MAURICE FILO, PH.D.

Senior Research Scientist at ETH Zürich

maurice.filo@bsse.ethz.ch
 Basel, Switzerland
 maurice-filo

) +41784010699

- https://maurice-filo.github.io/
 Maurice-Filo
- Offenburgerstrasse 41, Basel 4057
 @MauriceFilo





CAREER SUMMARY

My research career is fueled by my ambition to advance systems and synthetic biology by leveraging **mathematics**, **computational science and engineering**. To achieve this, I resort to my expertise in **computational biology**, **mathematics**, **control theory**, **numerical simulations**, **and modeling** to devise innovative approaches within the realms of systems and synthetic biology, and their implications in **pharmacology**, **biotechnology**, **and therapeutics**. With a strong foundation in theoretical and **programming skills**, I am adept at identifying key questions that hinder progress in the field and possess the ability to address them effectively. I have an established track record of **independent research**, demonstrated by publications in high-impact journals, while also being a valued **collaborator**. My dedication and motivation have allowed me to stand out in leading research institutions worldwide, such as ETH Zürich and UCSB. My ultimate goal is to harness my strong mathematical background to **revolutionize biological research** in the same way that physics and engineering experienced significant advancements when mathematics became integrated.

PERSONAL DETAILS

Nationality: Lebanese, Swiss Resident Permit B Language: English (Proficient), Arabic (Native), French (Basic), German (Beginner)

EDUCATION

Postdoctoral Researcher, Control Theory and S Eidgenössische Technische Hochschule (ETH) Zürich 2018-2024	ystems Biology (CTSB), Prof. Mus Basel, Switzerland 	tafa Khammash
• 10 publications (4 Published Journal Papers, 2 Publish	ed Conference Papers, 2 Preprints, 2 in	Preparation)
Ph.D. & Masters in Mechanical Engineering University of California, Santa Barbara (UCSB)	California LISA	
 Ph.D. Dissertation: Topics in Stochastic Stability, Optir Master Thesis: Topics in Modeling of Cochlear Dynam Majors: Dynamic Systems, Control & Robotics (DSCR) 7 Publications (2 Journal Papers, 1 Preprint and 4 Con 	nal Control & Estimation Theory ics: Computation, Response & Stability , , Computational Science & Engineering (ference Papers)	Analysis CCSE) GPA: 4/4
Masters in Electrical & Computer Engineering American University of Beirut (AUB) 2010-2013	Beirut, Lebanon	AMERICAN UNIVERSITY or BEIRUT
 Master Thesis: Nonlinear Nonlocal Two Dimensional G Majors: Control Theory, Signal & Image Processing 2 Publications (Journal Papers) 	Cochlear Modeling	GPA: 4/4
Diploma in Electrical Engineering Lebanese University (LU)	Beirut, Lebanon	
Diploma Thesis: Demining Robot Vision	V Bonat, Lobaron	الجامعة اللبنانية UNIVERSITE LIBANAISE
 Majors, Control & Power Systems 		FILST-Class Honours

RESEARCH PUBLICATIONS & PATENTS

Journal Articles/Preprints

- S. Anastassov, M. Filo, and M. Khammash, "Inteins: A swiss army knife for synthetic biology," *Biotechnology Advances*, p. 108 349, 2024.
- S. Anastassov, M. Filo^{*}, C.-H. Chang, and M. Khammash, "A cybergenetic framework for engineering inteinmediated integral feedback control systems," *Nature Communications*, vol. 14, no. 1, p. 1337, 2023.
- M. Filo, C.-H. Chang, and M. Khammash, "Biomolecular feedback controllers: From theory to applications," *Current Opinion in Biotechnology*, vol. 79, p. 102 882, 2023.
- M. Filo, A. Gupta, and M. Khammash, "Anti-windup protection circuits for biomolecular integral controllers," *bioRxiv* (under revision in Science Advances), pp. 2023–10, 2023.
- M. Filo, M. Hou, and M. Khammash, "A hidden proportional feedback mechanism underlies enhanced dynamic performance and noise rejection in sensor-based antithetic integral control," *bioRxiv*, pp. 2023–04, 2023.
- M. Filo, S. Kumar, and M. Khammash, "A hierarchy of biomolecular proportional-integral-derivative feedback controllers for robust perfect adaptation and dynamic performance," *Nature Communications*, vol. 13, no. 1, pp. 1–19, 2022.
- T. Frei, C.-H. Chang, **M. Filo**, A. Arampatzis, and M. Khammash, "A genetic mammalian proportional-integral feedback control circuit for robust and precise gene regulation," *Proceedings of the National Academy of Sciences*, vol. 119, no. 00, e2122132119, 2022.
- B. Bamieh and M. Filo[†], "An input-output approach to structured stochastic uncertainty," *IEEE Transactions on Automatic Control*, vol. 65, no. 12, pp. 5012–5027, 2020.
- M. Filo ^{*†} and B. Bamieh, "Investigating instabilities in the mammalian cochlea using a stochastic uncertainty model," *IEEE Transactions on Molecular, Biological and Multi-Scale Communications*, vol. 6, no. 1, pp. 1–12, 2020.
- M. Filo and B. Bamieh, "An input-output approach to structured stochastic uncertainty in continuous time," *arXiv* preprint *arXiv*:1806.09091, 2018.
- N. Hajj, M. Filo, and M. Awad, "Automated composer recognition for multi-voice piano compositions using rhythmic features, n-grams and modified cortical algorithms," *Complex & Intelligent Systems*, vol. 4, no. 1, pp. 55–65, 2018.
- M. Filo, F. Karameh, and M. Awad, "Order reduction and efficient implementation of nonlinear nonlocal cochlear response models," *Biological cybernetics*, vol. 110, no. 6, pp. 435–454, 2016.

