

Curriculum Vitae

Richard (Chaoyang) Chen, MD, PhD

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Nationality: US Citizen

EDUCATION

- **Fujian Medical University, Fujian, China**
MD of Medicine, 1982- 1987
- **Peking University (School of Medicine), Beijing, China**
PhD, Orthopaedic Surgery/Orthopaedic Biomechanics, 1987-1990
- **Wayne State University, Detroit, Michigan**
Postdoctoral Fellow, Biomechanics/Neurophysiology, Bioengineering Center, 1994-1998
Courses taken: Problem Solving using C++ (2000)
Entrepreneurship for small business (2006)

PROFESSIONAL EMPLOYMENT

Department of Orthopedic Surgery & Sports Medicine, Detroit Medical Center, Detroit, MI

Chief Research Scientist, Director of Research, Non-Physician Faculty. Feb 1, 2019- present

Role: Running Biomechanics Lab, Sports Medicine Lab, and Orthopaedics AI Lab.

Projects:

- Research and development of an athlete training assistive system for baseball player. Pitching motion analysis for performance enhancement of injury prevention among young baseball player using AI techniques-applications of wearable sensors and machine vision.
- Fingertip gripping strength sensors using thin film and customized circuit – applications in baseball players and robotic haptic hand sensory system.
- Computer vision and machine learning in prediction of elderly flat level falls based on gait pattern recognition-using Azure Kinect cameras and customized algorithms – development of a remote monitoring machine vision system
- Processing EMG and EEG signal for upper arm exoskeleton motion control using TensorFlow.
- Predicting Rotator Cuff Tear Severity Using Radiographic Images and Machine Learning Techniques using Keras.
- Using conventional statistical methods and machine learning for clinical data analysis to determine the importance of individual factors leading to postoperative complications in arthroplasty.

Department of Orthopedic Surgery, Henry Ford Health System, Detroit, MI

Clinical Research Coordinator, May 1, 2018- Jan 31, 2019

Projects:

- Clinical big data extraction and statistical analysis using RedCap, MARQCI database.
- Building resident research curriculum.

Department of Biomedical Engineering, Wayne State University, Detroit, Michigan

Professor (Affiliated) – Sept. 2022- Present

Projects:

- A Biomechanical Study of High Tibial Osteotomy and Patellofemoral Joint Contact Pressures
- Biomechanical study of a novel meniscus surgical repair.

Associate Professor – Research (Full time) Jan 2009.1 – Dec 2017;

Director of Robotic Rehabilitation laboratory

Projects:

- Development of cost-effective low limb ambulation assistive system
- Development of light-weight wearable upper arm exoskeleton system
- Efficiency comparison of various machine learning algorithms in real-time upper limb exoskeleton motion control
- Implantable nano-carbon tube multi-array electrode for brain computer interface

- Steady state visual evoked potential (SSVEP) in brain typing
- Human-vehicle-interaction: Response of human musculoskeletal system to incoming vehicle collision
- Monitoring driver's drowsiness using EEG signal and determination of the optimal location for electrode placement.

Bioengineering Center, Wayne State University, Detroit, Michigan

Research Associate 1998 – 2008

Projects:

- Neurophysiology and biomechanics of lower back pain and sciatic pain caused by lumbar disk herniation
- Neurophysiology of whiplash pain
- Processing and monitoring neural signals for determination of the severity of soft tissue injury.

Dept. of Civil Engineering, Biomechanics Lab, Fuzhou University, Fuzhou, Fujian, China

Research Fellow of collaborative research projects 1992-1994

Projects:

- Photoelasticity and biomechanical study of internal fixation of spine fracture.

Department of Orthopaedic Surgery, the First Hospital of Fujian Medical University, Fuzhou, China

Orthopedic Surgery Resident/Chief Resident/ attending Surgeon 1990-1994

- Practicing orthopedic surgery in trauma (fracture fixation), spine surgery, arthroplasty, microsurgery, vascular surgery
- Biomechanical research of spine fracture

Department of Orthopaedic Surgery, Peking University People Hospital, Beijing, China

Orthopedic Surgery, Resident, 1987-1990

- Rotated in general surgery, thoracic surgery, nephrology, anesthesia, orthopedic surgery as resident
- Performed clinical research

HONORS/AWARDS/RECOGNITION

Honors:

