BACHELOR‘S THESIS ASSIGNMENT

I. Personal and study details

Student's name: **Pelc Jakub** Personal ID number: **516090**

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

Department / Institute: **Department of Cybernetics**

Study program: **Open Informatics**

Specialisation: **Artificial Intelligence and Computer Science**

II. Bachelor’s thesis details

Bachelor’s thesis title in English:

Relative Pose Estimation Using Event-Based Measurements of LED Signals

Bachelor’s thesis title in Czech:

Odhad relativní polohy pomocí signálů LED měřených event kamerou

Guidelines:

With their high dynamic range and temporal resolution, modern event-based cameras enable accurate measurements of attributes of modulated LED signals. The goal is to design, implement, and test a relative pose estimation method for UAV swarms that utilizes the response characteristics of these cameras to the LED signals.
1. Research the working principles of event-based cameras. Research the existing Visible Light Positioning (VLP) methods such as Received Signal Strength Ratio (RSSR).
2. Analyze the response of a static event-based camera to UV LEDs used by the UVDAR localization system in UAV swarms. Modulate the signals with varying frequency, relative distance, and angle.
3. Design an approach for relative pose estimation of UAV swarm members, utilizing the analysis results and a proper fisheye lens calibration method.
4. Implement the proposed solution for a Robot Operating System (ROS). Test the implementation on the data used for the response analysis and discuss the results.
5. Conduct a real-world UAV swarming experiment. Compare the estimation results with a GNSS ground truth.

Bibliography / sources:

[1] Gallego, Guillermo, Tobi Delbruck, Garrick Orchard, Chiara Bartolozzi, Brian Taba, Andrea Censi, Stefan Leutenegger, et al. 2022. “Event-Based Vision: A Survey.” IEEE Transactions on Pattern Analysis and Machine Intelligence. Institute of Electrical and Electronics Engineers (IEEE). https://doi.org/10.1109/tpami.2020.3008413.
[2] Scaramuzza, D., A. Martinelli, and R. Siegwart. 2006. “A Flexible Technique for Accurate Omnidirectional Camera Calibration and Structure from Motion.” Fourth IEEE International Conference on Computer Vision Systems (ICVS’06). IEEE. https://doi.org/10.1109/icvs.2006.3.
[3] Jung, Soo-Yong, Seong Ro Lee, and Chang-Soo Park. 2014. “Indoor Location Awareness Based on Received Signal Strength Ratio and Time Division Multiplexing Using Light-Emitting Diode Light.” Optical Engineering. SPIE-Intl Soc Optical Eng. https://doi.org/10.1117/1.oe.53.1.016106.
[4] Walter, Viktor, Martin Saska, and Antonio Franchi. 2018. “Fast Mutual Relative Localization of UAVs Using Ultraviolet LED Markers.” 2018 International Conference on Unmanned Aircraft Systems (ICUAS). IEEE. https://doi.org/10.1109/icuas.2018.8453331.

Name and workplace of bachelor's thesis supervisor:

Ing. Vojtěch Vrba Multi-robot Systems FEE

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

RNDr. Petr Štěpán, Ph.D. Multi-robot Systems FEE

Date of bachelor's thesis assignment: **22.01.2025** Deadline for bachelor thesis submission: _____

Assignment valid until: **20.09.2026**

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prof. Dr. Ing. Jan Kybic
Head of department's signature

prof. Mgr. Petr Páta, Ph.D.
Vice-dean´s signature on behalf of the Dean

III. Assignment receipt

The student acknowledges that the bachelor'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 bachelor's thesis, the author must state the names of consultants and include a list of references.

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Date of assignment receipt Student's signature