Dr. M. A. Mabrok

CONTACT INFORMATION

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SUMMARY

I am an assistant professor with the Department of Mathematics and Physics at the Australian College of Kuwait. I have multidisciplinary teaching and research background in the fields of mathematics, dynamical systems and control and computer science, with emphasis on control systems, mathematical physics, and game theoretic learning. I have strong technical knowledge about robotics, linear and nonlinear systems and modeling and simulations of flexible-structure dynamical systems.

RESEARCH INTERESTS

- Mathematical modeling and simulation of dynamical systems.
- Robotics and intelligent systems.
- Game theory and evolutionary dynamics.
- Quantum control.

EDUCATION

Ph.D. in Dynamical Systems and Control

School of Engineering and Information Technology, University of New South Wales at Australian Defence Force Academy, Canberra, Australia, May 2013.

- Dissertation: *New Results on Negative Imaginary Systems Theory with Application to Flexible Structures and Nano-Positioning.*
- Adviser: Professor Ian Petersen.
- Areas of Study: Control Systems, dynamical systems and mechatronics.

M.Sc. in Mathematics

Mathematics Department, Faculty of Science, Suez Canal University, Egypt and Queensland University, Australia, May 2009.

- Thesis: *Studying the quantum properties for a system of atoms interacting with some field*
- Area of Study: Applied Mathematics, Mathematical Modeling, Quantum physics.

B.Sc. in Mathematics

Mathematics Department, Faculty of Science, Suez Canal University, Egypt, August 2004.

- Areas of Study: Applied Mathematics, Computer Science.

CAREER SUMMARY

Assistant Professor: **August 2017–Present**

Department of Mathematics, Faculty of Engineering, Australian Collage of Kuwait

I have taken duties in both teaching and research with the Department of Mathematics at the ACK. My responsibilities include developing and teaching existing and new modules in undergraduate level mathematics courses. My leadership positions include being one of the online-learning committee member that lead the transformation of the ACK into online-based. Also, I was appointed to lead the development of a new degree program within our school. In research, I have been particularly active in supervising PhD, and final year students in areas of dynamical systems and control. In addition, the following regular responsibilities:

- Teaching several engineering and math related courses.
- Developing and implement innovative instructional learning methods.
- Guiding, leading and mentoring students in educational research projects.
- Evaluating, monitoring and mentoring students' academic progress.

Postdoctoral Research Fellow: **August 2015–August 2017**

Robotics, Intelligent Systems and Control Lab at the King Abdullah University of Science and Technology.

This is an industry-facing role involved leadership as well as hands-on focused on the area of robotics, game theory and evolutionary dynamics and man-machine systems. Working in Shamma's robotics lab allowed me to develop a soled practical experience in algorithm

implementation and validation for multi-agent robot systems in several platforms such as robotic operating systems (ROS).

Postdoctoral Research Fellow **May 2014–August 2015**

Capability Systems Centre, University of New South Wales Canberra, Australia.

This position was funded from the Australian Defence Force. My research was focused on systems engineering and systems design. During this time, I was working on integrating nonfunctional requirements into axiomatic design methodology. Also, I developed a mathematical framework for recursive model-based system design.

TEACHING EXPERIENCE

I had the privilege to teach and work closely with both graduate and undergraduate students at an early stage of my academic career, as instructor, senior instructor and lecturer in the fields of mathematics. I have experienced in teaching different mathematics courses including:

- Applied Mathematics I & II.
- Engineering Mathematics I & II.
- Calculus I, II, & III .
- Partial Differential Equation.
- Real Analysis.
- Advanced Mathematical Methods.
- Differential equations I & II
- Linear algebra.
- Advanced Linear Algebra.
- Matlab programming.
- Numerical analysis.
- Electromagnetism and Modern Physics.

The variety of the courses I taught provided me with a unique opportunity to make connections between different fields of mathematics, engineering and physics. Thus, I strive to bring the different point of views to the classroom to enrich the students experiences and develop their analytical thinking skills. Moreover, the size of the classes I taught varied from small classes (20 students) to large classes (500 students) .

