Wei Liang, P.E., Ph.D.

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Education

Carnegie Mellon University — Pittsburgh, PA

Ph.D.Student in Building Performance and Diagnostics; GPA: 4.00 — *Aug. 2019 – May. 2024*

- **Advisor: Prof. Erica Cochran Hameen**
- **Dessertation**: An Automatic Mobile Sensing Platform for Indoor Environmental Quality Assessments
- **Major Courses**: **Introduction to Machine Learning**, **Computer Vision**, **SLAM**, **Optimal Control and Reinforcement Learning**, **Adaptive Control and Reinforcement Learning**, **Human-Robot Interaction**, **Sensing and Sensors**, **On-Device Machine Learning**, Off-grid Electricity Systems, HVAC and Power Supply for Low Carbon Buildings, Productivity, Health and the Quality of Buildings, Building Performance Modeling, Building Control and Diagnostics, GIS

University of California, Berkeley — San Francisco, CA

UC Berkeley Extension HVAC Specialization — *Aug. 2015 – May. 2016*

- **Major Courses**: HVAC System Design Considerations, HVAC System Load Calculations and Psychrometry, HVAC Control and Energy Management Systems

University of California, Merced — Merced, CA

M.S. in Mechanical Engineering; GPA: 3.87 — *Aug. 2012 – Dec. 2014*

- **Advisor: Prof. Jian-Qiao Sun**
- **Thesis**: Modeling and Control of Air Handling Units (AHUs) in Building HVAC System.
- **Major Courses**: Nonlinear Controls, Linear Controls, Numerical Linear Algebra, Numerical Analysis, Fractional Order Mechanics, Continuum Mechanics, Partial Differential Equations.

Nanjing University — Nanjing, Jiangsu, China

B.S. in Acoustics; GPA: 81/100 — *Sept. 2008 – Jun. 2012*

- **Thesis**: The Application of Compressive Sensing Principle in Acoustical Radiation Prediction.
- **Major Courses**: Fundamental of Acoustics, Sound and Structural Vibration, Ultrasonics, Electroacoustics, Audio-frequency Signals Processing Signals and Systems, Digital Signal Processing, Fluid Mechanics, Probability and Stochastic Process, Method of Mathematical Physics.

Research Experience

Post-doctorate Research Fellow — Jun.2024 - - Now

National University of Singapore, Sinagpore

- Mixed-Mode Ventilation integrated with Ceiling Fans in Tropics — *Jun. 2024 - Now*

Research Assistant — Oct.2022 - - May.2024

Carnegie Mellon University, Pittsburgh, PA

- Computer Vision-Aided Spatial Mapping of Thermal Comfort — *Apr. 2023 - Now*

  - Built a framework that uses an RGB-D camera, a thermal infrared camera, and a tracking camera to actively measure and map the spatial distribution of mean radiant temperature in an indoor environment using visual simultaneous localization and mapping (vSLAM) and semantic segemntations

- Spatiotemporal Indoor Environment Quality Measurements and Modeling *Apr. 2023 - Now*
  - Built a Multi-variable Gaussian Process Model as a Bayesian updating mechanism to incorporate the new data and refine the model of the IEQ spatiotemporal distribution.
  - Prediction results of temperature distribution maps throughout different timestamps achieve an RMSE of 0.65 $^{\circ}C$ compared to the ground truth data.

- Mobile Sensing Platform for Indoor Environment Quality *Aug.2020 - Now*
  - Built a mobile sensing platform including occupancy, thermal comfort, IAQ, and illuminance detection based on Raspberry Pi, ESP8266, Open CR, and Turtlebot 3.
  - Built a database and server based on InfluxDB, Mosquitto (MQTT broker), and Flask that achieved simultaneous data acquisition, storage, and association between the robot, the payload, and the robot PC.

- Improving Post-Occupancy Evaluation Engagement Using A Social Robot *Aug.2021 - Now*
  - Designed a framework to conduct a post-occupancy evaluation using a social robot via haptic and verbal interactions
  - Conducted a user study and a statistical analysis using a post-hoc Wilcoxon signed-rank test
  - The results reveal that participants were more responsive and provided more detailed feedback to social robots than traditional web-based surveys.

- Iterative Learning Control (ILC) for Thermal Control on a VAV Reheat System *Feb. 2022 - Now*
  - Designed an ILC feedforward controller that can overcome model discrepancies like forecast outdoor weather differences
  - The proposed control method achieved fast convergence in 3 days of roll-out on a numerical study on a real VAV reheat system

- MPC and ILC on Autonomous Racing *Oct.2020 - Dec.2020*
  - Simulated a race track and vehicle model to compare model predictive Control (MPC) and iterative learning control (ILC) on autonomous racing
  - Designed an iterative MPC control approach to improve the performance of track following and lap time on a racing condition

Ph.D. Intern - Building Modeling and Controls May. 2023 - - Aug. 2023
Lawerence Berkeley National Lab, Berkeley, CA

- Physics-consistent neural network MPC and Energy Flexibility

Ph.D. Intern - HVAC System Performance Analysis Oct. 2022 - - May. 2023
Pacific Northwest National Lab, Richland, WA

