SERGIO DANIEL HERNANDEZ CHARPAK

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French ○ Colombian

Research Overview

I am passioned researcher in the interface between AI/ML in healthcare, focusing on leveraging and integrating neuroimaging strategies with implantable neuroprosthetics to restore neurological functions for individuals with Parkinson's disease and spinal cord injuries.

Education

École Polytechnique Fédérale de Lausanne — Lausanne**, Switzerland**
Electrical Engineering, PhD Candidate — *September 2020-Present*
Neuroimaging to Guide the Delivery of Implantable Neuroprosthetics Restoring Neurological Function
.NeuroRestore

École Polytechnique Fédérale de Lausanne — Lausanne**, Switzerland**
Computational Science and Engineering, Master Thesis Student — *September 2017-February 2020*

Universidad de los Andes — Bogotá**, Colombia**
Physics, Bachelor of Science — *January 2010 - March 2017* - GPA **4.23**/5.00
Computing Engineering, Bachelor of Engineering — *January 2010 - March 2017* - GPA **4.23**/5.00
Japanese Language and Culture, Minor

Kyoto Institute of Culture and Language — Kyoto**, Japan**
Intermediate Japanese Student — *October 2013-March 2014*

Work Experience

École Polytechnique Fédérale de Lausanne (EPFL)
.NeuroRestore - Defitech Center for Interventional Neurotherapies
Lausanne, Switzerland
September 2020 - Present

Doctoral Assistant – .NeuroRestore – Clinical Division
Neuroimaging to guide the delivery of implantable neuroprosthetics restoring neurological function. Automatization of generation of personalized 3D models for simulations of spinal cord stimulation paradigms for patients suffering spinal cord injury or other neurological dysfunctions. Solving functional and anatomical variabilities on under the supervision of prof. *G. Courtine* and prof. *J. Bloch*

École Polytechnique Fédérale de Lausanne (EPFL)
G-Lab
Geneva, Switzerland
February - September 2020

Scientific Assistant – Neurorestore – Computational Neuroscience Unit
Contributing with image processing, data analysis in several research projects around personalized targeted spinal cord stimulation paradigms for spinal cord injury patients.

Nagra Kudelski Group
Cloud
Cheseaux, Switzerland
February – July 2019

Internship – Cloud Infra Team
Enabled real-time deep learning in production for anomaly detection in data streams using Pytorch, TF, Scala, Spark and Deeplearning4J. Developed neural networks models for unsupervised anomaly detection on time series deploying them for real time alert generation under supervision of eng. *Arnaud Gaillard*.

Research Experience

École Polytechnique Fédérale de Lausanne (EPFL)
G-Lab & MIP Lab
Geneva, Switzerland
September 2019 - February 2020

Master Thesis - Prof. Courtine's Laboratory & MIP Laboratory (prof. Van De Ville)
Conducted a lumbar Spinal Cord (SC) fMRI study to deconstruct segmental innervation of sensorimotor circuits in the lumbosacral SC in healthy. Integrated it into personalized targeted SC stimulation paradigms for patients under the direction of PhD students A. Rowald, N. Kinany, prof. *G. Courtine* and prof. *D. Van De Ville*.

École Polytechnique Fédérale de Lausanne (EPFL)
G-Lab
Geneva, Switzerland
August 2018 – February 2019

Master Semester Project - Prof. Courtine's Laboratory
Artificially represented brain input to spinal sensorimotor circuits through the implementation of a DL framework for unsupervised and supervised learning strategies to drive a biomechanical model of the lower limbs in human under the direction of PhD student *A. Rowald* and prof. *Gregoire Courtine.*

École Polytechnique Fédérale de Lausanne (EPFL)
MIP Lab
Geneva, Switzerland
February - July 2018

Master Semester Project - Medical Image Processing Laboratory
Processed high resolution 7-Tesla brain fMRI data FMRI data using the Total Activation method, and found the innovation-driven Co-Activation Patterns (iCAPs) and their time behaviors on three different paradigms. Worked under the direction of PhD student A. Tarun and prof. *Dimitri Van De Ville*.

Universidad de los Andes
Department of Computing Engineering
Bogotá, Colombia
August - December 2016

Undergraduate Thesis
Implemented part of an Image Analysis tool for the Segmentation of the aorta artery for applications such as the quantification of the elasticity of the aorta artery and quantification of the aorta artery calcifications under the direction of prof. *Marcela Hernandez* and prof. *Leonardo Florez*.

Laboratoire CPPM
LSST Project
Marseille, France
June 2016

Internship - LSST Project
Studied and implemented different image processing and statistic techniques for the detection of transients in astrophysical images. Under the supervision of scientist *Dominique Fouchez*.