GRANTS

- **Comprehensive Modeling and Prototyping of the Kuwaiti Water Distribution System** PI,2020-2021
  Value 50K USD, funded by Kuwait Foundation for the Advancement of Science.
- **Understanding the Human Decision Making Possess in *Human in the Loop Applications*.** PI,2020
  Submitted to Kuwait Foundation for the Advancement of Science.
- **Structural retrofitting with post-tensioned cables using actively controlled mechanical devices.** Co-PI,2017-2019
  Value 5K USD, funded by the Australian University of Kuwait.

AWARDS SCHOLARSHIPS

Mohamed Bin Zayed International Robotics Challenge (MBZIRC), 2017
- Second runner-up position and bronze medal in Challenge-II.

Research Publication Fellowship 2013
- School of Engineering and Information Technology, UNSW Canberra, Australia.

PRSS Scholarship 2012
- School of Engineering and Information Technology, UNSW Canberra, Australia.

Full Ph.D. scholarship 2010
- School of Engineering and Information Technology, UNSW Canberra, Australia.

Partnership and Ownership Initiative 2008
Ministry of Higher Education, Egypt, to visit University of Queensland, Brisbane Australia.

Outstanding Student Award 1999–2004
Suez Canal University for four years continuously in my undergraduate studies.

VISITING SCHOLAR

Robotics, Intelligent Systems and Control Lab 2015
King Abdullah University of Science and Technology (KAUST), Jeddah Saudi Arabia.

Los Alamos National Laboratory, 2012
Los Alamos, New Mexico, USA.

Theoretical Physics Group, School of Physics, 2008
University of Queensland, Brisbane, Australia.

PROFESSIONAL SERVICE

Referee Service

- *IEEE Transactions on Automatic Control*
- *IEEE Transactions of Control Technology*
- *Journal of Franklin Institute*
- *Mechantronics Journal*
- *IEEE American Control Conference*
- *IEEE Conference of Decision and Control*
- *ASME Dynamic Systems Control Conference*

ENTREPRENEUR INTERESTS

- Co-founder and Mathematical Modeling Specialist of **MED PREDICT**, which is start-up in the filed of Precision Medicine aims to develop software solutions for prediction of diseases course & treatment based on personalized patients profile.

PUBLICATIONS:

BOOK CHAPTERS

[1] M. Abdelkader, U. A. Fiaz, N. Toumi, **M. A Mabrok**, Jeff S. Shamma. *"RISCuer: A Reliable Multi-UAV Search and Rescue Testbed".* submitted to Unmanned Aerial Systems (2020)

JOURNAL PAPERS

[1] **M. A Mabrok**, Vu Phi Tran, and Ian R. Petersen. *"Robust adaptive learning control for different classes of dissipative systems."* Submitted to Journal of Franklin Institute, (2020)

[2] Vu Phi Tran, **M. A Mabrok**, Sreenatha G. Anavatti, Matthew A. Garratt and Ian R. Petersen. *"Robust Hybrid Strictly Negative Imaginary-Adaptive Neural-Fuzzy Tracking Control System and Adaptive Hybrid Model Identification for a Quadrotor Drone."* Submitted to IEEE Transactions on Systems, Man, and Cybernetics, (2020)

[3] Ahmed S, Saad, **M. A Mabrok**. *" Retrofitting of Bridge Superstructures Using Robust Control."* Submitted to International Journal of Control, (2020)

[4] Vu Phi Tran, **M. A Mabrok**, Sreenatha G. Anavatti, Matthew A. Garratt and Ian R. Petersen. *" Robust and Adaptive Negative Imaginary-Fuzzy Controller for Non-Linear Systems."* Submitted to IEEE Transaction on Cybernetics, (2020)

[5] **M. A. Mabrok** Maryam Ahmed Alyami, Emad E. Mahmoud. *"On the Dissipativity Property of Negative Imaginary Systemss."* Accepted in Alexandria Engineering Journal, (2020)

