INDUSTRIAL AI PORTFOLIO

Ali Naderi

Researcher | Mechatronics Engineer | Data Scientist

Bridging the gap between physical engineering systems and Physics-Informed Deep Learning to deliver robust, interpretable industrial solutions.

ABOUT ME

Professional Summary

Background

Researcher and senior graduate in mechatronics engineering with a deep passion for solving real-world engineering problems using advanced machine learning.

Experience

Over **7 years** of hands-on experience developing, deploying, and optimizing AI, Data Science pipelines, and complex data analysis frameworks.

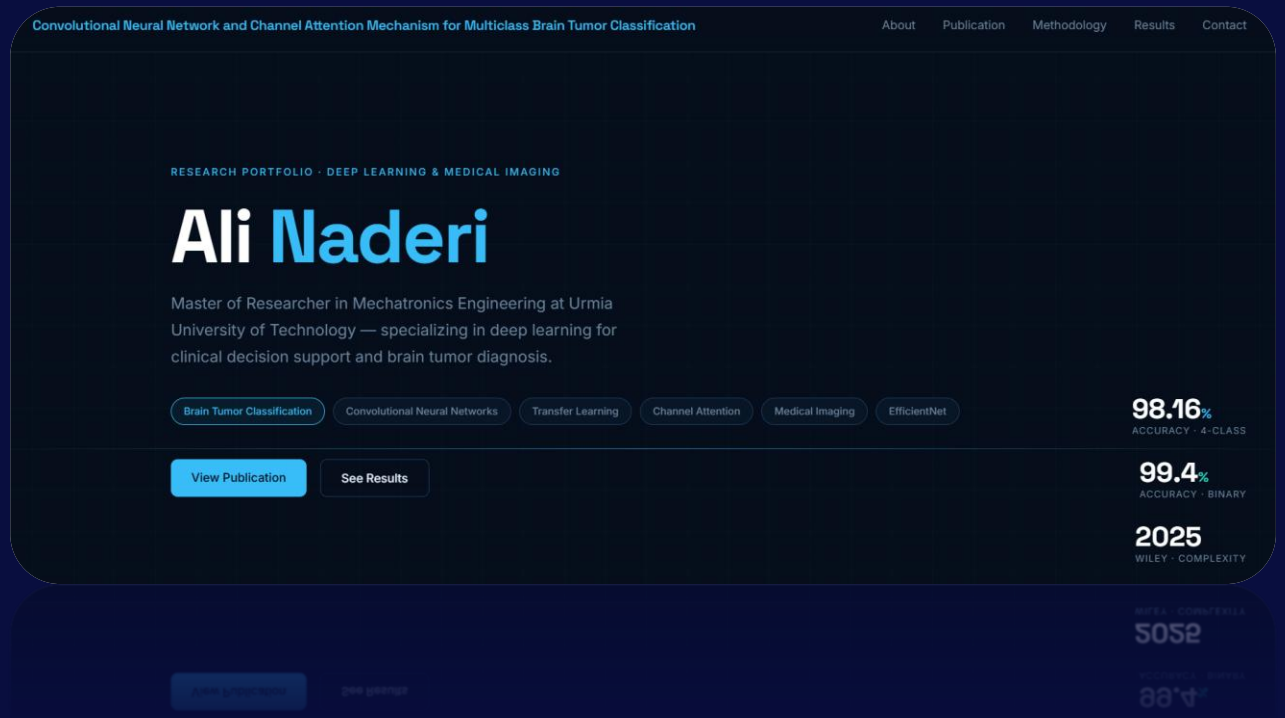
Track Record

Successfully executed advanced academic R&D and specialized corporate projects. Research has led to novel hybrid architectures and multiple papers in top-tier ISI journals and leading peer-reviewed conferences.

PROJECT 01

Automated Multiclass Brain Tumor Classification

Developed a state-of-the-art **Computer-Aided Diagnosis (CAD)** system for accurate, automated classification of brain tumors from MRI scans — providing a reliable, objective second opinion for clinical decision-making.



