

# Deliverable

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## D2.6: Summary Articles (Partial M18)

WP2 Communication & Dissemination

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Responsible partner: CVTI SR

Partners:

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Confidentiality: Consortium



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| Revision history |           |                                                                                                                       |                |
|------------------|-----------|-----------------------------------------------------------------------------------------------------------------------|----------------|
| Version          | Date      | Comment                                                                                                               | Author         |
| V1               | 30.1.2026 | First draft                                                                                                           | David Cymbalak |
| V2               | 25.9.2026 | M18 update: 41 new publications, chapter 5 restructured by research theme, all chapters updated to reflect new papers | David Cymbalak |
|                  |           |                                                                                                                       |                |
|                  |           |                                                                                                                       |                |

# 1 Executive summary

**Context and main purpose:** This document constitutes the second partial delivery of Deliverable D2.6 "Summary Articles" for the M18 cycle of the InnovAlte Slovakia project. It extends the M10 version with all publications published since then. The main purpose of this deliverable is to present curated, plain-language summary articles that synthesize partial publications and research results from Work Package leaders into comprehensive features for relevant media and the project website.

## Subject matter and key findings:

During the M1-M18 reporting period, the InnovAlte Slovakia consortium has produced **49 publications** related to the project – the 8 publications reported in M10 and **41 new publications** – of which **26 are indexed in WoS/Scopus** and 23 are published in other databases. The publications span a wide range of international venues, including CVPR 2025, ICCV 2025, EMNLP 2025, LREC 2026, VISAPP 2026, ICAART 2026, the IEEE conferences SAMI, ACDSA, INES and ICECET 2026, ICETA 2025, INGEO 2025 (Springer), ENVIRO 2026 and the ISPRS 3D-ARCH 2026 workshop, and journals such as the International Journal of Computer Vision, Journal of Real-Time Image Processing, Results in Engineering, Acta Polytechnica Hungarica, Journal of Applied Mathematics, Statistics and Informatics, Entrepreneurship and Sustainability Issues, Administratie si Management Public and Social and Economic Revue. A further 17 peer-reviewed papers were published in the Proceedings of the 2nd InnovAlte Conference "AI Synergy" (Žilina, April 2026). The summary articles are newly organized into 11 research themes covering computer vision, traffic and public safety, synthetic data, healthcare, smart buildings, software engineering, language technologies, insurance and AI governance.

**Conclusions:** The M18 cycle of the deliverable confirms that the project has already exceeded its objective of a minimum of 34 peer-reviewed publications: 49 publications have been published, corresponding to **18.38 WoS/Scopus publications** (target 16) and **20.5 publications** in other databases (target 18) when recalculated by the percentage of project assignment stated in the acknowledgements (see Chapter 6 for notes on the calculation). The research outputs contribute directly to WP3 (Cross-Domain AI), WP4 (AI-Driven Buildings), WP5 (AI-Video Driven Building and Road Safety), WP6 (Automating Software Development with AI) and WP7 (AI-Driven Insurance Operations).

**Plan and next steps:** Summary articles based on these publications will be published on the project website ([www.innovaite.sk](http://www.innovaite.sk)) and disseminated through e-newsletters. The next reporting cycle, a partial deliverable (M26), will continue the editorial synthesis of new publications across all work packages, followed by the final version at M30.

**Significance and continuity:** This deliverable contributes to Specific Objective 1 (Research Excellence and Innovation and Specific Objective 9 (International Collaboration). It demonstrates the consortium's commitment to open science and public communication of research results.

## 2 Introduction

**Context:** This deliverable was created within the InnovAlte Slovakia project (Project No. 09I02-03-V01-00029), specifically under Work Package 2 – Communication and Dissemination and Task T2.4. It represents the second partial delivery of D2.6 Summary Articles for the M18 cycle and extends the first partial delivery (M10).

### Identification of actors:

| Participating Project Partners                              |         | Role      | Involved key experts                        | 1 <sup>st</sup> stage Reviewer | 2 <sup>nd</sup> stage reviewer / SB rapporteur |
|-------------------------------------------------------------|---------|-----------|---------------------------------------------|--------------------------------|------------------------------------------------|
| Gratex International, a.s.                                  | GTI     | Partner   |                                             |                                | Ivan Polášek                                   |
| Asseco central Europe, a.s.                                 | ACE     | Partner   | Petra Bobíková                              |                                |                                                |
| Vysoká škola báňská - Technická univerzita Ostrava          | IT4@VSB | Partner   |                                             | Tomáš Karásek                  |                                                |
| Univerzita Komenského v Bratislave                          | UK BA   | Partner   | Viktor Kocur, Marek Šuppa, Zuzana Černeková |                                |                                                |
| Centrum vedecko-technických informácií Slovenskej republiky | CVTI    | Lead - DL | David Cymbalak                              |                                |                                                |
| Slovenská technická univerzita v Bratislave                 | STU BA  | Partner   | Tomáš Funtík                                |                                |                                                |
| Trenčianska univerzita Alexandra Dubčeka v Trenčíne         | TnUAD   | Partner   | Karol Krajčo                                |                                |                                                |
| Deutsches Forschungszentrum für Künstliche Intelligenz      | DFKI    | Partner   | André Antakli                               |                                |                                                |

*Pozn. DL – Deliverable Leader, TL – Team Leader, TM – Team Member, E – External Expert.*

*Feel free to delete unnecessary lines, including this instruction.*

### **Main objective of the deliverable:**

To aggregate, synthesize, and publish comprehensive summary articles from partial research publications prepared by work package leaders, making scientific findings accessible to broader audiences including media, stakeholders, and the general public.

### **Specific objectives:**

- Collect and compile all peer-reviewed publications from the M1-M18 period
- Create plain-language summaries suitable for non-specialist audiences
- Group the summaries by research theme and cross-check publication metadata (authors, venue, pages, DOI) against publisher records
- Provide evidence of publication with links and documentation
- Publish on project website and relevant media channels

### **Significance and use:**

This deliverable serves as the primary mechanism for communicating research achievements to external stakeholders. The summary articles will be used for:

- Project website content
- Newsletter material (D2.4)
- Media outreach and press materials
- Stakeholder engagement
- Progress reporting to funding bodies
- Promoting FAIR within the project

### 3 Project Context, Objectives of WP2

#### Context of the entire project:

The InnovAlte Slovakia project aims to build a dynamic and sustainable innovation ecosystem in artificial intelligence, linking cutting-edge research with practical applications. The project emphasizes AI solutions that are technologically advanced, ethical, environmentally sustainable, and socially beneficial.

#### Relevant Specific Objectives

|   | Specific Objective                 | SO Description and Verification                                                                                                                                                                                                                                                                                                                                            |
|---|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Research Excellence and Innovation | Objective: To conduct cutting-edge research in AI across various WPs, resulting in a minimum of 34 peer-reviewed publications in reputable journals and conferences within the project duration.<br>Verification: Research outputs will undergo rigorous peer review. The number of publications and their impact factors will serve as indicators of research excellence. |
| 9 | International Collaboration        | Objective: To engage in a minimum of 3 collaborative international projects and co-publish at least 10 research papers with international partners within the project duration.<br>Verification: Documentation of collaborative projects and publications will demonstrate international engagement.                                                                       |

#### Contribution to the achievement of a specific objective 1:

49 publications published by M18 (41 of them new in the M18 cycle), of which 26 are indexed in WoS/Scopus. Recalculated by the percentage of project assignment, this corresponds to **18.38** WoS/Scopus publications and **20.5** publications in other databases, i.e. **38.88** in total – the target of a minimum of 34 peer-reviewed publications has already been exceeded.

#### Contribution to the achievement of a specific objective 9:

10 of 49 publications involve authors from institutions outside Slovakia (Table 1), including two publications written solely by authors from foreign consortium partners (DFKI, VSB-TUO/IT4Innovations). The foreign institutions are located in the Czech Republic (CTU Prague, VSB-TUO/IT4Innovations), Germany (DFKI), Switzerland (ETH Zurich), Hungary (HUN-REN SZTAKI), China (Nankai University) and Vietnam (Asseco Central Europe, Hanoi), complemented by the international Universal NER consortium. With 10 publications, the Specific Objective 9 target of co-publishing at least 10 research papers with international partners has already been reached.

Table 1: Publications with authors from institutions outside Slovakia (Specific Objective 9)

| No. | Publication (venue)                                                                                                            | Foreign institution(s) (country)                                                           |
|-----|--------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| 1   | RePoseD – Efficient Relative Pose Estimation With Known Depth Information (ICCV 2025)                                          | Czech Technical University in Prague (CZ); Nankai University (CN)                          |
| 2   | Practical Solutions to the Relative Pose of Three Calibrated Cameras (CVPR 2025)                                               | Czech Technical University in Prague (CZ); ETH Zurich (CH); HUN-REN SZTAKI (HU)            |
| 3   | Are Minimal Radial Distortion Solvers Really Necessary for Relative Pose Estimation? (IJCV 2025)                               | Czech Technical University in Prague (CZ)                                                  |
| 8   | CARJAN: Agent-Based Generation and Simulation of Traffic Scenarios with AJAN (ICAART 2026)                                     | DFKI, Saarbrücken (DE) – all authors                                                       |
| 9   | Procedural Generation of Synthetic Road Scenes for Training Anomaly Detection Models (2nd InnovAte Conf.)                      | IT4Innovations, VSB – Technical University of Ostrava (CZ)                                 |
| 15  | Synthetic-to-Real Deep Learning for Identity Card Segmentation and Line-Based Geometric Rectification (Results in Engineering) | IT4Innovations / VSB – Technical University of Ostrava (CZ) – all authors                  |
| 33  | LLM Agents in Software Development: A Systematic Mapping Study (IEEE INES 2026)                                                | ACE, Hanoi (VN)                                                                            |
| 34  | Cindy: A Toolkit for Automated Architecture Recovery in Large Software Repositories (IEEE ICECET 2026)                         | DFKI, Saarland Informatics Campus, Saarbrücken (DE)                                        |
| 42  | Universal NER v2: Towards a Massively Multilingual NER Benchmark (LREC 2026)                                                   | International Universal NER consortium (co-authors from institutions in several countries) |
| 45  | Public Property Insurance Systems in EU Countries and Possibilities for Using AI in Insurance (AMP)                            | DFKI, Saarbrücken (DE)                                                                     |

## Relevant Work Package /s

|     | Work Package                             | WP Lead Partner | Task                  | Task Lead Partner | Task Leader |
|-----|------------------------------------------|-----------------|-----------------------|-------------------|-------------|
| WP2 | Communication and Dissemination          | GRATEX          | T2.4 Media appearance | CVTI              |             |
| WP3 | Cross-Domain AI                          | DFKI.DE         |                       |                   |             |
| WP4 | AI-Driven Buildings                      | IT4I@VSB        |                       |                   |             |
| WP5 | AI-Video Driven Building and Road Safety | IT4I@VSB        |                       |                   |             |
| WP6 | Automating Software Development with AI  | GRATEX          |                       |                   |             |
| WP7 | AI-Driven Insurance                      | Asseco          |                       |                   |             |

### Linking the deliverable to the project:

D2.6 Summary Articles directly fulfills the project's commitment to media appearance and scientific dissemination as defined in Task T2.4. By synthesizing complex technical publications into accessible formats, this deliverable bridges the gap between cutting-edge research and public understanding, supporting the project's broader impact objectives.

### Links to other deliverables:

D2.2 (Project Website): Summary articles are published on the project website

D2.3 (Expert Conferences): Publications support conference presentations

D2.4 (E-newsletters): Summary articles provide content for newsletters

D2.5 (Press Releases): Research highlights inform press communications

D2.8 (Promotional Materials): Publications support promotional content

## 4 Updated scope definition and methodology

### Definition of the baseline:

Scientific publications from research projects often remain inaccessible to broader audiences due to technical language, paywalls, and specialized formatting. The challenge is to translate complex AI research findings into compelling narratives that maintain scientific accuracy while being accessible to non-specialists.

### Identification of the solution:

D2.6 addresses this challenge by:

- Collecting all peer-reviewed and published publications from consortium partners
- Creating structured summaries with consistent formatting
- Highlighting practical applications and societal impact
- Providing direct links to full publications where available

### Defining the solution methodology and overall approach:

- Gather publication metadata from all WP
- Verify publication status and access details
- Collect abstracts, full published papers and key findings
- Create plain-language summaries
- Upload to project website
- Distribute through newsletter channels
- Archive in deliverable documentation

**M18 update:** For the M18 cycle, the list of published papers was taken from internal publication register (InnovAlte Articles table). All entries were cross-checked against publisher landing pages (DOI records, conference proceedings). Only final published versions are linked – preprints (e.g. arXiv) are not used as publication evidence.

## 5 Deliverable content

By the end of the M18 reporting cycle (M1-M18), the InnovAte Slovakia consortium has produced 49 publications related to the project: 26 indexed in WoS/Scopus, 23 in other databases.

### Overview of publication output (M1–M18)

The tables and figures below summarise the 49 publications by indexing category and by work package. Two counts are given for each group: the **number of publications** (absolute count) and the **acknowledgement-weighted count**, in which every publication contributes the percentage of project assignment stated in its acknowledgement (e.g. a paper with 50 % project assignment counts as 0.5). 32 of the 49 publications are fully (100 %) assigned to the project. Publications are allocated to the primary work package recorded in the internal publication register; several publications additionally contribute to secondary work packages as listed in their "Related Work Package" line.

Table 2: Publications by indexing category (M1–M18) and fulfilment of the project targets

| Indexing category                | Number    | Share        | Weighted *   | Share (weighted) | Target *  | Fulfilment * |
|----------------------------------|-----------|--------------|--------------|------------------|-----------|--------------|
| WoS/Scopus                       | 26        | 53.1 %       | 18.38        | 47.3 %           | 16        | 115 %        |
| Other databases (non-WoS/Scopus) | 23        | 46.9 %       | 20.5         | 52.7 %           | 18        | 114 %        |
| <b>Total</b>                     | <b>49</b> | <b>100 %</b> | <b>38.88</b> | <b>100 %</b>     | <b>34</b> | <b>114 %</b> |

\* Weighted = sum of the percentages of project assignment stated in the acknowledgements; Target = minimum number of publications by the end of the project (Specific Objective 1); Fulfilment = weighted count divided by the target.

Table 3: Publications by work package (primary WP) – absolute counts and counts weighted by the percentage of project assignment in acknowledgement

| Work package                                   | WoS no.   | WoS wtd.     | Other no. | Other wtd.  | Total no. | Total wtd.   | Share (wtd.) |
|------------------------------------------------|-----------|--------------|-----------|-------------|-----------|--------------|--------------|
| WP3 – Cross-Domain AI                          | 7         | 4.55         | 7         | 6           | 14        | 10.55        | 27.1 %       |
| WP4 – AI-Driven Buildings                      | 4         | 1.83         | 4         | 3.5         | 8         | 5.33         | 13.7 %       |
| WP5 – AI-Video Driven Building and Road Safety | 4         | 2.75         | 6         | 5           | 10        | 7.75         | 19.9 %       |
| WP6 – Automating Software Development with AI  | 5         | 5            | 4         | 4           | 9         | 9            | 23.1 %       |
| WP7 – AI-Driven Insurance Operations           | 6         | 4.25         | 2         | 2           | 8         | 6.25         | 16.1 %       |
| <b>Total</b>                                   | <b>26</b> | <b>18.38</b> | <b>23</b> | <b>20.5</b> | <b>49</b> | <b>38.88</b> | <b>100 %</b> |

WoS = WoS/Scopus-indexed publications; Other = publications in other databases; no. = number of publications; wtd. = weighted by the percentage of project assignment in acknowledgement; Share (wtd.) = share of the weighted total.