[6] **M. A. Mabrok**. *"Passivity Analysis of Replicator Dynamics and its Variations."* Accepted in IEEE Transactions of Automatic Control, (2020)

[7] **M. A. Mabrok**, Hassan Mohamed, Abdel-Halem Abdel-Aty and Ahmed Alzahrani *"Control Systems Models for Human-in-the-Loop: A survey."* Journal of Intelligent & Fuzzy Systems, vol. 38, no. 3, pp. 2611-2622. (2020)

[8] Samet Gler, Mohammed A. Algarni, Mohammad Z. Shaqura, Hassan Jaleel, **M. A. Mabrok**, iming Jiang, Yimeng Lu, and Jeff S. Shamma *"Perception, navigation, and manipulation in the team KAUST approach to the MBZIRC ground robotics challenge."* Journal of Field Robotics, (2019), 131.

[9] **M. A. Mabrok** *"Negative Imaginary H_2 Controller Synthesis Using Nonlinear Optimization."* International Journal of Control, pages 1-9,(2019)

[10] **M. A. Mabrok** *"Pattern detection for time series trajectories in human in the loop applications."* Journal of Intelligent & Fuzzy Systems, vol. 37, no. 1, pp. 115-123, 2019.

[11] Katanya Kuntz, Trevor Wheatley, Hongbin Song, James Webb, **M. A. Mabrok** and Elanor Huntington, H. and Hidehiro Yonezawa. *"Ultra-wide Frequency Response Measurement of an Optical System with a DC Photo-detector."* Optics Express, (2017).

[12] **M. A. Mabrok** and Mike Rayn. *"Category Theory as a Formal Mathematical Foundation for Model-Based Systems Engineering."* Applied Mathematics and Information Sciences, (2017). .

[13] Sajal K. Das, **M. A. Mabrok** and Ian R. Petersen. *"A Test to Determine Mixedness of Mixed Passive, Negative-Imaginary and Small-Gain Systems with Poles on the Imaginary Axis and Stability Analysis."* To appear in IEEE Transactions on Automatic Control, 2017. .

[14] **M. A. Mabrok** and Ian R. Petersen. *"Controller Synthesis for Negative Imaginary Systems: A data Driven Approach."* IET Control Theory and Applications, February, 2016. .

[15] D. Dong, **M. A. Mabrok**, I.R. Petersen, B. Qi, C. Chen, and H. Rabitz. *" Sampling-based Learning Control for Quantum Systems with Uncertainties."* IEEE Transactions on Control Systems Technology, November 2015. .

[16] **M. A. Mabrok**, M. Efatmaneshnik, and M.J. Ryan. *"Integrating Nonfunctional Requirements into Axiomatic Design methodology."* IEEE Systems Journal, 2015. .

[17] **M. A. Mabrok**, S. Elsayed, and M.J. Ryan. *"Mathematical Framework for Recursive Model-based System Design." Nonlinear Dynamics*, April, 2015. .

[18] **M. A. Mabrok**, MA Haggag, and IR Petersen. *"System identification algorithm for negative imaginary systems." International Journal of Applied and Computational Mathematics*, 2015. .

[19] **M. A. Mabrok**, Abhijit G. Kallapur, Ian R. Petersen, and Alexander Lanzon. *"A Generalized Negative Imaginary Lemma and Riccati-Based Static State-feedback Negative Imaginary Synthesis." Systems & Control Letters*, 2015. .

[20] **M. A. Mabrok**, A.G. Kallapur, I.R. Petersen, and A. Lanzon. *" Generalizing nNegative Imaginary Systems Theory to Include Free Body Dynamics: Control of Highly Resonant Structures with Free Body Motion." IEEE Transactions on Automatic Control*, Oct 2014. .

