

YUNMEI LIU

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EDUCATION

Ph.D. in Industrial & Systems Engineering

2019 – 12/2023 (*expected*)

University of Florida, *Gainesville, U.S.*

Ph.D. Minor: Statistics

Specialization: Human Factors and Systems Engineering

Dissertation title: Quantitative models for system rate of automation and operator situation awareness responses

Academic advisors: Dr. David B. Kaber

M.S. in Management Science and Engineering

2016 – 2019

Nanjing University, *Nanjing, China*

Specialization: Transportation Systems Analysis and Modeling

Graduate thesis title: User equilibrium in stochastic networks considering decision inertia

Academic advisors: Dr. Hongli Xu

B.S. in Industrial Engineering

2012 – 2016

Shandong University, *Jinan, China*

Academic advisors: Dr. Honglin Zhang

RESEARCH INTERESTS

My research interests focus on using the principles of human factors and systems engineering to design, analyze, and model human-in-the-loop systems. I specialize in the intersection of human factors, ergonomics, transportation engineering, statistics, and computer science. Specifically, my research areas include:

1. Modeling human-automation interaction and human performance

Develop quantitative models of human-automation interaction, human cognitive workload, situation awareness, and task performance in the human-in-the-loop systems, which can solve practical problems and be verified by experiments.

2. Predicting/forecasting human cognitive or physical states

Develop algorithms to process multimodal physiological signals in real time, applying advanced techniques such as feature engineering, machine learning, and deep learning to predict the cognitive workload and emotional states of users under extreme conditions.

3. Addressing human factors in surface transportation

Design or improve the use and placement of interchange guidance signs, on-road and in-vehicle delivery of service signs, and the use and interaction of in-vehicle technologies through driving experiments (field studies or simulated driving).

4. Improving usability of assistive technologies

Experimentally test the effects of different assistive technologies on user task performance, cognitive workload, and usability assessments, providing information to improve the design of their control interfaces.

5. Identifying and measuring system hazards and risks

Develop methods to identify system hazards and risks with severity levels of their consequences. Applications include transportation, healthcare, and manufacturing systems.

PUBLICATIONS

Refereed Journal Articles

1. **Liu, Y.**, Berman, J., Dodson, A., Park, J., Zahabi, M., Huang, H., Ruiz, J., and Kaber, D. (2022). Human-centered evaluation of EMG-based upper-limb prosthetic control modes. *Institute of Electrical and Electronics Engineers (IEEE) Transactions on Human-Machine Systems*. Minor Revision Submitted (August 2023).
2. Park, J., Berman, J., Dodson, A., **Liu, Y.**, Armstrong, M., Huang, H., Kaber, D. B., Ruiz, J., and Zahabi, M. (2023). Assessing workload in using electromyography (EMG)-based prostheses, *Ergonomics*. <https://doi.org/10.1080/00140139.2023.2221413>.
3. Kaber, D., **Liu, Y.** & Lau, M. Y. (2023). Considering severity of safety-critical system outcomes in risk analysis: an extension of fault-tree analysis. In: Le Coze, J.C., Antonsen, S. (eds) *Safety in the Digital Age. SpringerBriefs in Applied Sciences and Technology*. Springer, Cham. https://doi.org/10.1007/978-3-031-32633-2_6

Submitted Refereed Journal Articles

4. **Liu, Y.** & Kaber, D. (in 2nd review). Models of automation rate in human-in-the-loop systems and operator situation awareness responses. Submitted to *IEEE Transactions on Human-Machine Systems*.
5. **Liu, Y.**, Kaber, D., Cunningham, C., Chase, T., and Pyo, K. (in 2nd revision). Analysis of driver behavior at grade-separated intersections to support design. Submitted to *Applied Ergonomics*.
6. Lau, M., **Liu, Y.** & Kaber, D. (in 3rd review). A consequence severity-probability importance measure for fault tree analysis. Submitted to *International Journal of System Assurance Engineering and Management*.
7. Zhang, W., **Liu, Y.** & Kaber, D. (in 2nd review). Effect of interface design on cognitive workload in unmanned aerial vehicle control. Submitted to *International Journal of Human Computer Studies*.