- Publicity Chair, The 9th International Conference on Computing and Pattern Recognition, Association of Computer Machinery, Xiemen, China, 2020.
- Program Chair, The 8th International Conference on Computing and Pattern Recognition, Association of Computer Machinery, Beijing, China, 2019.
- Session Chair, Assistive Technology, Annual Meeting of Biomedical Engineering Society, Atlanta, GA, 2018.
- Program Chair. International Conference of Biomedical Image, Signal Processing, Newark, NJ, USA, 2017.
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Awards:

- The Best Oral Presentation, International Conference on Computing and Pattern Recognition, Association of Computer Machinery, Shanghai, China, 2021. Title: Predicting Rotator Cuff Tear Severity Using Radiographic Images and Machine Learning Techniques
- The Best Oral Presentation, International Conference on Computing and Pattern Recognition, Association of Computer Machinery, Xiemen, China, 2020. Title: Real-Time Surface EMG Pattern Recognition for Shoulder Motions Based on Support Vector Machine
- The Third Prize Award. "Low-Cost Development of High-Quality Automotive Safety Products." China Association of Automobile Manufacturers (CAAM) and Detroit Chinese Business Association (DCBA) Detroit, June 2014.
- John Paul Stapp Best Paper Award, Stapp Car Crash Conference, 2005
- New Investigator Recognition Award, Annual Meeting of Orthopaedic Research Society, Washington DC, 2004
- William D. Robinson Postdoctoral Fellowship Award, Arthritis Foundation, Michigan Chapter, Medical & Scientific Committee, 1997-1998.
- International Fellow, Annual Meeting of the International Society for the Study of the Lumbar Spine, Seattle, Washington 1994
- Sofamor-Danek Award for Outstanding Poster, Annual Meeting of the International Society for the Study of the Lumbar

Spine, Seattle, Washington 1994

INSTRUMENTATION AND SOFTWARE SKILLS

- Department of Biomedical Engineering, Wayne State University, for data analysis (t test, chi-square, ANOVA, Correlation (bivariate, partial, curve estimate), Logistic regression, Prediction for identifying groups (Factor analysis, hierarchical linear regression, Discriminant), ROC, Mann Whitney, Kappa, reliability, machine learning/neural network/multilayer Perceptron.) (more than 20 years' experience of using SPSS software for statistical analysis).
- G - Power software: Power analysis and sample size estimate
- Instron Material Testing Machine (E10000) and WaveMatrix
- Delsys Trigno Wireless EMG Acquisition System and software with built in accelerometer and gyroscope, single motor unit activity analysis algorithms.
- Perception neuron IMU sensors for motion capture.
- Azure computer vision camera for motion capture and joint angle 3D measurement.
- Online EMG signal processing using machine learning algorithms for robot control.
- Mimics Software: 3D Medical Image Processing for construction of human body into CAD and 3D printing.
- AcqKnowledge Data Acquisition and Analysis Software for FFT, PSD, EEG, ECG, EMG, EDA, HRV, force data.
- DEWETRON biomechanical data acquisition system and DeweSoft (SIRUS, Dewe Soft LLC), high-speed digital camera systems, Image express software, Linear accelerometers, Angular rate sensors.
- Keras machine learning for image processing and clinical diagnosis.
- Hyper mesh, LS-Dyna finite element analysis (FEA) software
- Brain computer interface (BCI): TGAM module for EEG recording, STM32 FFT processing, Arduino IDE for stepper motor control.

OTHER PROFESSIONAL RELATED SERVICE

1. Professional Reviewer:
 - Journal of Orthopedic Research,
 - Journal of American Medical Association (JAMA),
 - SAE International,
 - Applied Science.
 - Micromachines
 - Spine Journal
 - Healthcare
 - Frontiers in Neurorobotics
2. Editorial Board Member:
 - Archives of Orthopaedics
 - Healthcare
 - Frontiers in Neuroscience
3. Grant Review Panel:
 - Scientist Reviewer for the 2021 Traumatic Brain Injury and Psychological Health Research Program on the Focused Program - Prevention - 1 (FP-PRV-1). (DoD)

TEACHING (2017-2021, WSU)

Mentoring 2 PhD candidates

- Yang Zhou (graduated in 2020, currently working in Chinese Science Academy)
- Yousef Alshahrani (graduated in 2021 currently working in Taibah University, Saudi Arabia)

Mentoring visiting scholars from China.

