Enis BILICAN

7 years of experience | pro-enis@outlook.com | enis.pro/experiences

Machine Vision, AI & Embedded Systems Engineer
Automated Visual Inspection | 2D/3D Vision & LiDAR | Electronic & Sensor Systems

Machine Vision, AI and Embedded Systems Engineer with seven years of experience across pharmaceutical manufacturing, defense and critical systems, metallurgy, automotive R&D and industrial production environments. Experienced in developing complete industrial vision and sensing solutions, from feasibility studies, sensor and camera selection, optics and controlled lighting to algorithm development, embedded software integration, validation and production support. Strong hands-on expertise in 2D/3D vision, automatic visual inspection, defect detection, object localization and tracking, dimensional inspection, LiDAR and point-cloud processing, camera-LiDAR sensor fusion and deep-learning applications. Strong skills in C/C++, Python and C#, with experience in Embedded Linux and Yocto, real-time image processing, industrial communication and hardware/software integration. Worked on vision functions integrated with automated inspection machines, robotic platforms, embedded mechatronic systems and electronic sensor prototypes. Experienced collaborating with software, systems, electronics, mechanical engineering, QA, validation and production teams, as well as equipment suppliers.

TRAINING & CERTIFICATIONS

04/2025: Advanced C++ Training

05/2024: BA5 accreditation with Volta

01/2023: AI and Deep Learning with TensorFlow 2.0 certification

01/2022: Machine Learning training

12/2021: C# Intermediate certification

11/2021: Wireshark training

11/2021: Security accreditation VOL-VCA

10/2021: TIA PORTAL certification

04/2020: Electrical accreditation B0 – H0 – H0V

FORMAL EDUCATION

2021: Master’s degree in engineering & Industry 4.0 | University of Lille, France

2019: Bachelor of Science in Electronics, Electrical Engineering, Energy and Automation | University of Lille, France

SPOKEN LANGUAGES

- **ENGLISH :** Advanced
- **FRENCH :** Native
- **TURKISH :** Fluent

EXPERTISE

- Industrial machine vision R&D for automated inspection, industrial automation and robotics
- Complete vision-chain design, including sensor and camera selection, image acquisition, camera calibration, optics and controlled-lighting optimization
- Automatic visual inspection, defect detection, false-reject reduction and AI-based quality control
- 2D/3D vision, LiDAR, point-cloud processing and camera-LiDAR sensor fusion
- Object detection, localization and tracking, OCR, gauge reading, shape analysis and dimensional and volumetric inspection
- Deep learning for industrial computer vision, including dataset preparation, data annotation, model fine-tuning and inference validation
- Vision-guided robotics and integration with automated mechatronic systems
- Real-time image and sensor-processing software in C/C++, Python and C#
- Embedded and systems software engineering, including Embedded Linux and Yocto, for industrial and safety-critical applications
- Electronic, sensor and Industrial IoT integration, including microcontrollers, processing hardware, hardware/software interfaces, real-time data pipelines, storage and visualization
- Industrial communication systems, including CAN, TCP/IP, RTSP, MQTT, REST APIs and BLE
- Feasibility studies, proof-of-concept development, prototyping and technology assessment
- Technical requirements and specifications, system architecture and supplier coordination
- Design reviews, inspection-method optimization and machine-vision standardization
- Commissioning, troubleshooting, validation and production support in regulated industrial environments

TECHNICAL KNOWLEDGE

MACHINE VISION & IMAGE ACQUISITION
OpenCV, HALCON, ImageJ, 2D/3D machine vision, automatic visual inspection, industrial cameras, image acquisition, camera triggering and synchronization, camera calibration, optics, controlled lighting, thresholding, segmentation, image stitching, triangulation sensors, geometric processing, spatial transformations, dimensional and volumetric measurement, object detection, localization, tracking, OCR, gauge reading, shape analysis, LiDAR, 3D point clouds and camera-LiDAR sensor fusion

AI & DEEP LEARNING FOR COMPUTER VISION
PyTorch, TensorFlow, YOLOv6, YOLOv8, HALCON Deep Counting, deep learning, dataset preparation, data annotation, model fine-tuning, hyperparameter tuning, classification, object detection, defect detection, anomaly detection, GPU-based inference, AI model evaluation and inference validation. Generative AI tools: AI agents, ChatGPT, Copilot and AI-assisted workflows