Conference Proceedings

- M. Filo, S. Kumar, S. Anastassov, and M. Khammash, "Exploiting the nonlinear structure of the antithetic integral controller to enhance dynamic performance," in 2022 IEEE 61st Conference on Decision and Control (CDC), IEEE, pp. 1294–1299.
- M. Filo and M. Khammash, "Optimal parameter tuning of feedback controllers with application to biomolecular antithetic integral control," in 2019 IEEE 58th Conference on Decision and Control (CDC), IEEE, 2019, pp. 951–957.
- M. Filo and B. Bamieh, "A block diagram approach to stochastic calculus with application to multiplicative uncertainty analysis," in 2018 IEEE Conference on Decision and Control (CDC), IEEE, 2018, pp. 3270–3275.
- M. Filo and B. Bamieh, "Function space approach for gradient descent in optimal control," in 2018 Annual American Control Conference (ACC), IEEE, 2018, pp. 3447–3453.
- M. Filo and B. Bamieh, "Investigating cochlear instabilities using structured stochastic uncertainty," in 2017 IEEE 56th Annual Conference on Decision and Control (CDC), IEEE, 2017, pp. 1634–1640.
- M. Filo and B. Bamieh, "Sensor motion for optimal estimation in distributed dynamic environments," in 2017 American Control Conference (ACC), IEEE, 2017, pp. 3263–3269.

Patents

- M. Filo, S. Anastassov, C.-H. Chang, and M. Khammash, "Intein-based controllers," Patent pending.
- T. Frei, C.-H. Chang, M. Filo, and M. Khammash, "Pid feedback control systems for robust control of molecular networks," Patent pending.

CONTRIBUTED TALKS & CONFERENCE SESSIONS

Organized and chaired an invited conference session on Biological Controllers 2022 Conference on Decision and Control (CDC) in Cancun, Mexico

Exploiting the Nonlinear Structure of the Antithetic Integral Controller to Enhance Dynamic Performance **2022 Conference on Decision and Control (CDC) in Cancun, Mexico**

Optimal Parameter Tuning of Feedback Controllers with Application to Biomolecular Antithetic Integral Control **2019 Conference on Decision and Control (CDC) in Nice, France**

A Block Diagram Approach to Stochastic Calculus with Application to Multiplicative Uncertainty Analysis **2018 Conference on Decision and Control (CDC) in Miami, USA**

A Function Space Approach to Gradient Descent in Optimal Control 2018 American Control Conference (ACC) in Wisconsin, USA

Investigating Cochlear Instabilities Using Structured Stochastic Uncertainty 2017 Conference on Decision and Control (CDC) in Melbourne, Australia

Sensor Motion for Optimal Estimation in Distributed Dynamic Environments **2017 American Control Conference (ACC) in Seattle, Washington**

Possible Sources of Instabilities in the Cochlea

2015 SIAM Conference on Applications of Dynamical Systems in Snowbird, Utah

RESEARCH EXPERIENCE

Postdoc & Senior Research Scientist

Eidgenössische Technische Hochschule (ETH) Zürich

📋 2018 - present

Basel, Switzerland

- Developed a **deep machine learning** approach in **Python** to automatically design reaction networks with pre-specified properties.
- Developed a user-friendly MATLAB application for modeling and simulating biomolecular controllers in both deterministic and stochastic environments (youtube link: https://www.youtube.com/watch?v=SeFFJz4dxOA).
- Conducted a **simulation study** to control blood glucose concentration in **diabetic patients**, utilizing FDA-approved models.
- Conducted a simulation study of cholesterol control in the plasma.
- Collaborated closely with biologists to design, model, analyze, and test advanced genetic circuits.
- Designed, analyzed, and genetically implemented a series of biomolecular **Proportional-Integral-Derivative (PID)** controllers, resulting in a patent covering various architectures.
- Established a unifying **model analysis and reduction theory** for a wide range of biomolecular integral controllers. This led to a second patent covering the theory and genetic components.
- Designed and implemented a numerical method for the optimally tuning parameters of nonlinear feedback controllers.
- Designed molecular reaction networks capable of realizing anti-windup schemes.
- Studied **non-ideal conditions impacting genetic circuit** operation, such as saturation and resource burden, and developed guidelines to minimize their negative effects.
- Served as a reviewer for many journals and conferences including Nature, PNAS, Nature Communications, Cell Systems, IEEE Transactions on Automatic Control, ACS Synthetic Biology, Journal of Acoustic Society of America, Automatica, ACC, CDC, among others.