[21] **M. A. Mabrok**, A.G. Kallapur, I.R. Petersen, and A. Lanzon. *"Spectral Conditions for Negative Imaginary Systems with Applications to Nanopositioning." IEEE/ASME Transactions on Mechatronics*, June 2014. .

[22] **M. A. Mabrok**, A. Lanzon, A.G. Kallapur, and I.R. Petersen. *"Enforcing Negative Imaginary Dynamics on Mathematical System Models." International Journal of Control*, 2013. .

[23] Faisal AA El-Orany, A-SF Obada, **M. A. Mabrok**, and M. B. Wahiddin. *"Evolution of the Pair-coherent State with the Two-qubit: Entanglement and Cat-state Generation." Journal of Modern Optics*, 2008. .

[24] **M. A. Mabrok**, Abhijit G. Kallapur, Ian R. Petersen Lanzon A Three-mirror Optical Cavity Using Negative Imaginary Systems approach. *An International Journal of Quantum Information Review*, 2014.

[25] **M. A. Mabrok**, Abhijit G Kallapur, Ian R Petersen, and Alexander Lanzon. Generalized Negative Imaginary Lemma for Descriptor Systems. *Journal of Mechanics Engineering and Automation*, 2012.

CONFERENCE PAPERS

[1] Owyed, S., Abdel-Aty, A., **M. A. Mabrok**, and Zakaria, N. (2019, July). Mathematical Modeling and Simulation of 3-Qubits Quantum Annealing Processor. In Proceedings of the 2019 2nd International Conference on Mathematics and Statistics (pp. 14-18). ACM.

[2] **M. A. Mabrok** and Ian Pertersen. Negative Imaginary H_2 Controller Synthesis Using Nonlinear Optimization In *IEEE 57rd Annual Conference on Decision and Control (CDC)*, Miami Beach, FL, USA on Dec. 17-19, 2018.

[3] Ahmed Gallab **M. A. Mabrok** and Ian Pertersen. Extending Negative Imaginary Systems Theory to Nonlinear Systems In *IEEE 57rd Annual Conference on Decision and Control (CDC)*, Miami Beach, FL, USA on Dec. 17-19, 2018.

[4] **M. A. Mabrok** and Jeff Shamma. Passivity analysis of higher order evolutionary dynamics and population games In *IEEE 55rd Annual Conference on Decision and Control (CDC)*, Las Vegas, USA, 2016.

[5] **M. A. Mabrok** and I. Petersen. Data driven controller synthesis for negative imaginary systems. In *The 10th Asian Control Conference*, 2015.

[6] **M. A. Mabrok**, Mahmoud Efatmaneshnik, and Michael Ryan. Including non-functional requirements in the axiomatic design process. In *2015 9th Annual IEEE International Systems Conference (SysCon)*, 2015.

[7] A.-H. Abdel-Aty, N. Zakaria, and **M. A. Mabrok**. Dynamics of the entanglement over noisy quantum networks. In *International Conference on Computer and Information Sciences (ICCOINS)*, 2014.

[8] I**M. A. Mabrok** and Ian Petersen. Negative imaginary feedback systems. In *The 4rd Australian Control Conference*, 2014.

[9] **M. A. Mabrok**, MA Haggag, IR Petersen, and A Lanzon. A subspace system identification algorithm guaranteeing the negative imaginary property. In *)2014 IEEE 53rd Annual Conference on Decision and Control (CDC)*, 2014.

[10] Katanya B Kuntz, Trevor A Wheatley, James G Webb, Hongbin Song, **M. A. Mabrok**, and Elanor H Huntington. Frequency response measurement of optical cavities using an intensity modulated laser beam and direct power measurement. In *Australian Institute of Physics Congress*, 2014.

[11] **M. A. Mabrok**, Daoyi Dong, Chunlin Chen, and I.R. Petersen. Robust entanglement control between two atoms in a cavity using sampling-based learning control. In *2014 IEEE 53rd Annual Conference on Decision and Control (CDC)*, 2014.

