Khalil Al Handawi

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Profile

Research Design under uncertainty, additive manufacturing, multidisciplinary design optimization, agent-based modeling, transportation network modeling

Technical

Engineering systems
- Design for changeability and reliability, uncertainty quantification
- Analysis and allocation of design margins

Modeling and simulation:
- Finite element methods (thermomechanical, structural, electromagnetic)
- Agent-based methods, system dynamics models, Monte Carlo methods

Optimization:
- Blackbox and derivative-free optimization (mesh-adaptive direct search)
- Linear, nonlinear programming, and heuristics

Machine learning:
- Deep learning (recurrent neural networks), Graph representation learning
- Hyperparameter optimization and model selection

Software MATLAB/Simulink, Python (pandas, PyTorch, matplotlib, flask), C++ (CUDA, OpenMP, Qt) R (ggplot2, tidyverse), mySQL, FEA (Abaqus, ANSYS), CAD (SOLIDWORKS, NX Siemens), DAQ (NI LabVIEW)

Education

Jan 2017 – Dec 2020 **Doctor of Philosophy** *McGill University*
Mechanical Engineering , CGPA: 4.00
Concentraion Engineering design and optimization
Dissertation *Optimization driven set-based design under uncertain requirements*

Aug 2013 – Dec 2015 **Master of Science** *Khalifa University*
Mechanical Engineering , CGPA: 4.00
Concentraion Instrumentation and photonics
Dissertation *Internal corrosion detection of oil and gas pipelines using fiber optics*

Aug 2009 – June 2013 **Bachelor of Science** *Khalifa University*
Mechanical Engineering , First Class Honours, CGPA: 3.97
Capstone project *Development of a human operated mobile hexapod platform*

Experience

May 2022 – present **Computer Science and Operations Research, Université de Montréal** Montréal, Canada
Postdoctoral Researcher

- Work with the International Air Transport Association (IATA) to develop data analytics solutions for codesharing and flight scheduling in the civil aviation industry.
- Assess the effectiveness and impact of the IATA operation safety audit (IOSA) on air travel accessibility and cooperation between airlines.
- Maintain a mySQL database for storing flight records and other relevant data for research purposes.
- Use unsupervised learning, community detection, graph representation learning to discover latent community structures in the IATA dataset.

- Won a Natural Sciences and Engineering Research Council of Canada (NSERC) fellowship.

Sep 2022 – Dec 2022 **Deparment of Mechanical Engineering, McGill University** Montréal, Canada
Adjunct Lecturer

- The sole instructor of the Engineering System Optimization course (MECH559).
- Develop Python notebooks as teaching aids for the students to understand the implementation of modern optimization algorithms https://github.com/khbalhandawi/MECH559_notebooks.

Sep 2021 – Dec 2021 **Systems Engineering Design Lab, Chalmers University of Technology** Göteborg, Sweden
Postdoctoral Researcher

- Integrate my doctoral research on design under uncertainty into the activities of the SED lab.
- Author a Python library for sensitivity and robustness analyses in engineering systems: https://sed-group.github.io/mvmlib/index.html using Monte Carlo approaches and post-optimality analysis.
- Foster collaborations with the industry (GKN Aerospace) and write research proposals.

Jan 2021 – Apr 2022 **Systems Optimization Lab, McGill University** Montréal, Canada
Postdoctoral Researcher

- Develop statistical forecasting models for COVID-19 trajectories based on cross-sectional patient data. The forecasting models range in complexity from simple least squares models to recurrent neural network architectures.
- Deploy the trained forecasting models as a Flask application: https://covid-forecaster-lebanon.herokuapp.com/.
- Use stochastic blackbox optimization for hyperparameter tuning of said models.
- Build and publish a stochastic model of the spread of COVID-19 in a population using agent-based models and used stochastic blackbox optimization algorithms to identify possible public health policies https://github.com/khbalhandawi/COVID_SIM_GPU.

Jan 2017 – Jan 2021 **McGill University** Montréal, Canada
Research assistant

- Develop mathematical frameworks for quantifying design flexibility and robustness and managing uncertain requirements in aircraft system and subsystem design.
- Develop a thermomechanical simulation model for modeling additive manufacturing repair and life extension processes using transient coupled thermal/mechanical FEA simulations.
- Write automation scripts using NX Siemens and Abaqus Python APIs to automate geometry generation, meshing, anaylsis, and postprocessing of parametric simulations.
- Co-develop a novel lifecycle cost model based on system dynamics to model the effect of life extension on lifecycle costs.
- Use surrogate models to substitute expensive thermomechanical simulations in design studies and developed a variant of kernel smoothing for estimating the sensitivity of design solutions to different requirements by using a Jacobian matrix.
- Author a Flask application for conducting sensitivity and scalability studies on design of experiments data: https://github.com/khbalhandawi/scale_AM_webapp.

- Won a Fonds de Recherche du Québec Nature et Technologie (FRQNT) doctoral award.

