Yuanyuan Gao, PhD

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Rensselaer Polytechnic Institute, 110 8th street
Troy, NY, USA

EDUCATION

Rensselaer Polytechnic Institute — *2015 - 2020*
Ph.D. Mechanical Engineering; GPA 3.5 — Advisors: Prof. Xavier Intes, Prof. Suvranu De

Beihang University — *2010 - 2013*
M.S. Mechanical Engineering; GPA 3.6 — Advisors: Prof. Chao Yun

Beihang University — *2006 - 2010*
B.S. Aircraft Environment and Life Security Engineering; GPA 3.4

RESEARCH EXPERIENCE

Graduate Research Assistant at Rensselaer Polytechnic Institute — *2015 – Present*
Visiting Scholar at University of Buffalo — *Feb 2019 – Oct 2019*
Researcher at Harvard Medical School — *Feb 2016*

RESEARCH PROJECTS

- *Project 1 (PhD thesis): Evaluating brain activation changes during motor learning via functional near-infrared spectroscopy (fNIRS) under neurostimulation conditions*
  - Instructors: Dr. Suvranu De and Dr Xavier Intes
  - In a short-term crossover training study (1 day), I demonstrated that the left prefrontal cortex (PFC), middle primary motor cortex (M1) and supplementary motor area (SMA) were activated revealed by fNIRS technique after transcranial random noise stimulation (tRNS) and the bimanual motor skills were enhanced as well.
  - In a long-term grouped training study (12 days with follow-up visit and transfer tasks), I demonstrated that tRNS suppressed the activation in PFC and tDCS enhanced it in M1 region. The follow-up visit and transfer task performance was not significantly different across the conditions while transfer task demanded 10 times higher oxygen across the brain.
- *Project 2: Predicting surgical skills from fNIRS via deep learning models*
  - Instructor: Dr. Pingkun Yan
  - I achieved an accuracy of $R^2 = 0.73$ and $AUC = 0.91$ by designing a convolutional neural network (CNN) model to extract features from fNIRS data to regress out the motor skill level, which is much higher than conventional machine learning models, including support vector regression (SVR), kernel partial least squares (KPLS) and random forest (RF) algorithms.
- *Project 3: Predicting learning curve characteristics via machine learning approaches*
  - Instructor: Dr. Uwe Kruger
  - I successfully predicted the learning curve characteristics from the initial ten trials performance of the medical students ($R^2 = 0.81$) by employing the machine learning approach, KPLS. I further classified the students into two groups with unique learning characteristics through an unsupervised machine learning algorithm, k-means algorithm, revealing the motor learning nature of human.
- *Project 4: Removing motion artifacts in fNIRS data via deep learning approach*
  - Instructor: Dr. Pingkun Yan

- I constructed a sophisticated designed denoising autoencoder model to remove the motion artifact existing in fNIRS data, with lower error than conventionally used denoising methods. It is a pioneering work in fNIRS data processing field as the first to introduce deep learning approach and has opened a new chapter.

- *Project 5: Literature review on neuroimaging studies*
  - Instructor: Dr. Lora Cavuoto
  - I contributed to the general education of the neuroimaging field by composing a comprehensive review paper on neuroimaging studies, including fNIRS, fMRI, EEG, PET, and MEG modalities, on how those neuroimaging techniques revealed human motor learning nature and how transcranial electrical stimulation affects it. This work is well received by peer scholars.

TEACHING EXPERIENCE

Graduate Teaching Assistant *Fall 2015; Spring 2018*
Thermal and Fluid Engineering Department of Mechanical, Aerospace and Nuclear Engineering
Instructors: Dr. Diana-Andra Borca-Tasciu; Dr. Daniel Lander

Graduate Teaching Assistant *Fall 2016; Spring 2017*
Modeling and Analysis of Uncertainty School of Engineering at RPI
Instructor: Dr. Bimal K. Malaviya

Guest Lectures *Fall 2018*
Modeling of Biomedical Systems Department of biomedical engineering at RPI
Instructor: Dr. Uwe Kruger

Undergraduate Student Mentor *Spring 2018; Summer 2018*
fNIRS data processing and analysis Undergraduate Research Program (URP) at RPI
Instructor: Dr. Suvranu De
UG students: Jeanine Moreau; Yanting Liu; Yiying Huang.