PROGRAMMING & REAL-TIME SOFTWARE
C/C++, Python, C#, .NET, Qt, Boost, Bash, PyQt5, Flask, Dash, GStreamer, FFmpeg, Git and Java for Android

EMBEDDED, ELECTRONIC & ROBOTIC SYSTEMS
Embedded Linux, Yocto, SCADE Suite, SCADE Display, SCADE Test, microcontrollers, Arduino C, Raspberry Pi, HMI development, PWM control, differential-pressure sensing, electronic architecture, sensor integration, processing hardware, hardware/software integration, industrial test environments, Seidenader automated inspection systems, Brevetti Vision, Prometheus Brevetti configuration, Stäubli robotic handling systems and Boston Dynamics Spot configuration

COMMUNICATION & DATA
TCP/IP, CAN, RTSP, BLE, MQTT, REST APIs, LoRaWAN, Z-Wave, Wireshark, MySQL, PostgreSQL, InfluxDB, industrial data pipelines, data retention and real-time data processing

SOFTWARE & SYSTEM ENGINEERING
Feasibility studies, proof-of-concept testing, prototyping, technical specifications, system architecture, design reviews, code reviews, commissioning support, UAT, validation protocols, root-cause analysis, technical documentation, application standardization, IQ/OQ/PQ, GMP, Six Sigma, 5 Whys and KPI monitoring

FIELDS

- Pharmaceutical manufacturing
- Automotive R&D
- Metallurgy and heavy industry
- Defense and critical systems
- Food industry

PROFESSIONAL EXPERIENCE

FN Herstal : FROM 04/2025 TO PRESENT and FROM 01/2023 TO 10/2023

CRITICAL EMBEDDED SOFTWARE & COMPUTER VISION ENGINEER

Context of the project:
Development and integration of a safety-critical embedded mechatronic system combining C++ software, Embedded Linux and Yocto, HMI functions, camera-based and AI-assisted processing, CAN/TCP/IP communication and electromechanical subsystems. The assignment required system-level integration, hardware/software troubleshooting, validation and close collaboration with systems, software, QA and test engineers in a constrained embedded environment.

Achievements:
Contributed to system architecture, C++ development, SCADE models, HMI implementation and Embedded Linux/Yocto integration. Developed and integrated software functions, communication interfaces and computer-vision/AI algorithms using camera data and OpenCV/TensorFlow components. Supported prototype development, system integration, functional validation, troubleshooting and technical documentation.

Results:

- ✓ Created the main HMI proof of concept in C++ with Qt and contributed to the final HMI implementation with Ansys SCADE Display.
- ✓ Contributed to camera-based processing and AI-assisted functions under real-time and embedded constraints.
- ✓ Developed C++ and Python software for system configuration, CAN and TCP/IP communication, camera processing and AI-assisted functions.
- ✓ Supported embedded Linux deployment using Yocto and hardware/software integration activities.
- ✓ Integrated CAN and TCP/IP interfaces between software components and electromechanical hardware.
- ✓ Produced detailed design, interface, validation and troubleshooting documentation.
- ✓ Supported UAT, root-cause analysis and functional validation with QA and test engineers.
- ✓ Performed code reviews and coached developers on C++ practices and system-level integration.

Technical environment / methodologies:
C++, Python, OpenCV, TensorFlow, PyQt5, Qt, Boost, Embedded Linux, Yocto, Ansys SCADE Suite, SCADE Display, CAN, TCP/IP, native libraries, embedded hardware integration, Scrum methodology.

HSO Geneve, Otofacto, GSK : FROM 01/2021 TO PRESENT

AI & DIGITAL TECHNOLOGIES TRAINER

Context of the project:
Design and delivery of applied training programs to help engineering, operational and business teams adopt digital technologies, AI tools, industrial vision systems and productivity workflows. The objective was to bridge the gap between advanced technologies and practical day-to-day usage.

Achievements:

Supported multiple organizations in adopting AI-based analysis systems, industrial vision tools and productivity workflows. Trained engineers, project managers and administrative teams on AI tools, ChatGPT, Copilot, Microsoft 365 and automation-oriented methods, with a focus on practical implementation and measurable efficiency gains.