- Peng Xu (MD, PhD) (Department of Orthopaedic Surgery, Shan-Dong University, China) (2010)
- Xin Tao (PhD) (Department of Automotive Engineering, Tsinghua University, China) (2012)

- Xiangjie Meng (PhD) (Department of Automotive Engineering, Tsinghua University, China, (2014)
- Chao Zeng (PhD) (School of Geoscience and Info-Physics Central South University, Changsha, Hu-Nan, China, (2015)
- Pan Tian (PhD) (Department of Mechanical Engineering, Shanghai JiaoTong University, Shanghai, China) (2016. 1- 2016. 8)
- Biao Chen (PhD) (State Key Laboratory of Mechanical System and Vibration. Shanghai JiaoTong University, Shanghai, China) (2016.1 -2017.12)
- Xinuo Zhang (PhD), (Department of Orthopaedic Surgery, Capital Medical University, Chaoyang Hospital, Beijing, China) (2016.1-2017.12)
- Yongyu Jiang (PhD), (Institute of Robotics and Intelligent System, Xian JiaoTong University, Xian, Shaanxi, China) (2018-2019)
- Cheng Chen (PhD), (Department of Mechanical Engineering, Xian JiaoTong University, Xian, Shaanxi, China) (2018-2019)

Course teaching:

- BME 7670 Experimental Methods in Physiology (Winter terms, 2017 and 2018, 2019, 2020, 2121)
- BME 5995 Physiologic Signal Processing for Human Machine Interface (Summer course, 2017)
- BME 4010 Engineering Physiology Laboratory (Winter 2020)

RESEARCH GRANTS AND BRIEF DESCRIPTIONS

Active Grants:

“Motion Capture and Analysis among Young Baseball Players Using AI Techniques”. (RIM Foundation) (2022-2024). (Role: PI)(\$50,000).

This project is developing an artificial intelligence (AI) and machine learning (ML) techniques, as well as machine vision (MV) for young baseball athletes to prevent injury and enhance performance.

Previously Funded Grants:

"A Robust, Chronic Neural Prosthesis Using High-Capacity Graphene Electrodes and Biodegradable Silicon Support", NSF, 06/01/2012-2017. (Role Co-PI, PI: Mark Cheng) (\$600,000)

This project has developed nano-graphene electrodes as peripheral nerve interface and peripheral muscle interface. Nano technology and graphene materials are used to fabricate carbon nanotube multi-electrode arrays (CNT-MEAs) as recording electrode to capture high bio-fidelity less noise EMG signals.

“Parity-time Telemetric Sensors for Wireless Intracranial Pressure Monitoring” (Submitted to NIH Exploratory/Developmental Research Grant Award (R21) (2022-2025). (Role Co-PI), (PI: Mark Cheng, University of Alabama)

This project is developing a novel wireless, battery-free pressure sensor that can be used to monitor the intracranial pressure (ICP). The efficiency of the novel sensor will be tested using a chronic survival swine models.

“Effects of Novel Ultrasonic Surgical Cutting Devices on Peripheral Nerve Structure and Function”. Ethicon Inc. 9/01/2007-8/31/2012. (Role: PI)(\$350,000)

This project investigated the safe standards for operating ultrasonic surgical cutting devices (HK2, HKCB, Focus, ACE) on the muscles and their effects on the adjacent nerve.

“Determining Axonal Injury Tolerance in a Spinal Nerve Root Model”. NHTSA, DTNH22-08-R-00184, 9/01/2008-2/28/2011. (Role: co-PI)(PI: John Cavanaugh) (\$650,000)

This project investigated the spinal nerve tolerance to quasistatic and high-speed dynamic nerve stretch using neurophysiologic and immuno-chemistry staining techniques.

"Mechanisms of Sciatica Caused by Lumbar Disc Herniation," Orthopaedic Research and Education Foundation. 09/01/98 - 8/31/2000. (Role: PI)(\$100,000)

This project investigated the mechano-sensitivity, neural activity, and histologic changes of the lumbar spinal nerve after exposure to herniated nucleus pulposus.

