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BIOGRAPHICAL SKETCH

NAME: Sebastián Rueda Parra

eRA COMMONS USER NAME (credential, e.g., agency login): Sebastián Rueda Parra.

POSITION TITLE: Research Assistant, University of Idaho 01/28/2023

EDUCATION/TRAINING: PhD

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Universidad del Valle. Cali, Colombia	BS	06/16	Eng. Electronics, robotics, embedded systems
University of Idaho, US	PhD	12/22	Robotics, bio-signal digital signal processing

A. Personal Statement

Growing up in a family heavily involved in medicine, greatly influenced my curiosity towards this field. However, my technical abilities and the possibility of using engineering to impact medical decisions, depicted a more adequate panorama for my future. My academic training and research experience have provided me with excellent technical background in multiple disciplines related to electronics and computer sciences that include digital signal processing, programing with different languages, statistics, machine learning, robotics, electronic hardware design, and embedded systems. My earliest approaches to research happened as a research intern for the Fraunhofer institute of renewable energies (Germany), and as an undergraduate researcher mentored by Dr. Bladimir Bacca at the Universidad del Valle (Colombia). These experiences were not exactly in my field of predilection but motivated my decision to follow a scientific research career. I received several academic awards and scholarships during my undergraduate studies.

I enrolled the Assistive Robotics Laboratory led by Dr. Joel Perry and Dr. Eric Wolbrecht at the University of Idaho for my doctoral research. There, I used electrophysiological signals with the goal of investigating upper-extremity impairment in stroke survivors, as well as physiological aspects of movement and perception in humans, such as proprioception. The core of my investigation was centered on statistical signal processing of EEG and EMG, with major work devoted to guiding the use of these signals in robotic applications. Later, with the mentorship and collaboration of Dr. Disha Gupta (NCAN), we developed a novel experimental paradigm to study the neural correlates of proprioception in active bilateral motion. I oversaw all aspects of scientific research in this project. The results from this study highlighted one important feature of cortical activation related to processing of proprioceptive information, that is optimized with practice. Although only healthy participants were part of this study, these results can have great implications on understanding motor impairment in its relationship to proprioceptive damage, and to monitor rehabilitation therapy gains.

In my career, I have been part of research groups in 3 different countries, laying solid understanding on how research projects work, the importance of interdisciplinary teamwork, scientific collaboration, writing, and communication abilities in general. My future research will provide me with new conceptual and technical training in electrophysiological advanced signal processing for studying motor impairment in different motion disorders, both with and without the use of robotic devices. In addition, postdoctoral training also outlines a set of career development activities– e.g., grant writing, public speaking, lab management, and mentoring students – designed to enhance my ability to become an independent investigator.

Ongoing and recently completed projects that I would like to highlight include:

NIH-R01HD062744(David Reinkensmeyer), University of California. FINGER
Role: co-investigator
08/01/17- Present

NSF Award # 1532239
Role: co-investigator
08/01/17- Present
Development of an exoskeleton for simultaneous assessment of brain, muscular, and nervous system output during functional arm and hand tasks

B. Positions, Scientific Appointments, and Honors

<u>Positions and Scientific Appointments</u>

2017 – 2022	Teaching Assistant, Electrical Engineering department, University of Idaho, US. Digital Logic
2017 – 2019	Teaching Assistant, Electrical Engineering department, University of Idaho, US. Electrical Circuits
2017 – 2022	Graduate Research Assistant, Mechanical Engineering department, University of Idaho, US
2015 – 2017	R&D Engineer, Hardware and Firmware Development, Lynks ingenieria, Colombia
2014 – 2016	Research Assistant, Electronics Engineering, Universidad del Valle, Colombia
2014 – 2014	Research Assistant (internship) Fraunhofer-institut für Energiewirtschaft und Energiesystemtechnik, Kassel, Germany

<u>Honors</u>

2020	Outstanding Teaching assistant, Electrical Engineering department, University of Idaho
2013	DAAD young Engineer scholarship holder
2010,11,12,15	Scholarship for Top 5 best GPA scores, Engineering in Electronics, Universidad del Valle