- Performed feature-engineering and created a gradient-boosting-based machine learning model for energy consumption predictions for packaged air conditioning units with limited information

Graduate Student Researcher Aug. 2019 - - Oct. 2022
Carnegie Mellon University, Pittsburgh, PA

- 2020 CMU VentureWell Virtual Energy Hackathon *Oct.2020 - Oct.2020*

- Developed an automated script in Jupyter Notebook to predict the stability of a simulation and further optimize the result through curve fitting techniques
- Performed modal decomposition and reconstitution to evaluate the performance of power systems during different phases of a critical response

- Order Fulfillment Center Simulation *Feb. 2020 - Apr.2020*
  - Developed an order fulfillment system simulation, including order placement, order distribution, delivery, data collection, statistical data analysis, and improvement of the system based on analysis results in a team
  - Built a data ETL pipeline deployed on AWS using AWS Kinesis data stream and EMR
  - Performed order completion time online prediction linear regression model using Spark machine learning pipeline on AWS
  - Conducted PAC and K-means analysis on customer data to determine distinct types of customers and improve the stock of merchandise

- Life-cycle Analysis (LCA) for Datacenter Network *Nov. 2019 - Aug.2020*
  - Performed literature review and drafted the introductory paper of an innovative data center metric including both environmental and economical LCA.

- Kaggle Competition; ASHRAE - Great Energy Predictor *Oct 2019 - Dec 2019*
  - Team ranked top 20% of all competitors
  - Performed a building energy predictive model with LightGBM
  - Conducted feature engineering including classification, normalization, and drop-out with Pandas

Research Assistant Aug. 2012 - - Jul. 2015
University of California, Merced, Merced, CA

- Model Predictive Control of Air Handling Unit (AHU) Energy Efficiency *Feb. 2014 - Dec 2014*
  - Established an ETL (Extract, Transform, and Load) process to automatically download and pre-process building data used to be finished by a five-undergraduate-researcher group.
  - Designed an MPC optimal control strategy of an AHU with real-world data from a lab building on campus with a potential energy consumption reduction up to 27.8%.
  - Developed a linear regression model with physical-based parameters of HVAC system energy balance that predicts the dynamics with coefficients of determination larger than 0.98.
  - Improved 18% modeling accuracy based on Butterworth and Savitzky-Golay digital low-pass filter for air flow rate data smoothing
  - Performed statistical analysis on the correlation from model features to energy consumption to dig out the dominant component for energy efficiency.

- Real-Time Online Fault Detection and Diagnostics (FDD) of HVAC system *Apr. 2013 - Jan. 2014*
  - Initiated a program based on MATLAB string and terminal-calling function and Python SOAP module to release online data acquisition and storage from a SCADA system
  - Architected a real-time online stream FDD system on energy monitoring of HVAC system and saves 62% computing load by Principle Component Analysis (PCA)

- Multi-Objective PID Control By Simple Cell Mapping (SCM) Method *Aug. 2012 - Feb. 2013*

- Designed multi-object fractional-order PID controllers on a second order linear system and a nonlinear Duffing oscillation system on time domain which is hard to be done by linearization or stochastic search.
- Compared the performance of multi-objective full state feedback design using LQR approach on a first-order plus time-delay system using SCM and Genetic Algorithm (GA).

Industry Experience

Mechanical Engineer Aug. 2015 - - Jul. 2019

Gayner Engineers, San Francisco, CA

- HVAC System and Building Automation System (BAS) design for critical commercial buildings of healthcare, life science laboratory, library, and higher education
- Conducted building energy simulations and sustainability coordination for green building rating system (LEED, CalGreen, EnergyStar, and PG&E Saving by Design) based on California Title 24 and ASHRAE 90.1
- Commissioned and Energy Audited Mechanical, Electrical, and Plumbing (MEP) systems and medical equipment for healthcare and laboratory buildings
- Produced engineering drawings using AutoCAD, and Autodesk Revit
- Developed python-based API and scripts for BAS data collection, CAD, and energy simulation software to improve working efficiency (First in the company to do so)
- Coordinated with clients, vendors, contractors, and co-consultants in project management.

Teaching Experiences

Lecturer

Carnegie Mellon University, Pittsburgh, PA

48722, Building Performance Modeling Spring 2022, 2023 & 2024

- Serving as the sole instructor of a graduate-level course: Building Performance Modeling on a capacity of 30-student class
- Teaching whole-building simulations using EnergyPlus, eQuest, IES VE, and Revit CEA.