In-Preparation Refereed Journal Articles

8. **Liu, Y.**, Delgado, D., Park, J., Music, A., Berman, J., Kaber, D., Ruiz, J., Huang, H., and Zahabi, M.. Virtual Reality (VR) in the early phase design of EMG-based upper-limb prosthetics. Target journal: *Ergonomics*.
9. Park, J., Delgado, D., **Liu, Y.**, Music, A., Berman, J., Kaber, D., Ruiz, J., Huang, H., and Zahabi, M.. A evaluation of EMG-based upper-limb prosthetic control modes: Virtual Reality vs. physical devices. Target journal: *Applied Ergonomics*.
10. **Liu, Y.**, Yang, G., Pyo, K., Cunningham, C., Chase, T., Kaber, D.. Design consistency. Target journal: *Applied Ergonomics*.
11. **Liu, Y.** and Kaber, D.. Validity assessment for a SA response function in level of automation. Target journal: *Human Factors*.
12. **Liu, Y.** and Kaber, D.. Effects of driver experience and level of vehicle automation on SA, workload and performance. Target journal: *Applied Ergonomics*.
13. **Liu, Y.**, Grimaldi, N. S., Wozniak, D., Zahabi, M., and Kaber, D.. Integration of cognitive workload modeling and physiological responses for real-time user state classification. Target journal: *IEEE Transactions on Human-Machine Systems*.

Refereed Conference Proceedings

- C1. **Liu, Y.**, Kaber, D., Sabahi, S., Cunningham, C., and Pyo, K. (2022). Machine learning models of erroneous driver actions at novel interchange configurations. *IEEE International Conference on Human-Machine Systems*, pp. 1-6. <https://ieeexplore.ieee.org/document/9980657>
- C2. **Liu, Y.**, Pyo, K., Cunningham, C., Chase, T. and Kaber, D. (2022). Driver situation awareness and cognitive workload effects of novel interchange configurations and associated signage. *International Conference on Applied Human Factors and Ergonomics*, Vol. 60: 287-296. https://openaccess.cms-conferences.org/publications/book/978-1-958651-36-0/article/978-1-958651-36-0_32
- C3. **Liu, Y.** and Kaber, D. (2021). Quantitative models for automation rate and situation awareness response: A case study of levels of driving automation. *IEEE International Conference on Human-Machine Systems*, pp. 1-6. <https://ieeexplore.ieee.org/document/9582630>
- C4. Park, J., Berman, J., Dodson, A., **Liu, Y.**, Matthew, A., Huang, H., Kaber, D., Ruiz, J., and Zahabi, M. (2022). Cognitive workload classification of upper-limb prosthetic devices. *IEEE International Conference on Human-Machine Systems*, pp. 1-6. <https://ieeexplore.ieee.org/document/9980676>
- C5. Cauffman, S.J., Deng, Y., **Liu, Y.**, Cunningham, C., Kaber, D. and Feng, J. (2020). Driver logo sign detection and hazard responses during partially automated driving. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*. 64(1):1960-1964. <https://journals.sagepub.com/doi/10.1177/1071181320641472>
- C6. Park, J., Music, A., Daniel, D., Berman, J., Dodson, A., **Liu, Y.**, Ruiz, J., Huang, H., Kaber, D., and Zahabi, M. (2023). Cognitive workload and usability of virtual reality simulation for prosthesis training. *IEEE International Conference on Systems, Man, and Cybernetics*. Accepted.
- C7. Chen, Z., Song, Y., **Liu, Y.**, Wu, X.J., and Sebe, N. (2024). A unified framework of Riemannian classifiers for SPD neural networks. *International Conference on Learning Representations (ICLR)*. Submitted.
- *Top Conference in Machine Learning*
- C8. Grimaldi, N., **Liu, Y.**, McKendrick, R., Ruiz, J., and Kaber, D. (2024). Deep learning forecast of cognitive workload using fNIRS data. Target Conference: *IEEE International Conference on Human-Machine Systems*. About to submit.