"A Neurophysiological Study of the Intervertebral Disc and Adjacent Tissue," NIH R01, AR41739, NIAMS, 4/01/98 - 3/31/2002. (Role: co-PI)(PI: John Cavanaugh) (\$420,000)

This project investigated the nerve ectopic discharges, peripheral pain sensation, behavior change, and histologic changes of the lumbar spinal nerve, adjacent facet joint tissue after exposure to herniated nucleus pulposus.

"Neurophysiology of Whiplash Pain," Centers for Disease Control, 10/01/01- 9/3/07. (Role: co-PI)(PI: John Cavanaugh) (\$640,000)

This project investigated the mechanisms of cervical facet joint pain when facet joint was stretched at various strain at quasistatic speeds.

"Mechanical, Neurophysiological and Structural Changes of Spinal Nerve Roots Caused by Tensile Loading." Aircast Foundation. (Role: PI)(\$50,000)

This project investigated the spinal nerve tolerance to low-speed quasistatic nerve stretch using neurophysiologic and immuno-chemistry staining techniques.

"Photo-elasticity Biomechanics Studies of Internal Fixation of Thoracic-Lumber Spine Fracture". Health Department of Fujian Province, China, 8/01/92 - 7/31/94.

This project investigated the stress distribution in the vertebral body to predict the probability of internal fixation device failure using photoelastic biomechanical analysis methods.

Submitted Grant

"Parity-time Telemetric Sensors for Wireless Intracranial Pressure Monitoring". (Submitted to NIH Exploratory/Developmental Research Grant Award (R21) (2022-2025). (Role: Co-PI), (PI: Mark Cheng, University of Alabama)

This project is developing a novel wireless, battery-free pressure sensor that can be used to monitor the intracranial pressure (ICP). The efficiency of the novel sensor will be tested using a chronic survival swine models.

PUBLICATIONS

Journal Papers

Clinical Orthopaedic Research

1. Chen C, Zhao Z, Jiang H. Axial traction straight leg raising test for type lumbar disc herniation. Chinese Journal of Spine and Spinal Cord 1992; 2(3):125- 126.
2. He SJ, Wang HG, Chen C. Scoliosis Surgical Treatment - 54 Clinical Cases Review. Chinese Journal of Spine and Spinal Cord 1994;4(3):124-125.
3. Lin XJ, Chen CY. Advances on study of treatment of lumbar disk herniation by Chinese medicinal herbs. China Journal of Chinese Materia Medica (Zhongguo Zhong Yao Za Zhi) 2007;32(3):186-91. PMID: 17432134
4. Dougherty P, Chen C, Zhang Y. CORR® Curriculum - Orthopaedic Education: Orthopaedic Surgery Education in China. Clin Orthop Relat Res 2017; 475:35–38 / DOI 10.1007/s11999-016-5162-z
5. Michael Daniel, David Waters, Chaoyang Chen, Nicole Brouyette. "Tibial Schwannoma in multiple myeloma patient". SAGE Open Medical Case Reports 2019. 10;7:2050313X19838441. doi: 10.1177/2050313 X19838441.

