

SERGIO DANIEL HERNANDEZ CHARPAK

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French o Colombian

Research Overview

I am passionate 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

Electrical Engineering, PhD Candidate

Neuroimaging to Guide the Delivery of Implantable Neuroprosthetics

Restoring Neurological Function

.NeuroRestore

Lausanne, Switzerland

September 2020-Present

École Polytechnique Fédérale de Lausanne

Computational Science and Engineering, Master Thesis Student

Lausanne, Switzerland

September 2017-February 2020

Universidad de los Andes

Physics, Bachelor of Science

Computing Engineering, Bachelor of Engineering

Japanese Language and Culture, Minor

Bogotá, Colombia

January 2010 - March 2017 - GPA 4.23/5.00

January 2010 - March 2017 - GPA 4.23/5.00

Kyoto Institute of Culture and Language

Intermediate Japanese Student

Kyoto, Japan

October 2013-March 2014

Work Experience

École Polytechnique Fédérale de Lausanne (EPFL)

.NeuroRestore - Defitech Center for Interventional Neurotherapies

Lausanne, Switzerland

September 2020 - Present

École Polytechnique Fédérale de Lausanne (EPFL)

G-Lab

Geneva, Switzerland

February - September 2020

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

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

**École Polytechnique Fédérale
de Lausanne (EPFL)**

MIP Lab

Geneva, Switzerland

February - July 2018

Universidad de los Andes

Department of Computing
Engineering

Bogotá, Colombia

August - December 2016

Laboratoire CPPM

LSST Project

Marseille, France

June 2016

Universidad de los Andes

Department of Physics

Bogotá, Colombia

January - May 2016

Universidad de los Andes

School of Engineering

Bogotá, Colombia

August 2015 - December 2016

Fermi National Laboratory

Neutrino Division

Batavia, U.S.A.

June – July – August 2015

**Tokyo University of Marine
Science and Technology**

Tokyo, Japan

May - June 2014

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.

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.

Undergraduate Thesis

Implemented part of an Image Analysis tool for the Segmentation of the aorta artery for quantifications of the elasticity of the aorta artery and calcifications under the direction of prof. Marcela Hernandez and prof. Leonardo Florez.

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.

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.

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.

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.

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., Interling, 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., Interling 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.

Languages

French (fluent)

Spanish (fluent)

English (fluent)

Japanese (Elementary, JLPT level 4-3)

Github: <https://github.com/sercharpak>

Experienced

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

References

Prof. Grégoire Courtine

Director of *.NeuroRestore*

Ecole polytechnique fédérale de Lausanne

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