PUBLICATIONS

Journal papers

Yuanyuan Gao, Uwe Kruger, Steven Schwaitzberg, Xavier Intes and Suvranu De, "A Machine Learning approach to predict surgical learning curves," ***Surgery***, 167.2 (2020): 321-327. DOI: https://doi.org/10.1016/j.surg.2019.10.008.

Yuanyuan Gao, Lora Cavuoto, Steven Schwaitzberg, Jack E. Norfleet, Xavier Intes and Suvranu De, "The effects of transcranial electrical stimulation on human motor functions: A comprehensive review of functional neuroimaging studies," ***Frontiers in Neuroscience***, 14:744 (2020). DOI: https://doi.org/10.3389/fnins.2020.00744.

Yuanyuan Gao, Pingkun Yan, Uwe Kruger, Lora Cavuoto, Steven Schwaitzberg, Suvranu De and Xavier Intes, "Functional brain imaging reliably predicts bimanual motor skill performance in a standardized surgical task," ***IEEE TBME***, Early Access. DOI: 10.1109/TBME.2020.3014299.
*Featured in leading news outlet Digital Trends

Yuanyuan Gao, Hanqing Chao, Lora Cavuoto, Pingkun Yan, Uwe Kruger, Jack E. Norfleet, Basiel A. Makled, Steven Schwaitzberg, Suvranu De and Xavier Intes, "Deep learning-based motion artifact removal in functional near-infrared spectroscopy," ***Neuroimage***, under review. **Preprint**.

Yuanyuan Gao, Lora Cavuoto, Anirban Dutta, Uwe Kruger, Pingkun Yan, Jack E. Norfleet, Basiel A. Makled, Jessica Silvestri, Steven Schwaitzberg, Xavier Intes and Suvranu De, "tDCS-induced primary motor cortex activation diminishes errors in fine bimanual motor skill learning," ***Nature biomedical engineering***, Submitted.

Arun Nemani, **Yuanyuan Gao**, Meryem Yucel, Denise Gee, Clairice Cooper, Steven Schwaitzberg, Xavier Intes and Suvranu De, "Functional brain connectivity distinguishes surgical skill dexterity in both physical and virtual simulation environments," ***Neurophotonics***, Under Review.

Conference papers

Yuanyuan Gao, Lora Cavuoto, L., Pingkun Yan, Uwe Kruger, Jessica Silvestri, Steven Schwaitzberg, Jack E. Norfleet, Basiel A. Makled, Xavier Intes and Suvranu De, "Transcranial direct current stimulation speeds up surgical bimanual motor learning and increases functional activation," In MHSRS, Young Investigator breakout session **Award paper**, August 2020.

Yuanyuan Gao, Lora Cavuoto, Pingkun Yan, Uwe Kruger, Steven Schwaitzberg, Suvranu De and Xavier Intes, "A deep learning approach to remove motion artifacts in fNIRS data analysis," *OSA Biophotonics Congress: Biomedical Optics, Florida, USA, April 2020. (Oral presentation)*

Yuanyuan Gao, Lora Cavuoto, Pingkun Yan, Uwe Kruger, Jessica Silvestri, Steven Schwaitzberg, Suvranu De and Xavier Intes, "Monitoring the effect of transcranial Electric current Stimulation (tES) during a bimanual motor task via functional Near-InfraRed Spectroscopy (fNIRS)," *OSA Biophotonics Congress: Biomedical Optics, Florida, USA, April 2020. (Poster presentation)*

Yuanyuan Gao, Pingkun Yan, Uwe Kruger, Suvranu De and Xavier Intes, "Neuroimaging biomarkers for surgical skill level prediction," *SPIE.bios, San Francisco, CA, February 2019. (Poster presentation)*

