Yuanyuan Gao |

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Education

Rensselaer Polytechnic Institute	**Troy, New York, USA**
Ph.D. in Department of Mechanical Engineering	*08/2015-08/2020*
Beihang University	**Beijing, China**
MS in Department of Mechanical Engineering	*08/2010–07/2013*
Beihang University	**Beijing, China**
BS in Aircraft Environment and Life Security Engineering	*09/2006–07/2010*

Research Experience

Stanford University	**Stanford, CA 94304, USA**
Post-doctoral Fellow in Department of Psychiatry and Behavioral Sciences	*03/2023 – current*
Boston University	**Boston, MA 02215, USA**
Post-doctoral Associate in Department of Biomedical Engineering	*11/2020 – 02/2023*
Rensselaer Polytechnic Institute	**Troy, NY 12180, USA**
Graduate Research Assistant in Department of Mechanical Engineering	*08/2015-08/2020*
University at Buffalo	**Buffalo, NY, USA**
Visiting Scholar in Department of Civil Engineering	*02/2019-10/2019*
Harvard Medical School	**Boston, MA, USA**
Researcher	*02/2016-08/2016*

Teaching Experience

2022: Committee for undergraduate senior projects in the biomedical engineering department at Boston University. Instructor: Dr. Darren Roblyer

2021: Teaching Assistant for "fNIRS workshop" at Boston University. Instructor: Dr. David Boas

2018: Guest Lectures for "Modeling of Biomedical Systems" at Rensselaer Polytechnic Institute. Instructor: Dr. Uwe Kruger

2018: Undergraduate Student Mentor for "fNIRS data processing and analysis -Undergraduate Research Program (URP)" at Rensselaer Polytechnic Institute. Instructor: Dr. Suvranu De. UG students: Jeanine Moreau, Yanting Liu, Yiying Huang.

2015, 2018: Graduate Teaching Assistant for "Thermal and Fluid Engineering" at Rensselaer Polytechnic Institute. Instructors: Dr. Diana-Andra Borca-Tasciu; Dr. Daniel Lander

2016, 2017: Graduate Teaching Assistant for "Modeling and Analysis of Uncertainty" at Rensselaer Polytechnic Institute. Instructor: Dr. Bimal K. Malaviya

Research Project

Postdoctoral projects

Stanford University   **Stanford, MA, USA**
Clinical application of fNIRS   *2023 – current*
Applied functional near-infrared spectroscopy (fNIRS) technique on clinical topics, such as functional connectivity alteration by early-life pesticide exposure, ADHD and Fragile X syndrome, and etc.
Details:
○ Advisor: Dr. Allan L. Reiss
○ Examine associations of prenatal and early childhood biomarkers of OP exposure with intrinsic functional connectivity at ages 18-19 years. We hypothesize that OP exposure is associated with altered functional connectivity.
○ Examine associations among OP exposure, functional connectivity, and behavioral outcome (Conners ADHD/DSM-IV, Fourth Edition Scales, Parent and Teacher – "CADS"). We hypothesize that the functional connectivity matrix will be a mediator between pesticide exposure metrics and behavioral outcome.

Boston University   **Boston, MA, USA**
Development of advanced algorithms in neuroimaging   *2020 – 2023*
Developed advanced algorithms for functional near-infrared spectroscopy (fNIRS) technique.
Details:
○ Advisor: Dr. David Boas
○ Developed a new GPU-accelerated algorithm combing SS and DOT to extract the information on both spatial and temporal scales.
○ Developed resting-state brain functional connectivity analysis methodology using fNIRS validated by fMRI.
○ Validated the repeatability in fNIRS using fMRI data.
○ Conducted clinical trials investigating the neuroactivities during human daily life, both in normal people and diseases such as stroke and Parkinson's Disease.

Doctoral projects

Rensselaer Polytechnic Institute   **Troy, NY 12180, USA**
Evaluating brain activation changes during motor learning   *2015 – 2020*
Evaluating brain activation changes during motor learning via functional near-infrared spectroscopy (fNIRS) under neurostimulation conditions
Details:
○ Advisors: Dr. Suvranu De and Dr. Xavier Intes
○ In a longitudinal study (12 days of training), I demonstrated that transcranial direct current stimulation (tDCS) suppressed the activation in the M1 region.

Rensselaer Polytechnic Institute   **Troy, NY 12180, USA**
Deep learning approaches to removing motion artifacts in fNIRS data   *2019 – 2021*
The motion artifacts in fNIRS data were detected and removed by deep learning models.
Details:
○ 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 the fNIRS data processing field as the first to introduce a deep learning approach and has opened a new chapter.

Rensselaer Polytechnic Institute   **Troy, NY 12180, USA**
Deep learning models to predict surgical skills from fNIRS   *2017 – 2019*
I built deep learning models to predict surgical skills from fNIRS signals.
Details:
○ 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.

Rensselaer Polytechnic Institute   **Troy, NY 12180, USA**
Machine learning approaches to predict learning curve characteristics *2015 – 2018*

The surgical performance was predicted from the initial performance

Details:

○ Instructor: Dr. Uwe Kruger

○ I successfully predicted the learning curve characteristics from the initial ten trials performance of the medical students ($R2 = 0.81$) by employing the machine learning approach, kernel partial least squares (KPLS). I further classified the students into two groups with unique learning characteristics through an unsupervised machine learning algorithm, the k-means algorithm, revealing the motor learning nature of humans.

Rensselaer Polytechnic Institute   **Troy, NY 12180, USA**

Literature review on neuroimaging studies   *2015 − 2020*

A review on how neuroimaging techniques revealed human motor learning nature and how electrical stimulation affects it.

Details:

○ Instructor: Dr. Lora Cavuoto

○ I contributed to the review 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.

