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EDUCATION

Ph.D. Physics, UNIVERSITY AT ALBANY - STATE UNIVERSITY OF NEW YORK (SUNY) — Present

M.Sc. Physics, UNIVERSITY AT ALBANY - STATE UNIVERSITY OF NEW YORK (SUNY) [GPA 3.91/4] — 2021
(COURSE BASED) AWARDED DURING PH.D. STUDY ON MAY 5 2022

M.Sc. Physics, SHIRAZ UNIVERSITY OF IRAN [GPA 16.35/20] — 2016
(THESIS BASED)

B.Sc. Physics, SHIRAZ UNIVERSITY OF IRAN [GPA 17.05/20] — 2013

EXPERIENCE

Teaching Assistant, **UNIVERSITY AT ALBANY** (Aug 2019 – Present)

- General physics lab teacher
- Graduate course: Advance electromagnetism, Exploration in space and Quantum information

Research Assistant, **UNIVERSITY AT ALBANY** (May 2020 – Aug 2020)

- Python image processing using Open-CV, Pandas, NumPy etc. packages to identify patterns (glomeruli) in immunostaining brain images.
- LabVIEW programing (Python integrated) to automatically find best correction parameters to correct DHM (digital holography microscopy) images.

R&D Expert, **NITROUTRANS CO.** (Jan 2016 – Aug 2019)

Science consultant through developing new technologies and improving power electric products such as electrical bushing. Projects in Niroutrans:

- Develop electrical grading program (in **C++**) for electrical bushings (OIS, RIP and RIS) up to 800kv.
- Numerical simulation on electrical grading (In Ansys Maxwell/COMSOL EM) up to 800kv.
- Research on Kraft and Crepe insulating papers.
- Research on new generation of electrical insulation such as Polymer families.

COMPUTER SKILLS

Programing

- ✓ Python
- ✓ C++
- ✓ FORTRAN
- ✓ HTML
- ✓ CSS

Industrial simulation

- ✓ Ansys Maxwell
- ✓ COMSOL (EM)

Commercial software

- ✓ LabVIEW
- ✓ MATLAB
- ✓ Mathematica
- ✓ Maple

OS Experience

- ✓ Linux (Ubuntu, Fedora)
- ✓ Windows

PROJECTS

- **Programing**
  1. Develop a LabVIEW/Python program for DHM (digital holography microscopy) imaging. In this project a Python scripts were integrated into a LabVIEW program. This was done by Open-CV, NumPy, Pandas and several other Python packages to analyze real-time/offline images and find the best correction parameters to compensate optical disorder and unwanted curvatures. The goal was to make all steps to be done automatically without user interference.
  2. Image processing with Python to finding patterns in immunostaining mouse brain images to find all neural glomeruli network and analyze their properties such as size, population, and color compositions.
  3. C++ electrical grading design for electrical bushings for high voltages (several kV) applications. This was done with numerical solving electric field in three dimensions for cylindrical shape of electrical bushings. The program generates grading table for electrical insulation and its capacity as well. Also, a Python script asn an output to feed Ansys Maxwell software in order to be able visually simulate the electromagtic fields. All boundary conditions and material types are included in the output scripts. So, just need to import and run it in Ansys Maxwell and finalize the design without any prior programming or electromagnetic knowledge.
  4. Arduino setup to communicate with Python in Linux and windows operating systems. The Python script grab contexts from designated webpage and send the data to Arduino to display on LCD and trigger other sensors such as light sensor, sound sensor, 3-axis accelerometer etc.

- **Web Designing**
  1. Niroutrans company webpage - WordPress (http://ntc.co.ir/)
  2. Microbiology lab webpage in University at Albany - WordPress (https://microbiolab.org)
  3. Cosmetic beauty online shop - PrestaShop

- **Experimental**
  1. Setup "Terahertz quasi time domain spectroscopy" – University at Albany
  2. Raman Spectroscopy – University at Albany
  3. Resin Casting and producing RIS bushing prototype with polymer insulators - Niroutrans Co.

