Ulysseus Research Group thematic focus

Research topic: Autonomous mobility of connected autonomous vehicles (CAVs) in the cities of the future

Vision holder – TUKE IH: Prof. Juraj Gazda, TUKE

Main area of research: Recent advancements in artificial intelligence (AI) and computer vision are progressing the automotive industry, particularly in the development of connected autonomous vehicles (CAVs). The integration of AI with computer vision enables these vehicles to interpret and understand the environment around them, making real-time decisions that are critical for safety and efficient navigation. However, the high computational demands of processing these data-intensive tasks are pushing the boundaries of traditional on-board computing systems. This challenge has led to the exploration of edge computing as a viable solution. Edge computing allows data processing to occur closer to the data source, i.e., directly within the vehicles or at nearby edge servers, reducing latency and the need for bandwidth to send data to distant cloud servers. Research in this area focuses on optimizing data flow between vehicles and edge computing nodes to enhance the responsiveness and reliability of autonomous systems. This includes developing algorithms for quicker image and sensor data processing, improving machine learning models for better prediction accuracy, and ensuring seamless communication standards that support the massive data transfer required for a network of CAVs. This synergy between AI, computer vision, edge computing, and CAV technologies is paving the way for a future where autonomous vehicles are both commonplace and safe, contributing significantly to smart city ecosystems and modern transport networks.

Specific research problems & objectives:

- Develop edge computing solutions that minimize latency for real-time data processing essential for autonomous vehicle operations
- Optimize the network architecture to enhance data transfer speeds and efficiency between CAVs and edge computing nodes
- Create advanced algorithms that enable more accurate and quicker decision-making by processing complex visual and sensor data through AI
- Enhance computer vision techniques to improve the reliability and accuracy of environmental perception under various operational conditions
- Design scalable edge computing frameworks that can support an increasing number of CAVs without degradation in performance
- Address security and privacy concerns related to the extensive data sharing and processing required in CAV networks
- Develop energy-efficient computing solutions to extend the operational range and efficiency of autonomous vehicles
- Innovate AI-driven solutions that enable CAVs to adapt dynamically to changing traffic conditions and unforeseen road events

Expertise requested:

- Expertise in developing and optimizing algorithms for real-time image and video analysis
- Skills in designing, training, and deploying machine learning models, particularly deep learning, for predictive analytics and decision-making processes

- Knowledge of automotive systems, vehicle dynamics, and safety requirements essential for developing autonomous vehicle
- Proficiency in advanced network architectures, including 5G/6G, vehicular ad hoc networks (VANETs), and IoT communications for efficient data transfer

In the case of interest, we would like to arrange some meeting with more detailed presentation and discussion how to create domain specific research groups and how to manage cooperation and high impact R&I results.

5 most relevant publications of the TUKE team with regard to the Ulysseus activity:

[1] Maksymyuk, T., Gazda, J., M., & Dohler, M. (2020). Blockchain-empowered framework for decentralized network management in 6G. *IEEE Communications Magazine*, *58*(9), 86-92.

[2] Maksymyuk, T., Gazda, J., Bugár, G., Gazda, & Dohler, M. (2022). Blockchain-empowered service management for the decentralized metaverse of things. *IEEE Access*, *10*, 99025-99037.

[3] Vološin, M., Šlapak, E., Becvar, Z., Maksymyuk, T., Petík, A., Liyanage, M., & Gazda, J. (2023). Blockchain-based route selection with allocation of radio and computing resources for connected autonomous vehicles. *IEEE Transactions on Intelligent Transportation Systems*.

[4] Šlapak, E., Petík, A., Vološin, M., Dopiriak, M., Gazda, J., & Becvar, Z. (2023, December). Graph Neural Network Empowered Resource Allocation for Connected Autonomous Mobility. In *2023 Seventh IEEE International Conference on Robotic Computing (IRC), Los Angeles, USA,* (pp. 260-264). IEEE.

[5] Šlapak, E., Dopiriak, M., Faruque, M. A. A., Gazda, J., & Levorato, M. (2024). Distributed Radiance Fields for Edge Video Compression and Metaverse Integration in Autonomous Driving. *arXiv preprint arXiv:2402.14642*, *accepted in IEEE SmartComp 2024, Osaka, Japan*

Contact:

Prof. Juraj Gazda
Faculty of Electrical Engineering and Informatics, TUKE
Juraj.gazda@tuke.sk