

Fadi El Kalach

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Google Scholar: <https://scholar.google.com/citations?user=cpDqs3gAAAAJ&hl=en>

RESEARCH INTERESTS

- Smart Manufacturing, Advanced Manufacturing, Cognitive Manufacturing, Semantic Web, Knowledge Graphs, Time Series Classification, Anomaly Detection, Information Systems, Time Series Forecasting

EDUCATION

- **Clemson University – Greenville, South Carolina** **01/2025- 06/2026**
PhD. In Automotive Engineering
- **University of South Carolina - Columbia, South Carolina** **08/2022-12/2024**
PhD. in Mechanical Engineering
- **University of South Carolina - Columbia, South Carolina** **08/2020-12/2022**
MSc. In Computer Engineering
- **Lebanese American University – Beirut, Lebanon** **09/2015-02/2020**
BE. in Mechatronics Engineering

WORK EXPERIENCE

- **McNair Center for Aerospace Engineering – Columbia, South Carolina** **10/2020-Present**
 - **Research Technical Lead:** First graduate student to be part of the **Future Factories** team and the **Artificial Intelligence Institute at UofSC**
 - Constructed a manufacturing research testbed with advanced technologies including Edge Computing, Digital Twins, and IIoT capabilities.
 - Lead and mentored a group of 10 graduate students.
 - **Research Topic 1: Semantic Web**
 - **Project 1: Fault Tolerant Manufacturing Using Semantic Web**
 - Utilized Semantic Web technologies deployed at the Edge level to realize Autonomous Manufacturing use cases.
 - Created mapping from generated raw sensor data to RDF triples.
 - Semantic Modelling was done on a custom application developed and deployed on the Siemens IPC227E Edge device.
 - Generated real time Industrial Knowledge Graph.
 - Applied reasoning and knowledge extraction principles for decision making processes.
 - **Project 2: Increased AI Explainability in Manufacturing**
 - Employed Knowledge Graphs to address explainability issue of Machine Learning models in Manufacturing.
 - Explainability entails providing possible reasons to Technicians for a Machine Learning model's prediction, eradicating the "black-box".
 - **Research Topic 2: Time Series Classification (TSC)**
 - Developed a framework for real time deployment of TSC on industrial manufacturing systems.
 - Trained multiple TSC models to compare results.
 - Created end-to-end application for real time monitoring and classification of manufacturing assembly line.
 - **Research Topic 3: Cognitive Manufacturing**
 - Performed exhaustive literature review to establish new research field of Cognitive Manufacturing.
 - Defined the term Cognitive Manufacturing and associated trends within the field.
 - Publication was **accepted within the first submission** in a top 3 manufacturing journal.

- **Research Topic 4: Data Driven Advanced Manufacturing**
 - Collected, processed, and published two manufacturing datasets to be used for various research projects.
- **Siemens Technology, R&D Department – Princeton, New Jersey** **05/2023-08/2023**
 - **Automation Runtime System Research & Development Intern**
 - Developed Proof of Concept for a **Federated Information System**.
 - Vital as scalable solution for Vertical Integration of Manufacturing Systems.
 - Novel modular and interoperable solution ready to be implemented in manufacturing facilities.
 - Adopted technologies such as **GraphQL, Flask, Knowledge Graphs, and OPC UA**
- **University of South Carolina - Columbia, South Carolina** **08/2020-Present**
 - **Instructor:**
 - **CEC101: Introduction to Computer Concepts** **01/2021- 06/2021**
 - Held weekly lectures for a **Python** coding course.
 - Corrected and graded assignments and assessments.
 - **CEC102: General Applications Programming** **08/2020- 12/2020**
 - Held weekly lectures for a **HTML and CSS** coding course.
 - Corrected and graded assignments and assessments.
 - **Teaching Assistant:**
 - **ENCP734: Prototype Design and Manufacturing** **01/2022-Present**
 - Prepared lectures and tutorials used in the class
 - Help lectures in Siemens Process Simulate
 - Graded assignments and projects
- **Dar Al Handasah (Shair & Co) – Beirut, Lebanon** **07/2019-08/2019**
Leading International Engineering Consultancy Firm
 - **Controls and Instrumentation Engineering Consultant Intern**
 - Designed and presented PLC projects required for industrial automation.
 - Facilitated the development of Building Management System (BMS) designs.