PUBLICATIONS AND TALKS

- **(2021)** Automated quantification of vomeronasal glomeruli number, size, and color composition after immunofluorescent staining
  Chemical senses 46 (**link**)
- **(2021)** Iron-binding cellular profile of transferrin using label-free Raman hyperspectral imaging and singular value decomposition (SVD)
  Free Radical Biology and Medicine, Volume 169, June 2021, Pages 416-424 (**link**)
- **(2020)** Comparative phase imaging of live cells by digital holographic microscopy and transport of intensity equation methods
  Optics express 28 (5), 6123-6133 (**link**)

- **(2020)** Application of image processing to glomeruli analysis
  Oral presentation – PASCAL 2020 conference (University at Albany)
- **(2017)** Criticality in natural systems and human
  Oral presentation - VII GEFENOL Summer School on Statistical Physics of Complex Systems (IFISC) (**link**)
- **(2016)** Scale-free neuronal avalanches in the dHAN model
  Poster Presentation in Annual Physics Conference of Iran (**link** – Section P592)
- **(2014)** Introduction to complex Systems and its application to the brain
  Oral presentation - Heidelberg University-Germany

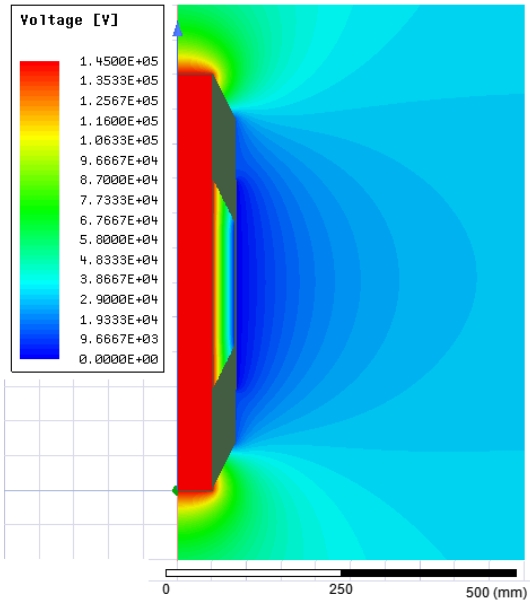
SEMINAR ATTENDANCE

- 2nd Interdisciplinary Seminar in Brain and Cognition — Shiraz University, Shiraz, Iran (2016)
- 3rd Workshop in Computational Neuroscience — Babol Noshirvani University of Technology, Babol, Iran (2016)
- Computational Neuroscience Workshop — Shiraz University, Shiraz, Iran (2015)
- Second Spring Interdisciplinary School for Nanotechnology Science — Shiraz University, Shiraz, Iran (2014)
- 18th school of physics in Zanjan Institute for Advanced Studies in Basic Sciences — IASBS, Zanjan, Iran (2013)
- Interdisciplinary Conference on Brain and Neuroscience — Shiraz University of Medical Science, Shiraz, Iran (2013)

Research and Development activities in NirouTrans Co.

Our mission in the R&D department of Niroutrans Company is to figure out best electrical and mechanical designs for special orders and develop new technologies in order to increase stability and make our products more affordable alongside with improving qualities. Niroutrans Company produces power electrical instrumental transformers (PT/CT), electrical bushings, breakers etc.

As a scientific consultor, I have proposed different solutions in mechanical and electrical problems for troubleshooting activities. Besides, during the last 2 years I have seriously involved in a wide variety of projects such as RIS electrical bushing technology. We (scientist members of R&D) start this project in order to satisfy our passion for research then the RIS (Resin impregnated synthetic) tended to be started. In this project, we struggled to design some grading systems to optimize electric field stress on products. Moreover, choosing the best polymer materials to fulfill our needs was a challenging scientific activity. I have used all of my electrodynamical knowledge to simulate electrical field by using C++ in order to numerically solve EM fields in environment. The program result is a Python script to feed Ansys Maxwell simulation software and visualize EM fields. The figure shows my primary try to simulate equipotential lines around the product.



I also engaged to magnetic field control of products, the structure of current and voltage transformer, optical generation of current transformers, resin, and other dielectric materials such as special crepe and kraft papers properties and a wide range of medium and high voltage products in details. My experiences in industrial research activities made me attracted to different areas of physics and I have learned that all part of the physics is outbreaking when you go further and deeper inside.