<u>Scientific Membership</u>

2019, 2022	American Society of Neurorehabilitation (ASNR), member
2019, 2021-22	Society of Neuroscience (SfN), member

C. Contributions to Science

1. Early Career

My early career contributions were focused on applying technical-engineering-related knowledge in the field of mobile robotics and embedded systems, using 8-bit micro-controllers. In the research project for the Universidad del Valle mentored by Dr. Bacca, I designed and developed Hardware and Firmware for 8-bit programable robots that were used to teach important programming skills to highschoolers and undergraduate students. Later, as an R&D engineer for *Lynks ingeniería*, a local company from my hometown, I developed embedded systems (Hardware and Firmware) to help sugar-cane farmers optimize their farming processes and use of water. These two experiences motivated me on pursuing a scientific research career.

a. Cortes, E. B. B., Gaviria, B. F., & **Rueda, S.** (2017). Development of a set of mobile robots for basic programming experimentation. *Revista UIS Ingenierías*, *16*(2), 207-216.

2. Development of methods for simultaneous acquisition of robotic and electrophysiological signals (EEG/EMG) for a bilateral exoskeleton (BLUE SABINO)

Dr. Perry directs one of the projects in the Assistive Robotics Lab, the design and development of a bilateral exoskeleton robot named BLUESABINO. The goal for this device is to be used as a multimodal (neuromuscular output, and kinematic/kinetic) assessment tool for stroke-related impairment of upper limbs. My role in this project was focused on the use of Electrophysiological signals such as electroencephalography (EEG) and electromyography (EMG) for assessment in robotic applications. My main contributions included: a) Gain experience and capacitate the research group in acquisition and signal processing for EEG/EMG. b) Design of methods and experimental paradigms for simultaneous acquisition of EEG/EMG in robotic applications. c) Review the literature to select metrics derived from EEG/EMG used clinically that are appropriate for the use with this device, discussed in a publication in which I am a main co-author. d) Support in GUI development and pilot testing of different device prototypes with healthy subjects and stroke survivors. e) Use of EMG to assess the transparency of the robot's controller. This device will be further tested with cohorts of stroke survivors in the future.

a. **Rueda, S.**, PhD Dissertation: Electrophysiological Data Analysis to Study Human Motion and Sensation: Searching for Features that Adapt with Training, University of Idaho, US, 2022.
b. Maura, R., **Rueda, S**., Stevens, R., Weeks, D., Wolbrecht, E., & Perry, J. Literature Review of Sensor-Based Upper Extremity Stroke Assessment via EEG, EMG, Kinematic and Kinetic Measurements and Their Reliability, Submitted/ in Review (JNER, manuscript in review).
c. **Rueda, S.**, Wolbrecht, E., & Perry, J. Characterization, Identification, and mitigation of movement artifacts in electroencephalographic measurements toward robot-aided neuromuscular assessment. 2019 ASNR (Abstract with poster presentation**,** American Society for Neurorehabilitation).

3. Analysis of behavioral data and EEG to predict motor gains and understand heterogeneity of response to robotic-assisted therapy in chronic stroke

In collaborative efforts with Dr. David Reinkensmeyer (Univ. of California, Irvine) and Dr. Disha Gupta (NCAN), we worked with data obtained from chronic stroke survivors that received robot-assisted therapy for fingers, using the FINGER robot. To study the heterogeneity in response to robotic-assisted therapy, we proposed a data-driven algorithm based on clustering that aids visualization of multidimensional features, standard scores for motor function before and after therapy were used. Groups of participants showing similar impairment at baseline and similar response to therapy were found. Using these groups, we identified a correspondence between baseline impairment and response to therapy; patients with similar impairment responded comparably to the therapeutic intervention. These findings highlighted the importance of multidomain assessment in understanding the response to therapy, and that pertinent therapy strategies should be adopted considering baseline patients' impairment. For the same group of patients, we investigated the relationship between Resting-state EEG power features and therapy-related gains in proximal (elbow and shoulder) and distal (finger) joints. Proposed modifications to metrics found in the literature were used to corroborate the predictive power of EEG in therapeutic interventions. The literature showed relationships between certain power ratios and changes in robotic-assisted therapies for elbow and shoulders. However, our results suggested that gains related to robotic interventions focused on specific joints are correlated to different EEG features.