[12] A.G. Kallapur, **M. A. Mabrok**, and I.R. Petersen. An integral resonant controller approach to frequency locking an optical cavity. In *2013 IEEE International Conference on Control Applications (CCA)*, 2013.

[13] **M. A. Mabrok**, D. Dong, I.R. Petersen, and C. Chen. Entanglement generation in uncertain quantum systems using sampling-based learning control. In *Proceedings of 19th IFAC World Congress*, Cape Town, South Africa, 2013.

[14] **M. A. Mabrok**, A. G. Kallapur, I. R. Petersen, and A. Lanzon. Stabilization of conditional uncertain negative-imaginary systems using Riccati equation approach. In *20th International Symposium on Mathematical Theory of Networks and Systems*, 2012.

[15] **M. A. Mabrok**, A.G. Kallapur, I.R. Petersen, and A. Lanzon. A stability result on the feedback interconnection of negative imaginary systems with poles at the origin. In *2012 2nd Australian Control Conference (AUCC)*, 2012.

[16] **M. A. Mabrok**, A.G. Kallapur, I.R. Petersen, and A. Lanzon. Stabilization of uncertain negative-imaginary systems using a Riccati equation approach. In *First International Conference on Innovative Engineering Systems (ICIES)*, 2012.

[17] **M. A. Mabrok**, A.G. Kallapur, I.R. Petersen, D. Schutte, T.K. Boyson, and A. Lanzon. Locking a three-mirror optical cavity: A negative imaginary systems approach. In *2nd Australian Control Conference (AUCC)*, 2012.

[18] Peter C Kuffner, Kathryn J Conroy, Toby K Boyson, Greg Milford, **M. A. Mabrok**, Abhijit G Kallapur, Ian R Petersen, Maria E Calzada, Thomas G Spence, Kennith P Kirkbride, et al. Quantum cascade laser-based substance detection: approaching the quantum noise limit. In *SPIE Defense, Security, and Sensing, International Society for Optics and Photonics*, 2011.

[19] **M. A. Mabrok**, A. G. Kallapur, I. R. Petersen, and A. Lanzon. Enforcing a system model to be negative imaginary via perturbation of hamiltonian matrices. In *Proc. 50th IEEE Conf. Decision and Control and European Control Conf. (CDC-ECC)*, 2011.

[20] **M. A. Mabrok**, A. G. Kallapur, I. R. Petersen, and A. Lanzon. A negative imaginary lemma for descriptor systems. In *Proc. Australian Control Conf. (AUCC)*, 2011.

[21] **M. A. Mabrok** A. G. Kallapur, I. R. Petersen, and A. Lanzon. Stability analysis for a class of negative imaginary feedback systems including an integrator. In *Proc. 8th Asian Control Conf. (ASCC)*, 2011.

[22] **M. A. Mabrok**, Abhijit G Kallapur, Ian R Petersen, Alexander Lanzon, et al. A new stability result for the feedback interconnection of negative imaginary systems with a pole at the origin. In *(CDC-ECC), 50th IEEE Conference on Decision and Control and European Control Conference*, 2011.

[23] **M. A. Mabrok**, Abhijit G. Kallapur, Ian R. Petersen, and Alexander Lanzon. A new stability result for the feedback interconnection of negative imaginary systems with a pole at the origin. In *Proceedings of the Conference Decision Control-European Control Conference, Orlando, Florida, USA*, 2011.

[24] **M. A. Mabrok**, Abhijit G. Kallapur, Ian R. Petersen, and Alexander Lanzon. Spectral conditions for the negative imaginary property of transfer function matrices. In *Proc. 18th IFAC World Congress; Milan, Italy*, 2011.

REFERENCES

Prof. Ian R. Petersen
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Relationship: Colleague, we published many papers together.

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Electrical Engineering, King Abdullah University of Science and Technology (KAUST) and the Julian T. Hightower Chair in Systems and Control (currently on leave) in the School of Electrical and Computer Engineering, Georgia Institute of Technology (Georgia Tech)
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