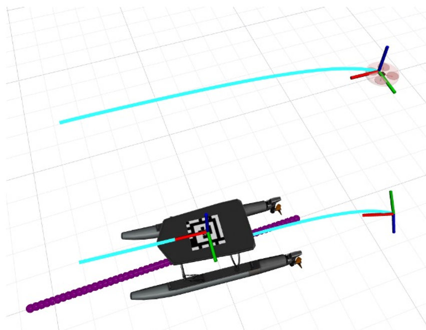
Collaborative Object Manipulation by a UAV-USV Team Using Tethers

- Novel 6DOF mathematical model of UAV-USV; UVDAR and AprilTag localiz.
- Optimal control using MPC









Filip Novák, Tomas Baca, Martin Saska. Collaborative Object Manipulation on the Water Surface by a UAV-USV Team Using Tethers. In IEEE IROS, 2024.

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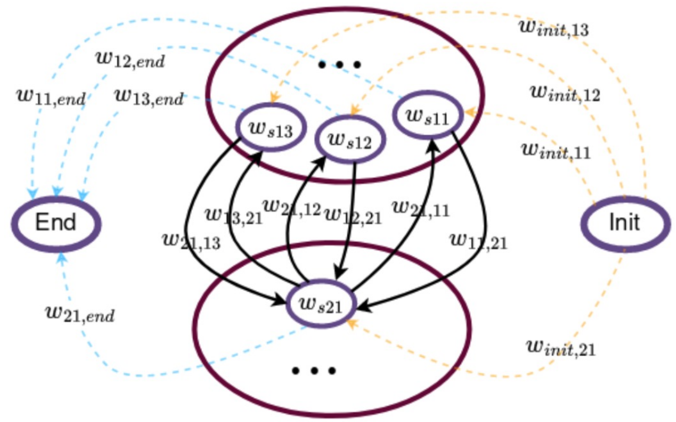
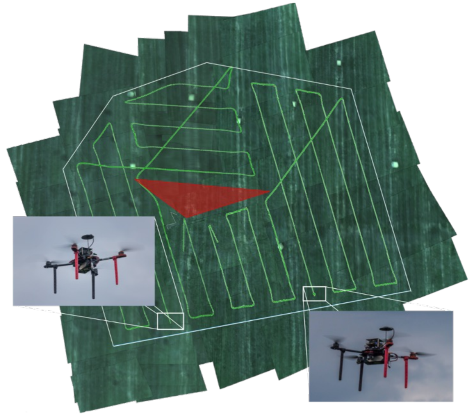
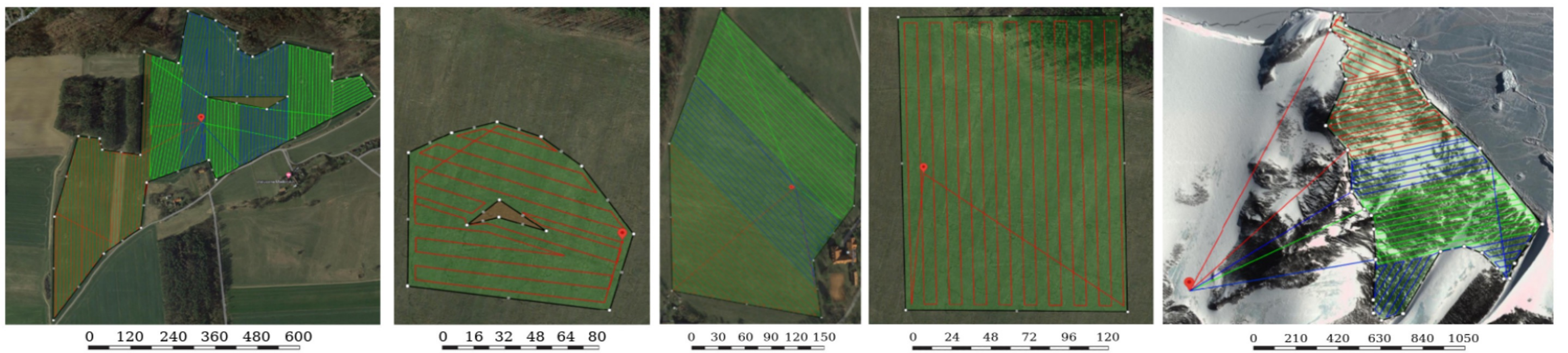
Energy-aware Multi-UAV Coverage Mission Planning with Optimal Speed of Flight



- Energy consumption used as an optimization objective.
- Efficient energy estimation from flight paths during planning
- Coverage Path Pplanning formulated as Multiple Set TSP (MS-TSP)

