Fellow	Gautam Sethia

Host Organisation	Fraunhofer Institute for Transportation and Infrastructure Systems (Fraunhofer IVI), Germany

Scientific coordinator	Dr. Martin Ufert

I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

During my ERCIM fellowship at Fraunhofer IVI, my work primarily focused on advancing battery modelling techniques and battery management systems (BMS) for e-mobility applications. I actively contributed to multiple projects, with a major role in the European Union Horizon ZEFES project, which aims to enable zero-emission freight transport. Within the ZEFES project, my core responsibility was the development of a comprehensive digital twin of the battery system. This digital twin integrates multiple key modules to simulate and monitor battery performance across various conditions and chemistries. The main components I developed include:

- Battery modelling for various chemistries, along with accurate parameterization
- State-of-Charge (SOC) estimation
- State-of-Health (SOH) estimation
- Thermal modelling to account for heat generation and dissipation dynamics
- Battery safety protection module, incorporating fault detection and limit enforcement
- Scalable modelling, from single cell to full battery pack representation

These modules collectively build a robust digital representation of the battery system for real-time applications. SOC and SOH estimations were implemented using Kalman Filter and machine learning approaches. In addition to the ZEFES project, I contributed to the HYPESS project, where I developed advanced SOC estimation algorithms tailored for aerial applications. These estimations also included confidence intervals, allowing for more reliable and transparent state tracking under uncertain operating conditions. Additionally, I introduced the concept of State of Safety (SoS)—a novel metric to quantitatively assess the operational safety of lithium-ion batteries under real-world conditions.

This research collectively supports the development of intelligent, safe, and efficient BMS solutions, and contributes toward realizing the next generation of battery-powered mobility systems.

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

- **Gautam Sethia**, Erik Berendes, Richard Kratzing, Thomas Lehmann, “Quantitative Assessment of State of Safety of Lithium-ion Batteries,” IEEE 19th International Conference on Compatibility, Power Electronics and Power Engineering (CPE-POWERENG), Antalya, pp. 1–6, May 2025. IEEE.
- Thomas Lehmann, Erik Berendes, Richard Kratzing, **Gautam Sethia**, “Learning the Ageing Behaviour of Lithium-ion Batteries using Electric Vehicle Fleet Analysis,” Batteries, MDPI, vol. 10, no. 12, p. 432, Dec. 2024.
- Farshid Naseri, **Gautam Sethia**, Erik Schaltz, “Electrical Characterization and Performance Review of a New High-Power Lithium Iron Phosphate Cell,” IECON 50th Annual Conference of the IEEE Industrial Electronics Society, Chicago, pp. 1–6, Nov. 2024. IEEE.

III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

- IEEE 19th International Conference on Compatibility, Power Electronics and Power Engineering (CPE-POWERENG), May 2025, Antalya, Turkey
- Oxford Battery Modelling Symposium, Oxford, UK, July 2025

IV – RESEARCH EXCHANGE PROGRAMME (REP)

As part of the ERCIM Research Exchange Programme, I visited VTT Technical Research Centre of Finland under the supervision of Dr. Pankaj Saha and Dr. Ari Hentunen. The purpose of this visit was to foster exchange of research ideas and build collaborations. I participated in scientific discussions, presented ongoing work in Fraunhofer IVI, and engaged with VTT researchers. The exchange contributed to strengthening my research direction and may lead to future collaboration and joint publications.

V – SUM UP OF THE FINAL SCIENTIFIC REPORT FOR THE ERCIM NEWSLETTER

Dr. Gautam Sethia conducted his ERCIM Fellowship at Fraunhofer IVI, Dresden, Germany, under the supervision of Dr. Martin Ufert. His research focused on battery modelling and battery management systems for e-mobility applications, including State-of-Charge (SOC), State-of-Health (SOH), thermal modelling, and State of Safety. During the fellowship, he contributed significantly to the EU Horizon ZEFES and HYPESS projects. As part of the Research Exchange Programme (REP), he collaborated with Dr. Pankaj Saha and his team at VTT Finland. Dr. Sethia aims to continue his research in battery systems and advanced energy technologies. He is open to future collaboration and can be reached via LinkedIn: http://www.linkedin.com/in/gautam-sethia-phd-b556ba71