Graduate Research Assistant University of California, Santa Barbara (UCSB)

2013 - 2018

- California, USA
- Developed a mathematical framework for **optimal field estimation via mobile tomographic sensors**.
- Designed and implemented a new numerical method for solving optimal control problems.
- Developed a framework for studying stochastic stability of dynamical systems with stochastic uncertainties.

- Developed and analyzed a class of stochastic **biomechanical models for cochlear dynamics**. In particular, stability analyses lead to connections with otoacoustic emissions and tinnitus.
- Devised various numerical techniques for **efficient simulations** of cochlear models.
- Studied mean square stability in infinite-dimensional and spatially circulant stochastic dynamical systems.

Graduate Research Assistant

American University of Beirut (AUB)

2011 - 2013

Beirut, Lebanon

Ghana, Africa

- Designed, implemented and analyzed an efficient model reduction scheme for the cochlea.
- Designed and implemented a deep machine learning algorithm for capturing the style of piano composers.

TEACHING EXPERIENCE

Lecturing & Lab Tutoring

Ashesi University

2023

- Participated in the ETH for Development (ETH4D) Master program in Mechatronics.
- Assisted in developing course materials for advanced control systems design and analysis.
- Delivered lectures and managed exercise and office hours sessions.
- Prepared and conducted hands-on tutorials on robotic programming of control algorithms, including LQR and LQG.

Lecturing & Graduate Students Supervision Eidgenössische Technische Hochschule (ETH) Zürich

2018-present

Basel, Switzerland

California, USA

Beirut Lebanon

- Introduction to Dynamical Systems with Professor Mustafa Khammash
- Advanced Bioengineering with Professor Mustafa Khammash
- Supervision of 3 Master Students (1 Master Thesis and 2 Master Projects)
- Co-supervision of 2 Doctoral Students

Teaching Assistant University of California, Santa Barbara (UCSB)

- Mechatronics lab instructor with Professor Bassam Bamieh
- Vibrations with Professor Igor Mezic
- Control Systems with Professor Bradley Paden

Teaching Assistant American University of Beirut (AUB)

2011 - 2013

- Graduate course in Pattern Recognition with Professor Mariette Awad
- C++ lab instructor
- Electronics lab instructor

FIELD WORK EXPERIENCE

Electrical Engineer Intern

National Oilwell Varco (NOV)

苗 Summer 2009

Dubai, UAE

• Troubleshooting of faults in Silicon Controlled Rectifier (SCR) rooms.

• Complete reassembling of SCR units for maintenance.

Electrical Engineer Intern Electricité De Zahle (EDZ)

Summer 2008

- Maintenance of power grids.
- Installations of new power transformers and transmission lines.
- Development of software power grids in Zahle using Geographic Information System (GIS).

PROGRAMMING SKILLS

MATLAB Simulink LabVIEW C C++ Python Julia LATEX
PIC PLC SBRIO NICVS
Blender TikZ Adobe Illustrator

Zahle, Lebanon

FELLOWSHIPS & AWARDS

0	Ranked First in the Competition for the Research Officer Position at INRIA, France (Declined by Applicant) https://www.inria.fr/fr/chargees-et-charges-de-recherche-de-classe-normale-crcn
00	"PID Feedback Control Systems for Robust Control of Molecular Networks" ranked among the Top 20 Inventions Spark Award (2021), https://ethz.ch/en/industry/researchers/ip/sparkaward/2021.html
Ŧ	Best PhD Thesis Award Center for Control, Dynamical-Systems & Computations (CCDC) (2019)
0	Featured as the Researcher of the Term Center for Control, Dynamical-Systems & Computations (CCDC) (2016) https://www.ccdc.ucsb.edu/content/maurice-filo
Ŧ	Best Teacher Assistant Award Department of Mechanical Engineering, UCSB (2015)
ö	CCDC Fellowship Center for Control, Dynamical-Systems & Computations (CCDC) (2013)
Q	Holbrook Foundation Fellowship Institute for Energy Efficiency (IEE), UCSB (2013)
EX	TRACURRICULAR EXPERIENCE
Priva	ite Piano Teacher

2004 - 2013

Music Major, Lebanese National Conservatory

i 1993 - 2005

• Piano, Music Theory, Solfegio and Harmony.

Classical Piano Concert

苗 April, 2004

- Lebanon
- Zahle & Beirut, Lebanon
- Grand Kadri Hotel, Lebanon

— History Marked <u>—</u> **GRAND KADRI HOTEL** Cristal Lebanon