6. Jonathan Lynch, Charles C. Yu, Chaoyang Chen, Stephanie Muh. "MRI and US in distal bicep tendon rupture". *Orthop Trauma Surg Res* 2019, doi: 10.1016/j.otsr.2019.01.021.
7. Oliver Scotting, Wayne North, Craig Silverton, Fawaz Hussain, Chaoyang Chen, Micheal Charters. Indwelling Urinary Catheter Necessary for Total Joint Arthroplasty Using Epidural Anesthesia. *Journal of Arthroplasty* 2019. <https://doi.org/10.1016/j.arth.2019.05.047>.
8. Felicity Fisk, MD; Sreten Franovic, MS, BS; Joseph Tramer, MD; Caleb M Gullidge, BS; Noah A Kuhlmann, MS, BS; Chaoyang Chen, MD, PhD; Vasilios Moutzouros, MD; Stephanie Muh, MD; Eric C Makhni. PROMIS CAT Forms Demonstrate Early Responsiveness in Patients Undergoing Rotator Cuff Repair across Multiple Health Domains. *J Shoulder Elbow Surg.* 2019 Dec;28(12):2427-2432. doi: 10.1016/j.jse.2019.04.055.
9. Franovic S, Gullidge CM, Kuhlmann NA, Williford TH, Chen C, Makhni EC. Establishing "Normal" Patient-Reported Outcomes Measurement Information System Physical Function and Pain Interference Scores: A True Reference Score According to Adults Free of Joint Pain and Disability. *JBJS Open Access.* 2019 Dec 10;4(4):e0019. doi: 10.2106/JBJS.OA.19.00019.
10. Kyle Schultz, Jeff Osborne, Karen Nelson, Vishnu Potini, Chaoyang Chen, Andrew Aljuni, Asheesh Bedi, James Bookout, Michael Yusaf, Shariff K Bishai. Intra- and interobserver reliability for predicting hip preservation versus hip arthroplasty utilizing plain radiographs with comparison of surgeon specialization. *Journal of Hip Preservation Surgery.* 2020 Feb 10, hnaa005, <https://doi.org/10.1093/jhps/hnaa005>, PMID: 32382432
11. Elizabeth Ann Klag, Kelechi R Okoroha, Gabriel Sheena; Noah A Kuhlmann; Chaoyang Chen; Stephanie J Muh. Does the use of a peri-articular anesthetic cocktail provide adequate pain control following shoulder arthroplasty? *Journal of Shoulder and Elbow Surgery* 2020, (DOI: 10.1177/1758573220916916)
12. Noah A Kuhlmann, Kevin A Taylor, MD, Christopher P Roche, Sreten Franovic, Chaoyang Chen, Bradley C Carofino, Pierre-Henri Flurin, Thomas W Wright, Bradley S Schoch, Joseph D Zuckerman, Stephanie J Muh. Acute versus delayed reverse total shoulder arthroplasty for proximal humerus fractures in the elderly: Mid-term outcomes. *Seminars in Arthroplasty* 2020, DOI: <https://doi.org/10.1053/j.sart.2020.05.007>
13. Patrick Schafer, Ali Mehaidli, Mark Zekaj, Muhammad T Padela, Syed Ahmad Rizvi, Chaoyang Chen, Zain Sayeed, Hussein Darwiche. Assessing knee anatomy using Makoplasty software a case series of 99 knees. *Journal of orthopaedics.* 2020, 20,347-351. DOI: 10.1016/j.jor.2020.05.023. PMID: 32684671.
14. Christopher Cooke, Jeffrey Osborne, Nancy Jackson, Patrick Keating, Jeff Flynn, David Markel, Chaoyang Chen, Stephen Lemos. Acetaminophen, Bupivacaine, Duramorph, and Toradol: A comparison of Chondrocyte Viability and Gene Expression changes in Osteoarthritic Human Chondrocytes. *Knee* 2020 13;27(6):1746-1752. doi: 10.1016/j.knee.2020.10.019
15. Alex Hamilton, Caden Nowak, Chaoyang Chen, Hussein Darwiche. Differences in immediate post-operative outcomes between robotic-assisted TKA and conventional TKA. *Arthroplasty Today.* 2021 Feb 27;8:57-62. doi: 10.1016/j.artd.2021.01.017. PMID: 33718557
16. Sreten Franovic; Yang Zhou; Emily Lau; Alexander D Pietroski; Noah A Kuhlmann; Chaoyang Chen; Stephanie J Muh. A Pilot Study for Assessing a Novel Method of Measuring Shoulder Activation in Healthy Volunteers Using Surface Electromyography. *Arch Orthop,* 2020, 1, 126 – 134.
17. Sanar Yokhana, Sasha Stine, David Alex Hamilton, Lauren Smith, Abdul Zalikha, Chaoyang Chen, Hussein Darwiche. The prevalence of posterolateral tibial baseplate overhang: An anatomical CT study. *J Orthop* 2021 Feb 9;23:259-263. doi: 10.1016/j.jor.2021.02.002. PMID: 33679017
18. Edward Rozek, Allison Cracchiolo, Patrick Keating, Chaoyang Chen, Stephen Lemos. Evaluation of Educational Advancement following a Sports Medicine Rotation. *International Journal of Sports and Exercise Medicine* 2021,7(4),1-6. DOI: 10.23937/2469-5718/1510196.
19. Lau E, Pietroski A, Franovic S, Zhou Y, Kuhlmann N, Chen C, Muh S. Surface Electromyography Reveals Middle Deltoid as The Functionally Dominant Shoulder Muscle After Reverse Total Shoulder Arthroplasty. *SN Comprehensive Clinical Medicine,* 2021 DOI: 10.21203/rs.3.rs-519913/v1.
20. Lauren N Stimson, Kevin R Steelman, Alex Hamilton, Chaoyang Chen, Hussein F Darwiche, Ali Mehaidli. Evaluation of Blood Loss in Conventional vs Makoplasty Total Knee Arthroplasty. *Arthroplasty Today.* 2022 DOI:<https://doi.org/10.1016/j.artd.2022.06.003>.
21. Christopher W Foote, Cheryl Vanier, Chaoyang Chen, Carlos H Palacio. Evaluation of Therapy in Traumatic Elderly Falls to Return Autonomy and Functional Status. *Surgery Open Science* 2022. DOI: <https://doi.org/10.1016/j.sopen.2022.09.008>
22. Muhammad Darwish, Constance McGraw, Christopher Foote, Chaoyang Chen, David Bar-Or, Carlos H. Palacio. Border-Fence Falls versus Domestic Falls at a South Texas Trauma Center. *Trauma Surgery & Acute Care Open*