Technical Architecture

- **Transfer Learning:** EfficientNetB7 (ImageNet pre-trained); first 4 MBConv blocks frozen, blocks 5–7 fine-tuned for domain-specific oncological patterns
- **Channel Attention Module (CAM):** Exploits inter-channel relationships via avg/max pooling to amplify clinically relevant tumor features
- **Optimized Classifier:** Batch Norm → 256-neuron Dense (Grid Search) → 45% Dropout → Softmax
- **Training:** SGDM optimizer, cross-entropy loss, L1/L2 regularization, rigorous data augmentation

R.GATE LINK

PROJECT 01 — RESULTS

Brain Tumor Classification: Benchmark Results

98.16%

4-Class Accuracy

Glioma, Meningioma, Pituitary Tumor, No-Tumor on Brats-4C dataset

99.4%

Binary Accuracy

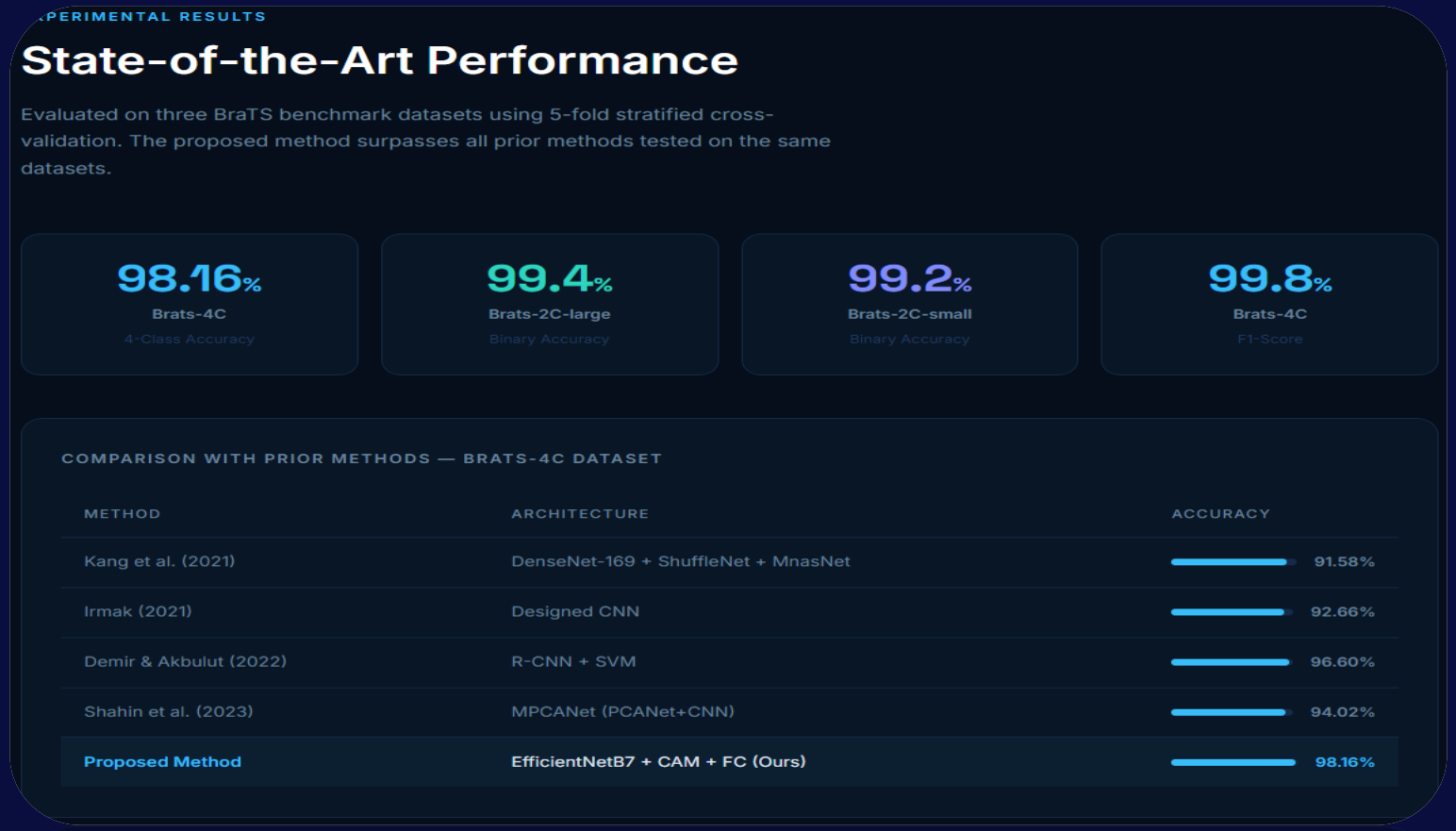
Brats-2C-large dataset

99.2%

Binary Accuracy

Brats-2C-small dataset

Results validated via **5-fold stratified cross-validation**. Peer-reviewed and published as a full-length research article in **Wiley Complexity (Volume 2025)**.



PROJECT 02

PhyQ-TransNet — Intelligent Fault Diagnosis for Rotating Machinery

Designed an automated diagnostic model to detect and classify micro-faults in rolling element bearings under severe industrial noise and varying loads — conditions where standard deep learning networks fail to generalize.

The Solution

PhyQ-TransNet — a novel hybrid Deep Learning architecture integrating a physics-informed feature extractor with a Transformer encoder. The system mirrors physical signal demodulation, bypassing "black-box" CNN limitations.

Key Methodological Highlights

- **Physics-Informed Architecture:** Mathematically aligned with classical signal demodulation principles
- **Extreme Noise Resilience:** Flawless accuracy even at **-10 dB SNR** (10× stronger noise)
- **Multi-Sensor Fusion:** Synchronous three-accelerometer data for maximum spatial fault resolution
- **Leakage-Free Validation:** Strict chronological data-splitting for true out-of-sample generalization

PROJECT 02 — PERFORMANCE

PhyQ-TransNet: Key Results & Deployment Blueprint

99.98%

IMB Accuracy

Across 5 international benchmarks

99.03%

Real Faults

Calibration ECE = 0.0047

99.72%

Extreme Noise

Robust under severe industrial noise

8.5ms

Inference Speed

~117 FPS, edge-compatible

1.4M

Parameters

Only 154 MB memory footprint

Benchmarks Validated

Comprehensively tested on **5 world-class international benchmarks**: CWRU, SGST, IMS, Paderborn, and NBS.