Technical Reports

- R1. Cunningham, C. M., Chase, R. T., Pyo, K., Kaber, D., and **Liu, Y.** (2022). Roadway signing and marking of unconventional grade separated intersection designs. Report No. FHWA/NC/2019-26, *North Carolina Department of Transportation*. Raleigh. <https://connect.ncdot.gov/projects/research/RNAProjDocs/RP2019-26%20Final%20Report.pdf>
- R2. Cunningham, C. M., Chase, R. T., Yang, G., Wright, W., Pyo, K., Kaber, D., and **Liu, Y.** (2023). Design consistency on corridors. Report No. FHWA/NC/2020-31, *North Carolina Department of Transportation*, Raleigh.

PRESENTATIONS

1. **Liu, Y. (Presenter)**, Kaber, D., Sabahi, S., Cunningham, C., and Pyo, K. (2022). Machine learning models of erroneous driver actions at novel interchange configurations. *Oral presentation given at the IEEE 3rd International Conference on Human-Machine Systems*. Orlando, FL. November.
2. **Liu, Y. (Presenter)**, Pyo, K., Cunningham, C., Chase, T. and Kaber, D. (2022). Driver situation awareness and cognitive workload effects of novel interchange configurations and associated signage. *Oral presentation given at the 13th International Conference on Applied Human Factors and Ergonomics*. New York, NY. July.
3. **Liu, Y.** and Kaber, D. (Presenter) (2021). Quantitative models for automation rate and situation awareness response: A case study of levels of driving automation. *Oral presentation given at the IEEE 2nd International Conference on Human-Machine Systems*. Magdeburg, Germany. September.

4. **Liu, Y. (Presenter)**, Pyo, K., Cunningham, C., Chase, T. and Kaber, D. (2023). Roadway signing and marking of unconventional grade separated intersection designs. *Poster presentation given at the North Carolina Department of Transportation 4th Annual Research & Innovation Summit*. Raleigh, NC. March.
5. **Liu, Y. (Presenter)**, Yang, G., Pyo, K., Wright, W. Chase, T. Cunningham, C., and Kaber, D. (2023). Design consistency on corridors. *Poster presentation given at the North Carolina Department of Transportation 4th Annual Research & Innovation Summit*. Raleigh, NC. March.
6. **Liu, Y. (Presenter)** (2023). Quantitative models for system automation rate and operator situation awareness. *Oral presentation given as a 3-minute pitch at the Institute of Industrial and Systems Engineers Doctoral Colloquium*. New Orleans, LA. May.
7. Park, J. (Presenter), Berman, J., Dodson, A., **Liu, Y.**, Matthew, A., Huang, H., Kaber, D, Ruiz, J., and Zahabi, M. (2022). Cognitive workload classification of upper-limb prosthetic devices. *Oral presentation given at the IEEE 3rd International Conference on Human-Machine Systems*. Orlando, FL. November.
8. Cauffman, S.J. (Presenter), Deng, Y., **Liu, Y.**, Cunningham, C., Kaber, D. and Feng, J. (2020). Driver logo sign detection and hazard responses during partially automated driving. *Oral presentation given at the 64th International Annual Meeting of the Human Factors and Ergonomics Society*. Virtual. October.
9. Park, J. (Presenter), Music, A., Daniel, D., Berman, J., Dodson, A., **Liu, Y.**, Ruiz, J., Huang, H., Kaber, D., and Zahabi, M. (2023). Cognitive workload and usability of virtual reality simulation for prosthesis training. *Oral presentation will be given at the IEEE International Conference on Systems, Man, and Cybernetics*. Hawaii, October.