Results:

- ✓ Industrial Machine Vision Systems: Trained 25 managers, engineers and quality leads on image-acquisition principles, camera and lighting configuration, inspection-algorithm optimization, performance analysis and troubleshooting.
- ✓ Visual Defect Detection with AI: Coached 12 pharmaceutical engineers on dataset preparation, model development, testing, validation and deployment strategies for AI-based quality-control applications.
- ✓ AI-Enabled Machine Implementation: Delivered a three-day international training program for 21 engineers and regulatory managers covering vision and AI integration, industrial IT architecture, validation requirements, compliance constraints and production deployment.
- ✓ Digital Productivity and LLM Workflows: Trained HR, administrative, engineering and operational teams on ChatGPT, Copilot and Microsoft 365 for documentation, data analysis, task automation, knowledge management and workflow optimization.
- ✓ Project Management and Microsoft 365: Delivered advanced training for engineers on project planning, progress monitoring, team collaboration, reporting and Copilot-assisted productivity.

Technical environment / methodologies:
Industrial Vision: Market analysis, production line implementation.
AI Tools: Python, TensorFlow, ChatGPT, Copilot.
Productivity Tools: Excel, VBA, Project, Teams, Word, PowerPoint and Outlook.
Methodology: Interactive workshops, personalized coaching, applied case studies.

TAKEDA : FROM 04/2024 TO 04/2025

AI PROJECT ENGINEER, VISION & IT WORKSTREAM LEAD

Context of the project:
Implementation of an advanced Automatic Visual Inspection system for multiple biological product formats in a regulated pharmaceutical environment. The machine combined 17 vision stations, controlled lighting, Brevetti Vision software, GPU-based AI processing and an industrial robot for container inversion and multi-angle inspection. The assignment also included three additional R&D vision projects covering syringe counting, robotic inspection and aseptic production-line monitoring.

Achievements:
Led the Vision and IT workstreams from requirements definition and technical specifications through supplier reviews, integration follow-up and validation preparation. Coordinated the interfaces between image acquisition systems, robotic handling, vision software, AI/GPU infrastructure, AWS data services and manufacturing systems. Worked with machine vendors, production, QA, engineering and validation teams to improve inspection performance and support GMP-compliant implementation.

Results:

- ✓ Led the Vision and IT workstreams and coordinated the integration of a 17-station Automatic Visual Inspection system combining Brevetti Vision, GPU-based AI processing and Stäubli robotic container handling.
- ✓ Defined and reviewed requirements for image acquisition, camera and lighting configuration, robotic interfaces, inspection performance and industrial IT integration.
- ✓ Reviewed supplier inspection algorithms through threshold calibration, defect-sensitivity analysis, false-positive reduction and inspection-method standardization.
- ✓ Defined defect taxonomies, inspection-performance criteria and AI model evaluation methods, supporting improved sensitivity, reduced false positives and overall inspection performance.
- ✓ Developed and evaluated a HALCON Deep Counting proof of concept for automated syringe counting using production images.
- ✓ Configured a Boston Dynamics Spot proof of concept for AI-assisted inspections in mezzanines and technical areas, integrating AI wrappers and a fine-tuned YOLOv6 model for gauge localization, dynamic OCR, automated gauge reading and abnormal-condition alerting.
- ✓ Designed and implemented a six-camera real-time monitoring system on an aseptic production line to detect uncontrolled vial overturning, trigger production-stop logic and generate real-time alerts.
- ✓ Sized the GPU infrastructure and defined AWS-based storage, data retention, network routing and manufacturing-system integration requirements.
- ✓ Coordinated supplier design reviews and multidisciplinary workshops with production, QA, engineering, validation and global stakeholders to support the first AI GMP-compliant implementation of the group.

Technical environment / methodologies:
MS Project, Python, PyTorch, YOLOv6, YOLOv8, HALCON Deep Counting, AI-based visual inspection, Boston Dynamics Spot, GPU-based inference and AWS processing infrastructure, Digital Twin Visual Components 4.6, Brevetti Vision configuration, Prometheus digital twin, pharmaceutical validation, USP <1790>.

ArcelorMittal: FROM 10/2023 TO 04/2024

R&D MACHINE VISION & EMBEDDED SOFTWARE ENGINEER - REAL-TIME PROCESSING & LIDAR

Context of the project:
R&D project focused on developing 2D/3D industrial vision solutions for dimensional inspection, shape analysis, and operator-safety applications on steel production lines. The system combined ultra-high-resolution industrial cameras, LiDAR point clouds, real-time streaming, and sensor fusion to inspect large products from a five-meter standoff distance and improve measurement reliability.