Universidad de los Andes
Department of Physics
Bogotá, Colombia
January - May 2016

Undergraduate Thesis
Titled *Laniakea in a Cosmological Context*. Detected galaxies superclusters in simulated cosmological structures based on galaxies velocities properties under the direction of prof. *Jaime E. Forero*.

Universidad de los Andes
School of Engineering
Bogotá, Colombia
August 2015 - December 2016

Undergraduate Research Assistant
Developed Python tools for testing prototypes in the project Astronomical Image processing from large all-sky photometric surveys for the detection and measurements of transients under the mentorship of prof. *Marcela Hernandez*.

Fermi National Laboratory
Neutrino Division
Batavia, U.S.A.
June –July – August 2015

IPM Intern – Muon G-2 Experiment
Part of the team for the Test Beam of a Straw Detector Prototype in charge of the High Voltage and assisted with the analysis of the data taken under the mentorship of scientist *Brendan C Casey*.

Tokyo University of Marine Science and Technology
Tokyo, Japan
May - June 2014

Visiting Student - Control and Robotics Laboratory
Assisted with the integration and control of a helicopter with Arduino under the supervision of professors *Sho* and *Ito*.

Teaching Experience

École Polytechnique Fédérale de Lausanne (EPFL)
Lausanne, Switzerland
2022,2023,2024

Master Thesis & Internships Supervisors
Proprioceptive map of the human subcortical neural motor network, Meriem Bourouba (Université Paris Cité)
Recurrent neural networks to study and control motor execution, Marion Pavaux (Université Paris-Saclay, École des Mines de Saint-Étienne)
Data-driven identification of lower limbs proprioceptive projections mapping, Neala Rohner (ETHZ)
M3D-SAM: Multi-purpose multi-modal zero-shot semi-to-fully automatic segmentation on medical imaging based on SAM, Hanane Moha-Ouchane (TUM)
Home-monitoring of gait for Parkinson's disease patients, Maxime Pillet (EPFL)
Automated Gait Analysis to Characterise Locomotor Deficits in Home Environments for Parkinson's Patients, Ian Enderli (EPFL)
Semi-automatic extraction of the spinal root centerlines, Raphaël Mariétan (EPFL)

École Polytechnique Fédérale de Lausanne (EPFL) Lausanne, Switzerland *2020,2021,2022,2023,2024*	**Semester Master projects** *Robustification of Personalized Spinal Cord Model Reconstruction*, Chléa Schiff (EPFL) *Learning the Natural Language of the Spinal Cord using Masked Autoencoders*, Léon Muller (EPFL) *Learning the natural language of the spinal cord*, Juliette Hars (EPFL) *Robustification of AI pipeline for personalized model reconstruction*, Nicolas Reategui (EPFL) *Self-supervised for MRI artifact detection and reconstruction*, Jonas Blanc (EPFL) *Automatic, accurate and robust vertebrae-based CT to MRI co-registration*, Benkirane, Ismail (EPFL) *Artificial biologically relevant spinal networks linking electrical stimulation and muscle responses in time*, Axelle Piguet (EPFL) *Segmentation and Identification of Vertebrae in CT scans*, Aline Brunner (Bachelor - EPFL) *Deep learning network for the segmentation of spinal roots*, Quentin Uhl (EPFL) *A computational approach to study control and execution of locomotion*, Daniele Hamm (EPFL)
École Polytechnique Fédérale de Lausanne (EPFL) Lausanne, Switzerland *2021,2022,2023,2024*	**Graduate Teaching Assistant** Teaching Assistant for Sensorimotor neuroprosthetics, Assistive Technology Challenge courses. Supervised group of students in the development of assistive technologies to solve specific challenges from individuals with disabilities.
Universidad de los Andes Bogotá, Colombia *2011,2012,2013,2014,2015*	**Undergraduate Teaching Assistant** Teaching Assistant for Object Oriented Programming, Data Structures, Modeling, Simulation and Optimization, and Computational Methods courses.

Publications

Schlienger R., Landelle C., **Hernandez-Charpak S.D.,** Mapping Human Proprioceptive Projections of Upper Limb Muscles through Spinal Cord fMRI. In preparation, **Journal of Neuroscience.**

Hernandez-Charpak S.D., et. al. Lumbosacral Spinal Cord fMRI: Towards Personalized Mapping Using Task-Evoked Activity. In review, **Imaging Neuroscience**.

Phillips, A.A., Gandhi A.P., Hankov N., **Hernandez-Charpak S.D.**, et. al. The implantable system that restores hemodynamic stability after spinal cord injury. In review, **Nature Medicine**.

