

I. Personal and study details

Student's name: **Werner Michal**

Personal ID number: **474638**

Faculty / Institute: **Faculty of Electrical Engineering**

Department / Institute: **Department of Computer Science**

Study program: **Open Informatics**

Specialisation: **Artificial Intelligence**

II. Master's thesis details

Master's thesis title in English:

Sensor Fusion of Source of Ionizing Radiation onboard a Group of Unmanned Drones

Master's thesis title in Czech:

Sensorická Fúze Zdroj Ionizující Radiace Skupinou Bezpilotních Dron

Guidelines:

The thesis aims to research, design, and implement an algorithm and software method for collaborative sensor fusion of measured ionizing radiation data from a group of unmanned aerial vehicle (UAV) drones. The drones are equipped with a miniature single-detector Compton camera radiation sensor that offers a specific way of sensing a direction towards a source of high-energy gamma radiation. Drones within the group can share the measured data and can collaborate on estimating the position of the radiation source. Moreover, drones can coordinate their behavior to optimize search time. This thesis participates in an industrial project that aims to tackle some of the fundamental and practical questions of homeland security and radiation mapping. The thesis will solve the following points:

1. Get familiar with the MRS UAV system [1] (control, simulation, and experimental validation with UAVs) and the principles of the Compton camera [2] detector.
2. Design and implement a method for the localization of multiple sources of ionizing radiation using the Compton camera data. Utilize data provided by the advisor that were recorded during the experiments with real-world radiation sources [3].
3. Design and implement a search strategy for a small group of UAVs (up to 4) using the data from the sensor fusion software from the previous point.
4. Demonstrate and evaluate the designed estimation method and the search strategy on recorded real-world data and in realistic robotic simulation (Gazebo/ROS [1]).

Bibliography / sources:

- [1] 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. *Journal of Intelligent & Robotic Systems* 102(26):1–28, May 2021.
- [2] T Baca, P Stibinger, D Doubravova, D Turecek, J Solc, J Rusnak, M Saska and J Jakubek. Gamma Radiation Source Localization for Micro Aerial Vehicles with a Miniature Single-Detector Compton Event Camera. In *2021 International Conference on Unmanned Aircraft Systems (ICUAS)*. June 2021, 338–346.
- [3] S.J. Wilderman, N.H. Clinthorne, J.A. Fessler, and W.L. Rogers. List-mode maximum likelihood reconstruction of Compton scatter camera images in nuclear medicine. In *IEEE Nuclear Science Symposium*, pages 1716–1720, November 1998.

Name and workplace of master's thesis supervisor:

Ing. Tomáš Bá a, Ph.D. Multi-robot Systems FEE

Name and workplace of second master's thesis supervisor or consultant:

Date of master's thesis assignment: **01.02.2023**

Deadline for master's thesis submission: **26.05.2023**

Assignment valid until: **22.09.2024**

Ing. Tomáš Bá a, Ph.D.
Supervisor's signature

Head of department's signature

prof. Mgr. Petr Páta, Ph.D.
Dean's signature

III. Assignment receipt

The student acknowledges that the master's thesis is an individual work. The student must produce his thesis without the assistance of others, with the exception of provided consultations. Within the master's thesis, the author must state the names of consultants and include a list of references.

Date of assignment receipt

Student's signature