Image processing application to identify Glomeruli (UAlbany)

Glomeruli are neuropil rich regions of the olfactory bulbs where the axons of olfactory/vomeronasal neurons and dendrites form synaptic connections. The organization of axons and the glomeruli they innervate largely relies on the type of olfactory receptor gene expressed by individual neurons in the main olfactory system, as olfactory sensory neurons (OSNs) expressing the same receptor innervate one or two glomeruli. However, in the accessory olfactory system, vomeronasal sensory neurons (VSNs) expressing the same receptor can innervate up to 30 different glomeruli in the accessory olfactory bulb (AOB). How these neurons choose their postsynaptic target is largely unknown.

Multiple genetic mutants that disrupting genes expressed in the vomeronasal organ demonstrate aberrant formation and organization of the AOB, including fewer but larger glomeruli. Interestingly, two cell surface molecules, Kirrel2 and Kirrel3, have been indicated to play a critical role in the organization of axons into glomeruli in the AOB. In an attempt to understand if cell surface molecules change in response to various genetic insults, we immunostained for the presynaptic marker vesicular glutamate transporter-2 (VGluT2) and the cell surface molecules Kirrel2 and Kirrel3 in control and mutant animals.

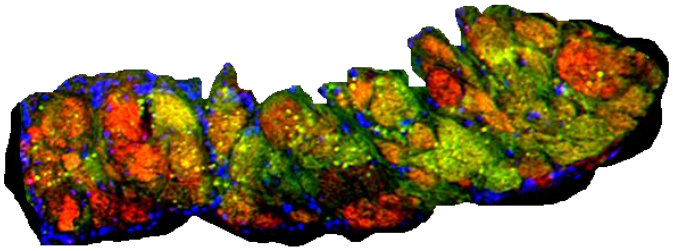


Figure 1, a section of an anterior AOB with three channels, Blue = DAPI/Nuclei counterstain; Red = BS-Lectin; Green = Olfactory marker protein

Analyzing the properties of stimulated glomeruli leads to quantitative distinction between control and mutant animals. Conventionally, these regions are identified by human on a flattened 3D image into a plan along x-y axis. However manually recognition these patterns even by image experts are not result in the same shapes. Eye sensitivity, personal preferences or all prior experiences lead to a bias selection.

Based on these premised we asked if we develop an unbiased tool which is able to identify patterns of glomerular structures to avoid biases. Shortening process time for a large set of images is another goal as well.

To achieve these goals, by embedding OpenCV library into a python script we able to look for these particular shapes in stacked multichannel images and extracts their properties such as size, color composition and population. Adaptive thresholding is crucial to turn the image into a binary environment and detecting contours which led into glomeruli detection in this case. We also examined the program sensitivity to adaptive block size thresholding by setting three different blocks. Additionally, we show how noise removal plays a critical rule here by limiting size of detected objects in image. Also to increase efficiency of batch processing, “multiprocessing” Python package was used as well.