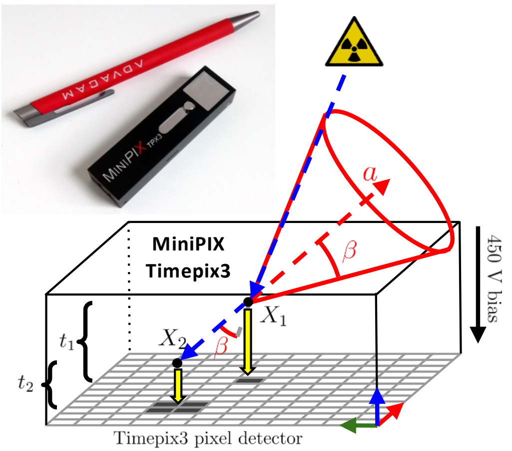


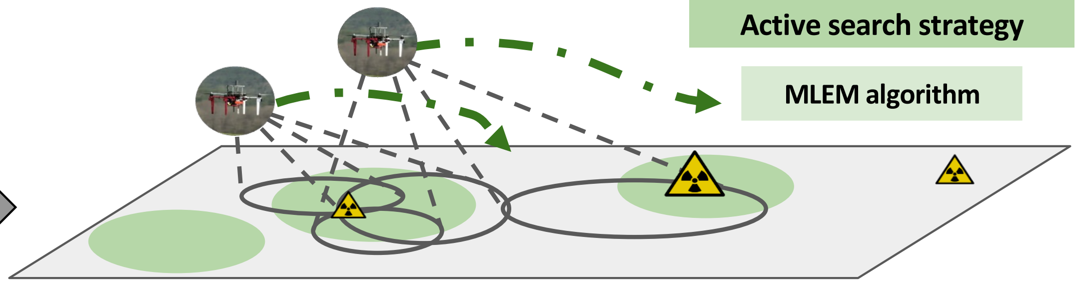


Denys Datsko, Frantisek Nekovar, Robert Penicka and Martin Saska IEEE RAL, 2024.

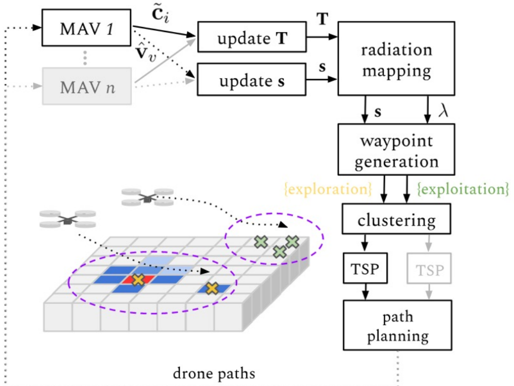
Autonomous localization of multiple ionizing radiation sources using miniature single-layer Compton cameras onboard a group of MAVs

Compton camera





Maximum likelihood expectation maximization (MLEM)

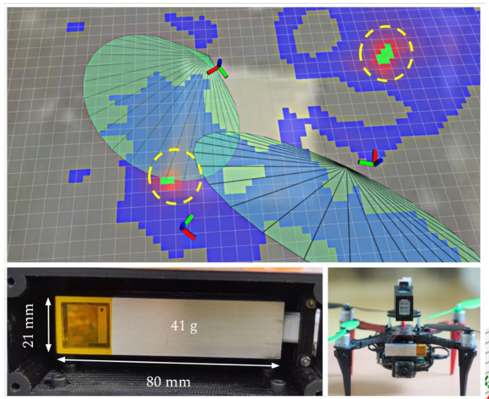


discretize the area of interest into *J* bins

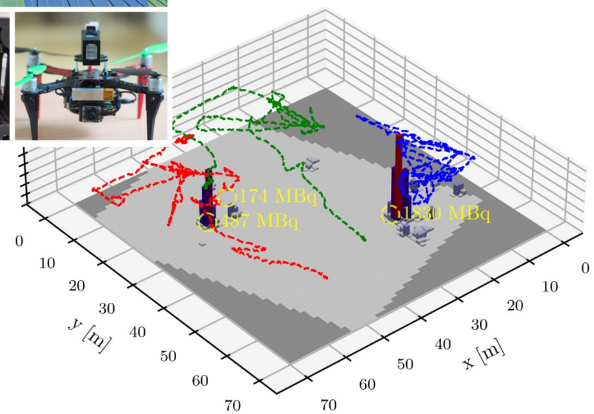
introduce λ - our hidden parameters

optimize using EM approach

$$\hat{\lambda}_j^{(l+1)} = \frac{\hat{\lambda}_j^{(l)}}{s_j} \sum_{i \in I} \frac{t_{ij}}{\sum_k t_{ik} \hat{\lambda}_k^{(l)}}$$



Real-world evaluation using 3 fully-autonomous aerial robots.