Achievements:
Conducted feasibility studies and developed real-time 2D/3D inspection prototypes using industrial cameras and LiDAR. Designed algorithms for object detection and localization, image stitching, dynamic camera calibration, straightness, squareness, convexity, thickness and shape inspection. Integrated a LiDAR system from initial configuration through point-cloud preprocessing and 3D object analysis, and validated camera-LiDAR consistency using relative and absolute error calculations. Developed RTSP streaming for integration with plant HMIs. All delivered tools have been successfully deployed and are currently used on production lines.

Results:

- ✓ Developed from scratch Python/OpenCV algorithms for object localization, dimensional inspection, straightness, squareness, convexity analysis, image stitching, and dynamic camera calibration.
- ✓ Developed C++ point-cloud preprocessing and 3D object-detection logic for industrial sensor data.
- ✓ Developed a low-level real-time RTSP image-streaming server in C using GStreamer and FFmpeg for industrial images up to 22,000 x 1,080 pixels.
- ✓ Developed feature-extraction and shape-analysis logic for background stabilization and detection of dimensional deviations.
- ✓ Integrated 2D camera data with LiDAR point clouds to improve thickness estimation, shape matching and inspection precision.
- ✓ Validated measurement robustness using camera-LiDAR cross-comparison, relative-error analysis and prototype testing under production conditions.

Technical environment / methodologies:
Python, C++, C, OpenCV, Boost, GStreamer, FFmpeg, Visual Studio, Git, industrial cameras, LiDAR drivers, 3D point clouds, RTSP streaming, sensor fusion, dynamic calibration, object localization and real-time image processing.

GSK (GlaxoSmithKline) : FROM 03/2022 TO 12/2022

MACHINE VISION & AUTOMATED INSPECTION ENGINEER

Context of the project:

Within GSK's Filling and Visual Inspection department, optimized Seidenader automatic inspection machines combining high-speed mechanical product handling, synchronized industrial cameras, controlled lighting and machine-vision software for syringe and vial inspection. The scope covered more than 50 vision programs across four GMP production lines, with inspection of particles, foreign objects, cracks, scratches and glass defects while controlling false-reject performance.

Achievements:

Developed, optimized and validated machine-vision programs while analyzing the complete automated mechatronic inspection chain: product feeding and mechanical handling, container presentation, image-trigger synchronization, camera acquisition, lighting, inspection algorithms and rejection mechanisms. Tuned camera and lighting configurations to improve defect visibility and balance sensitivity against false rejects. Troubleshot interactions between mechanical behavior, image quality and software parameters, and led to a Pharma 4.0 standardization initiative to harmonize more than a decade of product-specific inspection programs. Conducted cross-comparisons between vaccine-specific detection methods, identified best-performing approaches and drove convergence toward standardized and optimized inspection strategies.

Results:

- ✓ Optimized industrial camera settings, controlled lighting and inspection thresholds to reduce false rejects while maintaining high defect-detection sensitivity.
- ✓ Diagnosed the complete Seidenader mechatronic vision chain, including mechanical product handling, image acquisition, lighting, software programs and reject behavior.
- ✓ Developed and adjusted inspection logic for particles, foreign objects, cracks, scratches and glass defects across syringes and vial formats.
- ✓ Supported production troubleshooting, corrective actions and equipment optimization in collaboration with Production, Quality Assurance, Maintenance and Automation teams.
- ✓ Led the standardization of more than 50 machine-vision programs by comparing historical methods, identifying best-performing algorithms and harmonizing inspection strategies.
- ✓ Created a dashboard to monitor inspection KPIs, false-reject trends and detection performance, and led Six Sigma, 5 Whys and root-cause analysis investigations.
- ✓ Contributed to IQ/OQ/PQ qualification, validation protocols, technical documentation and GMP-compliant production support.

Technical environment / methodologies:

Seidenader automated inspection systems, machine-vision programming, industrial cameras, controlled lighting, image acquisition, Python, ImageJ, VBA, VMware, Six Sigma, 5 Whys, root-cause analysis, GMP, IQ/OQ/PQ and KPI monitoring.