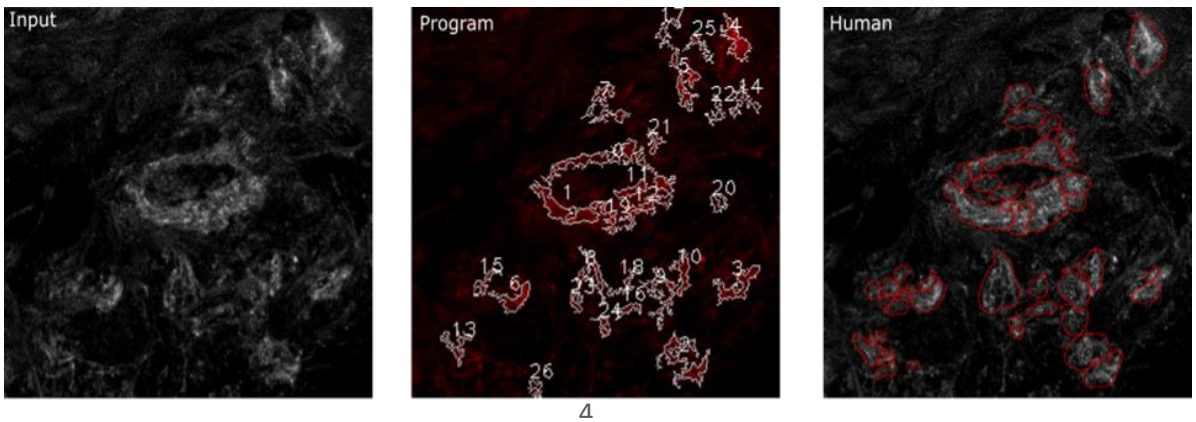


Figure 2, Portion of a Kirrel3 sample map and detected glomeruli (Program vs Manual)

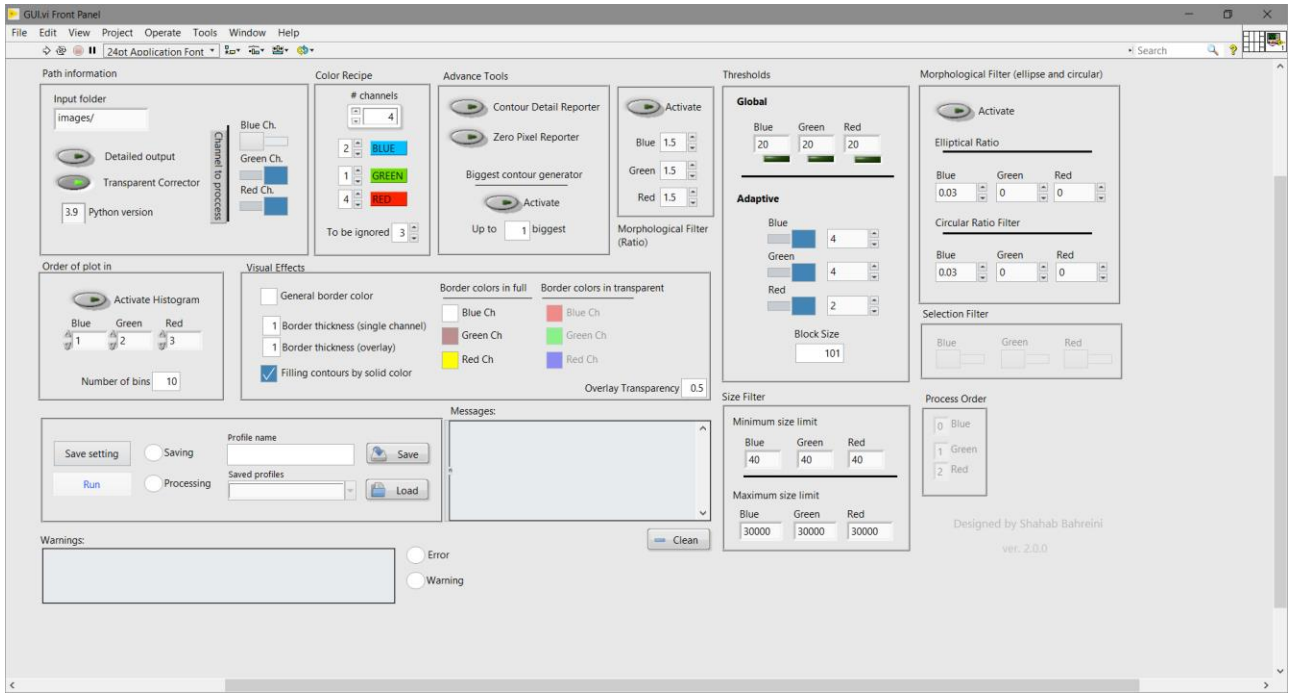
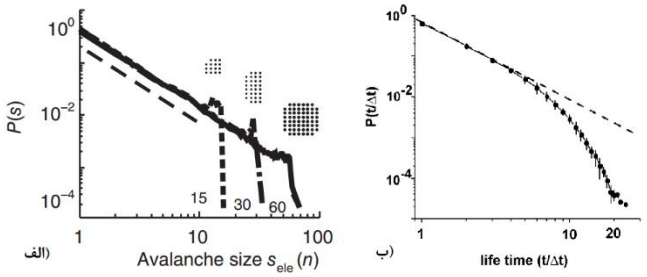


Figure 3, General look of program GUI designed by LabVIEW. Python scripts are integrated into the program as well.