June 2017 – Jan 2020 **GKN Aerospace Engine Systems** Trolhättan, Sweden
Visiting researcher

- Participate in a technology transfer to translate my research on optimization into industrial practice by provided training modules and workshops to GKN engineers (MATLAB and Python).
- Survey GKN engineers about their experience designing areoengine components for engine system manufacturers to create a timeline of expected design updates and changes. This data formed the basis of a case study for my research on design for flexibility and robustness.
- Set up advanced design automation and exploration tools to be used as part of GKN's workflow (engineering workbench) by integrated parametric design software (NX Siemens) with simulation software (Abaqus and ANSYS) to evaluate hundreds of concepts for a turbine rear frame.

Dec 2016 **Center for Autonomous Robotic Systems, Khalifa University** Abu Dhabi, UAE
Visiting researcher

- Conduct sensor fusion research for Remotely Piloted Aircraft Systems (RPAS).
- Fuse RPAS inertial measurement unit (IMU) data with high latency positioning measurements from an Optitrack motion capture system to obtain smooth high frequency attitude estimates suitable for control applications.

- Use the principles of quaternion transformation to translate observed attitude in the IMU reference frame to an inertial reference frame.
- Repurpose a DJI Wind 4 RPAS for firefighting by redesigning the drone platform to carry an extinguishant payload.
- Co-author a paper based on the repurposed RPAS to be published in a special issue of the Journal of Field Robotics.

Aug 2013 – Dec 2016 **Asset Integrity Management Systems Lab, Khalifa University** Abu Dhabi, UAE
Research Assistant

- Develop fiber optic sensors for monitoring mechanical and electrochemical phenomena such as strain, temperature, and corrosion.
- Work with fiber Bragg grating sensors for localized measurements of strain and temperature and their subsequent translation into corrosion rate.
- Establish a correlation between photoelastic properties of various waveguides (distrubuted and localized sensors) and the corrosion rate in oil and gas structures.
- Simulate photonic sensors in MATLAB by solving waveguide and Maxwell's equations.
- Develop a novel accelerated corrosion testing setup based on electrochemical cells for validating and verifiying the proposed corrosion sensors and establishing the calibration curve.

May 2014 – May 2015 **Khalifa University** Abu Dhabi, UAE
Khalifa university Baja SAE team leader

- Lead the first UAE national team to compete in the Baja SAE competition (Maryland, 2015).
- Guide the assembly team on integrating vehicle subsystems (chassis, suspension, and power train).
- Perform structural optimization on vehicle chassis using MATLAB and ANSYS.
- Provide workshops on finite elemenet anaylsis and computer aided design to team members.
- Prepare assembly and part drawings for the manufacturing team.

Jan 2018 – Dec 2019 **McGill University** Montréal, Canada
Teaching assistant

- Mechanical lab course – Prepared lab manuals, conducted labs, graded student reports, and incorporated MATLAB programming exercises into the syllabus.
- Engineering Professional Practice course – Conducted town halls, hosted guest lecturers, provided feedback to students, and gave several talks about entrepreneurship.

Aug 2013 – Dec 2015 **Khalifa University** Abu Dhabi, UAE
Teaching Assistant

- System dynamics and controls course – Conducted lab sessions and held office hours.
- Computer aided design – Conducted computer lab sessions.
- Mentored undergraduate students participating in the Abu Dhabi Solar Challenge.
- Co-mentored an undergraduate capstone project.

Aug 2012 – May 2012 **Yokogawa** Abu Dhabi, UAE
Engineering intern

- Wrote programs for industrial plant operation and control using distributed control systems.
- Visited the main headquarters in Japan to represent the Abu Dhabi National Oil Company.

Awards and recognition

May 2022 – Apr 2024 **Postdoctoral fellowship (PDF)** 90,000 CAD
National Sciences and Engineering Research council Canada

May 2019 – Dec 2021 **Doctoral Research award (B2X)** 56,000 CAD
Fonds de Recherche du Québec - Nature et Technologies

Jan 2017 – Dec 2019 **McGill Engineering Doctoral Award (MEDA)** 96,000 CAD
McGill University

Aug 2013 – Dec 2015 **ADNOC Graduate fellowship** 90,000 USD
Abu Dhabi National Oil Company

Our paper on scalable designs was selected for the 2021 ASME Journal of Mechanical Design Editor's Choice award	ASME IDETC 2022, St. Louis, USA
Awarded 2nd place for final problem presentation and winner of best data visualization in the 11th Montreal Industreal Problem Solving Workshop	IVADO, Montreal, Canada
Team leader of the first UAE team to successfully qualify and complete the Baja SAE competition	Khalifa University, Abu Dhabi, UAE
Awarded 2nd place in the Abu Dhabi Solar Challenge (10,000 AED)	Khalifa University, Abu Dhabi, UAE
Recognition for volunteering for the graduate School and student affair's events	Khalifa University, Abu Dhabi, UAE
Graduated honors with distinction (2,000 AED)	Khalifa University, Abu Dhabi, UAE