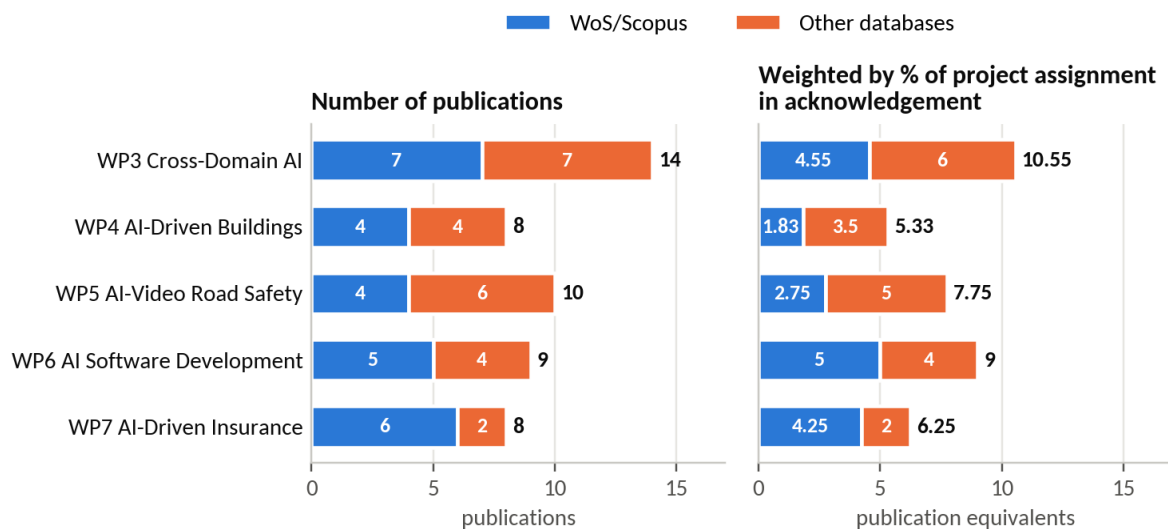


Figure 1: Publications by work package – number of publications (left) and weighted by the percentage of project assignment in acknowledgement (right), split into WoS/Scopus and other databases

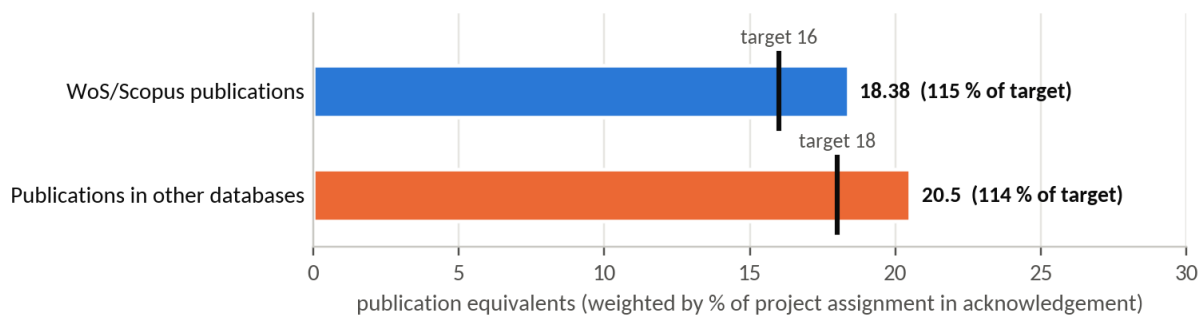


Figure 2: Progress towards the project publication targets (weighted by the percentage of project assignment in acknowledgement)

## Summaries of the published articles by research theme

The summaries of the published articles below are organized into 11 research themes:

| Section      | Research theme                                                                         | Publications (total) |
|--------------|----------------------------------------------------------------------------------------|----------------------|
| 5.1          | Camera Geometry, 3D Vision and Pose Estimation (Publications 1-5)                      | 5                    |
| 5.2          | AI Video Analytics for Traffic, Road and Public Safety (Publications 6-11)             | 6                    |
| 5.3          | Multicamera Systems and Video Input Processing (Publications 12-14)                    | 3                    |
| 5.4          | Synthetic Data, Rendering and Privacy-Preserving Learning (Publications 15-18)         | 4                    |
| 5.5          | Applied Computer Vision and Object Recognition (Publications 19-20)                    | 2                    |
| 5.6          | AI for Healthcare Diagnostics (Publications 21-22)                                     | 2                    |
| 5.7          | AI for Smart Buildings, BIM and Energy Efficiency (Publications 23-30)                 | 8                    |
| 5.8          | AI-Assisted Software Engineering (Publications 31-38)                                  | 8                    |
| 5.9          | Natural Language Processing for Slovak and Low-Resource Languages (Publications 39-43) | 5                    |
| 5.10         | AI in Insurance Operations (Publications 44-47)                                        | 4                    |
| 5.11         | AI Ethics, Governance and Industrial Data (Publications 48-49)                         | 2                    |
| <b>Total</b> |                                                                                        | <b>49</b>            |

## 5.1. Camera Geometry, 3D Vision and Pose Estimation

### Publication 1: RePoseD - Efficient Relative Pose Estimation With Known Depth Information

**Authors:** Yaqing Ding, Viktor Kocur, Vaclav Vavra, Zuzana Berger Haladova, Jian Yang, Torsten Sattler, Zuzana Kukelova

**Related Work Packages:** WP3 (Cross-Domain AI), WP5 (AI-Video Driven Building and Road Safety)

**Published In:** International Conference on Computer Vision (ICCV) 2025

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** This international collaboration between Slovak, Czech, and Chinese researchers introduces a novel framework for determining camera positions using depth information from single images. The method leverages recent advances in monocular depth estimation (MDE) to improve relative pose estimation, which is a fundamental problem in computer vision applications like 3D reconstruction and autonomous navigation. The new solvers outperform existing methods in both speed and accuracy.

**Key Innovation:** The framework jointly estimates scale and shift parameters along with relative pose, addressing the inherent ambiguity in depth predictions.

**Original Abstract:** Recent advances in monocular depth estimation methods (MDEs) and their improved accuracy open new possibilities for their applications. In this paper, we investigate how monocular depth estimates can be used for relative pose estimation. In particular, we are interested in answering the question whether using MDEs improves results over traditional point-based methods. We propose a novel framework for estimating the relative pose of two cameras from point correspondences with associated monocular depths. Since depth predictions are typically defined up to an unknown scale or even both unknown scale and shift parameters, our solvers jointly estimate the scale or both the scale and shift parameters along with the relative pose. We derive efficient solvers considering different types of depths for three camera configurations: (1) two calibrated cameras, (2) two cameras with an unknown shared focal length, and (3) two cameras with unknown different focal lengths. Our new solvers outperform state-of-the-art depth-aware solvers in terms of speed and accuracy. In extensive real experiments on multiple datasets and with various MDEs, we discuss which depth-aware solvers are preferable in which situation. The code is available at <https://github.com/kocurvik/mdrp>.

**Link:** [https://openaccess.thecvf.com/content/ICCV2025/papers/Ding\\_RePoseD\\_Efficient\\_Relative\\_Pose\\_Estimation\\_With\\_Known\\_Depth\\_Information\\_ICCV\\_2025\\_paper.pdf](https://openaccess.thecvf.com/content/ICCV2025/papers/Ding_RePoseD_Efficient_Relative_Pose_Estimation_With_Known_Depth_Information_ICCV_2025_paper.pdf)

## Publication 2: Practical Solutions to the Relative Pose of Three Calibrated Cameras

**Authors:** Charalambos Tzamos, Viktor Kocur, Yaqing Ding, Daniel Barath, Zuzana Berger Haladova, Torsten Sattler, Zuzana Kukelova

**Related Work Packages:** WP3 (Cross-Domain AI), WP5 (AI-Video Driven Building and Road Safety)

**Published In:** IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) 2025

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** Published at CVPR, one of the world's top computer vision conferences, this paper presents efficient new methods for determining the relative positions of three cameras from just four point correspondences. The researchers developed a clever technique using "mean-point correspondences" that simplifies the complex mathematical problem while achieving state-of-the-art accuracy. The new solvers are both efficient and easy to implement, making them practical for real-world applications in autonomous systems and 3D reconstruction.

**Key Innovation:** Novel use of approximate mean-point correspondences combined with existing efficient minimal solvers produces more robust and accurate results than previous approaches.

**Original Abstract:** We study the challenging problem of estimating the relative pose of three calibrated cameras from four point correspondences. We propose novel efficient solutions to this problem that are based on the simple idea of using four correspondences to estimate an approximate geometry of the first two views. We model this geometry either as an affine or a fully perspective geometry estimated using one additional approximate correspondence. We generate such an approximate correspondence using a very simple and efficient strategy, where the new point is the mean point of three corresponding input points. The new solvers are efficient and easy to implement, since they are based on existing efficient minimal solvers, i.e., the 4-point affine fundamental matrix, the well-known 5-point relative pose solver, and the P3P solver. Extensive experiments on real data show that the proposed solvers, when properly coupled with local optimization, achieve state-of-the-art results, with the novel solver based on approximate mean-point correspondences being more robust and accurate than the affine-based solver.

**Link:** [https://openaccess.thecvf.com/content/CVPR2025/papers/Tzamos\\_Practical\\_Solutions\\_to\\_the\\_Relative\\_Pose\\_of\\_Three\\_Calibrated\\_Cameras\\_CVPR\\_2025\\_paper.pdf](https://openaccess.thecvf.com/content/CVPR2025/papers/Tzamos_Practical_Solutions_to_the_Relative_Pose_of_Three_Calibrated_Cameras_CVPR_2025_paper.pdf)

## Publication 3: Are Minimal Radial Distortion Solvers Really Necessary for Relative Pose Estimation?

**Authors:** Viktor Kocur, Charalambos Tzamos, Yaqing Ding, Zuzana Berger Haladova, Torsten Sattler, Zuzana Kukelova

**Related Work Packages:** WP3 (Cross-Domain AI), WP5 (AI-Video Driven Building and Road Safety)

**Published In:** International Journal of Computer Vision, 2025

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** This research challenges conventional wisdom in computer vision by demonstrating that complex mathematical solvers for handling camera lens distortion may not be necessary in practice. The team compared traditional radial distortion solvers with simpler approaches and found that a combination of basic pinhole solvers with sampled distortion parameters, or neural network-based distortion estimation, achieves comparable results with significantly less implementation complexity.

**Key Innovation:** The paper provides practical guidance for choosing between simple sampling approaches and learning-based methods depending on the application context.

**Original Abstract:** Estimating the relative pose between two cameras is a fundamental step in many applications such as Structure-from-Motion. The common approach to relative pose estimation is to apply a minimal solver inside a RANSAC loop. Highly efficient solvers exist for pinhole cameras. Yet, (nearly) all cameras exhibit radial distortion. Not modeling radial distortion leads to (significantly) worse results. However, minimal radial distortion solvers are significantly more complex than pinhole solvers, both in terms of run-time and implementation efforts. This paper compares radial distortion solvers with two simple-to-implement approaches that do not use minimal radial distortion solvers: The first approach combines an efficient pinhole solver with sampled radial undistortion parameters, where the sampled parameters are used for undistortion prior to applying the pinhole solver. The second approach uses a state-of-the-art neural network to estimate the distortion parameters rather than sampling them from a set of potential values. Extensive experiments on multiple datasets, and different camera setups, show that complex minimal radial distortion solvers are not necessary in practice. We discuss under which conditions a simple sampling of radial undistortion parameters is preferable over calibrating cameras using a learning-based prior approach. Code and newly created benchmark for relative pose estimation under radial distortion are available at <https://github.com/kocurvik/rdnet>.

**Link:** <https://doi.org/10.1007/s11263-025-02657-3>

## Publication 4: Detecting 3D Line Segments for 6DoF Pose Estimation with Limited Data

**Authors:** Matej Mok, Lukáš Gajdošech, Michal Mesároš, Martin Madaras, Viktor Kocur

**Related Work Package:** WP3 (Cross-Domain AI)

**Published In:** Proceedings of the 21st International Conference on Computer Vision Theory and Applications (VISAPP 2026), Volume 3, pp. 616-623

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** Robots in factories and warehouses often need to know exactly where a storage bin is and how it is rotated before they can grab or fill it. Researchers from Comenius University developed a method that finds the top edges of a bin in a 3D scan and uses this simple geometry to calculate the bin's exact position and orientation. The method needs only little real training data (it is helped by synthetic data) and does not require a 3D CAD model of each individual bin, which makes it practical for real industrial settings.

**Key Innovation:** A 2D line-detection network (LeTR) was extended to work directly on 3D point clouds, and a newly annotated bin dataset is released publicly; the approach reaches about 3 cm translation and 8.2° rotation error, outperforming state-of-the-art methods.

**Original Abstract:** The task of 6DoF object pose estimation is one of the fundamental problems of 3D vision with many practical applications such as industrial automation. Traditional deep learning approaches for this task often require extensive training data or CAD models, limiting their application in real-world industrial settings where data is scarce and object instances vary. We propose a novel method for 6DoF pose estimation focused specifically on bins used in industrial settings. We exploit the cuboid geometry of bins by first detecting intermediate 3D line segments corresponding to their top edges. Our approach extends the 2D line segment detection network LeTR to operate on structured point cloud data. The detected 3D line segments are then processed using a simple geometric procedure to robustly determine the bin's 6DoF pose. To evaluate our method, we extend an existing dataset with a newly collected and annotated dataset, which we make publicly available. We show that incorporating synthetic training data significantly improves pose estimation accuracy on real scans. Moreover, we show that our method significantly outperforms current state-of-the-art 6DoF pose estimation methods in terms of the pose accuracy (3 cm translation error, 8.2° rotation error) while not requiring instance-specific CAD models during inference.

**Link:** <https://doi.org/10.5220/0014462600004084>

## Publication 5: Digital Twin of a Structured-Light 3D Camera

**Authors:** Lukáš Gajdošech, Matej Mok, Martin Madaras

**Related Work Package:** WP3 (Cross-Domain AI)

**Published In:** Proceedings of the 2nd InnovAlte Conference: AI Synergy: Connecting Research, Industry, and Regional Innovation, Žilina, 29 April 2026 (ISBN 978-80-8086-288-6), pp. 24-27

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** Structured-light 3D cameras project light patterns onto objects and measure how the patterns deform to obtain very precise 3D shapes, which is essential for quality control and robotics in industry. Getting enough real data from such sensors to develop and train new algorithms is difficult. The team from Comenius University built a "digital twin" – a realistic software simulation of the whole camera, including the projector, the patterns and the capture process – so that realistic 3D measurement data can be generated on a computer for any material or scene.

**Key Innovation:** Unlike simplified depth simulators, the twin explicitly models the triangulation process together with photometric realism, producing physically plausible data that behave consistently with the real sensor.

**Original Abstract:** Accurate 3D reconstruction in industrial environments requires millimeter-level precision and geometric traceability, which purely data-driven monocular approaches cannot guarantee. Structured-light cameras provide high-resolution depth based on triangulation, but development and evaluation of reconstruction pipelines and learning-based refinement methods are limited by restricted access to real sensor data. In this work, we present the concept of digital twin of a structured-light 3D camera. The system simulates an acquisition pipeline, including pattern projection, virtual scene rendering, precise camera and projector alignment, and synchronized pattern–capture sequences. Unlike simplified depth simulators, the proposed model combines photometric realism with explicit modeling of the triangulation process, enabling reproducible generation of physically plausible structured-light data across diverse materials and scenes. Preliminary evaluations indicate realistic behavior, consistent with real sensors, supporting its use for algorithm development, hybrid analytical–learning approaches, and synthetic training data generation.

**Link:** <https://doi.org/10.5281/zenodo.20022671> (DOI of the complete proceedings volume in Zenodo)

## 5.2. AI Video Analytics for Traffic, Road and Public Safety

### Publication 6: Efficient Vision-Based Vehicle Speed Estimation

**Authors:** Andrej Macko, Lukáš Gajdošech, Viktor Kocur

**Related Work Packages:** WP3 (Cross-Domain AI), WP5 (AI-Video Driven Building and Road Safety)

**Published In:** Journal of Real-Time Image Processing (JRTIP), 2025

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** Researchers from the InnovAlte consortium have developed a significantly faster method for estimating vehicle speeds from traffic camera footage. By replacing an older object detection architecture (RetinaNet) with a more efficient YOLOv6 architecture, the team achieved **8 times faster processing** while maintaining accuracy comparable to previous state-of-the-art methods. The approach was tested across various hardware platforms, including edge devices, making it practical for real-world deployment in traffic monitoring systems.

**Key Innovation:** The research demonstrates that smaller AI models with post-training quantization offer the best balance between accuracy and computational cost for real-world traffic safety applications.

**Original Abstract:** This paper presents a computationally efficient method for vehicle speed estimation from traffic camera footage. We build upon a previous state-of-the-art method that detects 3D bounding boxes of vehicles using vanishing point geometry and a modified RetinaNet object detector. We show that replacing RetinaNet with a better performing YOLOv6 architecture results in significant improvements in terms of computational efficiency without compromising vehicle speed estimation accuracy. We evaluate the modified method in several variants in terms of vehicle detection and speed estimation accuracy. Our extensive evaluation across various hardware platforms, including edge devices, demonstrates significant gains in frames per second (FPS) compared to the prior state-of-the-art, while maintaining comparable or improved speed estimation accuracy. We analyze the trade-off between accuracy and computational cost, showing that smaller models utilizing post-training quantization offer the best balance for real-world deployment. On the BrnoCompSpeed dataset, our best-performing model achieves better speed estimation accuracy, detection precision and recall than the previous state-of-the-art, while being eight times faster. The transferability of our approach is further confirmed by an evaluation on a different dataset.

**Link:** <https://doi.org/10.1007/s11554-025-01704-z>

## Publication 7: Billboard in Focus: Estimating Driver Gaze Duration from a Single Image

**Authors:** Carlos Pizarroso, Zuzana Berger Haladová, Zuzana Černeková, Viktor Kocur

**Related Work Package:** WP3 (Cross-Domain AI)

**Published In:** Proceedings of the 21st International Conference on Computer Vision Theory and Applications (VISAPP 2026), Volume 2, pp. 447-453

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** Roadside billboards are designed to catch the eye – which can also mean distracting drivers. Normally, measuring how long drivers look at a billboard requires expensive eye-tracking experiments. Researchers from Comenius University created a fully automatic system that first finds billboards in ordinary road images and then estimates how long a driver would look at them, using only a single image. The tool can help road authorities and advertisers assess the potential distraction risk of billboards without any special equipment.

**Key Innovation:** A two-stage pipeline (a YOLO billboard detector reaching 94% mAP50 plus a DINOv2-feature classifier) estimates driver gaze duration from individual frames with 68.1% accuracy, validated also on Google Street View images.

**Original Abstract:** Roadside billboards represent a central element of outdoor advertising, yet their presence may contribute to driver distraction and accident risk. This study introduces a fully automated pipeline for billboard detection and driver gaze duration estimation, aiming to evaluate billboard relevance without reliance on manual annotations or eye-tracking devices. Our pipeline operates in two stages: (1) a YOLO-based object detection model trained on Mapillary Vistas and fine-tuned on BillboardLamac images achieved 94% mAP50 in the billboard detection task (2) a classifier based on the detected bounding box positions and DINOv2 features. The proposed pipeline enables estimation of billboard driver gaze duration from individual frames. We show that our method is able to achieve 68.1% accuracy on BillboardLamac when considering individual frames. These results are further validated using images collected from Google Street View.

