# Başak ERSÖZ YILDIRIM

PhD Candidate in Electrical, Electronics and Communications Engineering
Department of Electronics and Telecommunications, Politecnico di Torino
Corso Duca degli Abruzzi 24, 10129 Torino, Italy
basak.ersozyildirim@polito.it
Google Scholar • LinkedIn • GitHub • MIRABILIS • Project GitHub

## RESEARCH INTERESTS

AI for scientific measurement and experimental systems; data science for experimental sensing and imaging; optical feedback and self-mixing interferometry; semiconductor-laser sensing; single-pixel and computational imaging; compressed sensing and inverse problems; reliability-aware machine learning; experimental signal and image processing; unsupervised operating regime discovery; uncertainty aware decision systems; biomedical sensing and imaging.

## EDUCATION

**PhD in Electrical, Electronics and Communications Engineering** **03/2024 – 02/2027 (expected)**
*Politecnico di Torino, Department of Electronics and Telecommunications* *Torino, Italy*
- Doctoral project: MIRABILIS – Mid-Infrared Label-Free Interferometric Detectorless Imaging Photonic Circuit, funded through PRIN 2022.
- Research focus: optical-feedback and self-mixing sensing, speckle-based single-pixel imaging, compressed sensing, experimental regime identification, and machine learning for reliable classification and reconstruction.
- Supervisors: Prof. Paolo Bardella, PhD and Prof. Lorenzo Columbo, PhD.

**MSc in Electrical Engineering** **2021 – 2023**
*Yıldız Technical University, Faculty of Electrical and Electronics Engineering* *İstanbul, Türkiye*
- Thesis: Deep-learning analysis and forecasting of Locational Marginal Prices using electricity market data from MISO, ISO New England, and PJM, with applications to bidding strategies under unpredictable events.
- Supervisor: Prof. Ozan Erdinç, PhD - oerdinc@yildiz.edu.tr.

**BSc in Electrical Engineering** **2014 – 2019**
*Yıldız Technical University, Faculty of Electrical and Electronics Engineering* *İstanbul, Türkiye*
- Supervisor: Prof. Nur Bekiroğlu, PhD - nbekir@yildiz.edu.tr.

## RESEARCH EXPERIENCE

**Doctoral Researcher – MIRABILIS Project** **03/2024 – present**
*Politecnico di Torino* *Torino, Italy*
- Use experimental and computational methods for compact optical sensing systems combining semiconductor lasers, optical feedback, self-mixing interferometry, speckle illumination, compressed sensing, and single-pixel imaging, with a long term objective in mid-infrared label free sensing.
- Work across the complete experimental pipeline, including laser based signal acquisition, nanofiber generated speckle illumination, photodiode monitoring, motorized scanning, camera based pattern recording, oscilloscope acquisition, and computational data analysis.
- Construct and analyze multimodal datasets containing self-mixing waveforms, photodiode signals, speckle images, scalar detector measurements, sensing matrices, target images, and reconstructed images under varying alignment and feedback conditions.
- Develop compact signal representations from raw waveforms and their temporal derivatives, and compare time domain descriptors with spectrogram and scalogram representations for experimental regime analysis.
- Apply standardization, PCA, t-SNE, and DBSCAN to identify stable operating regimes, reject sparse or regime inconsistent measurements, and improve the reliability of downstream classification.
- Design validation safe machine learning pipelines and compare classical and deep-learning models, including logistic regression, SVM, decision trees, random forests, CNNs, LSTM, BiLSTM, GRU, and BiGRU architectures.
- Demonstrate that measurement consistency and operating regime selection can have a greater impact on classification performance than increasing model complexity alone.
- Develop compressed sensing reconstruction workflows using experimentally measured speckle patterns, sensing-matrix construction, scalar optical measurements, and Moore - Penrose pseudoinverse reconstruction.
- Evaluate reconstruction quality using SSIM, PSNR, MSE, and RMSE, Macro-F1 and investigate the effects of pattern count, alignment error, and model measurement mismatch on image recovery.
- Contribute to experimental interpretation, data processing pipelines, manuscript preparation, figure and table generation, and international conference presentations within collaborations involving Politecnico di Torino, Università di Bari Aldo Moro, Politecnico di Bari, and industrial partners.

**Graduate Researcher** **10/2021 – 02/2024**
*Yıldız Technical University* *Istanbul, Türkiye*

- Developed LSTM-based forecasting models for Locational Marginal Prices during volatile and unpredictable electricity-market conditions.
- Studied ensemble-learning methodologies for electrocardiogram analysis and compared multiple supervised-learning approaches under a common evaluation framework.
- Completed focused training in machine learning, deep learning, computer vision, biomedical signal and image processing, and statistical data analysis.