Michal Werner, Tomas Baca, Petr Stibinger, Daniela Doubravova, Jaroslav Solc, Jan Rusnak, and Martin Saska. Autonomous localization of multiple ionizing radiation sources using miniature single-layer Compton cameras onboard a group of micro aerial vehicles. IEEE IROS, 2024.

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DEVELOPMENT & PROTOTYPING

Radiation-detecting Drone

A unique miniature drone solution for protecting the population from the adverse effects of radiation

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A Miniature Drone for A Miniature Radiation Camera

Advanced algorithms and artificial intelligence techniques can analyze and process the data collected by the miniature drones. This speeds up decision-making processes and provides valuable insights into potential risks or areas requiring further investigation.

Fly4Future, in collaboration with our valued partner Advacam, co-developed the miniature drone designed to meet the research needs of the RaDron project. Advacam focused on the development of cameras and advanced imaging methods. The miniature drone **can detect and search for stationary and moving sources of ionizing radiation** (e.g., Cs-137, Co-60, Co-57, Eu-152).

The **unique miniature Compton camera sensor** MiniPIX Timepix3, developed by Advacam, facilitates radiation detection. The onboard software is the result of research by our partner, **the MRS group at CTU in Prague**. The drone system has been tested, with the support of the Czech Metrology Institute (CMI), during numerous civil defense exercises with the National Institute for Nuclear, Chemical, and Biological Protection (SUJCHBO) and the National Radiation Institute (NRI) in Řež.

Fly4Future in cooperation with Advacam, is currently working on the commercializing the results of the RaDron research project.

The miniature radiation-detecting drone features a unique, state-of-the-art sensor. It accurately detects radiation even on moving targets.

https://fly4future.com/development-and-prototyping/radiation-detecting-drone/

AERIAL-CORE: AERIAL COgnitive integrated multi-task Robotic system with Extended operation range and safety

H2020 ICT-10-2019-2020: Robotics Core Technology

- 9 universities - key UAV groups in Europe, 6 strong European end-users
- Complete inspection and maintenance of large linear infrastructures
- Long range (Several kilometres) inspection of the infrastructure
- Maintenance activities based on aerial manipulation
- Aerial co-working safely and efficiently helping human workers in inspection

Uzakov 2020 ICUAS, Silano 2021 RAL, Silano 2021 Automatica, Kratky 2021 RAL, Nekovar 2021 RAL

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CUSTOM DRONES

Drones for Inspection of Power Lines

A unique SW for flying close to the high voltage poles in power line inspection.

CONTACT US

A Unique SW for Drones Flying Close to the Power Lines from Fly4Future

When it comes to electricity transmission, ensuring the safety and reliability of the network is of utmost importance. One critical aspect of achieving this is through regular inspections of the transmission network elements. Regular inspections play a vital role in the timely detection of defects, helping to prevent potential failures and ensuring uninterrupted power supply.

Traditionally, power line inspection has been performed using helicopters when defects are identified by an onboard expert during flight or by using video recordings afterward. The use of **drones offers numerous advantages**. In terms of safety, it eliminates the need for physical human presence. Thanks to high-resolution cameras and sensors, drones can collect **detailed images and data**, promptly detecting potential issues such as damaged or faulty lines. This enables **more accurate and thorough inspections**.

Drones can fly close to the power line and send real-time data to the operator interface.

https://fly4future.com/custom-drones/drones-for-inspection-of-power-lines/

AEROSTREAM PROJECT

AeroSTREAM Open Science:
Open Remote Laboratory 2023 - 2025

About AeroSTREAM Open Science

AeroSTREAM Open Remote Laboratory is a part of AeroSTREAM's Open Science initiative. Open Science's objectives are to enhance open collaboration between universities and industrial partners in different countries, and to share knowledge, tools and data throughout and after the AeroSTREAM project lifetime, not only with academia, but also with industry, end-users, public authorities, citizens, and society as such.

AeroSTREAM Open Remote Laboratory

AeroSTREAM Open Remote Laboratory aims to provide an open remote laboratory for autonomous unmanned vehicles. Using existing equipment of AeroSTREAM partners, this Laboratory will allow everyone to remotely conduct experiments on real UAVs. A staff member in the open remote lab will prepare the UAV for flight and personally monitor the safety of the experiment being conducted. The data collected will be open for scientists and the general public.