Milekovic, T., Martin Moraud E., Macellari N., Moerman C., Raschellà F., Sun S., Perich M.G., Varescon C., Demesmaeker R, Bruel A., Bole-Feysot L.N., Schiavone G., Pirondini E., YunLong C., Hao L., Galvez A., **Hernandez-Charpak S.D.**, et. al. A spinal cord neuroprosthesis for locomotor deficits due to Parkinson's disease. **Nature Medicine** 29, 2854–2865 (2023).

Lorach, H., Galvez, A., Spagnolo, V., Martel, F., Karakas, S., Intering, N., Vat, M., Faivre, O., Harte, C., Komi, S., Ravier, J., Collin, T., Coquoz, L., Sakr, I., Baaklini, E., **Hernandez-Charpak, S. D.**, Dumont, G., Buschman, R., Buse, N., … Courtine, G. (2023). Walking naturally after spinal cord injury using a brain–spine interface. **Nature**, 618(7963), 126–133. https://doi.org/10.1038/s41586-023-06094-5

Squair, J. W., Berney M., Castro Jimenez M., Hankov N., Demesmaeker R., Amir S., Paley A., **Hernandez-Charpak S.D.**, et al. "Implanted System for Orthostatic Hypotension in Multiple-System Atrophy." **New England Journal of Medicine** 386, no. 14 (April 7, 2022): 1339–44. https://doi.org/10.1056/NEJMoa2112809.

Rowald, A., Komi, S., Demesmaeker, R., Baaklini E., **Hernandez-Charpak S.D**., et al. Activity-dependent spinal cord neuromodulation rapidly restores trunk and leg motor functions after complete paralysis. **Nature Medicine** 28, 260–271 (2022). https://doi.org/10.1038/s41591-021-01663-5

Peñaranda-Rivera J. D., Paipa-León D. L., **Hernández-Charpak S.D.**, Forero-Romero J.E., Superclusters from velocity divergence fields, **Monthly Notices of the Royal Astronomical Society: Letters**, Volume 500, Issue 1, January 2021, Pages L32–L36, https://doi.org/10.1093/mnrasl/slaa177

Conferences

Society for Neuroscience 2024	**Posters** *Interfacing brain-decoded motor intentions with the cervical spinal cord to restore voluntary arm and hand movements*, Collin T., Spagnolo V., Sakr I., Carparelli G., **Hernandez-Charpak S.D.**, et al.
Society for Neuroscience 2023	**Posters** *Automated Generation of Spinal Cord Models for Pre-Operative Planning of Epidural Electrical Stimulation Surgical Interventions*, **Hernandez-Charpak S.D.**, et. al. *Non-Invasive And Invasive Methodologies of Stimulating the Cervical Spinal Cord in Order to Improve Upper-Limb Functions After Tetraplegia*, Collin T., Spagnolo V., Berny M., Intering N., Hervé J., Sakr I., Galvez A., Carparelli G., **Hernandez-Charpak S.D.**, et. al. *Automated Configuration of Epidural Electrical Spinal Cord Stimulation for Neurological Disorders*, Carparelli G., Abranches P., Macellari N., Komi S., Yang X., Harte C., Dumont G., Collin T., **Hernandez-Charpak S.D.**, et. al.
Society for Neuroscience 2022	**Posters** *A Spinal Cord Neuroprosthesis That Alleviates Locomotor Deficits In PD*, Milekovic T., Moraud E.M., Nicolo Macellari, Moerman C., Raschellà F., Sun S, Perich M.G., Varescon C., Demesmaeker R., Bruel A., Bole-Feysot L.N., Schiavone G., Jianzhong Y., Galvez A., **Hernandez-Charpak S.D.**, et. al. *A Task-Adaptive Spinal Neuroprosthesis to Improve Gait Deficits in People With Parkinson's Disease***,** Macellari N., Moerman C., Sasportes C.D., Harte C., Varescon C., Bole-Feysot L.N., Carparelli G., **Hernandez-Charpak S.D.**, et. al.
XV LARIM (Latin American Regional IAU Meeting) Cartagena, Colombia *October 2016*	**Oral Talk** **Laniakea in a Cosmological Context:** Galaxies superclusters detection in simulated cosmological structures under the direction of prof. Jaime E. Forero.

Skills

Software and programming

Proficient

Python, MATLAB, C, C++, Java, Git, LaTeX, Bash, Pytorch, Microsoft Powerpoint, Adobe Illustrator

OS: Linux, Windows and Mac OS.

Github: https://github.com/sercharpak

Experienced

Sim4life, TensorFlow, Deeplearning4J, Spark, Scala, Processing, Arduino, Assembler, UML, MPI, Neuron, Quantum Espresso

Languages

French (fluent) Spanish (fluent) English (fluent) Japanese (Elementary, JLPT level 4-3)

References

Prof. Grégoire Courtine

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