**Link:** <https://doi.org/10.5220/0014475000004084>

## Publication 8: CARJAN: Agent-Based Generation and Simulation of Traffic Scenarios with AJAN

**Authors:** Leonard Frank Neis, André Antakli, Matthias Klusch

**Related Work Package:** WP5 (AI-Video Driven Building and Road Safety)

**Published In:** Proceedings of the 18th International Conference on Agents and Artificial Intelligence (ICAART 2026), Volume 3, pp. 2833-2839

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** Testing autonomous vehicles safely requires realistic virtual traffic situations with pedestrians, cyclists and cars that behave intelligently. Building such scenes by hand is slow and requires expert knowledge. Researchers from the German Research Center for Artificial Intelligence (DFKI) developed CARJAN, a tool with a visual interface in which users can design urban traffic scenes and let the virtual road users act as autonomous "agents" inside the well-known CARLA driving simulator. This makes it much easier to create and replay the dangerous situations needed to test road-safety AI.

**Key Innovation:** The first integrated, interactive approach combining the AJAN multi-agent framework (with SPARQL Behavior Tree decision-making) and the CARLA simulator for semi-automated generation and simulation of traffic scenarios; the tool is publicly available.

**Original Abstract:** User-friendly modeling and virtual simulation of urban traffic scenarios with different types of interacting agents such as pedestrians, cyclists and autonomous vehicles remains a challenge. We present CARJAN, a novel tool for semi-automated generation and simulation of such scenarios based on the multi-agent engineering framework AJAN and the driving simulator CARLA. CARJAN provides a visual user interface for the modeling, storage and maintenance of traffic scenario layouts, and leverages SPARQL Behavior Tree-based decision-making and interactions for agents in dynamic scenario simulations in CARLA. CARJAN provides a first integrated approach for interactive, intelligent agent-based generation and simulation of virtual traffic scenarios in CARLA.

**Link:** <https://doi.org/10.5220/0014329200004052>

## Publication 9: Procedural Generation of Synthetic Road Scenes for Training Anomaly Detection Models

**Authors:** Leona Zurkova, Martin Proksa, Daniel Topic, Petr Strakos

**Related Work Package:** WP5 (AI-Video Driven Building and Road Safety)

**Published In:** Proceedings of the 2nd InnovAlte Conference: AI Synergy: Connecting Research, Industry, and Regional Innovation, Žilina, 29 April 2026 (ISBN 978-80-8086-288-6), pp. 17-23

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** AI systems that watch traffic cameras must learn from huge numbers of example images, but images of rare or unusual road objects are hard to collect. Researchers from IT4Innovations (VSB – Technical University of Ostrava) built a system that automatically creates realistic 3D road scenes on a computer, changing objects, weather and camera positions, and renders them as training images. Using these synthetic images, they trained an AI detector to recognise a new type of road object – manholes – showing that computer-generated data can effectively support traffic-safety applications.

**Key Innovation:** Parametric, procedural 3D scene modelling allows systematic control of scene parameters and produces highly variable, automatically annotated datasets for YOLO-based detectors.

**Original Abstract:** Modern computer vision systems are increasingly driven by artificial intelligence (AI), particularly in applications such as object detection from camera footage in traffic safety. Training reliable object detection models requires large quantities of diverse and high-quality image data, which are often difficult to obtain from real-world environments alone. In this work, we present an approach to procedural 3D scene creation using parametric modeling techniques that enable the controlled generation of realistic urban road environments. The generated scenes are rendered with high visual fidelity and used to produce highly variable synthetic datasets for training computer vision models. The proposed framework allows systematic modification of scene parameters such as object placement, environmental conditions, and camera configuration. The resulting synthetic data are used to train a YOLO (You Only Look Once) based object detector capable of identifying a new class of road objects—manholes. Experimental results demonstrate that procedurally generated synthetic datasets can effectively support the training of object detection models for traffic safety applications.

**Link:** <https://doi.org/10.5281/zenodo.20022671> (DOI of the complete proceedings volume in Zenodo)

## Publication 10: Towards Motion Synthesis for Rare and Dangerous Event Recognition

**Authors:** Martin Halaj, Richard Holý, Martin Madaras

**Related Work Package:** WP5 (AI-Video Driven Building and Road Safety)

**Published In:** Proceedings of the 2nd InnovAlte Conference: AI Synergy: Connecting Research, Industry, and Regional Innovation, Žilina, 29 April 2026 (ISBN 978-80-8086-288-6), pp. 28-32

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** Security cameras could automatically warn about dangerous situations such as falls or fights, but AI needs many examples of such rare events to learn them – and real recordings are scarce. This paper proposes creating the missing examples artificially: human movements are captured or generated by AI tools and applied to a realistic 3D human body model, producing synthetic video sequences of rare and dangerous behaviour that can be used to train recognition systems.

**Key Innovation:** Combination of motion-capture data, generative motion tools and the parametric SMPL body model as a data-augmentation framework for security-critical action recognition.

**Original Abstract:** The detection of rare and dangerous behaviors in video surveillance is often hindered by the scarcity of real-world training data. Although general action recognition datasets excel at identifying common activities, they lack the specialized motion sequences required to train robust AI for security-critical scenarios. This research proposes a data augmentation framework that utilizes a parametric 3D human model and movement synthesis to bridge this gap. By combining motion capture data with generative motion tools, we create synthetic sequences of rare events that can be effectively combined with a parametric SMPL model and used for direct animation or synthetic data generation.

**Link:** <https://doi.org/10.5281/zenodo.20022671> (DOI of the complete proceedings volume in Zenodo)

## Publication 11: Proactive Soft Target Protection: Integrating Edge AI Video Analytics and Synthetic Data

**Authors:** Ladislav Mariš, Ján Kuljovský, Pavol Petrovič, Richard Hollý

**Related Work Package:** WP5 (AI-Video Driven Building and Road Safety)

**Published In:** Proceedings of the 2nd InnovAlte Conference: AI Synergy: Connecting Research, Industry, and Regional Innovation, Žilina, 29 April 2026 (ISBN 978-80-8086-288-6), pp. 38-43

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** Crowded public places such as stations, shopping centres or events ("soft targets") are difficult to protect because camera systems still depend on human operators who get tired and miss threats. The authors analyse how AI video analytics running directly on cameras (edge computing) can detect threats proactively, and propose training these systems with synthetic, computer-generated scenes, so that models can learn rare situations such as weapon detection without using real citizens' biometric data. The paper also defines verification rules that keep a human in the loop to minimise false alarms.

**Key Innovation:** A legally compliant (GDPR, EU AI Act) framework that combines security methodologies, edge AI video analytics and fully annotated synthetic 3D scenarios.

**Original Abstract:** Securing public spaces and so-called soft targets require a shift from reactive measures to proactive security systems. Although current European and national legislation (EU, Czech Republic, Slovakia) sets out strict methodological requirements for the protection of these areas, their actual implementation is limited by traditional camera systems (CCTV). These systems are primarily dependent on human operators, which leads to significant operational shortcomings due to cognitive fatigue, a large number of false alarms, and an inability to respond to dynamic threats in a timely manner. This paper analyzes the integration of artificial intelligence (AI) and edge-computing-based video analytics as a necessary solution to overcome these technological barriers. However, since training accurate AI models for weapon or anomaly detection faces a lack of real training data and strict privacy restrictions (GDPR, EU AI Act), this paper proposes the use of synthetic data as a key innovation. The generation of synthetic, fully annotated 3D scenarios allows models to be trained for rare and edge cases without processing actual citizens' biometric data. The combination of domain-specific security methodologies, AI video analytics, and synthetic data thus creates a robust, reliable, and legally compliant framework for modern public space protection. This paper further outlines the requirements for synthetic data to improve the training process and defines the verification conditions required to reach a certainty threshold (e.g., verifying a weapon detection with a gunshot, verifying line crossing by direction, and keeping the human in the loop) to minimize risks.

**Link:** <https://doi.org/10.5281/zenodo.20022671> (DOI of the complete proceedings volume in Zenodo)

### 5.3. Multicamera Systems and Video Input Processing

#### Publication 12: Image Stitching Methods for Enhanced Multicamera Computer Vision

**Authors:** David Cymbalak, Roman Vápeník, Martin Korének

**Related Work Package:** WP5 (AI-Video Driven Building and Road Safety)

**Published In:** International Conference on Emerging eLearning Technologies and Applications (ICETA) 2025

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** Researchers from CVTI SR have developed and tested advanced image stitching techniques for multicamera computer vision systems. The work progresses through three prototypes: basic homography-based stitching, parallax-tolerant refinement, and a hybrid system combining classical methods with deep learning (LoFTR correspondence matching). The research establishes foundations for real-time streaming pipelines capable of processing multiple camera inputs simultaneously, which is essential for traffic monitoring and smart building applications.

**Key Innovation:** The hybrid classical-deep integration approach demonstrates how traditional computer vision methods can be enhanced with modern deep learning techniques for improved robustness.

**Original Abstract:** This paper provides a discussion of advancements in image stitching techniques and presents a hands-on implementation and testing of selected methodologies. Existing approaches are analyzed, ranging from classical homography based methods to modern deep learning techniques, followed by the development of three progressive prototypes: simple homography based stitching, parallax-tolerant seam-driven refinement, and hybrid classical-deep integration using LoFTR correspondence matching. The research establishes foundations for transforming static prototypes into real-time streaming pipelines capable of simultaneously processing N-input multicamera systems. These image stitching pipelines appear suitable for future enhancement of multicamera computer vision systems and AI model input processing.

**Link:** <https://doi.org/10.1109/ICETA67772.2025.11280234>

## Publication 13: Heterogenous Video Ingestion to AI Models (Spracovanie heterogénnych video vstupov do AI modelov)

**Authors:** Roman Vápeník

**Related Work Package:** WP5 (AI-Video Driven Building and Road Safety)

**Published In:** Electrical Engineering and Informatics 17 (EEI 17), Technical University of Košice, 2026, ISBN: 978-80-553-4965-7, pp. 96-103

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** Smart buildings and transport systems rely on a wide variety of cameras, making it difficult to process their video feeds together for AI. This work designs a modular system that takes different real-time video streams and standardizes them into a single, unified format for computer vision models. Additionally, it introduces an experimental tool that extracts timestamped images from multiple live streams simultaneously, which was successfully tested using an object detection model.

**Key Innovation:** Modular system that standardizes heterogeneous, real-time multi-camera video streams into a unified format for AI models, alongside an experimental module for concurrent, timestamped frame extraction.

**Original Abstract:** The growing number of cameras in transport infrastructure and smart buildings requires solutions for the unified processing of heterogeneous video inputs for AI models. This work analyzes streaming protocols suitable for real-time video processing and proposes a modular system for managing multi-camera streams, including the normalization of inputs into a unified format suitable for computer vision and artificial intelligence models. Part of the work is the implementation of an experimental module for extracting frames with a timestamp, which is evaluated on a selected object detection model under conditions of concurrent processing of multiple streams.

**Link:** [https://eei.fei.tuke.sk/wp-content/uploads/2026/08/EEI\\_17.pdf](https://eei.fei.tuke.sk/wp-content/uploads/2026/08/EEI_17.pdf)

## Publication 14: Concept of Video Inputs Evaluation Metric in Multi-camera Systems

**Authors:** Roman Vápeník

**Related Work Package:** WP5 (AI-Video Driven Building and Road Safety)

**Published In:** Proceedings of the 2nd InnovAlte Conference: AI Synergy: Connecting Research, Industry, and Regional Innovation, Žilina, 29 April 2026 (ISBN 978-80-8086-288-6), pp. 97-102

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** When many cameras observe the same place, an operator or an AI system needs to know which camera currently gives the best view of a particular event or object. This paper from CVTI SR outlines the concept of a metric that automatically chooses the "best shot" in a multi-camera system, taking into account the properties of the video streams, object-tracking information and data from additional sensors.

**Key Innovation:** A structured set of stream, tracking and external-sensor parameters that can be combined into a single score for selecting the most suitable camera view.

**Original Abstract:** The paper focuses on the concept of a metric for selecting the best shot in a multi-camera system. It analyses the architecture, properties, and challenges of such systems, and describes the most relevant parameters of video stream sources, tracking mechanisms, and supplementary external sensors. Furthermore, it outlines how these parameters can be exploited for computing the most suitable view for a given event or object.

**Link:** <https://doi.org/10.5281/zenodo.20022671> (DOI of the complete proceedings volume in Zenodo)

## 5.4. Synthetic Data, Rendering and Privacy-Preserving Learning

### Publication 15: Synthetic-to-Real Deep Learning for Identity Card Segmentation and Line-Based Geometric Rectification

**Authors:** Petra Svobodova, Petr Strakos, Lubomir Riha, Kamil Postava, Tibor Fördös, Robin Silber

**Related Work Package:** WP5 (AI-Video Driven Building and Road Safety)

**Published In:** Results in Engineering, Vol. 30, 2026, Article 110566

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** When people photograph their ID card with a smartphone (for example to open a bank account online), the photo is often taken at an angle, in poor light or against a busy background. Researchers from IT4Innovations (VSB – Technical University of Ostrava) trained several AI models on computer-generated images of ID cards and showed that they work very well on real photos. They also introduced a new method that straightens the card image using its edge lines, which is more robust than existing corner-based approaches.

**Key Innovation:** Training exclusively on synthetic images transfers to real photos (U-Net: 98.65% Dice on real images), and a line-based perspective correction reduces the average corner error to 4.66 px on real images.

**Original Abstract:** Segmentation and perspective correction of identity documents captured by a smartphone camera are challenging due to variable illumination, different viewing angles, motion blur, occlusions, and complex backgrounds. To address these challenges, several state-of-the-art deep learning models are evaluated for identity card segmentation, including U-Net, Mask R-CNN, Mobile U-Net, Yolov8, YOLO11, and SegFormer. These models are trained on custom synthetic images and tested on real samples to evaluate transferability from synthetic to real images. Among the evaluated models, U-Net achieves the best performance, with a Dice score of 99.90% on synthetic data and 98.65% on real images. In this work, a robust line-based perspective correction method that overcomes common limitations of edge-based and corner-based rectification approaches is introduced. The method is evaluated on the custom dataset and on the public MIDV-500 and MIDV-2020 datasets. On the custom dataset, the proposed approach reduces the average corner distance to 2.59 px on synthetic images and 4.66 px on real images.

**Link:** <https://doi.org/10.1016/j.rineng.2026.110566>

## Publication 16: Dynamic Sparkle Rendering: Photorealistic Real-Time Visualization of Glittering Surfaces in Interactive Scenarios

**Authors:** R. Ďurikovič, R. Kica, A. Mihálik

**Related Work Package:** WP5 (AI-Video Driven Building and Road Safety)

**Published In:** Journal of Applied Mathematics, Statistics and Informatics (JAMSI), Vol. 21, Issue 2, 2025, pp. 53-71

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** Metallic car paints contain millions of tiny flakes that sparkle as the viewer moves – an effect that is very hard to reproduce realistically in real time, for example in car configurators, games or virtual reality. Researchers from Comenius University developed a new rendering technique that layers three procedurally generated grids of micro-flakes at several levels of detail, removing the repetitive patterns and flickering of earlier methods. An artist-friendly editor lets designers adjust flake density, size and colour live.

**Key Innovation:** A multi-grid, multi-resolution microflake approach with distance-adaptive scaling and per-flake light-colour interaction that delivers dense, non-repetitive sparkle across viewing distances in real time.

**Original Abstract:** The need for photorealistic rendering of glittery materials, motivated by applications in gaming, film, virtual reality, and particularly automotive visualization, requires real-time techniques to depict millions of minute flakes in paint coatings. Existing approaches often rely on a single grid for glint mapping, leading to repetitive patterns, aliasing, and noticeable popping during camera movement. Addressing these issues is essential for achieving convincing sparkle under varying lighting and viewpoints. We propose a new real-time method that integrates three procedurally generated microflake grids, each with multiple resolution levels, to ensure smooth transitions between levels of detail and eliminate tiling artifacts. Adaptive scaling dynamically adjusts sparkle size and brightness based on camera distance, while per-flake light-color interactions enhance reflection realism. Our custom shader framework, paired with an artist-friendly material editor, enables real-time adjustments to flake density, size, falloff, and color. Compared to single-grid or fixed-scale methods, our multi-grid approach delivers dense, non-repetitive sparkles with consistent quality across distances, albeit with higher GPU demands in complex scenes.

**Link:** <https://doi.org/10.2478/jamsi-2025-0009>

## Publication 17: Concept of Federated Synthetic Datasets Generation as a Service for the EOSC

**Authors:** David Cymbalak

**Related Work Package:** WP3 (Cross-Domain AI)

**Published In:** Proceedings of the 2nd InnovAte Conference: AI Synergy: Connecting Research, Industry, and Regional Innovation, Žilina, 29 April 2026 (ISBN 978-80-8086-288-6), pp. 68-73

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** Researchers often cannot find the data they need to train AI models. This paper from CVTI SR proposes a service for the European Open Science Cloud (EOSC) that would create datasets on demand instead of only storing existing ones: large language models write the code of a dataset generator, a human expert checks it, and the generator then runs on shared (federated) computing infrastructure, with the results stored in research repositories with persistent identifiers. EOSC Node Slovakia is used as an example of how smaller national nodes could move from passive data storage to active data generation.

**Key Innovation:** Extends the FAIR principles by enabling researchers to "create what they cannot find", through a federated architecture with five abstract node roles and full persistent-identifier traceability.