AGC : FROM 10/2021 TO 02/2022

SENSOR SOFTWARE, 3D VISION & LIDAR R&D ENGINEER

Context of the project:
Automotive R&D project focused on integrating LiDAR sensors behind windshields and analyzing the impact of different glass configurations on 3D sensing performance. The objective was to acquire, standardize and process point-cloud data from multiple LiDAR sensors to evaluate optical behavior, improve sensor reliability and support accurate environmental modeling for autonomous driving applications.

Achievements:
Developed robust LiDAR data reception, parsing and near-real-time post-processing software using TCP/IP communication and AGC-specific analysis protocols. Implemented point-cloud standardization, spatial transformations, distance calculations and geometric feature extraction, while supporting AI and deep-learning experiments for object characterization, 3D data interpretation and sensor-performance evaluation.

Results:

- ✓ Developed C# and Python software for the acquisition, parsing and standardization of 3D LiDAR point clouds.
- ✓ Extended the software and data-processing pipeline to support three LiDAR models from different manufacturers.
- ✓ Developed LiDAR data reception, parsing and standardization algorithms for automotive sensor R&D.
- ✓ Integrated multiple sensors through TCP/IP and implemented robust self-diagnostic logic for constrained test environments.
- ✓ Built dynamic point-cloud extraction, storage and near-real-time processing workflows.
- ✓ Implemented spatial transformations, distance calculations and geometric feature extraction for 3D sensor analysis.
- ✓ Supported deep-learning experiments and hyperparameter optimization for object characterization across different windshield materials.
- ✓ Validated algorithms under real test conditions and compared sensor behavior across multiple glass configurations.

Technical environment / methodologies:
C#, .NET Framework, Python, TensorFlow, Wireshark, TCP/IP communication, LiDAR software, 3D point-cloud processing, geometric analysis, spatial mathematics, deep learning, near-real-time parsing.

PASQUIER : FROM 09/2020 TO 10/2021

MACHINE VISION & AUTOMATION SOFTWARE ENGINEER

Context of the project:
End-to-end development of a mobile industrial machine-vision and electronic prototype designed for product traceability, sorting and quality control through real-time volume measurement and color analysis, with automated feedback to the plant information system.

Achievements:
Designed and developed the complete hardware, electronic and software architecture of a mobile machine-vision prototype. Translated production and quality needs into functional specifications, selected the sensing, lighting and processing architecture, and implemented algorithms for 3D volume measurement and color analysis. Built a functional mobile machine-vision prototype that could be moved between production lines to evaluate different product families and prepare the solution for plant-wide deployment.

Results:
- ✓ Led the design and deployment of an Industry 4.0 machine-vision solution, proposing technical improvements and alternative architectures for product traceability, sorting and quality control.
- ✓ Translated production and quality needs into functional and technical specifications for an industrial vision system.
- ✓ Conducted technology selection for 3D sensors, cameras, lighting conditions, processing hardware and mechanical integration.
- ✓ Developed Python/C++ algorithms for 3D volumetric measurement, point-cloud processing and dynamic adaptation to multiple product formats.
- ✓ Designed CIELAB and DeltaE color-inspection algorithms and optimized lighting and environmental conditions for repeatable acquisition.
- ✓ Built the complete mobile prototype integrating vision sensors, .NET HMI, electrical systems, database communication and custom mechanical housing.
- ✓ Implemented automated calibration, reliability monitoring and production-line trials across different product families.
- ✓ Trained technicians and documented operating, calibration and troubleshooting procedures.

Technical environment / methodologies:
Python, C++, OpenCV, NumPy, Colour-Science, ImageJ, .NET HMI, 3D triangulation sensor SDK, point-cloud processing, industrial lighting optimization, database communication and AutoCAD electrical design.

CONNECTED AND VENTILATED MASK : FROM 10/2020 TO 04/2021

ELECTRONICS ENGINEER - EMBEDDED DESIGN & BLE COMMUNICATION

Context of the project:
Development of a connected ventilated mask prototype integrating embedded control, airflow regulation, BLE communication and Android-based monitoring.

Achievements:
Designed a first functional prototype combining a 3D-printed structure, Arduino-based embedded control, PWM fan regulation, differential pressure sensing and BLE communication with a native Android application.