a. **Rueda, S.**, Perry, J., Wolbrecht, E., Reinkensmeyer, D., & Gupta, D. Pre-training neural correlates for predicting gains from robot-assisted finger training after stroke. 2022 ASNR (Abstract with poster presentation, American Society for Neurorehabilitation)
b. **Rueda, S**., Perry, J., Wolbrecht, E., & Gupta, D. Visualization of multivariate behavioral data in stroke subjects during robotic rehabilitation therapy for fingers. 2021 SfN (Abstract with poster presentation, Society for Neuroscience).

4. FINGER, a robot to investigate proprioception and rehabilitate stroke survivors

Investigations with the FINGER robot, an exoskeleton robot that assists movement of index and middle fingers, highlighted a significant contribution of sensory damage in motor impairment after brain injury. This robot was previously used to study proprioception and to deliver rehabilitation therapy to stroke survivors. Under the supervision of Dr. Wolbrecht and in Collaboration with UCI, we enhanced the capabilities of the FINGER robot by including support for the thumb, which allows the study of more realistic gestures. This new version of the robot is being tested in an RTC for a cohort of people with stroke who are receiving interventions for improving proprioception and motion. My contributions to this project were related to electronic hardware design for signal adequation and updating the Graphical interface used to interact with participants. This GUI was a videogame coded in Visual Basic and required changes pertinent for supporting for the thumb. Further work sough to improve the usability of the robot in EEG experiments. We plan on using this device for future investigation of the neural correlates of proprioception and their changes with stroke.

a. Ketkar, V., **Rueda, S**., Glasgow, I., Gonzalez, J., Perry, J., & Wolbrecht, E. Design and Development of a Spherical Five-Bar Thumb Exoskeleton Mechanism for Post-Stroke Rehabilitation. 2021 ICORR (Abstract with poster presentation, International Conference on Rehabilitation Robotics).

5. Study and identification of neural correlates of bilateral active proprioception

One of the most important lessons of the above research was the awareness about the relationship between proprioceptive damage and motor impairment in different neurological disorders. This knowledge opens a new world of possibilities in how to rehabilitate patients with motor deficits by targeting their proprioceptive damage.

However, there are several questions regarding physiological aspects of proprioception that need to be addressed to provide proprioceptive therapy proficiently. In a project mentored by Dr. Gupta, we used EEG to investigate human motion and sensation. For this, we developed a novel method to study the neural correlates of proprioception during active bilateral and unilateral movements in healthy and trained participants (professional musical instrument players). I oversaw all major aspects of this research that resulted in a subsequent first author publication (in review), in which we were able to identify the role of low-beta power modulation in relationship to proprioceptive processing and motor learning. Other results from this study will be shared in further publications. The identification of this feature is significant as it could be used to quantify altered proprioceptive neural processing in skill and movement disorders. This in turn can be useful as an assay for pre and post sensory-motor intervention research.

a. **Rueda, S.,** Perry, J., Wolbrecht, E. & Gupta, D. Neural correlates of Bilateral Proprioception and Adaptation with Training. Submitted/ in Review (PLOS ONE, manuscript in review)
b. **Rueda, S**., Perry, J., Wolbrecht, E., & Gupta, D. Neural Correlates of Bilateral and Unilateral Proprioception in People with Musical Instrument Training. 2022 SfN (Abstract with poster presentation, Society for Neuroscience).

D. Scholastic Performance

YEAR	COURSE TITLE	GRADE
	UNIVERSITY OF IDAHO	
2017	Controls	A
2017	Assistive Robotic Technologies	A
2018	Robotics	A
2018	Linear Systems Theory	B
2018	Neural Network Design	A
2018	Advanced Controls	A
2018	Random Signals	A
2019	Machine Learning	A
2019	Digital Filters	A
2019	Evolutionary Computation	A
2020	Estimation Theory for Signal Processing, Communications and Control	A
2020	Deep Learning	A
2021	Multivariate Statistical Analysis	A