Publication

Journal Papers

8. **Yuanyuan Gao**, De'Ja Rogers, Alexander von Lühmann, Antonio Ortega-Martinez, David A. Boas, and Meryem Yücel. Short-separation regression incorporated diffuse optical tomography (ss-dot) image reconstruction modeling for high-density functional near-infrared spectroscopy (fnirs). *Neurophotonics*, under review, 2022

7. Antonio Ortega-Martinez, De'Ja Rogers, Jessica Anderson, Parya Farzam, **Yuanyuan Gao**, Bernhard Zimmermann, Meryem A. Yücel, and David A. Boas. How much do time-domain functional near-infrared spectroscopy (fNIRS) moments improve estimation of brain activity over traditional fNIRS? *Neurophotonics*, 10(1):013504, 2022

6. **Yuanyuan Gao**, Hanqing Chao, Lora Cavuoto, Pingkun Yan, Uwe Kruger, Jack E. Norfleet, Basiel A. Makled, Steven D. Schwaitzberg, Suvranu De, and Xavier R. Intes. Deep learning-based motion artifact removal in functional near-infrared spectroscopy. *Neurophotonics*, 9(4):041406, 2022

5. Arun Nemani, Anil Kamat, **Yuanyuan Gao**, Meryem A. Yucel, Denise Gee, Clairice Cooper, Steven D. Schwaitzberg, Xavier Intes, Anirban Dutta, and Suvranu De. Functional brain connectivity related to surgical skill dexterity in physical and virtual simulation environments. *Neurophotonics*, 8(1):015008, 2021

4. **Yuanyuan Gao**, Lora Cavuoto, Anirban Dutta, Uwe Kruger, Pingkun Yan, Arun Nemani, Jack E. Norfleet, Basiel A. Makled, Jessica Silvestri, Steven Schwaitzberg, Xavier Intes, and Suvranu De. Decreasing the surgical errors by neurostimulation of primary motor cortex and the associated brain activation via neuroimaging. *Frontiers in Neuroscience*, 15, 2021

3. **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 Transactions on Biomedical Engineering*, 68(7):2058–2066, 2021

2. **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, 2020

1. **Yuanyuan Gao**, Uwe Kruger, Xavier Intes, Steven Schwaitzberg, and Suvranu De. A machine learning approach to predict surgical learning curves. *Surgery*, 167(2):321–327, 2020

Conference papers

7. **Yuanyuan Gao**, De'Ja Rogers, Alexander Luhmann, Antonio Ortega-Martinez, David Boas, and Meryem Yucel. Short separation regression incorporated diffuse optical tomography (ss-dot). In *Society of fNIRS conference*, 2022

6. **Yuanyuan Gao**, De'Ja Rogers, Alexander Luhmann, Antonio Ortega-Martinez, David Boas, and Meryem Yucel. Short separation generalized linear model (glm) based image reconstruction of functional near-infrared spectroscopy (fnirs) data. In *Society of fNIRS virtual conference*, 2021

5. **Yuanyuan Gao**, Lora Cavuoto, 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*, 2020

4. **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. In *Biophotonics Congress: Biomedical Optics 2020 (Translational, Microscopy, OCT, OTS, BRAIN)*, page BM2C.7. Optica Publishing Group, 2020

3. **Yuanyuan Gao**, Lora Cavuoto, Pingkun Yan, Uwe Kruger, Jessica Silvestri, Steven Schwaitzberg, Xavier Intes, and Suvranu De. Monitoring the effect of transcranial electric current stimulation (tes) during a bimanual motor task via functional near-infrared spectroscopy (fnirs). In *Biophotonics Congress: Biomedical Optics 2020 (Translational, Microscopy, OCT, OTS, BRAIN)*, page JTh2A.29. Optica Publishing Group, 2020

2. **Yuanyuan Gao**, Pingkun Yan, Suvranu De, and Xavier Intes. fnirs as a quantitative tool to asses and predict surgical skills. In *Biophotonics Congress: Optics in the Life Sciences Congress 2019 (BODA,BRAIN,NTM,OMA,OMP)*, page BW4A.2. Optica Publishing Group, 2019

1. **Yuanyuan Gao**, Pingkun Yan, Uwe Kruger, Suvranu De, and Xavier Intes. Neuroimaging biomarkers for surgical skill level prediction. In *SPIE.bios*, 2019

Awards

2022: Poster Excellence Award, Society of fNIRS conference
2020: Young Investigator Competition Finalist Award for Excellence, Military Health System Research Symposium
2013: Outstanding Graduate in Beijing
2011: BUAA Graduate Students Second Prize Scholarship
2007: BUAA undergraduate Students Second Prize Scholarship

Professional Activities

Editorial board

Frontiers in Medical Engineering

Committee members

2022: SfNIRS Conference, Organizing Committee Member
2021: V-SfNIRS Conference, Organizing Committee Member
2021: V-SfNIRS Conference, host of multimodal measurements panel.

Review experience

Machine Learning and Machine Intelligence (6 papers); Applied Optics (2 papers); Journal of Biomedical Optic (1 paper); Neurophotonics (4 paper); IEEE JBHI (1 paper); Journal of Alzheimer's Disease (1 paper); Biomedical Optics Express (4 papers); Cortical Cortex (1 paper); Frontiers in Neuroscience (1 paper); Frontiers in Neuroergonomics (1 paper); Journal of the Optical Society of America A (1 paper)

Work Experience

2013-2015: Engineer in SAIC Motor Commercial Vehicle Technical Center in Shanghai, China

2012: Internship as Project Manager of Automated pharmacy store, IRON(Suzhou), Jiangsu, China

2011: Internship as Assistant of production department; Akivator(Kunshan), Jiangsu, China

2009: Internship, Nanjing electrical and hydraulic center, Nanjing, China