An introduction to master thesis (Shiraz University of Iran)

One of the most common behaviors of natural systems is critical behavior. This behavior is meant to reveal events that follow the power-law rule. Some of the researchers believe criticality is a significant clue to recognizing complex systems. Studies of complex systems have been a major part of interdisciplinary sciences in the twenty-first century. It is generally accepted that Brain is the most important complex system in nature and has evolved over a million years. One of the fastest growing fields to study this complex organ is neuroscience. Throughout neuroscience studies, avalanche sizes and their duration have been interesting to scientists. The size and duration of such neuronal avalanches show scale-free (power-law) statistics, which can be considered as a strong clue to “critical brain hypothesis”. In other words, power-law behavior of brain provides strong evidence for its critical dynamics, which in turn provides a simple explanation for many functional advantages of the brain, including efficient information storage and transmission, optimal dynamic range, as well as stability along with variability. In this thesis, we try to study a top-down modeling (dHAN) which can model brain's collective features such as associative thought process by its dynamics. The dense homogeneous associative network (dHAN) model of the brain provides a generic model which is independent of individual neuronal dynamics complications and can, therefore, be considered as a very general model of the brain with no regards to specifics. By the means of statistical analysis and finite-size-scaling method, we have shown while there is a specific balance between inhibitory and excitory factors, critical behavior appears in the systems. Furthermore, our findings show that if the excitory strengths decrease enough, the systems go to sub-critical dynamics with size-independent activity. Comparing our findings to experimental data, accentuate the importance of critical behavior in neural networks by a general top-down model which apparently has no signs of criticality in its dynamics. Numerical analysis was implemented in C++ programing and differential equations was solved by Runge-Kutta 4th order.



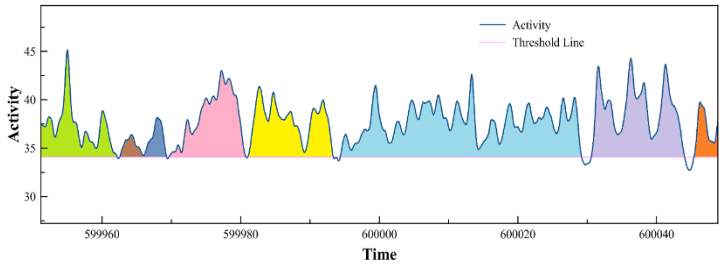


Figure 2, Identifying avalanches by setting a threshold. Each color indicates one neural avalanche.

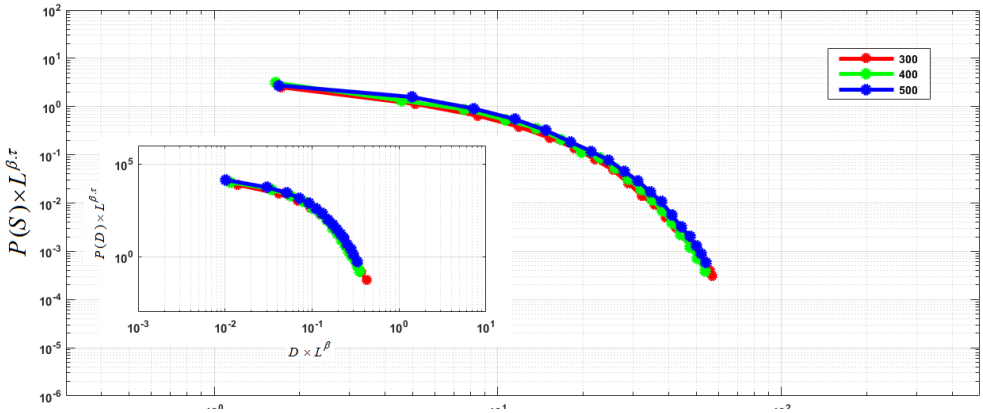


Figure 3, Logarithmic scale of frequency of neural avalanches size for dHAN model in three different network size