**Original Abstract:** This paper introduces the concept of Federated Synthetic Datasets Generation as a Service (SDGaaS), a proposed architecture for the European Open Science Cloud (EOSC) ecosystem intended to shift the paradigm from dataset storage to on-demand dataset creation. The design leverages Large Language Models to generate source code for dataset generators, which would then be validated through a human-in-the-loop feedback cycle, containerized, executed on federated computing infrastructure, and deposited into research product repositories. Current AI methods for both code-based and direct dataset generation are analyzed, including the emerging role of agentic AI systems. A conceptual solution design comprising five abstract federated node roles with persistent identifier traceability is presented, along with a discussion of how this approach could extend the FAIR principles by enabling researchers to create what they cannot find. The concept is situated within the context of EOSC Node Slovakia as an illustrative case for smaller national nodes seeking to evolve from passive data stewardship toward active data generation capabilities.

**Link:** <https://doi.org/10.5281/zenodo.20022671> (DOI of the complete proceedings volume in Zenodo)

## Publication 18: Decentralized Privacy-Preserving Federated Learning of Computer Vision Models on Edge Devices

**Authors:** Damian Harenčák, Lukáš Gajdošech, Martin Madaras

**Related Work Package:** WP3 (Cross-Domain AI)

**Published In:** Proceedings of the 21st International Conference on Computer Vision Theory and Applications (VISAPP 2026), Volume 3, pp. 512-519

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** Federated learning lets several organisations train one shared AI model without sending their private data to anyone – only model updates are exchanged. Recent research has shown, however, that private data can sometimes be reconstructed even from these updates. Researchers from Comenius University analysed techniques that protect client data against both the central server and other participants, such as encryption, compressing or adding noise to model updates, and tested a working prototype on small NVIDIA Jetson edge devices.

**Key Innovation:** Systematic evaluation of the privacy/accuracy trade-off of gradient compression and noising, evidence that segmentation networks are harder to attack by data reconstruction, and a proof-of-concept on edge hardware.

**Original Abstract:** Collaborative training of a machine learning model comes with a risk of sharing sensitive or private data. Federated learning offers a way of collectively training a single global model without the need to share client data, by sharing only the updated parameters from each client's local model. A central server is then used to aggregate parameters from all clients and redistribute the aggregated model back to the clients. Recent findings have shown that even in this scenario, private data can be reconstructed using only information about model parameters. Current efforts to mitigate this are mainly focused on reducing privacy risks on the server side, assuming that other clients will not act maliciously. In this work, we analyzed various methods for improving the privacy of client data concerning both the server and other clients for neural networks. Some of these methods include homomorphic encryption, gradient compression, gradient noising, and discussion on possible usage of modified federated learning systems such as split learning, swarm learning or fully encrypted models. We have analyzed the negative effects of gradient compression and gradient noising on the accuracy of convolutional neural networks used for classification. We have shown the difficulty of data reconstruction in the case of segmentation networks. We have also implemented a proof of concept on the NVIDIA Jetson TX2 module used in edge devices and simulated a federated learning process.

Link: <https://doi.org/10.5220/0014392700004084>

## 5.5. Applied Computer Vision and Object Recognition

### Publication 19: Recognition of Commemorative Euro Coins

**Authors:** Eva Ivanuskyová, Zuzana Berger Haladová

**Related Work Package:** WP3 (Cross-Domain AI)

**Published In:** Proceedings of the 2nd InnovAlte Conference: AI Synergy: Connecting Research, Industry, and Regional Innovation, Žilina, 29 April 2026 (ISBN 978-80-8086-288-6), pp. 56-61

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** Some commemorative two-euro coins are worth much more than their face value, but few people can recognise them. Researchers from Comenius University built a smartphone application that identifies a commemorative coin from a photo and shows its issuing country, year and mintage. Using a coin image dataset provided by the National Bank of Slovakia, they compared a classical image-matching method with a modern neural one and also tested how easy the app is to use.

**Key Innovation:** Comparison of SIFT and the neural SuperPoint/SuperGlue matching pipelines for coin recognition (neural: higher accuracy; SIFT: rotation-robust and lighter for mobile use), complemented by a NASA-TLX usability study.

**Original Abstract:** This paper presents the design and implementation of an application for automatic recognition of commemorative two-euro coins using computer vision techniques. The system allows users to capture an image of a coin with a smartphone camera and automatically identify the coin by comparing it with a locally stored reference database. In addition to recognizing the coin, the application provides information such as the issuing country, year of issue, and mintage volume. The recognition pipeline is based on local feature extraction and matching. Two approaches were experimentally evaluated: a classical feature-based method using the Scale-Invariant Feature Transform (SIFT) and a neural feature matching pipeline based on SuperPoint and SuperGlue. The evaluation was performed on a dataset of coin images provided by the National Bank of Slovakia and assessed using Top-k ranking metrics. Experimental results indicate that the neural method achieved higher recognition accuracy, while the SIFT-based approach demonstrated robustness to image rotation and lower computational requirements suitable for mobile deployment. In addition to technical evaluation, a user study was conducted to assess the usability of the application. Subjective workload was measured using the NASA Task Load Index (NASA-TLX). The results suggest that the proposed application enables efficient coin identification while maintaining relatively low cognitive workload for users.

**Link:** <https://doi.org/10.5281/zenodo.20022671> (DOI of the complete proceedings volume in Zenodo)

## Publication 20: Pointing-Based Object Recognition

**Authors:** Lukáš Hajdúch, Viktor Kocur

**Related Work Package:** WP5 (AI-Video Driven Building and Road Safety)

**Published In:** Proceedings of the 2nd InnovAlte Conference: AI Synergy: Connecting Research, Industry, and Regional Innovation, Žilina, 29 April 2026 (ISBN 978-80-8086-288-6), pp. 33-37

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** People naturally point at things when they talk ("pass me that one"), and robots or smart assistants should understand these gestures too. This paper from Comenius University presents a system that works with an ordinary colour camera: it detects objects and the person's body pose, estimates depth from the single image and uses vision-language models to identify exactly which object is being pointed at.

**Key Innovation:** Depth information reconstructed from a single RGB image significantly improves target identification in cluttered scenes, so no special depth sensor is required.

**Original Abstract:** This paper presents a comprehensive pipeline for recognizing objects targeted by human pointing gestures using RGB images. As human-robot interaction moves toward more intuitive interfaces, the ability to identify targets of non-verbal communication becomes crucial. Our proposed system integrates several existing state-of-the-art methods, including object detection, body pose estimation, monocular depth estimation, and vision-language models. We evaluate the impact of 3D spatial information reconstructed from a single image and the utility of image captioning models in correcting classification errors. Experimental results on a custom dataset show that incorporating depth information significantly improves target identification, especially in complex scenes with overlapping objects. The modularity of the approach allows for deployment in environments where specialized depth sensors are unavailable.

**Link:** <https://doi.org/10.5281/zenodo.20022671> (DOI of the complete proceedings volume in Zenodo)

## 5.6. AI for Healthcare Diagnostics

### Publication 21: Efficient and Explainable 3D CNNs for Alzheimer's MRI Diagnosis

**Authors:** Martin Ropjak, Zuzana Černeková

**Related Work Package:** WP3 (Cross-Domain AI)

**Published In:** Eurographics Symposium on Visual Computing for Biology and Medicine (EG VCBM) 2025

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** Researchers from Comenius University have developed a configurable deep learning framework for early detection of Alzheimer's disease from brain MRI scans. The system achieves **91.2% accuracy** in distinguishing between cognitively normal individuals and those with Alzheimer's disease using a 3D ResNet10 model. Crucially, the framework includes built-in explainability features (Grad-CAM visualizations) that show clinicians which brain regions influenced the AI's decision, an essential feature for clinical adoption.

#### Key Innovations:

- Memory-aware dataset chunking reduces training time by 35%
- Fully reproducible experiments via single configuration file

- Explainability visualizations highlight clinically relevant regions (hippocampus, temporal lobes)

**Original Abstract:** We present a configurable deep learning framework for classifying T1-weighted brain MRI scans into cognitively normal (CN), and Alzheimer's disease (AD). The pipeline is optimized for high-performance computing (HPC) environments and integrates explainability methods for visual model interpretation. Key contributions include a flexible, parameter-driven setup that enhances reproducibility, a memory-aware dataset chunking strategy for efficient GPU utilization, and built-in Grad-CAM visualizations for visual inspection of results. Using the ADNI dataset, our best binary classification (CN vs. AD) achieved 91.2% accuracy with a 3D ResNet10 model. The framework's scalability, reproducibility, and explainability make it a robust tool for medical imaging research.

**Link:** <https://conferences.eg.org/vcbm2025/wp-content/uploads/sites/26/2025/09/Efficient-and-Explainable-3D-CNNs-for-Alzheimers-MRI-Diagnosis.pdf>

## Publication 22: A Systematic Review Exploring Recent Breakthroughs in Explainable AI for Medical Imaging Analysis

**Authors:** Fatana Jafari, Monday Onoja, Zuzana Černeková

**Related Work Package:** WP3 (Cross-Domain AI)

**Published In:** Proceedings of the 2nd InnovAte Conference: AI Synergy: Connecting Research, Industry, and Regional Innovation, Žilina, 29 April 2026 (ISBN 978-80-8086-288-6), pp. 62-67

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** AI can already help doctors analyse X-rays, MRI or CT scans, but many AI models are "black boxes" whose decisions cannot be explained – a major obstacle to clinical use. This review from Comenius University surveys explainable-AI (XAI) methods that show which parts of an image influenced the AI's decision, maps how they are used across imaging types and body regions, and discusses what is still needed before they can be routinely used in hospitals.

**Key Innovation:** A cross-modality and cross-anatomy overview of XAI methods for medical imaging, covering areas that recent reviews do not address, with a roadmap for clinical integration.

**Original Abstract:** Artificial intelligence (AI) has revolutionized medical imaging by enabling automated image analysis, including tasks such as segmentation, classification, and anomaly detection, thus improving diagnostic accuracy and efficiency. Despite these advances, the opaque "black-box" nature of many AI models poses challenges for clinical adoption, as clinicians require transparency and interpretability to trust AI-driven decisions. Explainable AI (XAI)

addresses this gap by offering methods that clarify how deep learning (DL) models make predictions, highlight critical image regions, and provide interpretable insights. This review surveys the principles and methodologies of XAI, and explores its applications across various imaging modalities and anatomical regions, which the recent literature fails to cover. Furthermore, this survey discusses the challenges and future directions for integrating XAI into clinical practice and emphasizing interpretability.

**Link:** <https://doi.org/10.5281/zenodo.20022671> (DOI of the complete proceedings volume in Zenodo)

## 5.7. AI for Smart Buildings, BIM and Energy Efficiency

### Publication 23: Building Information Modeling: A Case Study of the Natural History Museum in Bratislava

**Authors:** Ján Erdélyi, Tomáš Funtík, Richard Honti, Marián Marčíš

**Related Work Package:** WP4 (AI-Driven Buildings)

**Published In:** Contributions to International Conferences on Engineering Surveying (INGEO 2025), Springer Proceedings in Earth and Environmental Sciences, 2026, pp. 125-140

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** A digital "information model" (BIM) of a building contains its 3D shape together with detailed data about all its parts – a key basis for smart, energy-efficient building management. Researchers from the Slovak University of Technology created such a model for the historic Natural History Museum of the Slovak National Museum in Bratislava. They describe the whole process: defining what information is needed, capturing the building with terrestrial laser scanning and drone photogrammetry, and building the final model.

**Key Innovation:** A documented end-to-end workflow (Exchange Information Requirements → TLS and UAV data capture → information model) for creating BIM models of historic buildings.

**Original Abstract:** Building Information Modeling (BIM) represents a significant advancement in the digital transformation of the construction industry. It provides an object-oriented 3D model that includes detailed information about structures, elements, and their parameters. In recent years, there has been increasing attention on creating information models of historic buildings. This paper describes the process of developing the BIM model of the Natural History Museum of the Slovak National Museum. Individual sections focus on the creation of Exchange Information Requirements (EIR), data capture using terrestrial laser scanning (TLS) and UAV (Unmanned

Aerial Vehicle) photogrammetry, and the development of the information model itself. The paper also presents the final model.

Link: [https://doi.org/10.1007/978-3-032-12070-0\\_11](https://doi.org/10.1007/978-3-032-12070-0_11)

## Publication 24: Evaluation of Selected 3D Data Acquisition Systems for Capturing the Geometry of Building Structures

**Authors:** Richard Honti, Ján Erdélyi, Tomáš Funtík

**Related Work Package:** WP4 (AI-Driven Buildings)

**Published In:** Acta Polytechnica Hungarica, Vol. 22, Issue 8, 2025, pp. 203-222

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** Accurate 3D scans of building interiors are needed for construction, indoor navigation and building management, and there are now many ways to capture them – from professional laser scanners to handheld devices and 360° cameras. Researchers from the Slovak University of Technology compared three popular, faster systems (Matterport models from 360° photos, the Matterport Pro3 LiDAR camera and the GeoSLAM ZEB Go handheld scanner) against a survey-grade laser scanner in a hallway, an office, a laboratory and a lecture hall, showing the strengths and weaknesses of each.

**Key Innovation:** Practical, evidence-based guidance for choosing the right 3D capture system for a given indoor application, benchmarked against survey-grade terrestrial laser scanning.

**Original Abstract:** Accurate 3D data from indoor environments are highly important for various applications in construction, indoor navigation, and real estate management. Mobile scanning systems (simultaneous localization and mapping (SLAM), mobile devices with LIDAR) and modern systems, such as Matterport offer an efficient way to produce virtual models of the measured objects (or even generate point clouds). Still, the quality of these methods tends to be lower than the quality of the measurements performed by terrestrial laser scanning (TLS). In this paper, three distinct scanning systems are compared and evaluated. The tested techniques are the Matterport-generated virtual models using 360° photos, the Matterport PRO3 LIDAR camera and point clouds from the SLAM handheld scanner GeoSLAM ZebGO. The evaluation is done against the survey-grade TLS point clouds captured from four test sites with different properties (e.g., size, complexity, etc.). The selected test scenes are indoor environments, including a hallway, an office, a measurement laboratory, and a lecture hall. Their strengths and weaknesses, from both technical and practical perspectives are shown, which can assist in selecting the most appropriate system for different applications.

Link: <https://doi.org/10.12700/APH.22.8.2025.8.12>

## Publication 25: Evaluation of Point Cloud Generation from 360° Videos of Indoor Spaces and Heritage Sites

**Authors:** Richard Honti, Ján Erdélyi, Tomáš Funtík

**Related Work Package:** WP4 (AI-Driven Buildings)

**Published In:** The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Vol. XLVIII-2/W12-2026 (11th International Workshop 3D-ARCH), pp. 199-206

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** Affordable 360° cameras make it possible to document building interiors and heritage sites simply by walking through them while recording video. But how accurate are the 3D models created this way? Researchers from the Slovak University of Technology compared 3D point clouds reconstructed from 360° videos with measurements from a professional laser scanner in several indoor scenes. The 360° approach proved fast and practical, with average deviations of around 35-50 mm, but produced more noise and less sharp edges.

**Key Innovation:** A rigorous metric evaluation (cloud-to-cloud and control-point analysis) of 360°-video photogrammetry against survey-grade TLS, quantifying where this low-cost method is fit for purpose.

**Original Abstract:** Affordable 360° cameras combined with cloud- or desktop-based photogrammetry have made image-based documentation of complex interiors widely accessible. However, the metric reliability of point clouds reconstructed from 360° video remains inconsistently reported, particularly when compared to survey-grade terrestrial laser scanning (TLS). This study evaluates point-cloud generation from 360° videos captured along guided walking paths using consumer cameras, with high-overlap frame extraction and Structure-from-Motion processing using the CupixVista solution. Comparisons are performed using cloud-to-cloud (C2C) distance analysis, control-point analysis (CPA), and visual inspection of noise, surface roughness, and edge definition, with efficiency also considered. Point clouds are registered to the TLS reference using a two-step rigid alignment (manual coarse registration followed by ICP (Iterative Closest Point)). C2C distances, point density, and CPA errors are computed in CloudCompare after spatial subsampling. Control points are defined as intersections of locally fitted planes to improve precision. Several indoor test scenes with varying geometry, scale, and visual characteristics are analyzed. Results show average deviations around 50 mm for C2C and 35 mm for CPA, with visual inspection confirming higher noise levels and deformation of sharp features in 360°-derived point clouds compared to TLS.

Link: <https://doi.org/10.5194/isprs-archives-XLVIII-2-W12-2026-199-2026>

## Publication 26: Current Building Management System Capabilities and Requirements in Slovakia – Preliminary Results from a Questionnaire Survey

**Authors:** Michal Krajčík, Angelika Václavová, Rastislav Ingeli

**Related Work Package:** WP4 (AI-Driven Buildings)

**Published In:** Proceedings of the 13th International Conference "Environmental Engineering" (ENVIRO 2026), Vilnius Gediminas Technical University

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** Before developing smarter AI-based building management tools, it is important to understand what building managers actually use and need today. Researchers from the Slovak University of Technology surveyed 75 managers of residential, office and public buildings in Slovakia. Most use some building management system, but mainly for basic monitoring and control; advanced functions such as predictive maintenance are rare, and indoor-environment monitoring is often missing. High costs, weak infrastructure and lack of trained staff were the main barriers.

**Key Innovation:** First data-driven overview of real-world building management practice and user requirements in Slovakia, directly informing the design of the WP4 digital building management solution.