Publications

Submitted preprints

K. Al Handawi, A. Brahma, D. Wynn, M. Kokkolaras and O. Isaksson (2023). Design space exploration and evaluation using margin-based trade-offs. *Journal of Mechanical Design*
funded partially by NSERC and Area of Advance of Chalmers University

Refereed Journal Articles

A. Khalil, **K. Al Handawi**, Z. Mohsen, A. Abdel Nour, R. Feghali, I. Chamseddine and M. Kokkolaras (2022). Weekly nowcasting of new COVID-19 cases using past viral load measurements. *Viruses*, *14*(7): pp 1414. doi: 10.3390/V14071414

K. Al Handawi and M. Kokkolaras (2021). Optimization of infectious disease prevention and control policies using artificial life. *IEEE Transactions on Emerging Topics in Computational Intelligence*, doi: 10.1109/TETCI.2021.3107496 *funded by an NSERC discovery grant*

K. Al Handawi, M. Panarotto, P. Andersson, O. Isaksson and M. Kokkolaras (2021). Optimization of design margins allocation when making use of additive remanufacturing. *Journal of Mechanical Design*, *144*(1): pp 012001. doi: 10.1115/1.4051607
funded partially by NSERC, FRQNT, CARIC and EU Horizon 2020 research and innovation programme

M. Chehadeh, M. Wahbah, M. Awad, O. AbdulHay, **K. Al Handawi**, L. Seneviratne, I. Greatbatch and Y. Zweiri (2021). Novel aerial firefighting system for suppression of incipient cladding fires. *Journal of Field Robotics*, (*In Press*)
funded by Emaar Properties PJSC

K. Al Handawi, P. Andersson, M. Panarotto, O. Isaksson and M. Kokkolaras (2020). Scalable set-based design optimization and remanufacturing for meeting changing requirements. *Journal of Mechanical Design*, *143*(2): pp 021702. doi: 10.1115/1.4047908
funded partially by NSERC, FRQNT, CARIC and EU Horizon 2020 research and innovation programme

K. Al Handawi, N. Vahdati, O. Shiryayev and L. Lawand (2017). Analytical modeling tool for design of hydrocarbon sensitive optical fibers. *Sensors*, *17*(10): pp 2227. doi: 10.3390/s17102227
funded by Abu Dhabi National Oil Company

L. Lawand, O. Shiryayev, **K. Al Handawi**, N. Vahdati and P. Rostron (2017). Corrosivity sensor for exposed pipelines based on wireless energy transfer. *Sensors*, *17*(6): pp 1238. doi: 10.3390/s17061238
funded by Abu Dhabi National Oil Company

K. Al Handawi, N. Vahdati, P. Rostron, L. Lawand and O. Shiryayev (2016). Strain-based FBG sensor for real-time corrosion rate monitoring in pre-stressed structures. *Sensors and Actuators B: Chemical*, *236*: pp 276 – 285. doi: 10.1016/j.snb.2016.05.167
funded by Abu Dhabi National Oil Company

Conference Papers

K. Al Handawi, P. Andersson, M. Panarotto, O. Isaksson and M. Kokkolaras (2020). Scalable set-based design optimization and remanufacturing for meeting changing requirements. *in Proceedings of the International Design Engineering Technical Conferences & Computers and Information in Engineering Conference*, Virtual conference, IDETC2020.

L. Lawand, **K. Al Handawi**, M. Panarotto, P. Andersson, O. Isaksson and M. Kokkolaras (2019). A lifecycle cost-driven system dynamics approach for considering additive re-manufacturing or repair in aero-engine component design. *in Proceedings of the Design Society: International Conference on Engineering Design*, Delft, Netherlands, ICED19: pp 1343 – 1352. doi: 10.1017/dsi.2019.140

K. Al Handawi, N. Vahdati, O. Shiryayev, and L. Lawand (2016). Corrosion monitoring along infrastructures using distributed fiber optic sensing. *in Proceedings of SPIE Smart Structures/NDE, International Society for Optics and Photonics, Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems*, Las Vegas, USA, SPIE2016. doi: 10.1117/12.2218820

L. Lawand, O. Shiryayev, **K. Al Handawi**, N. Vahdati and P. Rostron (2016). Corrosivity monitoring system using RFID-based sensors. *in Proceedings of SPIE Smart Structures/NDE, International Society for Optics and Photonics, Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems*, Las Vegas, USA, SPIE2016. doi: 10.1117/12.2218813

Course work

- Advanced mechanics of materials
- Engineering systems optimization
- Continuum mechanics
- Applied numerical methods
- Applied finite element analysis
- Material engineering and corrosion
- Measurements and instrumentation
- Advanced vibrations
- Fracture mechanics
- Viscous and compressible fluid flows

Converstation starters

- 3D printing hobbyist
- Competitive gaming
- Weightlifting and strength training
- Automotive enthusiast