PUBLICATIONS

- El Kalach, F., Wickramarachchi, R., Harik, R., & Sheth, A. (2023). A Semantic Web Approach to Fault Tolerant Autonomous Manufacturing. *IEEE Intelligent Systems*, 38(1), 69-75.
- El Kalach, F., Solanki, J., Todkar, A. (2024). A Federated Information System Framework for Vertical Integration, *Accepted, North American Manufacturing Research Conference (NAMRC)*
- El Kalach, F. (2023). A semantic web approach to fault tolerant autonomous manufacturing (Order No. 29397944). Available from Dissertations & Theses @ University of South Carolina; ProQuest Dissertations & Theses Global. (2840913778). Retrieved from <https://www.proquest.com/dissertations-theses/semantic-web-approach-fault-tolerant-autonomous/docview/2840913778/se-2>
- El Kalach, F., Yousif, I., Wuest, T. et al. Cognitive manufacturing: definition and current trends. *J Intell Manuf* (2024). <https://doi.org/10.1007/s10845-024-02429-9>
- Harik, R., Kalach, F. E., Samaha, J., Clark, D., Sander, D., Samaha, P., ... & Saha, N. (2024). Analog and Multi-modal Manufacturing Datasets Acquired on the Future Factories Platform. arXiv preprint arXiv:2401.15544.
- Kirkpatrick, M., Sander, D., El Kalach, F., & Harik, R. (2023). Motion capture based calibration for industrial robots. *Manufacturing Letters*, 35, 926-932.
- Farahani, M., El Kalach, F., Harik, R., Wuest, T. (2024). High-resolution time-series classification in smart manufacturing systems, *Accepted, North American Manufacturing Research Conference (NAMRC)*
- Yousif, I., Burns, L., El Kalach, F. et al. Leveraging computer vision towards high-efficiency autonomous industrial facilities. *J Intell Manuf* (2024). <https://doi.org/10.1007/s10845-024-02396-1>
- Shyalika, C.; Wickramarachchi, R.; El Kalach, F.; Harik, R.; Sheth, A. Evaluating the Role of Data Enrichment Approaches towards Rare Event Analysis in Manufacturing. *Sensors* 2024, 24, 5009. <https://doi.org/10.3390/s24155009>
- Samaha, P., El Kalach, F., Harik, R. (2024). Leveraging the usage of Blockchain toward trust-dominated manufacturing systems, *Under Review, Journal of Manufacturing Systems*
- Shyalika, C.; Roy, K.; Prasad, R.; Kalach, F.E.; Zi, Y.; Mittal, P.; Narayanan, V.; Harik, R.; Sheth, A. RI2AP: Robust and Interpretable 2D Anomaly Prediction in Assembly Pipelines. *Sensors* 2024, 24, 3244. <https://doi.org/10.3390/s24103244>
- Prasad, R., Shyalika, C., Zand, R., Kalach, F. E., Venkataramanan, R., Harik, R., & Sheth, A. "AssemAI: Interpretable Image-Based Anomaly Detection for Manufacturing Pipelines, *Accepted, ICMLA* (2024).

PUBLICATION IN PROGRESS

- **El Kalach, Fadi** and Farahani, Mojtaba and Wuest, Thorsten and Harik, Ramy, Real-Time Defect Detection and Classification in Robotic Assembly Lines: A Machine Learning Framework. Available at SSRN: <https://ssrn.com/abstract=4882365> or <http://dx.doi.org/10.2139/ssrn.4882365>
- **El Kalach, F.**, Solanki, J., Todkar, A. (2024). Semantic Integration of OPC UA Information Models Through a Federated Information System, *In Progress*.
- **El Kalach, F.**, Venkataramanan, R., Sheth, A., Harik, R., (2024) Utilizing Knowledge Graphs for Increased Explainability in Manufacturing, *In Progress*.
- McCormick, M., **El Kalach, F.**, Harik, R., Wuest, T. (2024) Real-Time Robotics Assembly Line Manufacturing Datasets, *In Progress*
- Farahani, M., **El Kalach, F.**, Harper, A., Harik, R., Wuest, T. (2024). Time-Series Forecasting in Smart Manufacturing Systems: An Experimental Evaluation of the State-of-the-art Algorithms, *In Progress*

PATENTS

- Todkar, A., Solanki, J., Yuezbasoglu, E., El Kalach, F.; Siemens Corporation, *Patent Pending*, Semantic model and data sync between OPC devices using Federated Information System, USA