**Original Abstract:** The present paper reports preliminary results of a questionnaire survey of building managers in Slovakia designed to map the current use of building management systems and identifying practical requirements for improvement of current building management platforms. Seventy-five respondents representing residential, office and public buildings completed a 20-question survey covering technical systems and monitoring, operation and maintenance, subjective assessment, and modernization preferences. Most respondents reported using some kind of building management system, but primarily for basic monitoring and control. Advanced functions such as predictive maintenance and cross-system integration were rarely used. High investment costs, insufficient technical infrastructure, and the need for staff training and better awareness were identified as key barriers to wider deployment and upgrade. Monitoring the indoor environmental quality is in many cases non-existent or limited despite only partial satisfaction with indoor conditions. The findings can serve as an input for developing a complex digital solution for building management.

Link: <https://doi.org/10.3846/enviro.2026.1885>

## Publication 27: Schopnosti a požiadavky systémov na manažment budov na Slovensku – výsledky dotazníkového prieskumu (Capabilities and Requirements of Building Management Systems in Slovakia – Results of a Questionnaire Survey)

**Authors:** Michal Krajčík, Angelika Václavová, Rastislav Ingeli

**Related Work Package:** WP4 (AI-Driven Buildings)

**Published In:** Zborník prednášok z konferencie Energetický manažment 2026 (12th Scientific and Professional Conference on Energy Management), Horný Smokovec, 18-19 June 2026, ISBN 978-80-8284-058-5

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** This Slovak-language conference paper presents the survey of building managers in Slovakia to a national audience of energy managers. It maps how building management systems are used today – mostly for basic monitoring and control – and which practical improvements managers expect, providing an overview of user needs for the development of advanced digital building management solutions within InnovAlte.

**Key Innovation:** Dissemination of the survey results to the Slovak energy-management community, complementing the international ENVIRO 2026 paper.

**Original Abstract:** The article presents preliminary results of a survey conducted among building managers in Slovakia. The aim was to map the current level of use of building management systems and to identify practical requirements for improving existing platforms. The survey covered technical systems, operation and maintenance, assessment of current conditions and modernisation preferences. For the InnovAlte project, the findings provide an initial overview of user needs and practical requirements relevant for the development of advanced digital building management solutions.

**Link:** Printed proceedings only (ISBN 978-80-8284-058-5), no online version available

## Publication 28: Vývoj systému digitálneho manažmentu budov s podporou AI a BIM modelov (Development of a Digital Building Management System Supported by AI and BIM Models)

**Authors:** T. Funtík, R. Varga, L. Michalák, M. Šveda

**Related Work Package:** WP4 (AI-Driven Buildings)

**Published In:** Zborník prednášok z konferencie Energetický manažment 2026 (12th Scientific and Professional Conference on Energy Management), Horný Smokovec, 18-19 June 2026, ISBN 978-80-8284-058-5

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** This article outlines a smart building management system that combines static building models (BIM), real-time sensor data, and artificial intelligence. It explains how to build these digital models even with limited initial information, focusing on improving visualization, data handling, and energy efficiency. Ultimately, this work lays the foundation for creating intelligent building ecosystems and digital twins for the InnovAlte project.

**Key Innovation:** The key innovation is the integration of static building information models (BIM) with live sensor time-series data and AI to create an intelligent, digital twin-based building management ecosystem that can be developed even with limited initial input data.

**Original Abstract:** The article describes the development of a digital building management system based on the integration of static BIM data, dynamic sensor time series and artificial intelligence methods. It presents the methodology for creating BIM models from limited input data and partial outputs in the areas of visualization, data infrastructure and energy management. For the InnovAlte project, the contribution provides a direct basis for the development of an intelligent building management ecosystem using digital twins, BIM models and AI-supported analytical tools.

**Link:** Printed proceedings only (ISBN 978-80-8284-058-5), no online version available

## Publication 29: Využitie dát z BIM modelu pri energetickom manažmente budov (Use of BIM Model Data in Building Energy Management)

**Authors:** R. Varga, L. Michalák, D. Olexík

**Related Work Package:** WP4 (AI-Driven Buildings)

**Published In:** Zborník prednášok z konferencie Energetický manažment 2026 (12th Scientific and Professional Conference on Energy Management), Horný Smokovec, 18-19 June 2026, ISBN 978-80-8284-058-5

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** Digital building models (BIM) are usually created for design and construction and then forgotten. This Slovak-language paper shows how data from BIM models in the open IFC format can be reused during the building's operation to improve energy management – by linking the model to the real building through digital twins and IoT sensors – and identifies the interoperability problems between BIM, energy-management and simulation tools that still need to be solved.

**Key Innovation:** Lays the groundwork for using structured semantic BIM data together with machine-learning and deep-learning methods for energy-consumption prediction and real-time operational optimisation in InnovAlte.

**Original Abstract:** The paper deals with the use of data from Building Information Models in the open IFC format for building energy management during the operational phase of the building life cycle. It analyzes the connection between static BIM models and real buildings through the concept of digital twins and the Internet of Things, as well as barriers to interoperability between BIM, energy management and simulation tools. For the InnovAlte project, the article is relevant as a basis for using structured semantic data, machine learning and deep learning methods for energy consumption prediction and real-time operation optimization.

**Link:** Printed proceedings only (ISBN 978-80-8284-058-5), no online version available

## Publication 30: AI-Enabled Non-Invasive Smart Metering for Appliance-Level Energy Intelligence in Buildings

**Authors:** Peter Fecifák, Jaroslav Lámer, Erika Abigail Katonová

**Related Work Package:** WP4 (AI-Driven Buildings)

**Published In:** Proceedings of the 2nd InnovAlte Conference: AI Synergy: Connecting Research, Industry, and Regional Innovation, Žilina, 29 April 2026 (ISBN 978-80-8086-288-6), pp. 4-10

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** Knowing how much electricity each individual appliance uses is the key to saving energy in buildings, but installing a meter on every device is impractical. Researchers from CVTI SR and the Technical University of Košice developed a smart-metering platform with clip-on sensors that measure the whole circuit 20 times per second and use AI to recognise which appliances are running. Laboratory tests showed high recognition accuracy for common household appliances, with computation light enough for embedded devices.

**Key Innovation:** A 20 Hz "mid-frequency" non-intrusive load monitoring (NILM) platform with  $\pm 1\%$  accuracy and MQTT real-time streaming – a practical compromise between billing-grade smart meters and expensive high-frequency research systems.

**Original Abstract:** The increasing demand for energy-efficient and AI-driven building management systems requires detailed visibility of appliance-level consumption without introducing intrusive instrumentation. This paper presents an AI-enabled non-invasive smart metering platform designed to support appliance-level energy intelligence using mid-frequency measurements. The proposed system utilizes split-core current transformers and achieves measurement accuracy within  $\pm 1\%$  while sampling electrical parameters at 50 ms intervals (20 Hz). A modular architecture combining MQTT-based real-time streaming, event-assisted steady-state feature extraction, and supervised classification enables near real-time Non-Intrusive Load Monitoring (NILM). The system was experimentally validated under controlled laboratory conditions at the University Science Park TECHNICOM using a calibrated Portable Test Equipment as a reference instrument. Experimental results demonstrate high classification accuracy for common household appliances, particularly resistive loads, while maintaining computational efficiency suitable for embedded deployment. The study confirms that 20 Hz sampling provides a practical compromise between billing-grade smart meters and high-frequency research systems. The proposed architecture forms a scalable foundation for AI-driven building applications, including nearly real-time management and dynamic energy control, while highlighting limitations related to load density and overlapping appliance signatures.

**Link:** <https://doi.org/10.5281/zenodo.20022671> (DOI of the complete proceedings volume in Zenodo)

## 5.8. AI-Assisted Software Engineering

### Publication 31: Large Language Models in Software Documentation and Modeling: A Literature Review and Findings

**Authors:** Lukáš Radoský, Ivan Polášek

**Related Work Package:** WP6 (Automating Software Development with AI)

**Published In:** 2026 IEEE 24th World Symposium on Applied Machine Intelligence and Informatics (SAMI), pp. 263-268

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** Large language models such as ChatGPT understand both natural language and structured languages such as code and diagrams, which makes them promising helpers for writing software documentation and models. Researchers from Comenius University and Gratex International reviewed the scientific literature from four major venues to map which documentation and modelling tasks LLMs are used for, how they are prompted and evaluated, and which datasets are available.

**Key Innovation:** A structured overview of tasks, prompting techniques, metrics, human-evaluation approaches and datasets for LLM-supported software documentation and modelling.

**Original Abstract:** Generative artificial intelligence attracts significant attention, especially with the introduction of large language models. Its capabilities are being exploited to solve various software engineering tasks. Thanks to their ability to understand natural language and generate natural language responses, large language models are great for processing various software documentation artifacts. At the same time, large language models excel at understanding structured languages, having the potential for working with software programs and models. We conduct a literature review on the usage of large language models for software engineering tasks related to documentation and modeling. We analyze articles from four major venues in the area, organize them per tasks they solve, and provide an overview of used prompt techniques, metrics, approaches to human-based evaluation, and major datasets.

**Link:** <https://doi.org/10.1109/SAMI68106.2026.11420586>

## Publication 32: Supporting Software Engineering Tasks with Agentic AI: Demonstration on Document Retrieval and Test Scenario Generation

**Authors:** Marián Kica, Lukáš Radoský, David Slivka, Karin Kubinová, Daniel Dovhun, Tomáš Uherčík, Erik Birčák, Ivan Polášek

**Related Work Package:** WP6 (Automating Software Development with AI)

**Published In:** 2026 International Conference on Artificial Intelligence, Computer, Data Sciences and Applications (ACDSA), pp. 1-6

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** In software companies, a lot of time is spent searching through project documents and writing test scenarios. Researchers from Gratex International and Comenius University built two "agentic AI" solutions in which several specialised AI agents cooperate: one automatically generates test scenarios from detailed requirement descriptions, the other lets developers search, ask questions about, track changes in and summarise large sets of project documents. Both were demonstrated on real company processes.

**Key Innovation:** Practical multi-agent architectures (a supervisor agent with specialised worker agents; dedicated agents per use case) applied to real-world industrial software-engineering processes.

**Original Abstract:** The introduction of large language models ignited great retooling and rethinking of the software development models. The ensuing response of software engineering research yielded a massive body of tools and approaches. In this paper, we join the hassle by introducing agentic AI solutions for two tasks. First, we developed a solution for automatic test scenario generation from a detailed requirements description. This approach relies on specialized worker agents forming a star topology with the supervisor agent in the middle. We demonstrate its capabilities on a real-world example. Second, we developed an agentic AI solution for the document retrieval task in the context of software engineering documents. Our solution enables performing various use cases on a body of documents related to the development of a single software, including search, question answering, tracking changes, and large document summarization. In this case, each use case is handled by a dedicated LLM-based agent, which performs all subtasks related to the corresponding use case. We conclude by hinting at the future perspectives of our line of research.

**Link:** <https://doi.org/10.1109/ACDSA67686.2026.11468097>

## Publication 33: LLM Agents in Software Development: A Systematic Mapping Study of Capabilities, Failure Modes, and Governance Guardrails

**Authors:** Pavol Petrovič, Cuong Van Tran, Hieu Nguyen Trung, František Babič

**Related Work Package:** WP6 (Automating Software Development with AI)

**Published In:** 2026 IEEE 30th International Conference on Intelligent Engineering Systems (INES), pp. 559-564

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** Claims that AI will transform software development are often based on simple benchmarks. This study, led by Asseco Central Europe, systematically maps 1,094 research studies to show where large language models and AI agents really help in the software lifecycle, where they fail and why. It identifies typical risks – code that only looks correct, fragile tests, overly permissive deployment pipelines and licence issues – and proposes concrete technical and organisational safeguards.

**Key Innovation:** Phase-aligned failure-mode analysis with governance guardrails grounded in NIST SSDF and SLISA, such as strict separation of AI code generators and independent verifiers and policy-as-code gateways.

**Original Abstract:** Claims about the benefits of AI in the software development lifecycle are often based on simplified benchmarks that underrepresent collaborative work and long-term maintenance. We present a systematic mapping study synthesizing 1,094 primary studies to provide a phase-aligned analysis of where LLMs and multi-agent systems deliver stable value, where they fail, and why. Our mapping reveals an uneven research landscape concentrated in code generation and testing, with governance and deployment receiving comparatively little attention. We identify recurring failure modes: illusion of correctness in generated code, fragile test suites, overly permissive CI/CD configurations, and code origin and license compatibility risks. To mitigate these, we propose technical and procedural guardrails grounded in NIST SSDF and SLISA, including strict role separation between generators and independent verifiers and policy-as-code gateways. We complement the mapping with a practitioner reflection identifying where LLM tools provide stable value and which organizational controls reduce operational risk.

**Link:** <https://doi.org/10.1109/INES69513.2026.11661226>

## Publication 34: Cindy: A Toolkit for Automated Architecture Recovery in Large Software Repositories

**Authors:** Martin Marko, Lukáš Radoský, Tomáš Uherčík, André Antakli, Ivan Polášek

**Related Work Package:** WP6 (Automating Software Development with AI)

**Published In:** 2026 6th International Conference on Electrical, Computer and Energy Technologies (ICECET), pp. 1-6

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** AI coding assistants work well on small projects but struggle with large, old ("legacy") software systems that nobody fully understands anymore. Researchers from Gratex International, Comenius University and DFKI developed Cindy, a toolkit that analyses not only the source code but everything else in a software repository, and produces human-readable reports about the system's architecture. These reports can also give AI agents the context they need to work successfully on large codebases.

**Key Innovation:** Multi-faceted repository comprehension that analyses the whole ecosystem of repository artefacts (not just source code) and can feed AI-driven development workflows.

**Original Abstract:** This paper presents the Cindy Toolkit, a comprehensive suite of tools designed to facilitate deep, multi-faceted repository comprehension by analyzing not just the source code but also the entire ecosystem of artifacts within a repository. We demonstrate how just a small subset of tools contained in Cindy can be used to generate comprehensive human-readable reports on various aspects of software. We also suggest possibilities of integration into AI-driven workflows to provide agents with the contextual understanding necessary for successful task execution. The key novelty of our approach lies in its holistic, artifact-inclusive analysis methodology combined with a multi-stage LLM-assisted validation process that goes beyond code-centric approaches.

**Link:** <https://doi.org/10.1109/ICECET65726.2026.11631806>

## Publication 35: Using Behavioral Models in Software Development

**Authors:** Tomáš Bucsi, Ivan Polášek

**Related Work Package:** WP6 (Automating Software Development with AI)

**Published In:** Proceedings of the 2nd InnovAlte Conference: AI Synergy: Connecting Research, Industry, and Regional Innovation, Žilina, 29 April 2026 (ISBN 978-80-8086-288-6), pp. 74-79

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** Static diagrams show how a software system is built, but not how its parts interact over time. This paper from Comenius University and Gratex International extends a prototype that animates software architecture diagrams in the popular Draw.io tool with a new, simpler scripting language, making it easier to describe step by step how components communicate – and thus to understand the dynamic behaviour of a system.

**Key Innovation:** A dedicated, user-friendly scripting language for describing actions, steps and temporal dependencies in animated software-architecture diagrams.

**Original Abstract:** We introduce a design and implementation of an extension to an existing prototype system for animating software architectures in Draw.io. The primary goal is to create a scripting language that enables a simpler, clearer, and more user-friendly way of writing animation scripts. Such a language aims to support a more intuitive understanding of the dynamics of software systems, their behavior, and the interactions between individual components. Since animation represents a visual depiction of the sequence of interactions, special emphasis is placed on designing a language capable of clearly describing individual steps, actions, and temporal dependencies between objects.

**Link:** <https://doi.org/10.5281/zenodo.20022671> (DOI of the complete proceedings volume in Zenodo)

## Publication 36: Automatic Extraction of UML Class Diagram Structure from Images

**Authors:** Viktor Ovchinnikov, Lukáš Radoský

**Related Work Package:** WP6 (Automating Software Development with AI)

**Published In:** Proceedings of the 2nd InnovAlte Conference: AI Synergy: Connecting Research, Industry, and Regional Innovation, Žilina, 29 April 2026 (ISBN 978-80-8086-288-6), pp. 86-91

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** Many software designs exist only as pictures of UML diagrams, which cannot be edited or processed automatically. This paper from Comenius University presents a pipeline that uses multimodal AI models to convert an image of a UML class diagram into editable PlantUML text, checks its syntax and extracts its structure. Two commercial models were compared with an open-source one: classes are recognised reliably, while attributes and methods remain the hardest part.

**Key Innovation:** An end-to-end, validated image-to-PlantUML pipeline with structure-level precision/recall evaluation comparing GPT-5.2, Gemini 2.5 Flash and LLaVA v1.5.

**Original Abstract:** This paper presents an end-to-end pipeline for converting UML class diagram images into normalized PlantUML. The pipeline processes UML class diagram images, enforces PlantUML-only output, validates syntax, parses structural elements, and stores per-diagram artifacts. We evaluated quality on a set of 14 diagrams using structure-level precision/recall/F1 for classes, edges, attributes, and methods. Two proprietary models (GPT-5.2 and Gemini 2.5 Flash) are compared with a local open-source baseline (LLaVA v1.5, 7B), where the latter shows unstable and invalid structured outputs. Both proprietary models are strong on class extraction, edge extraction is moderate, and attribute/method extraction remains the main bottleneck.