Teaching Assistant

Carnegie Mellon University, Pittsburgh, PA

48768, Indoor Environmental Quality	Fall 2021
48729, Sustainability, Health and Productivity	Fall 2021
48722, Building Performance Modeling	Spring 2021
48721, Building Controls and Diagnostics	Spring 2021
48116, Building Physics	Fall 2020

Teaching Assistant

University, of California, Merced, Merced, CA

ME 021, Engineering Computing	Fall 2014, Summer 2014 & Fall 2013
ME 140, Vibration and Control	Spring 2014 and Spring 2013
ME 142, Mechatronics	Spring 2014
ENGR 065, Circuit Theory	Summer 2013

Technical Skills

Expertise

- Proficient: Building HVAC System, Building Energy Simulation, Indoor Environmental Quality, Model Predictive Control, Adaptive Control, Iterative Learning Control, Optimal Control
- Advanced: Nonlinear Control, Building Automation System, Numerical Optimization, Machine Learning, Smart Grid, Reinforcement Learning, Robotics
- Intermediate: Statistical Data Analysis, Construction Management, Robotics, Computer Vision

Computing (Proficient)

- Programming Languages: Python, MATLAB, Julia, R, C, C++, Julia
- Software: EnergyPlus, IES VE, Design Builder, Modelica, Trace 700, eQuest, HOMER Pro
- Typesetting: LaTeX, Microsoft Office, Scientific Word, Pages
- Operating Systems: MacOS, Ubuntu, Raspbian, Windows
- Drawing Production: Autodesk Revit, AutoCAD, BlueBeam, Adobe Acrobat DC, Rhino, Grasshopper

Publications

1. **Wei Liang**, Han Li, Sicheng Zhan, Adrian Chong, and Tianzhen Hong. Energy flexibility quantification of a tropical net-zero office building using physically consistent neural network-based model predictive control. *Advances in Applied Energy*, 14:100167, 2024
2. Ruoxin Xiong, Ying Shi, Haoming Jing, **Wei Liang**, Yorie Nakahira, and Pingbo Tang. Calibrating subjective data biases and model predictive uncertainties in machine learning-based thermal perception predictions. *Building and Environment*, 247:111053, 2024
3. **Wei Liang**, Sizhe Ma, Erica Cochran, and Katherine A Flanigan. Distributed mpc-ilc thermal control design for large-scale multi-zone building hvac system. *ACM SIGENERGY Energy Informatics Review*, 3(2):34–46, 2023
4. **Wei Liang**, Sizhe Ma, Erica Cochran Hameen, and Katherine Flanigan. Integrated mpc-ilc control design for thermal control of a large-scale variable air volume reheat systems in buildings. In *Proceedings of the 9th ACM international conference on systems for energy-efficient buildings, cities, and transportation*, 2022
5. **Wei Liang**, Ruoxin Xiong, Pengkun Liu, Pingbo Tang, and Erica Cochran Hameen. Improving post-occupancy evaluation engagement using social robots. In *Proceedings of the 9th ACM international conference on systems for energy-efficient buildings, cities, and transportation*, 2022
6. Eric Kumar, Erica Cochran Hameen, and **Wei Liang**. Global marginal carbon footprint evaluation of internet services with building energy models. In *BuildSIM-Nordic 2020*. IBPSA-Nordic, SINTEF Academic Press, 2020

7. **Wei Liang**, Rebecca Quinte, Xiaobao Jia, and Jian-Qiao Sun. MPC control for improving energy efficiency of a building air handler for multi-zone VAVs. *Building and Environment*, 92:256–268, 2015

8. Furui Xiong, Zhichang Qin, Carlos Hernández, Yousef Sardahi, Yousef Narajani, **Wei Liang**, Yang Xue, Oliver Schütze, and Jian-Qiao Sun. A multi-objective optimal pid control for a nonlinear system with time delay. *Theoretical and Applied Mechanics Letters*, 3(6), 2013

9. Yousef Sardahi, Yousef Naranjani, **Wei Liang**, Jian-Qiao Sun, Carlos Hernandez, and Oliver Schuetze. Multi-objective optimal control design with the simple cell mapping method. In *ASME 2013 International Mechanical Engineering Congress and Exposition*, pages V04BT04A025–V04BT04A025. American Society of Mechanical Engineers, 2013

10. Carlos Hernández, Yousef Naranjani, Yousef Sardahi, **Wei Liang**, Oliver Schütze, and Jian-Qiao Sun. Simple cell mapping method for multi-objective optimal feedback control design. *International Journal of Dynamics and Control*, 1(3):231–238, 2013

Certifications

Professional Mechanical Engineer (M38549) Jun. 2017 - - Now
Board for Professional Engineers, Land Surveyors, and Geologists - California

LEED AP BD+C Jun. 2017 - - Now
Green Business Certification, Inc.

Deep Learning Specialization (4LJHJDPJMNVS) Jul. 2018 - - Now
Coursera

Honors

Carnegie Mellon University, Pittsburgh, PA, USA
Graduate Small project Help (GuSH) Research Grant 2020-2023
School of Architecture - letter of commendation 2020-2021

University of California, Merced, CA, USA
Mechanical Engineering Bobcat Award 2014
UC Merced Graduate Summer Fellowship 2013

Nanjing University, Nanjing, Jiangsu, China
People's Scholarship 2010

Organizations

ASHRAE Feb. 2016 - - Now
Associate Member

Professional services

Reviewer

- Building and Environment (2015-2019)

- Developments in the Built Environment (2022-Now)

References

Dr. ***Erica Cochran Hameen***
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