CONFERENCES

- **North American Manufacturing Research Conference (NAMRC 2023)**
 - **Roles:** Presenter, Attendee
- **North American Manufacturing Research Conference (NAMRC 2024)**
 - **Roles:** Presenter, Attendee, Reviewer, Moderator
- **The Sixth International Symposium on Automated Composites Manufacturing (ACM6)**
 - **Roles:** Chair of Hospitality Committee

WORKSHOPS HELD

- **Siemens Process Simulate Workshop at the University of South Carolina:** A powerful digital twin software for process design, simulation, and analysis.
- **Yaskawa Robot Programming and Operation Workshop at the University of South Carolina**

SELECTED MEDIA COVERAGE

- **ABC Columbia**, *UofSC, Verizon partner to launch "Innovation Experience Hub"*, 2022, <https://www.abccolumbia.com/2022/09/16/uofsc-verizon-partner-to-launch-innovation-experience-hub/>
- **The Daily Gamecock**, *Collaborative robots in McNAIR Center build relationship between humans, robots in workforce*, 2024, <https://www.dailygamecock.com/article/2024/01/collaborative-robots-in-mcnair-center-build-relationship-between-humans-and-robots-in-the-workforce-news-wolfe>

CONTRIBUTION TO GRANTS AND PROPOSALS

- **National Science Foundation (NSF) EPSCoR RII Track 2 FEC:** Enabling Factory to Factory (F2F) Networking for Future Manufacturing. **Award Amount: \$3.8 Million**
 - Project Manager:
 - Ensure all tasks and deliverables progress in a timely manner.
 - Host biweekly update meetings between the four different research teams involved in the grant.
 - Compile a yearly progress report to be submitted to NSF.
 - Graduate Researcher
 - Achieved objectives of Semantic Web integration and Time Series Classification in Manufacturing Systems.
- **South Carolina Research Authority (SCRA):** Enabling Factory to Factory (F2F) Networking for Future Manufacturing across South Carolina. **Award Amount: \$1.2 Million**
 - Graduate Researcher
 - Achieved objectives of Semantic Web integration and Time Series Classification in Manufacturing Systems.

VOLUNTEER WORK

- Member of **Robotics Club and IEEE Club**
- Secretary for **Graduate Student Association** At UofSC

OUTREACH AND ECONOMIC DEVELOPMENT

- **Economic Development:** Hosted tours at the McNair Center for Aerospace Research to prominent public figures such as **Mayor Daniel Rickenmann** and Chief of Naval Research, **Rear Admiral Lorin Shelby**. Represented the University of South Carolina at Scout Motors announcement at South Carolina State House with **Governor Henry McMaster**.
- **ENCP101 Course with Lexington Technology Center:** The University of South Carolina and Lexington Technology Center partnered to work on a dual enrollment class for high school students to earn college credit. The class was generally an introduction to engineering topics such as: design, control systems, automation, and many more. Tasks completed include mentoring to assist in completion of a semester long project and taught a portion of the lectures. This class was asynchronous for most of the semester, but the LTC students had the opportunity to come to the McNair Aerospace Center to work hands-on with industrial equipment.
- **Edventure:** Our research team facilitated two outreach events at the Edventure Children's Museum. For the day, the aerospace section of the museum was dedicated to a paper glider activity. The kids were able to design and decorate their own gliders with the help of our team. They were then able to test their designs in a variety of distance and accuracy challenges. And in the courtyard, there were periodic bottle rocket launches. This event correlated with the museum's goals of inspiring children to learn.
- **Batesburg Leesville High School:** On Friday, February 24th, 2023, our team of graduate students from the University of South Carolina visited Batesburg-Leesville High School to conduct an outreach event. This event allowed high school students to work collaboratively with each other and our team of engineers to explore skills that will be utilized in their education and career if they were to pursue a STEM degree. The students had access to two activities: Hydrobot Arm Kits and Arduino Kits.
- **Saluda River Academy:** On March 31st, 2023, our team visited Saluda River Academy for the Arts and conducted an outreach activity with elementary school students. The team facilitated eight different STEM themed activities and got to interact with the students and get them excited about this career field. The focus for this outreach was to primarily keep their attention and share a fun memory, so that when they are older and deciding on their careers this may help to steer them towards engineering
- **Richland Northeast High School:** Presented at STEM Career Day to high school students about the possible career trajectories for graduate students.
- **Industry Collaboration:** Closely collaborated with Industrial partners such as Siemens and IBM