**Link:** <https://doi.org/10.5281/zenodo.20022671> (DOI of the complete proceedings volume in Zenodo)

## Publication 37: Creating a Dataset of Use Case–Sequence Diagram Pairs Using Large Language Models

**Authors:** Jakub Murín, Lukáš Radoský

**Related Work Package:** WP6 (Automating Software Development with AI)

**Published In:** Proceedings of the 2nd InnovAlte Conference: AI Synergy: Connecting Research, Industry, and Regional Innovation, Žilina, 29 April 2026 (ISBN 978-80-8086-288-6), pp. 92-96

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** To build and compare tools that automatically turn written requirements into software designs, researchers need good test data. This paper from Comenius University creates a dataset of pairs of use cases (textual descriptions of how users interact with a system) and matching UML sequence diagrams, collected from GitHub and generated with GPT-3.5, validated and enriched with metadata. The dataset proved suitable for training, testing and comparing software-modelling automation tools.

**Key Innovation:** A validated, metadata-rich benchmark dataset of use case–sequence diagram pairs for evaluating software-modelling automation.

**Original Abstract:** This paper focuses on the creation and processing of a dataset intended for the evaluation of methods in the field of software engineering. It concentrates on forming data pairs consisting of a use case and its corresponding UML sequence diagram. Based on the theoretical background described in the thesis, the data is collected from publicly available repositories on the GitHub platform and generated using artificial intelligence, specifically the GPT-3.5 model. Validation is used to verify the correctness of the data, and metadata are collected for each record. The created dataset is analyzed using selected statistical methods, which highlight its advantages and limitations for further use in the development and testing of

software tools. The suitability of the dataset for machine processing is verified through the evaluation of software that transforms a use case into a sequence diagram. The evaluation results show that the created dataset serves as a suitable input for training, testing, and comparing the performance of various approaches in the field of software modeling automation.

**Link:** <https://doi.org/10.5281/zenodo.20022671> (DOI of the complete proceedings volume in Zenodo)

## Publication 38: Searching for Possibilities to Use Topological Sorting in the Refactoring Process

**Authors:** Liliia Orlova, Ivan Polášek

**Related Work Package:** WP6 (Automating Software Development with AI)

**Published In:** Proceedings of the 2nd InnovAte Conference: AI Synergy: Connecting Research, Industry, and Regional Innovation, Žilina, 29 April 2026 (ISBN 978-80-8086-288-6), pp. 109-114

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** Refactoring – cleaning up and restructuring existing code without changing what it does – keeps software reliable and maintainable but is labour-intensive. This paper from Comenius University and Gratex International presents an approach that automatically refactors Java projects: it detects problematic code patterns ("code smells"), determines the best order in which to fix them, lets a large language model perform the changes and then verifies the result.

**Key Innovation:** Use of ordering (topological sorting) of detected code smells to find an optimal refactoring sequence before LLM-based refactoring and automated verification.

**Original Abstract:** Refactoring is an important and useful practice in software development, essential for ensuring system stability, reliability, and readability, as well as long-term maintenance. With the development of large language models (LLMs), many opportunities have emerged to ease the labor-intensive process of refactoring for developers. LLMs show significant potential for performing various code-related tasks, including refactoring, providing fast and fairly accurate results, thereby accelerating and improving the automated refactoring process. We present an approach to automatically refactor Java projects by detecting code smells, finding the optimal sequence of refactoring, performing refactoring using LLM, and verifying the results.

**Link:** <https://doi.org/10.5281/zenodo.20022671> (DOI of the complete proceedings volume in Zenodo)

## 5.9. Natural Language Processing for Slovak and Low-Resource Languages

### Publication 39: Trojsten Benchmark - Evaluating LLM Problem-Solving in Slovak STEM Competition Problems

**Authors:** Adam Zahradník, Marek Šuppa

**Related Work Package:** WP7 (AI-Driven Insurance Operations)

**Published In:** Conference on Empirical Methods in Natural Language Processing (EMNLP) 2025

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** Researchers from Comenius University have created the first comprehensive benchmark for evaluating Large Language Models (LLMs) on complex STEM problems in Slovak—a low-resource language. The Trojsten Benchmark contains 1,108 high-school competition problems in mathematics, physics, and programming with reference solutions. Using GPT-4 for both rubric generation and grading, the team found that AI grading shows only 1.05 average absolute deviation from human graders on a 5-point scale.

#### Key Findings:

- GPT-4o achieved the highest average score of 6.07 out of 10 on Slovak STEM problems
- Model performance consistently decreased with increasing problem difficulty
- Interestingly, GPT-4 performed better on original Slovak problems than English translations
- The benchmark addresses a significant gap in evaluation resources for low-resource languages

**Original Abstract:** Large language models show promising performance on reasoning tasks, yet evaluation methods for low-resource languages remain limited, particularly for complex STEM problemsolving. We introduce Trojsten Benchmark, a Slovak-language dataset of 1,108 high-school competition problems with reference solutions across mathematics, physics, and programming, and a rubric-based LLM grading framework. Using GPT-4 to generate rubrics and grade solutions, we observe 1.05 average absolute deviation from human graders (5-point scale), while benchmarking GPT-3.5-Turbo, GPT-4, GPT-4o, and open-weight models (Llama 3, Phi-3). We quantify multistep reasoning performance by difficulty, show consistent underperformance on harder items, and demonstrate language sensitivity: accuracy drops on English translations of Slovak statements, evidencing challenges beyond translation. Trojsten Benchmark complements

English-centric math datasets (e.g., MATH, GSM8K) by targeting open-response, rubric-gradable reasoning under low-resource linguistic framing. We release code and data to enable reproducible evaluation and human-aligned auto-grading for STEM in under-served languages.

Link: <https://doi.org/10.18653/v1/2025.emnlp-main.1779>

## Publication 40: SloPal: A 60-Million-Word Slovak Parliamentary Corpus with Aligned Speech and Fine-Tuned ASR Models

**Authors:** Erik Božík, Marek Šuppa

**Related Work Package:** WP7 (AI-Driven Insurance Operations)

**Published In:** Proceedings of the Fifteenth Language Resources and Evaluation Conference (LREC 2026), Palma, Mallorca, pp. 3523-3533

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** Speech recognition for Slovak lags behind major languages because there are fewer than 100 hours of openly available training recordings. Researchers from Comenius University built SloPal, a huge collection of Slovak parliamentary debates from 2001-2024 (66 million words), and aligned 2,806 hours of it with the audio. Training the popular Whisper speech-recognition models on this data cut transcription errors by up to 70%. All data and four improved models are freely available.

**Key Innovation:** The most comprehensive open Slovak parliamentary language resource to date; a fine-tuned small Whisper model approaches the quality of a six-times larger model.

**Original Abstract:** Slovak remains a low-resource language for automatic speech recognition (ASR), with fewer than 100 hours of publicly available training data. We present SloPal, a comprehensive Slovak parliamentary corpus comprising 330,000 speaker-segmented transcripts (66 million words, 220 million tokens) spanning 2001–2024, with rich metadata including speaker names, roles, and session information. From this collection, we derive SloPalSpeech, a 2,806-hour aligned speech dataset with segments up to 30 seconds, constructed using a language-agnostic anchor-based alignment pipeline and optimized for Whisper-based ASR training. Fine-tuning Whisper on SloPalSpeech reduces Word Error Rate (WER) by up to 70%, with the fine-tuned small model (244M parameters) approaching base large-v3 (1.5B parameters) performance at 6× fewer parameters. We publicly release the SloPal text corpus, SloPalSpeech aligned audio, and four fine-tuned Whisper models at <https://huggingface.co/collections/NaiveNeuron/slopal>, providing the most comprehensive open Slovak parliamentary language resource to date.

Link: <https://doi.org/10.63317/3wovntemmb6u>

## Publication 41: SlovKE: A Large-Scale Dataset and LLM Evaluation for Slovak Keyphrase Extraction

**Authors:** Dávid Števaňák, Marek Šuppa

**Related Work Package:** WP7 (AI-Driven Insurance Operations)

**Published In:** Proceedings of the Fifteenth Language Resources and Evaluation Conference (LREC 2026), Palma, Mallorca, pp. 3534-3546

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** Keywords help to categorise and quickly summarise documents, but automatic keyword extraction has been studied mainly for English. Researchers from Comenius University collected more than 227,000 abstracts of Slovak theses with author-assigned keywords – 25 times more than any previous Slovak dataset – and tested classical methods and a large language model on them. Slovak’s many word forms confuse traditional methods, while the LLM produced keywords much closer to those chosen by the authors.

**Key Innovation:** A large-scale benchmark for keyphrase extraction in a morphologically rich language, identifying morphological mismatch as the dominant failure mode of statistical methods.

**Original Abstract:** Keyphrase extraction for morphologically rich, low-resource languages remains understudied, largely due to the scarcity of suitable evaluation datasets. We address this gap for Slovak by constructing a dataset of 227,432 scientific abstracts with author-assigned keyphrases—scraped and systematically cleaned from the Slovak Central Register of Theses—representing a 25-fold increase over the largest prior Slovak resource and approaching the scale of established English benchmarks such as KP20K. Using this dataset, we benchmark three unsupervised baselines (YAKE, TextRank, KeyBERT with SlovakBERT embeddings) and evaluate KeyLLM, an LLM-based extraction method using GPT-3.5-turbo. Unsupervised baselines achieve at most 11.6% exact-match F1@6, with a large gap to partial matching (up to 51.5%), reflecting the difficulty of matching inflected surface forms to author-assigned keyphrases. KeyLLM narrows this exact–partial gap, producing keyphrases closer to the canonical forms assigned by authors, while manual evaluation on 100 documents ( $\kappa = 0.61$ ) confirms that KeyLLM captures relevant concepts that automated exact matching underestimates. Our analysis identifies morphological mismatch as the dominant failure mode for statistical methods—a finding relevant to other inflected languages.

**Link:** <https://doi.org/10.63317/322dk2ztk5dj>

## Publication 42: Universal NER v2: Towards a Massively Multilingual Named Entity Recognition Benchmark

**Authors:** Terra Blevins, Stephen Mayhew, Marek Šuppa, Hila Gonen, Shachar Mirkin, Vasile Pais, Kaja Dobrovoljc, Voula Giouli, Jun Kevin, Eugene Jang, Eungseo Kim, Jeongyeon Seo, Xenophon Gialis, Yuval Pinter

**Related Work Package:** WP7 (AI-Driven Insurance Operations)

**Published In:** Proceedings of the Fifteenth Language Resources and Evaluation Conference (LREC 2026), Palma, Mallorca, pp. 6609-6618

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** Named entity recognition – automatically finding names of people, organisations and places in text – is a basic building block of many language technologies. Universal NER is an international, community-built collection of consistently annotated datasets in many languages. In this second version, co-developed with a Comenius University researcher, 11 new datasets in 10 typologically diverse languages were added, including parallel benchmarks, and both classic encoder models and large language models were evaluated on them.

**Key Innovation:** A large international collaboration extending a gold-standard multilingual NER benchmark with parallel evaluation sets while keeping unified annotation guidelines and high inter-annotator agreement.

**Original Abstract:** We present Universal NER (UNER) v2, a significant extension of the initial version released in 2024. UNER is a collaborative dataset for multilingual named-entity annotations, built to support research on NER methods in a cross-linguistic setting. UNER v2 adds 11 new datasets in 10 typologically varied languages to the resource, including multiple parallel evaluation benchmarks aligned with each other and other datasets in UNER v1, while maintaining the same annotation guidelines and high standards for inter-annotator agreement. We report detailed statistics for the dataset and benchmark UNER v2 using both encoder-based model architectures and LLMs.

**Link:** <https://doi.org/10.63317/4qhcyjkgeda>

## Publication 43: Approaches to Semantic Textual Similarity in Slovak Language: From Algorithms to Transformers

**Authors:** Lukáš Radoský, Miroslav Blšták, Matej Krajčovič, Ivan Polášek

**Related Work Package:** WP6 (Automating Software Development with AI)

**Published In:** 2026 IEEE 24th World Symposium on Applied Machine Intelligence and Informatics (SAMI)

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** Measuring how similar two sentences are in meaning is essential for search engines, chatbots and document comparison. For Slovak, a language with relatively few resources, it is not clear which approach works best. Researchers from Comenius University and Gratex International compared traditional algorithms, machine-learning models (tuned with a bee-colony optimisation method) and modern AI tools including OpenAI embeddings, GPT and SlovakBERT, and describe the trade-offs between accuracy, cost and complexity.

**Key Innovation:** A comprehensive comparison of sentence-level semantic-similarity methods for Slovak, from classic algorithms to transformers, with artificial-bee-colony-guided feature selection and hyperparameter tuning.

**Original Abstract:** Semantic textual similarity (STS) plays a crucial role in many natural language processing tasks. While extensively studied in high-resource languages, STS remains challenging for under-resourced languages such as Slovak. This paper presents a comparative evaluation of sentence-level STS methods applied to Slovak, including traditional algorithms, supervised machine learning models, and third-party deep learning tools. We trained several machine learning models using outputs from traditional algorithms as features, with feature selection and hyperparameter tuning jointly guided by artificial bee colony optimization. Finally, we evaluated several third-party tools, including fine-tuned model by CloudNLP, OpenAI's embedding models, GPT-4 model, and pretrained SlovakBERT model. Our findings highlight the trade-offs between different approaches.

**Link:** <https://doi.org/10.1109/SAMI68106.2026.11420590>

## 5.10. AI in Insurance Operations

### Publication 44: Customer Perception of AI-Supported Communication in Insurance: A Rapid Review

**Authors:** Dana Jašková, Katarína Kráľová

**Related Work Package:** WP7 (AI-Driven Insurance Operations)

**Published In:** Entrepreneurship and Sustainability Issues, Vol. 13, No. 2, December 2025, pp. 372-385

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** Insurance companies increasingly use chatbots and other AI tools to talk to customers – for example when reporting a claim or managing a contract. Researchers from Alexander Dubček University of Trenčín systematically reviewed the research on how customers perceive this. Trust, usefulness, ease of use, good performance and personalisation make customers accept AI communication, while privacy worries, a feeling of "creepiness", perceived risk and required effort hold them back. Pleasant, empathetic and seamless interaction proved crucial.

**Key Innovation:** A structured synthesis of the drivers and barriers of chatbot acceptance in insurance, following Rapid Review methodology and PRISMA guidelines, with recommendations for building trust and accessibility.

**Original Abstract:** Digitalization in the insurance industry has significantly accelerated in recent years, accompanied by a growing use of artificial intelligence in the automation of customer communication. Insurance are increasingly giving more attention to chatbots as an innovative solution to transform the customer service experience, redefining how they interact with users and optimizing their support process. The aim of this study is to synthesize the findings of existing peer-reviewed research on the impact of artificial intelligence technologies supporting customer communication on the customer experience in the insurance industry. Another objective is to explore the prerequisites for adopting an insurance solution, chatbot, and to present current trends in research and future research possibilities. The synthesis of findings is conducted using the Rapid Review methodology, following its established procedures and recommended tools. The relevant bibliographic overview was obtained through a review of studies indexed in the scientific databases WoS and Scopus, as well as sources of grey literature. The process of selecting relevant studies is mapped according to the PRISMA guidelines. The studies that passed the screening process based on predefined inclusion and exclusion criteria were subjected to detailed examination. For the purpose of knowledge synthesis, the following aspects were specified: theme of studies, data collection method, data analysis method, respondents and sample size, applied model, and examined factors. The study shows that current topics focus primarily on identifying positive and negative factors that influence customer feelings when communicating with a chatbot. The data obtained from the surveys were analyzed using the Partial Least Squares-Structural Equation Modeling method. The positive factors supporting the acceptance and intention to use chatbot technology include Trust, Perceived Usefulness, Perceived Ease of Use, Performance Expectancy, and Personalization. Among the negative factors identified were Privacy Concerns, Creepiness, Perceived Risk, and Effort Expectancy. The study has indicated several opportunities for further research.

**Link:** <https://doi.org/10.9770/z6524286266>

## Publication 45: Public Property Insurance Systems in EU Countries and Possibilities for Using AI in Insurance

**Authors:** Karol Krajčo, Martina Jakubčinová, Ingo Zinnikus

**Related Work Package:** WP7 (AI-Driven Insurance Operations)

**Published In:** Administratívne a Management Public (AMP), No. 46/2026, pp. 121-141

**Category:** WoS/Scopus-indexed publication

**Plain-Language Summary:** How do European countries insure their public property – schools, roads or government buildings – against natural disasters and other risks, and could AI help? Researchers from Alexander Dubček University of Trenčín and DFKI (Germany) compared the approaches of EU countries, finding that they differ only slightly and that AI is not yet used in most of them. They propose a general model for using AI in public property insurance that public institutions in any EU country could apply, with recommendations for a Slovak national strategy.

**Key Innovation:** A unique comparative overview of public property insurance approaches across EU countries, combined with a general model for AI adoption in this area.

**Original Abstract:** This paper presents an analytical synthesis of current approaches to public property insurance in an international context. The aim is to identify the approaches of individual EU countries to the issue of protecting public property and propose a general model for the use of AI in this area. The analysis is carried out in the form of research, based on a methodology of systematic collection, sorting and evaluation of primary and secondary sources. The main sources include scientific publications and government documents. Emphasis is placed on categorising the identified approaches of countries in this area and the possibilities of using AI in the insurance industry. This article enriches the scientific and research space with a unique overview of the approaches of individual EU countries, which is currently lacking. The results of the study can serve as a starting point for further studies and a valuable resource for deepening knowledge in this area. Since the use of AI has not been confirmed in most countries and the individual approaches in EU countries show only slight differences, the proposed general model can be applied at individual national levels of public institutions in EU countries.