AEROSTREAM

Registration

Before you submit your experiment, please, read our AeroSTREAM Experiment Preparation instructions.

You will also need your CV and your experiment description in pdf ready to upload.

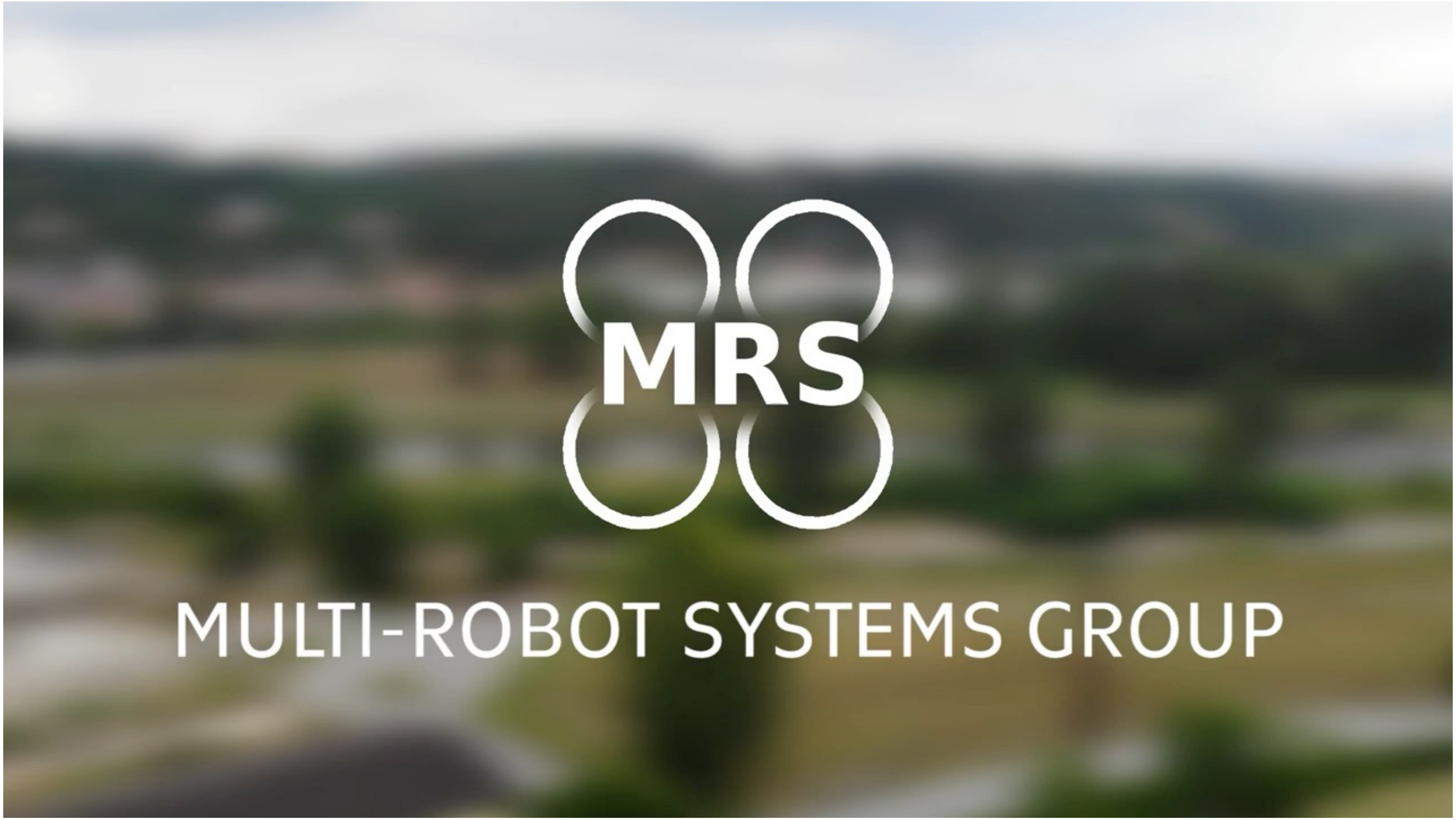
REGISTER HERE

Registration deadline is September 13, 2024

Funding

Funded by the European Union

This project received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101071270.



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Thank you for your attention

IEEE RAS SUMMER SCHOOL ON MULTI-ROBOT SYSTEMS 2025

https://mrs.fel.cvut.cz/summer-school-2025

JUL 30 - AUG 5, 2025 - Prague, Czech Republic

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