Yuanyuan Gao, Pingkun Yan, Uwe Kruger, Suvranu De and Xavier Intes, "fNIRS as a quantitative tool to assess and predict surgical skills," *OSA Biophotonics Congress: Optics in the Life Sciences, Tucson, AZ, April 2019. (Oral presentation)*

Yuanyuan Gao, "Research on the location assignment problem of automation of pharmacy storage", *The ninth Session of Graduate Student Academic Forum of Beijing University (Conference paper)*

Patents

"Access Mechanism of Automatic Pharmacy Storage Systems", *201210110543X*
"Pneumatic Medicine Out-putting Device and Method", *2012100914371*
"Pneumatic Rod-type Medicine Out-putting device and method", *2012101268206*

CERTIFICATION

Introduction to transcranial direct current stimulation (offline) *March 2016*
Harvard Medical School
Databases and SQL for Data Science (online) *March 2020*
Coursera

SKILLS

Programming Language: **Python**, C/C++/C#, VB, SQL;
Statistical Tools: **Matlab**, SPSS, Minitab, G*Power;
Computer Aided Design/Engineering: Solidworks, CATIA, autoCAD, ANSYS, NX, CFD;
Operating Systems: Windows, Linux (Ubuntu) and Mac OS;
Hardware: fNIRS spectrometers; Trans-cranial electrical stimulation device; Laparoscopic skill trainer;
Others: Microsoft Office Series, Latex.
Language: Proficient in English and Mandarin.

AWARDS

- Young Investigator Competition Finalist Award for Excellence, Military Health System Research Symposium, 2020
- Outstanding Graduate in Beijing, 2013
- BUAA Graduate Students Second Prize Scholarship, 2011
- BUAA undergraduate Students Second Prize Scholarship, 2007

OTHER RESEARCH EXPERIENCE

Master Projects *Aug 2010 – Jul 2013*

Advisor: Chao Yun

- *90kg Palletizing Robot Program*
  - Mechanical structure design and motion simulation analysis of wrist, big arm, rear arm and waist part using Solidworks software; All engineering drawings by CAXA software;
  - Debug the system using PMAC motion control card;
  - Responsible for motor, rail, belt wheels calculation, selection and procurement.
- *Automatic Pharmacy Storage Systems program*
  - Undertook project prophase investigation, proposed solutions with widely various ideas;
  - Access mechanism system were analyzed, and optimal scheme of improvement was given through ADAMS software;
  - The stress static and dynamic analysis and vibration analysis of elevator system were given using ANSYS software, and improve the structure to enhance the rigidity strength and vibration performance;
  - Mechanical structure design of prototype experimental platform using SolidWorks software and participate in the process of manufacture;
  - Debugged the system prototype using PLC, programmed the PC management software using C#.NET, program genetic algorithm to optimize the simulation calculation to the storage location assignment by Matlab.

Undergraduate Projects *Sept 2006-Jul 2010*

Advisor: Yong Huang

- A Small Wind Tunnel Design
  - Designed 3-D mechanical structure and drawing work of the small wind tunnel.
- Study on Numerical Cabin Pressure Control System
  - The flow fields of the butterfly and gate outflow valves in the numerical cabin pressure control system are numerically simulated and calculated.

WORK EXPERIENCE

SAIC Motor Commercial Vehicle Technical Center *Shanghai, China*

IP (Instrument Panel) & DP (Door Panel) Engineer *Aug 2013 - Jun 2015*

- Program: SV71 Main responsible parts: Console
  - Achievement: changing design of Console to enlarge the storage space and right rudder Console Development project
- Program: SV61& EV69 Main responsible parts: IP and DP
  - Achievement: Quality Improvement Project
  - Award: New Start of Season of the Department of Body and Design

OTHER EXPERIENCE

- College women's volleyball team captain *Sept 2006*
- Volunteer, Beijing 2008 Olympics *Aug 2008*

- Internship, Nanjing electrical and hydraulic center *July 2009*
- Internship as Assistant of production department; Akivator(Kunshan) *Aug 2011*
- Internship as Project Manager of Automated pharmacy store, IRON(Suzhou) *Aug 2012*