SELECTED HONORS AND AWARDS

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| • Linda Parker Hudson Graduate Fellowship Award (\$2,500) , University of Florida | 2023 |
| • Certificates of Outstanding Achievement , University of Florida | 2022 |
| • Harold D. Haldeman, Jr. Fellowship Award (\$2,000) , University of Florida | 2022 |
| • Academic Scholarship (\$1,200) , Nanjing University | 2016, 2017, 2018 |
| • Excellent Student Fellowship , Shandong University | 2013, 2014, 2015 |
| • Best Undergraduate Thesis , Shandong University | 2016 |
| • The Most Outstanding Student at Shandong University , Shandong University | 2015 |

RESEARCH EXPERIENCE

Graduate Research Assistant, University of Florida

1. **Research on Automation Rate and Situation Awareness Responses (Dissertation)** 2019 – Present
 - Pioneered the development of a new "automation rate" model to quantify the level of automation in human-in-the-loop systems.
 - Designed and implemented a comprehensive algorithm for automation rate calculation, providing a reliable and practical solution.
 - Conducted a detailed case study analysis to validate the feasibility and practicality of the automation rate model.
 - Established a novel relationship between the automation rate and operator situation awareness response through quantitative modeling.
 - Designed and executed a driving simulator experiment to gather empirical data and verify the relationship between the automation rate and human performance responses.
 - Processed and analyzed data using advanced statistical methods, including descriptive and inferential statistics, to derive meaningful insights.
 - Led the writing of one journal paper and one conference proceeding papers draft.

Skills and Keywords: *Automation rate, quantitative modeling, human performance responses, driving simulator, experiment design, case study analysis, data collection, data analysis, descriptive and inferential statistics, Python and R Studio programming.*

2. Real-time Perceptually-enabled Task Guidance in the Extremes (DARPA Project) 2022-Present

- Identified appropriate signal types and acquisition devices for achieving the project's goals through a comprehensive literature review.
- Led the feature extraction process and extracted 11 features from eye-tracker and Empatica E4 devices.
- Led the construction of three machine learning classification models to predict high cognitive load in extreme situations, based on real-time multimodal physiological signals from users.
- Addressed challenges related to missing data and feature selection for time-series data.
- Developed deep learning models to predict users' cognitive workload based on fNIRS data.
- Conducted hierarchical task analysis and developed a human performance model using Cogulator.
- Led the development of the protocol for the machine learning model training experiment, including equipment preparation, orientation, training, and testing procedures.
- Led the writing of one journal paper and one conference proceeding papers draft.

Skills and Keywords: *Feature extraction, machine learning, data science, deep learning, hierarchical task analysis, human performance modeling, protocol development.*

3. EMG-based Assistive Human-Machine Interface Design (NSF Project) 2020-Present

- Designed and implemented a human factors experiment to study the effects of powered-prosthetic design and control modes on user performance of activities of daily living (ADLs) tasks.
- Conducted hierarchical task analysis, developed a human performance model using Cogulator.
- Processed and analyzed experimental data using Python and R Studio, demonstrating data analysis skills and expertise in statistical methods, including descriptive and inferential statistics.
- Developed the Phase 2 experiment to demonstrate the fundamental motor skill training through the integration of the EMG-based HMI with virtual reality.
- Led the selection of EMG sensor locations, measurement of maximal voluntary contraction, time lag calculation, and development of MATLAB code for real-time EMG raw signal processing.
- Led the development of the protocol for Phase 2 experiment, including equipment preparation, orientation, training, and testing procedures.
- Utilized data analysis skill to identify and salvage messy experimental data
- Led the writing of two journal papers and contributed to multiple journal and conference proceeding paper drafts.

Skills and Keywords: *Human factors experiment design, hierarchical task analysis, human performance modeling, data analysis, statistical analysis, EMG signal processing, protocol development, technical writing for journal and conference proceedings, MATLAB, Python and R Studio programming.*

4. Roadway Signage for Novel Grade-separated Interchanges (NC DOT Project) 2019-2022

- Designed and implemented situation awareness queries to collect data on driver behavior and performance at different interchanges and signage configurations.
- Designed and executed human factors experiment to investigate the effects of innovative interchange geometry and traffic control device design on driver visual behavior and performance.
- Processed and analyzed experimental data using Python and R Studio, demonstrating data analysis skills and expertise in statistical methods, including descriptive and inferential statistics.
- Led the development of machine learning models to predict erroneous driver actions based on driver status.
- Drafted the final report for the project, presenting the findings and conclusions.