Results:

- ✓ Conducted technology benchmarking and market analysis to identify existing solutions, evaluate market constraints and support cost-effective design decisions.
- ✓ Studied airflow behavior to ensure user comfort by avoiding imposed breathing rhythms. Developed an embedded control algorithm using a differential pressure sensor to compare internal and external mask pressure and dynamically adjust fan speed as well as opening and closing cycles.
- ✓ Optimized comfort and autonomy through energy-management strategies, battery sizing and mass-distribution analysis, including the integration of batteries with different capacities.
- ✓ Designed the mechanical structure in Autodesk Inventor for 3D printing, ensuring flexibility, user comfort and cable routing through a dedicated “spider-web” architecture while meeting functional specifications.
- ✓ Designed the electronic architecture around an Arduino Nano platform, selecting and sizing components for safe operation, integrating current-limiting and protective components and capacitors to minimize electrical disturbances and improve signal quality.
- ✓ Implemented Bluetooth Low Energy (BLE) communication between the embedded system and an Android application for configuration and monitoring.
- ✓ Developed Android application features allowing users to configure ventilation modes, switch between automatic and manual fan-speed control, and visualize operational statistics through dashboards.
- ✓ Implemented data preprocessing and feedback mechanisms within the application to support ventilation-performance analysis and energy-consumption monitoring.

Technical environment / methodologies:
Arduino C, BLE communication, Android Studio, Java, XML, PWM control, differential pressure sensor, Autodesk Inventor, 3D printing, Fritzing, electromagnetic disturbance management.

CONNECTED AND SMART HOME : FROM 10/2019 TO 06/2020

IOT APPLICATION & EMBEDDED COMMUNICATION ENGINEER

Context of the project:
Design and development of a connected smart-home ecosystem aimed at controlling household equipment through a mobile application while evaluating multiple industrial and consumer communication protocols. The project focused on interoperability between heterogeneous devices, embedded systems and cloud-connected services.

Achievements:
Designed the overall system architecture, integrating embedded controllers, wireless communication technologies and user-facing applications. Evaluated and implemented several communication protocols to ensure reliable connectivity, scalability and interoperability between devices.

Results:

- ✓ Developed a cross-platform mobile application to monitor and control connected devices from a centralized interface.
- ✓ Implemented BLE communication between embedded devices and the mobile application for local control and configuration.
- ✓ Integrated Z-Wave technology through a gateway architecture to manage smart lighting systems.
- ✓ Developed REST API interactions to exchange data between connected devices, gateways and external services.
- ✓ Implemented LoRaWAN connectivity for long-range, low-power communication scenarios.
- ✓ Configured MQTT-based messaging to enable event-driven communication and real-time device status updates.
- ✓ Designed and tested end-to-end communication workflows involving multiple protocols and heterogeneous devices.

Technical environment / methodologies:
Arduino C, WinDev, BLE, Z-Wave, REST API, LoRaWAN, MQTT, mobile application development, embedded systems, wireless communication, IoT architecture.

SMART IIOT SENSORS : FROM 10/2019 TO 01/2020

IIOT & DATA VISUALIZATION ENGINEER

Context of the project:
Development of an end-to-end Industrial IoT monitoring platform dedicated to environmental data acquisition, processing, storage and visualization. The objective was to transform raw sensor measurements into actionable insights through automated data pipelines and interactive dashboards.

Achievements:
Designed and implemented the complete data lifecycle, from sensor acquisition and preprocessing to database storage, analytics and visualization. Focused on data reliability, scalability and real-time monitoring capabilities. Implemented two communication architectures: a client-server model and a message-based model. Integrated the resulting data flows into two separate IIoT platforms, demonstrating that the data format was platform-agnostic and readily reusable across applications.

Results:

- ✓ Integrated temperature and humidity sensors with a Raspberry Pi platform to create a low-cost industrial monitoring solution.
- ✓ Developed Python data-processing pipelines using NumPy and Pandas for data cleansing, aggregation and formatting.
- ✓ Implemented MQTT and REST-based communication services to support reliable data collection and transmission.
- ✓ Designed a time-series storage architecture using InfluxDB for historical analysis, trend monitoring and data retention.
- ✓ Created interactive dashboards with Dash to visualize live measurements, system status and configuration parameters.
- ✓ Implemented automated data acquisition and logging mechanisms to reduce manual intervention and improve traceability.
- ✓ Validated end-to-end data flows from sensor acquisition to visualization and reporting.

Technical environment / methodologies:
Python, NumPy, Pandas, Matplotlib, Dash, REST API, MQTT, InfluxDB, Raspberry Pi, time-series databases, data pipelines, sensor integration, Fritzing.