2022. (Submitted).

Orthopaedic Biomechanics and Sports Medicine

23. Micah Lissy, Jeffrey Osborne, Patrick Keating, Nathan Richards, Chaoyang Chen, Stephen Lemos. Physseal-Sparing Posteromedial Portal Approach Reduced Distance between Guide Pin and Neurovascular Structures. *Knee Surgery, Sports Traumatology, Arthroscopy (KSSTA)* 2021. (DOI: 10.1007/s00167-020-06043-z) PMID: 32405665.
24. Timothy Doig, Paul Fagan, Todd Frush, Lisa Lovse, Chaoyang Chen, Stephen Lemos. The All-Inside All-Suture Technique Demonstrated Better Biomechanical Behaviors in Meniscus Radial Tear Repair. *Knee Surgery, Sports Traumatology, Arthroscopy* 2020 June (DOI: 10.1007/s00167-020-06078-2)
25. Halloran JP, Esquivel AO, Cracchiolo AM, Chen C, Lemos SE. The Role of the MPFL and MPTL in Patellar Stability – A Biomechanical Study. *Arch Orthop.* 2020; 1(2): 49-54.
26. Steven Johnson, Amanda Esquivel, Lisa Lovse, Allison Cracchiolo, Chaoyang Chen, Stephen Lemos. Anatomic Acromioclavicular Joint Reconstruction with and without Acromioclavicular Ligament Reconstruction: A Comparative Biomechanical Study. *Shoulder and Elbow* 2022. DOI:10.1177/17585732211068322.
27. Thomas Nguyen, Chaoyang Chen, Hannah Joines, Nicholas Paolucci, Perry Merillat, Heather Preston, Stephen Lemos. Flexor Pronator Mass Contribution to Elbow Valgus Stability: A Biomechanical Project The Orthopaedic Journal of Sports Medicine 10(7_suppl5):2325967121S0074. DOI: 10.1177/2325967121S00746
28. Michael Freehill, Michael Walsh, Nathan Richards, John Morasso, Traci Ackron, Emily Lau, Chaoyang Chen, Corey Tremble, Richard Ryu, Stephen Lemos. Hand Size and Ulnar Collateral Ligament Injury in Professional Baseball Players. Annual Meeting of ASES 2022, Atlanta, GA, October 6 – 9.
29. Heather Preston, Hannah Joines, Chaoyang Chen, Devan Higginbotham, Andrew Tsai. Anatomic and Biomechanical Study of Thumb Carpometacarpal Dislocations: A Laboratory Study. *Hand* 2022, (submitted).