- Led and submitted one journal and two conference proceeding papers.

Skills and Keywords: *Situation awareness, Qualtrics surveys, human factors experiment design, data analysis, statistical analysis, machine learning, report writing, Python and R Studio programming.*

5. Other Involved Projects

2019-Present

- Systems safety analysis research
- Unmanned aerial vehicle interface design
- Consistency in the design of interchanges in high-density traffic corridors
- Non-safety-related in-vehicle and on-road message displays

Graduate Student, Nanjing University

6. User Equilibrium in Stochastic Networks Considering Route Choice Inertia

2016 – 2019

- Defined the generalized travel time from two dimensions (length and uncertainty), and reliability coefficient represented the travelers' risk preference.
- Proposed a route choice model with context-dependent preference and compared it with the existing model from theoretical and numerical aspects to validate and ensure the model's compatibility.
- Developed a user equilibrium model under stochastic traffic network, analyzed the equilibrium conditions, and formulated the equivalent nonlinear complement problem.
- Analyzed the nature of the solution through numerical examples.

Skills and Keywords: *Route choice modeling, equilibrium analysis, nonlinear complement problem formulation, numerical analysis.*

TEACHING EXPERIENCE

Teaching Assistant, University of Florida

- Systems Management (Graduate level) 2023, 2022, 2021

Guest Lecture, University of Florida

- Economic Evaluation (Graduate level) 2023, 2022
- Queuing Theory and Analysis (Graduate level) 2023
- Reliability Engineer (Graduate level) 2023
- Human Systems Integration (Graduate level) 2023

Teaching Assistant, Nanjing University

- Multivariate Statistics and Data Analysis (Graduate level) 2017

LEADERSHIP AND SERVICES

University-Related Service

- Initiated and served as the inaugural student President, HFES Chapter, University of Florida.
- Led and coordinated student chairs and staff, 3rd International Conference on Human-Machine Systems.
- Participated in the Dean Search Committee, College of Engineering, University of Florida.

Professional Service

- Served as session chair and reviewer, *3rd International Conference on Human-Machine Systems*.
- Acted as reviewer for journals: *IEEE Transactions on Human-Machine Systems, Human Factors, Cognition, Technology & Work*.

MENTORING EXPERIENCE

- Vives, A., Visiting Scholar, French Air & Space Force Academy (1/2023-6/2023).
- Grimaldi, N., Ph.D. Research Assistant, Industrial and Systems Engineering (ISE) Department (3/2022 - present).
- Pfaffenbichler, R., Graduate Research Assistant, ISE Department (8/2022 - 6/2023).
- Xia, S., Undergraduate Research Assistant, ISE Department (3/2022 - 12/2022).
- Chen, E., Undergraduate Research Assistant, Computer Science Department (8/2022 - 6/2023).

TEACHING INTERESTS

Undergraduate Level:

- Introduction to Human Factors
- Occupational Safety

Graduate Level:

- System Design
- System Safety
- System Management
- User Experience Design
- Human Factors in System Design
- Applied Probability Methods in Engineering
- Applied Non-parametric Method in Engineering

PROFESSIONAL AFFILIATION

- Student Member, Human Factors and Ergonomics Society
- Student Member, IEEE

SKILLS

- **Programming Languages:** Python, R, MATLAB
- **Prototype & Design Tools:** UC-winRoad, Qualtrics, LaTeX, Invision
- **Analysis Tools:** SPSS, JMP, Cogulator
- **Equipment:** Driving Simulator (FORUM8 Co. Ltd), Electromyography System (Delsys), Eyetracker (PupilLabs), E4 Wristband (Empatica)
- **Language:** Chinese (Native), English