## INDUSTRY RESEARCH AND DEVELOPMENT EXPERIENCE

**TCU Connectivity Engineer, R&D** **03/2021 – 10/2022**
*Ford Motor Company & Ford Otosan – Ford Transit / Ford of Europe* *İstanbul, Türkiye*

- Supported end-to-end development, integration, validation, and sign-off of telematics control units and connected vehicle features across distributed Ford of Europe teams.
- Translated requirements from business, customer, manufacturing, CRM, electric vehicle, and IT teams into technical specifications and validation activities.
- Analyzed modem quality data, connectivity metrics, and field issues; coordinated troubleshooting across software, electrical, manufacturing, and supplier teams using Agile delivery practices.
- Worked on connected user-facing functions where mobile applications, cloud services, in-vehicle communication networks, and electronic control units must operate as one reliable system.

**Multimedia Systems Engineer, R&D** **03/2020 – 03/2021**
*Ford Motor Company & Ford Otosan – Ford Trucks, FMax* *İstanbul, Türkiye*

- Developed and released multimedia, navigation and voice guidance, in-vehicle audio systems (Speakers (front, rear, tweeters, woofers), microphones (for handsmfree calls), bluetooth audio streaming, integration with steering wheel controls and the infotainment software), radio (AM/FM/DAB), antennas, power outlet (12-24V), and emergency connectivity components for heavy commercial vehicles.
- Coordinated suppliers and production, quality, marketing, integration, and validation teams to resolve field and manufacturing issues and obtain product approvals.
- Supported the transition from Windows CE to Linux-based multimedia infrastructure, integration of HERE navigation, and introduction of Digital Audio Broadcasting functionality.

**Research and Development Engineer** **06/2018 – 03/2020**
*Arçelik A.Ş. / BEKO* *İstanbul, Türkiye*

- Designed sensor based product concepts, PCB prototypes, and Arduino based embedded systems for household/whitegood appliances, including vacuum cleaner and dryer demonstrators prepared for IFA Germany.
- Integrated pressure sensing to infer floor conditions and adapt suction or motor behaviour automatically, linking sensor interpretation to comfort, efficiency, and product control.
- Explored conductive, capacitive, temperature, humidity, load, current, airflow, and image based sensing concepts for automatic dryness and fabric condition estimation in dryer systems.
- Identified data abnormalities and investigated sensor driven opportunities for product and process optimization, developing a system level perspective from measurement to practical decision.

## PUBLICATIONS

### Manuscripts Under Review / Submitted

**B. Ersöz**, P. Chaudhary, M. Dabbicco, M. Brambilla, L. Columbo, and P. Bardella, "DBSCAN Cleaning with t-SNE and Machine Learning of Experimental Optical Feedback Self-Mixing Waveforms," *IEEE Access manuscript*, 2026. **[under review]**

S. N. İpek, N. Bekiroğlu, M. Taşkıran, and **B. Ersöz**, "KAN-CAS: A KAN-Assisted Cascade Model for PMSM Sizing Estimation in Electric Vehicle Applications." *Engineering Science and Technology, an International Journal (Elsevier), 2026.* **[under review]**

### Conference Publications

**B. Ersöz**, P. Chaudhary, M. Dabbicco, M. Brambilla, L. Columbo, and P. Bardella, "Learning Operating Regimes from Experimental Data in Optical Feedback Systems," *IEEE 50th Annual Computers, Software, and Applications Conference (COMPSAC), Madrid, Spain*, 2026. **[full paper & presented]**

**B. Ersöz**, P. Chaudhary, P. Bardella, M. Dabbicco, L. Columbo, and M. Brambilla, "DBSCAN Controlled Target Classification Using Self Mixing with a Semiconductor Laser," *International Conference on Transparent Optical Networks (ICTON), Prague, Czech Republic*, 2026. **[presented]**

**B. Ersöz**, P. Chaudhary, M. Dabbicco, M. Brambilla, L. Columbo, and P. Bardella, "Density Core Regime Selection in Experimental Self Mixing Optical Feedback Signals Using DBSCAN," *Italian Conference on Optics and Photonics (ICOP), L'Aquila, Italy*, 2026. **[presented]**