Hardware Optimization

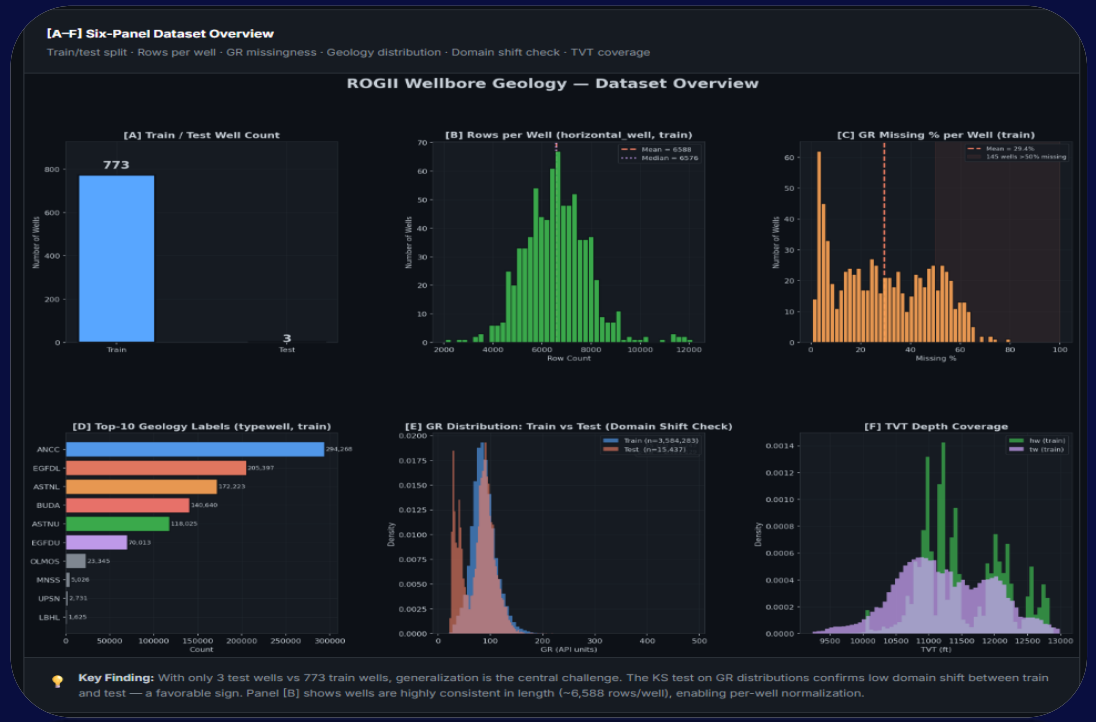
Built with **Python & PyTorch 2.5.1**. Optimized for edge-AI on standard hardware (Intel i5, Windows 11). Compact architecture: **1.4M parameters**, **3.21 GFLOPs**, ultra-fast **~8.5 ms** inference — fully compatible with real-time industrial IoT controllers.

Manuscript submitted to *International Journal of Machine Tools and Manufacture* (Elsevier Q1).

PROJECT 03

ROGII Wellbore Geology Prediction Pipeline

Engineered an end-to-end production-grade data science framework to process, clean, and decode multi-variate geological signals from a large-scale Kaggle challenge — transforming unrefined telemetry