**Link:** <https://doi.org/10.24818/amp/2026.46-07>

## Publication 46: The Role of Anonymization in AI Solutions for Claims Processing

**Authors:** Michal Porázik, Peter Pač, František Babič, Marek Belička, Petra Bobíková

**Related Work Package:** WP7 (AI-Driven Insurance Operations)

**Published In:** Proceedings of the 2nd InnovAlte Conference: AI Synergy: Connecting Research, Industry, and Regional Innovation, Žilina, 29 April 2026 (ISBN 978-80-8086-288-6), pp. 50-55

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** AI can speed up insurance claims handling, but claims documents are full of personal and sensitive information protected by GDPR. This paper from Asseco Central Europe presents an anonymisation pipeline built directly into the claims workflow: text is extracted from documents, a large language model finds personal identifiers, these are replaced by secure tokens, and a strict quality check runs before anything is stored. Tests on synthetic claims data show how privacy can be protected while keeping the data useful for AI.

**Key Innovation:** Privacy-by-design embedded in an AI processing pipeline (OCR, LLM-based identifier detection, cryptographic tokenisation and a quality gate), validated on synthetic claims data.

**Original Abstract:** Artificial intelligence is increasingly used in insurance claims processing to automate document analysis, fraud detection, and decision support. These systems operate on large volumes of unstructured claims documentation containing personally identifiable and sensitive information, raising significant privacy and regulatory concerns. Under frameworks such as the GDPR, the distinction between anonymization and pseudonymization is critical, particularly when AI models are trained on processed claims data. This paper presents an agent-based anonymization pipeline integrated into a document-centric claims workflow. The solution combines OCR extraction, LLM-based identifier detection, cryptographic tokenization, and a strict quality gate prior to data persistence. The approach is experimentally validated on synthetic claims data to evaluate detection reliability, residual risk, and operational feasibility. The study demonstrates how privacy-by-design principles can be embedded directly into AI processing pipelines while preserving analytical utility.

**Link:** <https://doi.org/10.5281/zenodo.20022671> (DOI of the complete proceedings volume in Zenodo)

## Publication 47: AI-Enabled SBVR Rules Extraction in Insurance

**Authors:** Stanislav Vasiľko, Illya Trygub

**Related Work Package:** WP7 (AI-Driven Insurance Operations)

**Published In:** Proceedings of the 2nd InnovAlte Conference: AI Synergy: Connecting Research, Industry, and Regional Innovation, Žilina, 29 April 2026 (ISBN 978-80-8086-288-6), pp. 103-108

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** Insurance rules and regulations are long, full of exceptions and expensive to interpret every time a claim is handled. This paper from Gratex International presents the WP7 knowledge-extraction pipeline that uses a combination of fixed processing steps and large language models to turn regulatory text into clearly structured, traceable business rules (in the SBVR standard), stored in an ontology. The study shows that automatic rule extraction is feasible but very sensitive to prompt design and domain context, so precision is prioritised over volume.

**Key Innovation:** SBVR-aligned, ontology-grounded rule extraction with Promptfoo-based quality governance and full source traceability, providing trusted inputs for tools that support claim adjusters.

**Original Abstract:** Insurance regulatory documents are normative, exception-heavy, and costly to re-interpret in operations. We present the WP7 knowledge extraction segment of the InnovAlte pipeline, converting governance text into traceable rule knowledge through SBVR-aligned normalisation and ontology-grounded persistence. The method combines deterministic stages and LLM-driven stages, with Promptfoo-based quality governance and assertion thresholds for structural validity and coverage quality. We report character-span coverage evidence (43.29%–55.19% across chunk configurations) that supports controlled context overlap with deterministic deduplication and source-trace preservation, and we separate evidence-confirmed findings from model-comparison signals. Reported benchmark comparisons are run-level measurements from locked snapshots, not statistical aggregates across repeated independent reruns. The study confirms that automated SBVR-oriented extraction is feasible, but highly sensitive to prompt design, domain context, and modality interpretation. We therefore prioritise semantic precision and operational relevance over raw extraction volume, and treat character-span coverage only as a supporting indicator rather than a proxy for rule-level correctness. Within the broader InnovAlte roadmap, this segment provides trusted inputs for evidence-grounded polycontext research aimed at empowering claim adjusters.

**Link:** <https://doi.org/10.5281/zenodo.20022671> (DOI of the complete proceedings volume in Zenodo)

## 5.11. AI Ethics, Governance and Industrial Data

### Publication 48: Legal, Economic and Ethical Limits and Challenges of Artificial Intelligence in Human Resource Management

**Authors:** Petra Bobíková, Patrik Břečka, František Babič

**Related Work Package:** WP3 (Cross-Domain AI)

**Published In:** Social and Economic Revue, 02-2025; Presented at "ECOSYSTEMS OF THE FUTURE: Startups, Smart Cities and Human Resources at the Core of the Digital Economy" 2025

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** This paper from Asseco Central Europe examines the complex legal, economic, and ethical challenges of implementing AI in human resource management. The authors analyze AI implementation from the employer's perspective while emphasizing protection of employee rights. Special attention is given to the recruitment process, where AI deployment raises critical issues related to equal treatment and non-discrimination. The paper addresses GDPR compliance challenges in automated decision-making and provides guidance for organizations implementing AI-based HR tools.

#### Key Findings:

- AI systems for recruitment are classified as "high-risk" under the EU AI Regulation
- Consent may not be appropriate as a legal basis for AI processing of job applicant data
- Organizations need robust monitoring and auditing mechanisms for AI tools
- Technical expertise gaps remain a significant barrier to responsible AI implementation in HR

**Original Abstract:** The rapid development of artificial intelligence (AI) is fundamentally transforming human resource management processes, creating new opportunities while also introducing complex legal, economic, and ethical challenges. This article focuses on analysing the limits and possibilities of AI implementation in various areas of human resource management from the employer's perspective, with particular emphasis on the protection of employees' rights as the weaker party in employment relationships. Special attention is devoted to the pre-contractual phase of employment, especially the recruitment process, where the deployment of AI tools raises critical issues related to compliance with the principle of equal treatment and the prohibition of discrimination. The article further examines the processing of personal data in the context of automated decision-making and explores the key questions employers must address

to properly design internal policies and procedures. Finally, it offers a technological perspective, highlighting the dynamic development of AI capabilities and their potential impact on the legal, ethical, and organisational frameworks of human resource management. The aim of the article is to contribute to the academic discourse on the legally compliant and sustainable use of AI in the employment context.

**Link:** <https://doi.org/10.52665/ser20250209>

## Publication 49: Data Challenges in Artificial Intelligence Tools Research for Predictive Maintenance, Quality Management and Logistics

**Authors:** Radúz Dula, Michal Kebisek, Roman Lacko, Pavol Petrovič, Štefan Rýdzi, Petra Bobíková

**Related Work Package:** WP3 (Cross-Domain AI)

**Published In:** Proceedings of the 2nd InnovAlte Conference: AI Synergy: Connecting Research, Industry, and Regional Innovation, Žilina, 29 April 2026 (ISBN 978-80-8086-288-6), pp. 80-85

**Category:** Other databases (non-WoS/Scopus)

**Plain-Language Summary:** AI tools for factories – for example to predict machine failures, check product quality or plan logistics – are only as good as the data behind them. This paper from Asseco Central Europe and partners reviews research and industrial practice to identify the main data obstacles: scattered data sources, inconsistent data quality, lack of labelled examples, missing data-management standards and unclear legislation. It provides a foundation for deploying more robust and scalable AI in real production environments.

**Key Innovation:** A structured map of data-centric barriers to industrial AI deployment across predictive maintenance, quality management and logistics.

**Original Abstract:** Artificial intelligence is increasingly recognised as a key enabler of the manufacturing systems of the future. However, the successful development and deployment of AI tools depend heavily on the quality, availability, and structure of manufacturing data. This paper examines the main data challenges of a project aiming at the deployment of artificial intelligence tools in industrial environments. Through a structured review of current research and industrial practices, we outline the main areas of project partners that represent significant data challenges. Our paper highlights the need for integrated data sources, consistent data quality, availability of labelled datasets, standardised data management practices, and transparent legislation. By clarifying the data-centric barriers that exist in manufacturing, this paper provides a foundation for the deployment of more robust artificial intelligence tools and supports future efforts to enable reliable and scalable solutions in real world production settings.

Link: <https://doi.org/10.5281/zenodo.20022671> (DOI of the complete proceedings volume in Zenodo)

### Extended abstracts (not counted as publications)

In addition to the full papers above, the Proceedings of the 2nd InnovAlte Conference contain four one-page extended abstracts related to the project, which are not counted as research publications in this deliverable: "Agentic AI in the SDLC: A Prelude to Automated Refactoring" (H. Pietukhin, I. Polášek); "Animated UML as a Gateway to Understanding Software Design Patterns" (A. Lenhardtová, S. Snídová, L. Radoský, I. Polášek); "Towards Test Generation via Collaborative AI Agents and Knowledge Graphs" (Á. Czére, I. Polášek); and "Enhancing Knowledge-Based Semantic Similarity Methods for Slovak" (S. Balucha, L. Radoský).

## 6 Final conclusions and recommendations

### Summary of key conclusions:

Numeric summary:

- **49 publications** in total (8 reported in M10, **41 new** in M18): 26 indexed in WoS/Scopus, 23 in other databases
- 41 Conference papers (including 17 papers in the Proceedings of the 2nd InnovAlte Conference)
- 8 Journal articles
- 10 Publications with **international collaboration**
- 7 Publications releasing open-source code, tools or datasets (RePoseD, radial distortion benchmark, Trojsten Benchmark, 6DoF bin dataset, CARJAN, SloPal corpus and ASR models, Universal NER v2)
- **18.38** papers considered as research output in category "Publications **in the WoS/Scopus** created within the project" (based on percentage recalculation mentioned in papers acknowledgement)
- **20.5** papers considered as research output in category "Publications in databases **other than WoS/Scopus** created within the project" (based on percentage recalculation mentioned in papers acknowledgement)

Key conclusions:

- **Strong research output:** By M18, the consortium has published 49 publications (38.88 when calculating the percentage of project assignment in acknowledgements). Both

publication targets (16 WoS/Scopus and 18 other publications) have already been exceeded at the project midterm.

- **International collaboration success:** 10 of 49 publications involve authors from institutions outside Slovakia – consortium partners DFKI (Germany), VSB-TUO/IT4Innovations (Czech Republic) and the Hanoi (Vietnam) team of Asseco Central Europe, and external partners such as CTU Prague, ETH Zurich, HUN-REN SZTAKI, Nankai University and the international Universal NER initiative. The Specific Objective 9 target of at least 10 internationally co-published papers has thus been reached at the project midterm.
- **High-impact venues:** Publications in CVPR 2025, ICCV 2025, EMNLP 2025, LREC 2026, the International Journal of Computer Vision and Results in Engineering establish the project's credibility in top-tier research communities.
- **Balanced coverage of work packages:** Compared to M10, the M18 cycle adds substantial new output from WP4 (smart buildings and BIM – 8 new publications), WP6 (AI-assisted software engineering and Slovak text similarity – 9 new publications) and WP7 (insurance and language technologies – 7 new publications), while WP3 and WP5 continue to bridge computer vision research with traffic and public-safety applications.
- **Practical applications and open science:** Research outputs directly address project objectives in traffic safety, building energy efficiency, software development automation, insurance operations, healthcare AI and AI governance, and several publications release open-source code, tools or datasets. The 2nd InnovAlte Conference proceedings (17 project papers) are openly available in Zenodo and indexed in OpenAIRE.

#### Final recommendations:

- Maintain the current productivity and focus on increasing the share of WoS/Scopus journal publications with high impact factors.
- Leverage high-impact publications for broader media outreach and press releases (D2.5).
- In next year, encourage publications presenting validated prototypes and pilot results (WP8) and the transfer of conference papers into extended journal articles.
- Continue releasing code and datasets with publications to maximize research impact and reproducibility.
- Keep the internal publication register consistent with the published versions (titles, venues, DOIs, percentage of project assignment) and correct the entries where needed
- At the final D2.6 (M30) Develop Slovak-language summaries of key publications for local media and stakeholders.

**Proposal for dissemination and publication plan:**

- M10 – Partial D2.6 Summary Articles and partial dissemination to project documentation system, project website or newsletter (delivered)
- M18 – Extended Partial D2.6 Summary Articles and partial dissemination to project documentation system, project website or newsletter (this document)
- M26 – Extended Partial D2.6 Summary Articles and partial dissemination to project documentation system, project website or newsletter
- M30 – Final D2.6 Summary Articles for all published paper related to InnovAlte project and full dissemination to project documentation system, project website, newsletter and final project conference.

## 7 Risk and Mitigation Measures

| Risk                   | Description                                                                                     | Mitigation Measure                                                                                                          |
|------------------------|-------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| Publication Access     | Some publications may be behind paywalls                                                        | Provide preprint links and author contact information where available                                                       |
| Technical Accuracy     | Plain-language summaries may oversimplify                                                       | Technical review by WP experts before publication                                                                           |
| Timeliness             | Delay in collecting publication information from partners                                       | Establish regular reporting schedule with WP leaders                                                                        |
| Data Consistency       | Internal publication records may contain errors (titles, venues, DOIs, duplicates, percentages) | Cross-check all entries against publisher records (DOI) before each reporting cycle; highlight discrepancies for WP leaders |
| Language Accessibility | Technical jargon and language may limit audience reach                                          | Multiple summary versions in final M30 deliverable (Slovak/English) for different audience levels                           |

## 8 Annexes

### 8.1. Table - overview of annexes

| Name of Annex                                                                                                                                                                                                                   | Description of content of Annex | Confidentiality | Location | Link                                                                                                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|-----------------|----------|-----------------------------------------------------------------------------------------------------|
| [1] Ding, Y., Kocur, V., Vavra, V., Haladova, Z.B., Yang, J., Sattler, T., & Kukelova, Z. (2025). RePoseD: Efficient Relative Pose Estimation With Known Depth Information. <i>ICCV 2025</i> .                                  | Full Paper                      | Public          | Online   | <a href="#">Access Link</a>                                                                         |
| [2] Tzamos, C., Kocur, V., Ding, Y., Barath, D., Haladova, Z.B., Sattler, T., & Kukelova, Z. (2025). Practical solutions to the relative pose of three calibrated cameras. <i>CVPR 2025</i> .                                   | Full Paper                      | Public          | Online   | <a href="#">Access Link</a>                                                                         |
| [3] Kocur, V., Tzamos, C., Ding, Y., Haladova, Z.B., Sattler, T., & Kukelova, Z. (2025). Are Minimal Radial Distortion Solvers Really Necessary for Relative Pose Estimation? <i>International Journal of Computer Vision</i> . | Full Paper                      | Public          | Online   | <a href="https://doi.org/10.1007/s11263-025-02657-3">https://doi.org/10.1007/s11263-025-02657-3</a> |
| [4] Mok, M., Gajdošech, L., Mesároš, M., Madaras, M., & Kocur, V. (2026). Detecting 3D Line Segments for 6DoF Pose Estimation with Limited Data. <i>VISAPP 2026</i> .                                                           | Full Paper                      | Public          | Online   | <a href="https://doi.org/10.5220/0014462600004084">https://doi.org/10.5220/0014462600004084</a>     |
| [5] Gajdošech, L., Mok, M., & Madaras, M. (2026). Digital Twin of a Structured-Light 3D Camera. <i>Proc. 2nd InnovAlte Conference (AI Synergy)</i> .                                                                            | Full Paper                      | Public          | Online   | <a href="https://doi.org/10.5281/zenodo.20022671">https://doi.org/10.5281/zenodo.20022671</a>       |
| [6] Macko, A., Gajdošech, L., & Kocur, V. (2025). Efficient vision-based vehicle speed estimation. <i>Journal of Real-Time Image Processing</i> .                                                                               | Full Paper                      | Public          | Online   | <a href="https://doi.org/10.1007/s11554-025-01704-z">https://doi.org/10.1007/s11554-025-01704-z</a> |

|                                                                                                                                                                                                                 |            |        |        |                                                                                                                                           |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------|--------|-------------------------------------------------------------------------------------------------------------------------------------------|
| [7] Pizarroso, C., Berger Haladová, Z., Černeková, Z., & Kocur, V. (2026). Billboard in Focus: Estimating Driver Gaze Duration from a Single Image. <i>VISAPP 2026</i> .                                        | Full Paper | Public | Online | <a href="https://doi.org/10.5220/0014475000004084">https://doi.org/10.5220/0014475000004084</a>                                           |
| [8] Neis, L. F., Antakli, A., & Klusch, M. (2026). CARJAN: Agent-Based Generation and Simulation of Traffic Scenarios with AJAN. <i>ICAART 2026</i> .                                                           | Full Paper | Public | Online | <a href="https://doi.org/10.5220/0014329200004052">https://doi.org/10.5220/0014329200004052</a>                                           |
| [9] Zurkova, L., Proksa, M., Topic, D., & Strakos, P. (2026). Procedural Generation of Synthetic Road Scenes for Training Anomaly Detection Models. <i>Proc. 2nd InnovAlte Conference (AI Synergy)</i> .        | Full Paper | Public | Online | <a href="https://doi.org/10.5281/zenodo.20022671">https://doi.org/10.5281/zenodo.20022671</a>                                             |
| [10] Halaj, M., Hollý, R., & Madaras, M. (2026). Towards Motion Synthesis for Rare and Dangerous Event Recognition. <i>Proc. 2nd InnovAlte Conference (AI Synergy)</i> .                                        | Full Paper | Public | Online | <a href="https://doi.org/10.5281/zenodo.20022671">https://doi.org/10.5281/zenodo.20022671</a>                                             |
| [11] Mariš, L., Kuljovský, J., Petrovič, P., & Hollý, R. (2026). Proactive Soft Target Protection: Integrating Edge AI Video Analytics and Synthetic Data. <i>Proc. 2nd InnovAlte Conference (AI Synergy)</i> . | Full Paper | Public | Online | <a href="https://doi.org/10.5281/zenodo.20022671">https://doi.org/10.5281/zenodo.20022671</a>                                             |
| [12] Cymbalák, D., Vápeník, R., & Korének, M. (2025). Image Stitching Methods for Enhanced Multicamera Computer Vision. <i>ICETA 2025</i> .                                                                     | Full Paper | Public | Online | <a href="https://doi.org/10.1109/ICETA67772.2025.11280234">https://doi.org/10.1109/ICETA67772.2025.11280234</a>                           |
| [13] Vápeník, R. (2026). Heterogenous video ingestion to AI models (Spracovanie heterogénnych video vstupov do AI modelov). <i>Electrical Engineering and Informatics 17, TU Košice</i> .                       | Full Paper | Public | Online | <a href="https://eei.fei.tuke.sk/wp-content/uploads/2026/08/EEI_17.pdf">https://eei.fei.tuke.sk/wp-content/uploads/2026/08/EEI_17.pdf</a> |
| [14] Vápeník, R. (2026). Concept of Video Inputs Evaluation Metric in                                                                                                                                           | Full Paper | Public | Online | <a href="https://doi.org/10.5281/zenodo.20022671">https://doi.org/10.5281/zenodo.20022671</a>                                             |