P. Chaudhary, P. Loverre, **B. Ersöz**, P. Bardella, L. Columbo, M. Dabbicco, M. Brambilla, and S. Linari, "Characterization of Nanofiber Bundles for Single Pixel Imaging," *2025 IEEE 15th International Conference on Nanomaterials: Applications & Properties (NAP)*, 2025. DOI: 10.1109/NAP68437.2025.11216273

**B. Ersöz**, P. Chaudhary, P. Bardella, M. Dabbicco, L. Columbo, and M. Brambilla, "Inaccuracy Amplified: Compressed Sensing Under Experimental Misalignment," *International Conference on Numerical Simulation of Optoelectronic Devices (NUSOD)*, 2025. DOI: 10.1109/NUSOD64393.2025.11199519

P. Bardella, M. Brambilla, L. L. Columbo, M. Dabbicco, **B. Ersöz**, and P. Chaudhary, "Common-Path Optical Feedback Interferometry Design of Single-Pixel Imaging Experiments," *Optical Methods for Inspection, Characterization, and Imaging of Biomaterials VI, Proceedings of SPIE*, 2025. DOI: https://doi.org/10.1117/12.3068763

**B. Ersöz**, P. Bardella, L. Columbo, M. Novarese, M. Dabbicco, and M. Brambilla, "Single-Pixel Imaging with Optical Phase Arrays: A Machine-Learning-Assisted Approach," *AI and Optical Data Sciences VI, Proceedings of SPIE 13375, pp. 222–225*, 2025. DOI: https://doi.org/10.1117/12.3044444

**B. Ersöz**, M. Taşkıran, and K. N. Bekiroğlu, "Ensemble Learning Methodologies for Electrocardiogram Analysis: A Comparative Study," *International Conference on Intelligent and Innovative Technologies in Computing, Electrical and Electronics (IITCEE)*, 2024. DOI: 10.1109/IITCEE59897.2024.10467494

M. Dabbicco, L. Columbo, **B. Ersöz**, M. Brambilla, and P. Bardella, "Mid Infrared Label Free Interferometric Detectorless Imaging Photonic Circuit," *2024 IEEE 14th International Conference on Nanomaterials: Applications & Properties (NAP)*, 2024. DOI: 10.1109/NAP62956.2024.10739687

M. Dabbicco, **B. Ersöz**, P. Bardella, L. L. Columbo, and M. Brambilla, "Towards a Label Free Coherent Detectorless Imaging Module in Photonic Integrated Circuits," *Biomedical Spectroscopy, Microscopy, and Imaging III, Proceedings of SPIE 13006, 130060R*, 2024. DOI: 10.1117/12.3029530

**B. Ersöz**, S. Yıldız, A. S. Türkoğlu, O. Erdinç, and A. R. Boynueğri, "Evaluating LMP Forecasting with LSTM Networks: A Deep Learning Approach to Analyzing Electricity Prices During Unpredictable Events," *2023 5th Global Power, Energy and Communication Conference (GPECOM), pp. 477–482*, 2023. DOI: 10.1109/GPECOM58364.2023.10175743

## SKILLS

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|---|---|
| **Scientific computing** | MATLAB (primary environment throughout the PhD); Python; Simulink; SQL; C (basic); numerical modelling; algorithm development; reproducible data processing pipelines; scientific visualisation; statistical analysis. |
| **Data science skills** | Data preparation and quality control; feature engineering; dimensionality reduction and manifold analysis; clustering and anomaly detection; supervised and unsupervised learning; deep neural networks; model selection and hyperparameter optimization; validation safe experimental design; uncertainty, error, and per-class performance analysis. |
| **Photonics and engineering systems** | Optical feedback and self-mixing interferometry; semiconductor-laser sensing; single-pixel and computational imaging; compressed sensing and inverse reconstruction (Moore - Penrose pseudoinverse reconstruction); speckle-pattern analysis; experimental data acquisition; sensor technologies; embedded sensing and communication systems, including CAN, I²C, and Bluetooth; automotive connectivity; diagnostics; requirements engineering; system integration; validation; quality. |
| **Professional strengths** | Independent and interdisciplinary research; analytical problem formulation and solving; translation of imperfect measurements into reliable decisions; scientific writing and conference presentation; cross institutional collaboration; technical communication across research, engineering, supplier, and product teams; structured troubleshooting and project ownership. |

## REFERENCES

**Prof. Paolo Bardella, PhD**
Department of Electronics and Telecommunications
Politecnico di Torino

**Prof. Lorenzo Columbo, PhD**
Department of Electronics and Telecommunications
Politecnico di Torino

**Atlas Noyan Gerelioğlu, MSc**
HCV Electromechanical Systems Leader,
Ford Otosan