

1	CEIPEX RESEARCH TOPIC LEVEL 2: Cybernetics and Robotics
2	RESEARCH GROUP: Cybernetics and Robotics (P. Václavek)
3	TOPICS/FOCUS: Transformers applications for industrial systems faults detection, prediction and mitigation
4	SUMMARY: This project develops a unified AI pipeline that leverages transformer architectures for multivariate time-series sensing and large language models (LLMs) for unstructured maintenance knowledge to detect, predict, and mitigate faults in industrial systems. Objectives: (i) real-time anomaly detection and early warning using temporal transformers with multimodal sensor fusion; (ii) prognostics of remaining useful life via sequence-to-sequence forecasting with uncertainty quantification; (iii) automated root-cause analysis and remediation planning by fine-tuning domain LLMs on service logs, incident reports, and OEM manuals; and (iv) closed-loop mitigation through decision support integrated with existing systems. Methods include self-supervised pretraining on historical telemetry, domain adaptation to new assets, distillation/quantization for edge deployment, and attention-based explanations aligned with engineering constraints. A digital-twin testbed and synthetic fault injection complement real datasets. Deliverables comprise a modular toolkit (APIs, on-prem edge runtimes), safety guardrails for human-in-the-loop validation, and reproducible benchmarks, enabling scalable, interpretable, and standards-compliant fault intelligence across heterogeneous industrial assets.
5	RG WEBPAGE/CONTACT: https://www.ceitec.eu/cybernetics-and-robotics/rg390 Prof. Pavel Václavek, Ph.D.