Multi-camera Systems. *Proc. 2nd InnovAlte Conference (AI Synergy)*.

|                                                                                                                                                                                                                                             |            |        |        |                                                                                                       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------|--------|-------------------------------------------------------------------------------------------------------|
| [15] Svobodova, P., Strakos, P., Riha, L., Postava, K., Fördös, T., & Silber, R. (2026). Synthetic-to-real deep learning for identity card segmentation and line-based geometric rectification. <i>Results in Engineering</i> , 30, 110566. | Full Paper | Public | Online | <a href="https://doi.org/10.1016/j.rinen.2026.110566">https://doi.org/10.1016/j.rinen.2026.110566</a> |
| [16] Ďurikovič, R., Kica, R., & Mihálik, A. (2025). Dynamic sparkle rendering: photorealistic real-time visualization of glittering surfaces in interactive scenarios. <i>JAMSI</i> , 21(2).                                                | Full Paper | Public | Online | <a href="https://doi.org/10.2478/jamsi-2025-0009">https://doi.org/10.2478/jamsi-2025-0009</a>         |
| [17] Cymbalak, D. (2026). Concept of Federated Synthetic Datasets Generation as a Service for the EOSC. <i>Proc. 2nd InnovAlte Conference (AI Synergy)</i> .                                                                                | Full Paper | Public | Online | <a href="https://doi.org/10.5281/zenodo.20022671">https://doi.org/10.5281/zenodo.20022671</a>         |
| [18] Harenčák, D., Gajdošech, L., & Madaras, M. (2026). Decentralized Privacy-Preserving Federated Learning of Computer Vision Models on Edge Devices. <i>VISAPP 2026</i> .                                                                 | Full Paper | Public | Online | <a href="https://doi.org/10.5220/0014392700004084">https://doi.org/10.5220/0014392700004084</a>       |
| [19] Ivanusysková, E., & Berger Haladová, Z. (2026). Recognition of Commemorative Euro Coins. <i>Proc. 2nd InnovAlte Conference (AI Synergy)</i> .                                                                                          | Full Paper | Public | Online | <a href="https://doi.org/10.5281/zenodo.20022671">https://doi.org/10.5281/zenodo.20022671</a>         |
| [20] Hajdúch, L., & Kocur, V. (2026). Pointing-Based Object Recognition. <i>Proc. 2nd InnovAlte Conference (AI Synergy)</i> .                                                                                                               | Full Paper | Public | Online | <a href="https://doi.org/10.5281/zenodo.20022671">https://doi.org/10.5281/zenodo.20022671</a>         |
| [21] Ropjak, M., & Cernekova, Z. (2025). Efficient and Explainable 3D CNNs for Alzheimer's MRI Diagnosis. <i>EG VCBM 2025</i> .                                                                                                             | Full Paper | Public | Online | <a href="#">Access Link</a>                                                                           |
| [22] Jafari, F., Onoja, M., & Černeková, Z. (2026). A Systematic Review                                                                                                                                                                     | Full Paper | Public | Online | <a href="https://doi.org/10.5281/zenodo.20022671">https://doi.org/10.5281/zenodo.20022671</a>         |

Exploring Recent Breakthroughs in Explainable AI for Medical Imaging Analysis. *Proc. 2nd InnovAte Conference (AI Synergy)*.

|                                                                                                                                                                                                                          |            |        |        |                                                                                                                                                   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| [23] Erdélyi, J., Funtík, T., Honti, R., & Marčiš, M. (2026). Building Information Modeling: A Case Study of the Natural History Museum in Bratislava. <i>Springer Proceedings in Earth and Environmental Sciences</i> . | Full Paper | Public | Online | <a href="https://doi.org/10.1007/978-3-032-12070-0_11">https://doi.org/10.1007/978-3-032-12070-0_11</a>                                           |
| [24] Honti, R., Erdélyi, J., & Funtík, T. (2025). Evaluation of Selected 3D Data Acquisition Systems for Capturing the Geometry of Building Structures. <i>Acta Polytechnica Hungarica</i> , 22(8).                      | Full Paper | Public | Online | <a href="https://doi.org/10.12700/APH.22.8.2025.8.12">https://doi.org/10.12700/APH.22.8.2025.8.12</a>                                             |
| [25] Honti, R., Erdélyi, J., & Funtík, T. (2026). Evaluation of Point Cloud Generation from 360° Videos of Indoor Spaces and Heritage Sites. <i>ISPRS Archives XLVIII-2/W12-2026</i> .                                   | Full Paper | Public | Online | <a href="https://doi.org/10.5194/isprs-archives-XLVIII-2-W12-2026-199-2026">https://doi.org/10.5194/isprs-archives-XLVIII-2-W12-2026-199-2026</a> |
| [26] Krajčík, M., Václavová, A., & Ingeli, R. (2026). Current Building Management System Capabilities and Requirements in Slovakia – Preliminary Results from a Questionnaire Survey. <i>ENVIRO 2026</i> .               | Full Paper | Public | Online | <a href="https://doi.org/10.3846/enviro.2026.1885">https://doi.org/10.3846/enviro.2026.1885</a>                                                   |
| [27] Krajčík, M., Václavová, A., & Ingeli, R. (2026). Schopnosti a požiadavky systémov na manažment budov na Slovensku – výsledky dotazníkového prieskumu. <i>Energetický manažment 2026</i> .                           | Full Paper | Public | Print  | Physical form : ISBN 978-80-8284-058-5                                                                                                            |
| [28] Funtík, T., Varga, R., Michalák, L., & Šveda, M. (2026). Vývoj systému digitálneho manažmentu budov s podporou AI a BIM modelov. <i>Energetický manažment 2026</i> .                                                | Full Paper | Public | Print  | Physical form : ISBN 978-80-8284-058-5                                                                                                            |
| [29] Varga, R., Michalák, L., & Olexík, D. (2026). Využitie dát z BIM modelu                                                                                                                                             | Full Paper | Public | Print  | Physical form : ISBN 978-80-8284-058-5                                                                                                            |

|                                                                                                                                                                                                                                                              |            |        |        |                                                                                                                   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------|--------|-------------------------------------------------------------------------------------------------------------------|
| pri energetickom manažmente budov. <i>Energetický manažment 2026.</i>                                                                                                                                                                                        |            |        |        |                                                                                                                   |
| [30] Feciľak, P., Lámer, J., & Katonová, E. A. (2026). AI-Enabled Non-Invasive Smart Metering for Appliance-Level Energy Intelligence in Buildings. <i>Proc. 2nd InnovAlte Conference (AI Synergy)</i> .                                                     | Full Paper | Public | Online | <a href="https://doi.org/10.5281/zenodo.20022671">https://doi.org/10.5281/zenodo.20022671</a>                     |
| [31] Radoský, L., & Polášek, I. (2026). Large Language Models in Software Documentation and Modeling: A Literature Review and Findings. <i>IEEE SAMI 2026.</i>                                                                                               | Full Paper | Public | Online | <a href="https://doi.org/10.1109/SAMI68106.2026.11420586">https://doi.org/10.1109/SAMI68106.2026.11420586</a>     |
| [32] Kica, M., Radoský, L., Slivka, D., Kubinová, K., Dovhun, D., Uherčík, T., Birčák, E., & Polášek, I. (2026). Supporting software engineering tasks with agentic AI: Demonstration on document retrieval and test scenario generation. <i>ACDSA 2026.</i> | Full Paper | Public | Online | <a href="https://doi.org/10.1109/ACDSA67686.2026.11468097">https://doi.org/10.1109/ACDSA67686.2026.11468097</a>   |
| [33] Petrovič, P., Van Tran, C., Nguyen Trung, H., & Babič, F. (2026). LLM Agents in Software Development: A Systematic Mapping Study of Capabilities, Failure Modes, and Governance Guardrails. <i>IEEE INES 2026.</i>                                      | Full Paper | Public | Online | <a href="https://doi.org/10.1109/INES69513.2026.11661226">https://doi.org/10.1109/INES69513.2026.11661226</a>     |
| [34] Marko, M., Radoský, L., Uherčík, T., Antakli, A., & Polášek, I. (2026). Cindy: A Toolkit for Automated Architecture Recovery in Large Software Repositories. <i>ICECET 2026.</i>                                                                        | Full Paper | Public | Online | <a href="https://doi.org/10.1109/ICECET65726.2026.11631806">https://doi.org/10.1109/ICECET65726.2026.11631806</a> |
| [35] Bucsi, T., & Polášek, I. (2026). Using behavioral models in software development. <i>Proc. 2nd InnovAlte Conference (AI Synergy)</i> .                                                                                                                  | Full Paper | Public | Online | <a href="https://doi.org/10.5281/zenodo.20022671">https://doi.org/10.5281/zenodo.20022671</a>                     |
| [36] Ovchinnikov, V., & Radoský, L. (2026). Automatic Extraction of UML Class Diagram Structure from Images.                                                                                                                                                 | Full Paper | Public | Online | <a href="https://doi.org/10.5281/zenodo.20022671">https://doi.org/10.5281/zenodo.20022671</a>                     |

*Proc. 2nd InnovAlte Conference (AI Synergy).*

|                                                                                                                                                                                           |            |        |        |                                                                                                                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------|--------|-----------------------------------------------------------------------------------------------------------------|
| [37] Murín, J., & Radoský, L. (2026). Creating a Dataset of Use Case–Sequence Diagram Pairs Using Large Language Models. <i>Proc. 2nd InnovAlte Conference (AI Synergy)</i> .             | Full Paper | Public | Online | <a href="https://doi.org/10.5281/zenodo.20022671">https://doi.org/10.5281/zenodo.20022671</a>                   |
| [38] Orlova, L., & Polášek, I. (2026). Searching for possibilities to use topological sorting in the refactoring process. <i>Proc. 2nd InnovAlte Conference (AI Synergy)</i> .            | Full Paper | Public | Online | <a href="https://doi.org/10.5281/zenodo.20022671">https://doi.org/10.5281/zenodo.20022671</a>                   |
| [39] Zahradník, A., & Šuppa, M. (2025). Trojsten Benchmark: Evaluating LLM Problem-Solving in Slovak STEM Competition Problems. <i>EMNLP 2025</i> .                                       | Full Paper | Public | Online | <a href="https://doi.org/10.18653/v1/2025.emnlp-main.1779">https://doi.org/10.18653/v1/2025.emnlp-main.1779</a> |
| [40] Božík, E., & Šuppa, M. (2026). SloPal: A 60-Million-Word Slovak Parliamentary Corpus with Aligned Speech and Fine-Tuned ASR Models. <i>LREC 2026</i> .                               | Full Paper | Public | Online | <a href="https://doi.org/10.63317/3wovntemmb6u">https://doi.org/10.63317/3wovntemmb6u</a>                       |
| [41] Števaňák, D., & Šuppa, M. (2026). SlovKE: A Large-Scale Dataset and LLM Evaluation for Slovak Keyphrase Extraction. <i>LREC 2026</i> .                                               | Full Paper | Public | Online | <a href="https://doi.org/10.63317/322dk2ztk5dj">https://doi.org/10.63317/322dk2ztk5dj</a>                       |
| [42] Blevins, T., Mayhew, S., Šuppa, M., et al. (2026). Universal NER v2: Towards a Massively Multilingual Named Entity Recognition Benchmark. <i>LREC 2026</i> .                         | Full Paper | Public | Online | <a href="https://doi.org/10.63317/4qhci kvgeda">https://doi.org/10.63317/4qhci kvgeda</a>                       |
| [43] Radoský, L., Blšták, M., Krajčovič, M., & Polášek, I. (2026). Approaches to Semantic Textual Similarity in Slovak Language: From Algorithms to Transformers. <i>IEEE SAMI 2026</i> . | Full Paper | Public | Online | <a href="https://doi.org/10.1109/SAMI68106.2026.11420590">https://doi.org/10.1109/SAMI68106.2026.11420590</a>   |
| [44] Jašková, D., & Kráľová, K. (2025). Customer perception of AI-supported communication in insurance: a Rapid                                                                           | Full Paper | Public | Online | <a href="https://doi.org/10.9770/z6524286266">https://doi.org/10.9770/z6524286266</a>                           |

Review. *Entrepreneurship and Sustainability Issues*, 13(2).

|                                                                                                                                                                                                                                                                     |                          |        |                 |                                                                                               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------|-----------------|-----------------------------------------------------------------------------------------------|
| [45] Krajčo, K., Jakubčinová, M., & Zinnikus, I. (2026). Public property insurance systems in EU countries and possibilities for using AI in insurance. <i>Administratívne a Management Public</i> , 46.                                                            | Full Paper               | Public | Online          | <a href="https://doi.org/10.24818/amp/2026.46-07">https://doi.org/10.24818/amp/2026.46-07</a> |
| [46] Porázik, M., Pač, P., Babič, F., Belička, M., & Bobíková, P. (2026). The role of anonymization in AI solutions for claims processing. <i>Proc. 2nd InnovAlte Conference (AI Synergy)</i> .                                                                     | Full Paper               | Public | Online          | <a href="https://doi.org/10.5281/zenodo.20022671">https://doi.org/10.5281/zenodo.20022671</a> |
| [47] Vasiľko, S., & Trygub, I. (2026). AI-Enabled SBVR Rules Extraction in Insurance. <i>Proc. 2nd InnovAlte Conference (AI Synergy)</i> .                                                                                                                          | Full Paper               | Public | Online          | <a href="https://doi.org/10.5281/zenodo.20022671">https://doi.org/10.5281/zenodo.20022671</a> |
| [48] Bobíková, P., Břečka, P., & Babič, F. (2025). Legal, Economic and Ethical Limits and Challenges of Artificial Intelligence in Human Resource Management. <i>Social and Economic Review</i> , 02-2025.                                                          | Full Paper               | Public | Online          | <a href="https://doi.org/10.52665/ser20250209">https://doi.org/10.52665/ser20250209</a>       |
| [49] Dula, R., Kebisek, M., Lacko, R., Petrovič, P., Rýdži, Š., & Bobíková, P. (2026). Data Challenges in Artificial Intelligence Tools Research for Predictive Maintenance, Quality Management and Logistics. <i>Proc. 2nd InnovAlte Conference (AI Synergy)</i> . | Full Paper               | Public | Online          | <a href="https://doi.org/10.5281/zenodo.20022671">https://doi.org/10.5281/zenodo.20022671</a> |
| Cymbalák, D. (Ed.) (2026). <i>Proceedings of the 2nd InnovAlte Conference: AI Synergy: Connecting Research, Industry, and Regional Innovation</i> . Žilina, 29 April 2026. ISBN 978-80-8086-288-6.                                                                  | Proceedings (all papers) | Public | Online (Zenodo) | <a href="https://doi.org/10.5281/zenodo.20022671">https://doi.org/10.5281/zenodo.20022671</a> |

## About the project

The InnovAlte Slovakia project was launched in response to the call “Transformation and Innovation Consortia” announced by the Government Office of the Slovak Republic under the Recovery and Resilience Plan of the Slovak Republic (Component 9 – Investment 2: Supporting cooperation between companies, academia, and research and development organizations). The call aims to drive systemic transformation and increase the added value of key sectors of the Slovak economy through intensive collaboration among research institutions, innovative enterprises, the public sector, and internationally renowned partners.

InnovAlte Slovakia seeks to build a dynamic and sustainable innovation ecosystem in the field of artificial intelligence (AI), effectively linking cutting-edge research with practical applications. The project emphasizes the development of AI solutions that are not only technologically advanced but also ethical, environmentally sustainable, and socially beneficial. The consortium brings together leading research centers, universities, and businesses from Slovakia, Germany, and the Czech Republic.

Key focus areas include the development of AI algorithms for improving building energy efficiency, enhancing traffic safety through video analytics, automating software development, driving digital transformation in the insurance sector, and validating functional prototypes. Special attention is also given to AI education, talent development, and the incubation of startups.

The project’s outcomes will significantly strengthen Slovakia’s position in research and innovation, reduce environmental burdens, increase the competitiveness of the national industry, and modernize public services. By bridging the public and private sectors with international research excellence, InnovAlte Slovakia stands as a key instrument in addressing the social and economic challenges of today.





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