AI and Machine Learning - EMG/EEG signal processing for robot control & Medical image processing

30. Cheng Chen, Christine Chen, Xuesong Mei, Chaoyang Chen, Guoxin Ni, Stephen Lemos. Effects of Image Augmentation and Dual-layer Transfer Machine Learning Architecture on Tumor Classification. ICCPR 2019: Proceedings of the 8th International Conference on Computing and Pattern Recognition, October 2019, Pages 282–287. Publisher: Association for Computing Machinery, New York, NY, United States. ISBN:978-1-4503-7657-0. <https://doi.org/10.1145/3373509.3373584>.
31. Yang Zhou, Chaoyang Chen, Juan Ni, Guoxin Ni, Min Li, Guanghua Xu, John Cavanaugh, Mark Cheng, Stephen Lemos. EMG Signal Processing for Hand Motion Pattern Recognition Using Machine Learning Algorithms. *Archives of Orthopaedics* 2020; 1(1): 17-26. 10.33696/Orthopaedics.1.005
32. Yongyu Jiang, Christine Chen, Xiaodong Zhang, Chaoyang Chen, Yang Zhou, Guoxin Ni, Stephanie Muh, Stephen Lemos. Shoulder Muscle Activation Pattern Recognition Based on sEMG and Machine Learning Algorithms. *Computer Methods and Programs in Biomedicine* 2020 <https://doi.org/10.1016/j.cmpb.2020.105721>
33. Yongyu Jiang, Xiaodong Zhang, Chaoyang Chen, Zhufeng Lu, Yachun Wang. Deep Learning Based Recognition of Hand Movement Intention EEG in Patients with Spinal Cord Injury. The Annual IEEE International Conference on CYBER Technology in Automation, Control, and Intelligent Systems. 2020. 10.1109/CYBER50695.2020.9279190.
34. Yongyu Jiang, Christine Chen, Xiaodong Zhang, Wei Zhou, Chaoyang Chen and Stephen Lemos. Processing EEG Signal for Hand Motion Pattern Recognition Using CNN Machine Learning Algorithms". *ACM Conference Proceedings in ICCPR 2020* (ISBN: 978-1-4503-8783-5) <https://dl.acm.org/doi/abs/10.1145/3436369.3437433>
35. Yang Zhou, Chaoyang Chen, Mark Cheng, Sreten Franovic, Stephanie Muh and Stephen Lemos. Real-Time Surface EMG Pattern Recognition for Shoulder Motions Based on Support Vector Machine. *ACM Conference Proceedings in ICCPR 2020* (ISBN: 978-1-4503-8783-5). <https://dl.acm.org/doi/abs/10.1145/3436369.3437434>
36. Yang Zhou, Chaoyang Chen, Mark Cheng, Yousef Alshahrani, Sreten Franovic, Emily Lau, Guanghua Xu, Guoxin Ni, John M Cavanaugh, Stephanie Muh, Stephen Lemos. Comparison of Machine Learning Methods in sEMG Signal Processing for Shoulder Motion Recognition. *Biomedical Signal Processing and Control* 2021. <https://doi.org/10.1016/j.bspc.2021.102577>.
37. Yusik Cho, Alena Jalics, Ding Lv, Marissa Gilbert, Kathy Dickson, Dawei Chen, Hannah Joines, Brandon Kakos, Chaoyang Chen and Stephen Lemos. Predicting Rotator Cuff Tear Severity Using Radiographic Images and Machine Learning Techniques. ICCPR 2021: 2021 10th International Conference on Computing and Pattern Recognition, October 2021, Pages 237–241. DOI: 10.1145/3497623.3497661
38. Biao Chen, Chaoyang Chen, Jie Hu, Zain Sayeed, Jin Qi, Hussein Darwiche, Bryan Little, Shenna Lou, Muhammad

Darwish, Christopher Foote, Carlos Palacio-Lascano. Computer Vision and Machine Learning-Based Gait Pattern Recognition for Flat Fall Prediction. *Sensor* 2022. (Submitted)

