

# MAURICE FILO, PH.D.

## Postdoc at ETH Zürich

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## CAREER SUMMARY


My research career is fueled by the ambition to advance **biotechnology** 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 Systems Biology (CTSB), Prof. Mustafa Khammash  
**Eidgenössische Technische Hochschule (ETH) Zürich**   
📅 2018-present 📍 Basel, Switzerland  
• 10 publications (4 Published Journal Papers, 2 Published Conference Papers, 1 Preprint, 3 in Preparation)

Ph.D. & Masters in Mechanical Engineering  
**University of California, Santa Barbara (UCSB)**   
📅 2013-2018 📍 California, USA  
• Ph.D. Dissertation: Topics in Stochastic Stability, Optimal Control & Estimation Theory  
• Master Thesis: Topics in Modeling of Cochlear Dynamics: Computation, Response & Stability Analysis  
• Majors: Dynamic Systems, Control & Robotics (DSCR), Computational Science & Engineering (CSE) GPA: 4/4  
• 7 Publications (2 Journal Papers, 1 Preprint and 4 Conference Papers)

Masters in Electrical & Computer Engineering  
**American University of Beirut (AUB)**   
📅 2010-2013 📍 Beirut, Lebanon  
• Master Thesis: Nonlinear Nonlocal Two Dimensional Cochlear Modeling  
• Majors: Control Theory, Signal & Image Processing GPA: 4/4  
• 2 Publications (Journal Papers)

Diploma in Electrical Engineering  
**Lebanese University (LU)**   
📅 2005-2010 📍 Beirut, Lebanon  
• Diploma Thesis: Demining Robot Vision  
• Majors: Control & Power Systems  
First-Class Honours

# RESEARCH EXPERIENCE

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## Postdoc

### 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 prototyping and simulating biomolecular controllers in both deterministic and stochastic environments.
  - 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 complex **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.
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## 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.
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## Graduate Research Assistant

### American University of Beirut (AUB)

📅 2011 – 2013

📍 Beirut, Lebanon

- 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**.
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# TEACHING EXPERIENCE

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## Lecturing & Graduate Students Supervision

### Eidgenössische Technische Hochschule (ETH) Zürich

📅 2018-present

📍 Basel, Switzerland

- 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)
  - Supervision of 2 Doctoral Students
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## Teaching Assistant

### University of California, Santa Barbara (UCSB)

📅 2013 – 2015

📍 California, USA

- 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

📍 Beirut Lebanon

- 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)



📅 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

📍 Zahle, Lebanon

- 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

## FELLOWSHIPS & AWARDS

🏆 "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>

🏆 Best PhD Thesis Award  
Center for Control, Dynamical-Systems & Computations (CCDC) (2019)

🏆 Featured as the Researcher of the Term  
Center for Control, Dynamical-Systems & Computations (CCDC) (2016)  
<https://www.ccdc.ucsb.edu/content/maurice-filo>

🏆 Best Teacher Assistant Award  
Department of Mechanical Engineering, UCSB (2015)

🏆 CCDC Fellowship  
Center for Control, Dynamical-Systems & Computations (CCDC) (2013)

🏆 Holbrook Foundation Fellowship  
Institute for Energy Efficiency (IEE), UCSB (2013)

# 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**

# EXTRACURRICULAR EXPERIENCE

## Private Piano Teacher

📅 2004 - 2013

📍 Lebanon



## Music Major, Lebanese National Conservatory

📅 1993 - 2005

📍 Zahle & Beirut, Lebanon



- Piano, Music Theory, Solfeggio and Harmony.

## Classical Piano Concert

📅 April, 2004

📍 Grand Kadri Hotel, Lebanon



History Marked

GRAND KADRI HOTEL  
Cristal Lebanon

# RESEARCH PUBLICATIONS & PATENTS

## 📄 Journal Articles

- S. Anastassov, M. Filo<sup>\*</sup>, C.-H. Chang, and M. Khammash, "A cybergenetic framework for engineering intein-mediated 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, 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<sup>†</sup>, "An input-output approach to structured stochastic uncertainty," *IEEE Transactions on Automatic Control*, vol. 65, no. 12, pp. 5012-5027, 2020.
- M. Filo<sup>\*†</sup> 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.
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## 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.
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## 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.

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\* co-first author, † corresponding author