logs into stable, generalizable predictive metrics for automated lithology and wellbore geology forecasting.



Pipeline Architecture

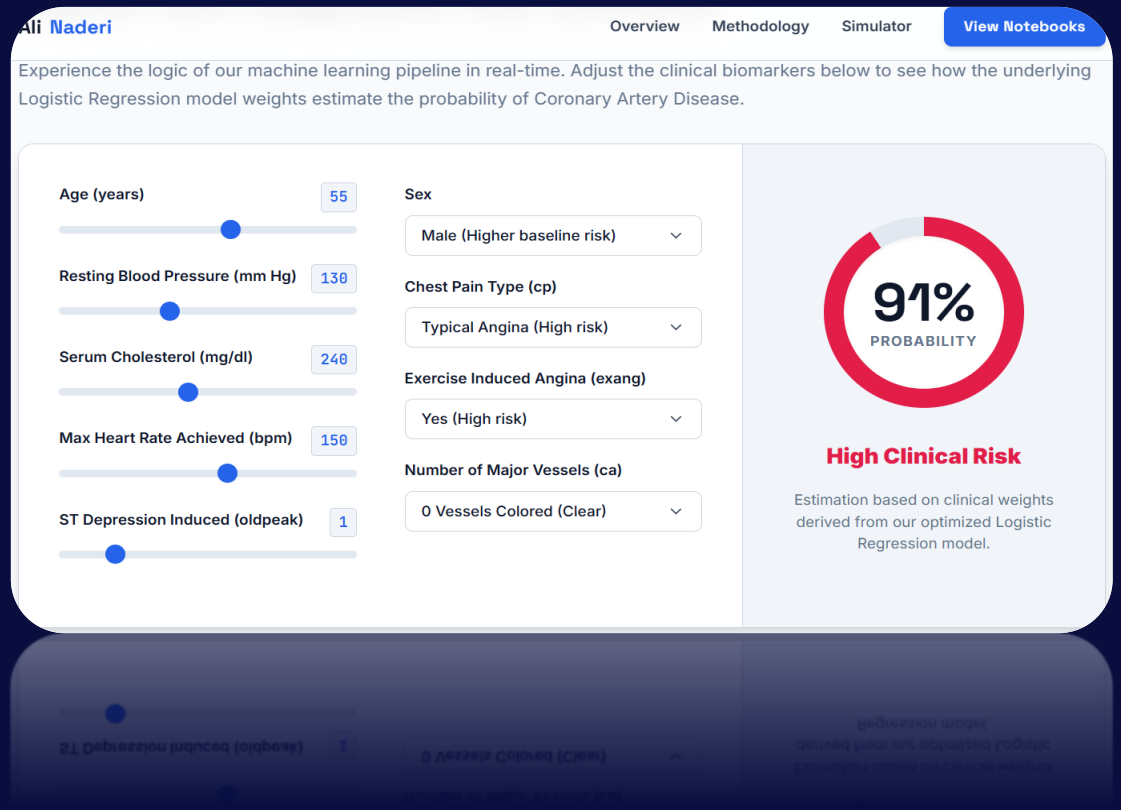
- **Core Stack:** Python (modular, object-oriented), Pandas & NumPy (heavily vectorized)
- **Statistical Modeling:** Trend analysis, localized signal smoothing, variance distribution alignment
- **Zero-Leakage Preprocessing:** Strict cross-validation isolation across distinct well groups
- **Feature Synthesis:** Rolling rates of change and sliding standard deviations boosting signal-to-noise ratio
- **Validation:** Spatial and chronological well-sequence protocol preventing geological data leakage