Brain Computer Interface and Robotic Neurorehabilitation

39. Chaoyang Chen, Guanghua Xu, John M Cavanaugh. Advance in Rehabilitative Intuitive Robotics. *Journal of Applied Biotechnology and Bioengineering*. 2016. DOI:10.15406/jabb.2016.01.00002.
40. Wenqiang Yan, Guanghua Xu, Min Li, Jun Xie, Chengcheng Han, Sicong Zhang, Ailing Luo, and Chaoyang Chen. Steady-State Motion Visual Evoked Potential (SSMVEP) Based on Equal Luminance Color Enhancement. *PLoS One* 2017 Jan 6;12(1):e0169642. doi: 10.1371/journal.pone.0169642.
41. Min Li; Guanghua Xu; Jun Xie; Chaoyang Chen. A review: Motor rehabilitation after stroke with control based on human intent. *Proc Inst Mech Eng H*. 2018 Feb 1:954411918755828. doi: 10.1177/0954411918755828.
42. Chengcheng Han, Guanghua Xu, Jun Xie, Sicong Zhang, Chaoyang Chen. Highly Interactive Brain-Computer Interface Based on Flicker-Free Steady-State Motion Visual Evoked Potential. *Scientific Report* 2018,8(1).
43. Min Li, Jiazhou Chen, Bo He, Guanghua Xu, Jun Xie, shengchen Zhu, Chaoyang Chen. Structure optimization and motion planning of a consecutive multiple-section hand exoskeleton. *The Journal of Xian Jiaotong University* 2019 (10):1-11.
44. Gui Yin, Xiaodong Zhang, Dawei Chen, Hanzhe Li, Jiangcheng Chen, Chaoyang Chen, Stephen Lemos. Processing Surface EMG Signals for Exoskeleton Motion Control. *Frontiers in Neurorobotics*. 2020 doi: 10.3389/fnbot.2020.00040.
45. Yousef Alshahrani, Yang Zhou, Chaoyang Chen, Hannah Joines, Tangfei Tao, Guanghua Xu, Stephen Lemos. Performance Validation of An Upper Limb Exoskeleton Using Joint ROM Signal. *Archives of Orthopaedics* 2021; 2(1), 20-30.
46. Min Li, Chen Jiazhou, Guoying He, Lei Cui, Chaoyang Chen, Emanuele Lindo Secco, Wei Yao, Jun Xie, Guanghua Xu, Helge A. Wurdemann. Attention Enhancement for Exoskeleton assisted Hand Rehabilitation using Fingertip Haptic Stimulation. *Front. Robot. AI*, 2021 | <https://doi.org/10.3389/frobt.2021.602091>
47. Yang Zhou, Chaoyang Chen, Yousef Alshahrani, Mark Cheng, Guanghua Xu, Min Li, Wei Zhou, Linjing Wu, Brandon Kakos, Todd Frush, Stephen Lemos. Real-time Multiple-Channel Shoulder EMG Processing for a Rehabilitative Upper-limb Exoskeleton Motion Control Using ANN Machine Learning. *IEEE Proceedings of 27th International Conference on Mechatronics and Machine Vision in Practice*, Shanghai, China. Nov. 2021. DOI: 10.1109/M2VIP49856.2021.9665156

Implantable Nerve Sensor/ Micro-Probe by Nanotechnology

48. Yi W, Chen C, Feng Z, Xu Y, Zhou C, Masurkar N, Cavanaugh JM; Cheng M. A Flexible and Implantable Microelectrode Arrays Using High-temperature Grown Vertical Carbon Nanotubes and a Biocompatible Polymer Substrate. *Nanotechnology*. 2015 Mar 27;26(12):125301. doi: 10.1088/0957-4484/26/12/125-301.
49. Tian P, Chen C, Hu J, Qi J, Wang Q, Chen J, Cavanaugh J, Peng Y, Cheng M. A novel fabrication method of carbon electrodes using 3D printing and chemical modification process. *Biomed Microdevices*. 2017 Nov 23;20(1):4. doi: 10.1007/s10544-017-0247-3.
50. Tian P, Yi W, Chen C, Hu J, Qi J, Zhang B, Cheng MM. Flexible 3D carbon nanotubes cuff electrodes as a peripheral nerve interface. *Biomed Microdevices*. 2018 Feb 19;20(1):21. doi: 10.1007/s10544-018-0268-6.
51. Xinuo Zhang, Chaoyang Chen, Guoxin Ni, Yong Hai, Biao Chen, Yang Zhou, Boshen Zhang, Gui Chen, Mark Ming-Cheng Cheng. Carbon multi-electrode arrays as peripheral nerve interface for neural recording and nerve stimulation. *Medical Devices and Sensor*. 2019. DOI: 10.1002/mds3.10026
52. Biao Chen, Boshen Zhang, Chaoyang Chen, Jie Hu, Jin Qi, Pan Tian, Xinuo Zhang, Guoxin Ni, Mark Cheng. Dual-function high-aspect ratio glassy carbon neural electrode arrays for brain machine interface. *Biomedical Microdevices* 2020 (DOI: 10.1007/s10544-020-00498-0).
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Human Vehicle Interface/Interaction

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