Project Link

PROJECT 04

Clinical Decision Support System — Heart Disease Prediction

Engineered a clinically-validated ML classification pipeline maximizing patient **Recall** (minimizing false negatives) on the **UCI Cleveland Dataset** (303 patients, 13 clinical features). Final architecture: **Stacking Classifier** (SVM + Random Forest + KNN base estimators, Logistic Regression meta-classifier) with Soft Voting Ensembles.



Clinical Indicators

- Resting ECG & ST Depression — myocardial ischemia diagnosis
- Max Heart Rate & Angina — exercise-induced cardiac thresholds
- Cholesterol & Blood Pressure — baseline systemic risk factors

Methodology

- Deep EDA: Q-Q Normality, Mann-Whitney U, Chi-Square with Cramer's V
- Zero-Leakage ColumnTransformer: Yeo-Johnson transforms, One-Hot Encoding, Standard Scaling, VIF audits
- Stratified 5-Fold GridSearchCV across Decision Trees, Random Forests, KNN, SVM, and XGBoost

Project Link

PROJECT 05

Real-Time Traffic Density Estimation Pipeline

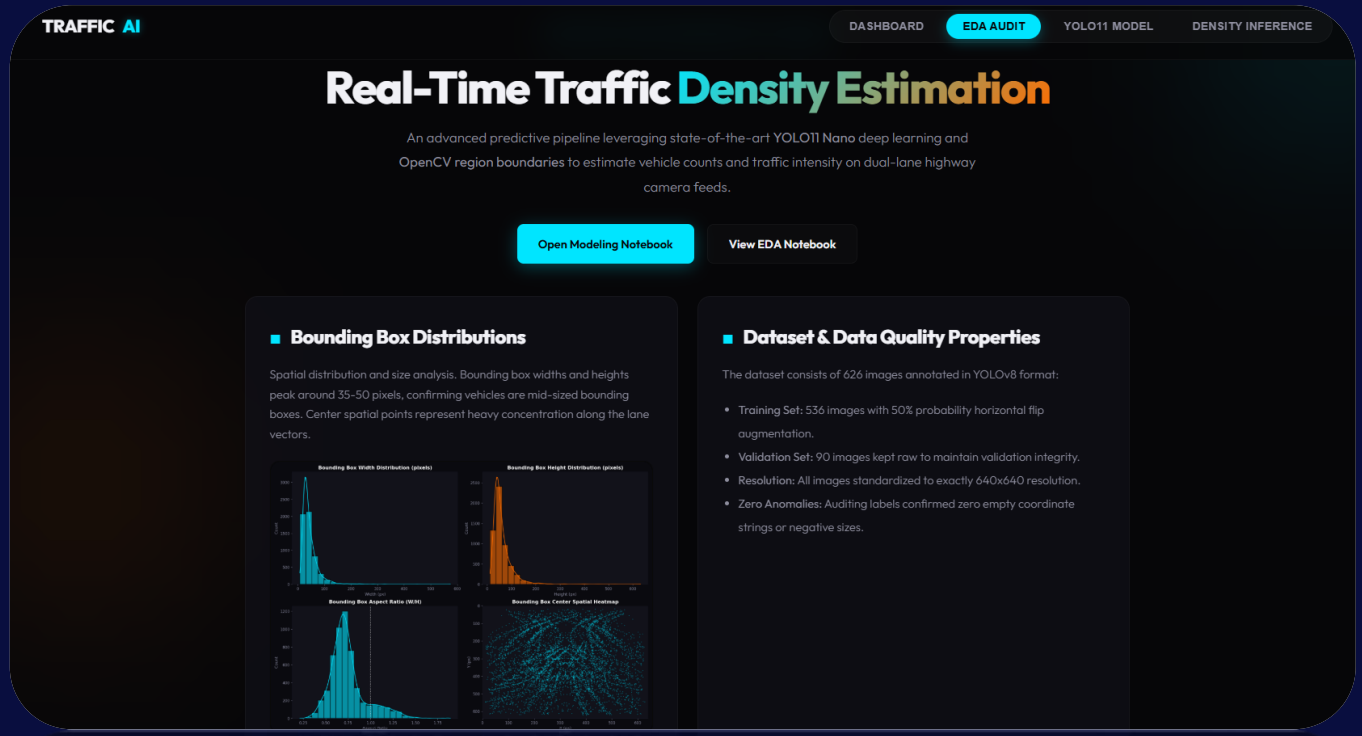
An advanced predictive pipeline leveraging **YOLO11 Nano** deep learning and OpenCV region boundaries to automate vehicle tracking and traffic intensity analysis on dual-lane highway camera feeds.

Core Performance Metrics

- **Bounding Box Precision: 91.2%** — minimal false positives
- **Bounding Box Recall: 94.7%** — high true positive rate under shadows/glare
- **mAP50: 97.4%** — Mean Average Precision at IoU 0.50
- **mAP50-95: 72.4%** — ultra-tight bounding box contours

Dataset & Hardware

- 626 high-res images (YOLOv8 schema), 536 train + 90 validation, 640×640 resolution
- Fine-tuned on **GTx 1650 CUDA** over 50 epochs
- Exported to compressed **10.1 MB ONNX** format for OpenCV cross-platform deployment



Project Link

CONNECT

Strategic Advantages, Services & Contact

Competitive Advantages

- **Physics-Informed Expertise:** Mechatronics background merges physical domain knowledge with deep learning for interpretable, robust industrial AI
- **Hardware Optimization:** Resource-efficient algorithms for fast inference on accessible enterprise hardware (Intel i5, Windows 11)
- **Research-Driven:** Methodical code architecture backed by ISI publication track record

Services Offered

- **Predictive Maintenance:** Custom fault diagnosis models for rotating machinery
- **Data Engineering:** Scalable ETL architectures and cleaning pipelines
- **BI Dashboards:** Lightweight Streamlit tools for real-time analytics
- **Automotive Tuning:** Advanced ECU remapping via WinOLS
- **R&D Consulting:** Technical documentation and LaTeX for research projects

Let's build intelligent, data-driven solutions together. Reach out for