Abubakr Muhammad

Postdoctoral Research Fellow
School of Computer Science, McGill University, Montreal, Canada

Bio

- **Date of Birth:** December 19, 1976 **Nationality:** Pakistan **Marital Status**: Married
- **Current Address :** 104N McConnell Bldg., McGill Univ., Montreal, QC, Canada H3A 2A7
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Education

- **PhD in Electrical Engineering, Georgia Institute of Technology, USA** *2005*
  Dissertation topic: *Graphs, simplicial complexes and beyond: Topological tools for multiagent coordination.* Winner of Sigma-Xi Best PhD thesis award 2006
- **MS in Mathematics, Georgia Institute of Technology, USA** *2005*
  Concentration in topology and geometry
- **MS in Electrical & Computer Engineering, Georgia Institute of Technology** *2002*
  Concentration in signal processing, communications and control
- **BSc in Electrical Engineering, UET, Lahore, Pakistan** *2000*
  Thesis title: *Synchronized chaos for secure communication*

Academic Research Experience

- **Postdoctoral Research Fellow** *Nov 2006–present*
  Quantum Information Processing Group, McGill University
  Center for Intelligent Machines (CIM), McGill University
- **Postdoctoral Researcher** *Jan 2006–June 2007*
  General Robotics, Sensing & Perception Lab (GRASP), University of Pennsylvania
- **Research Assistant** *Aug 2001–Dec 2005*
  Center for Research in Embedded Systems (CREST), Georgia Institute of Technology
- **Visiting Research Scholar** *Dec 2004*
  Department of Mathematics, Stanford University
- **Visiting Research Scholar** *June 2004*
  Department of Mathematics, University of Illinois, Urbana-Champaign

Industry Experience

- **Research Scientist** *May 2002–July 2002*
  Advanced Engineering Research Organization (AERO), Pakistan
- **Design Engineer** *March 2000–July 2001*
  And Or Logic (pvt) Ltd, Islamabad, Pakistan
- **Internee** *May 1997–July 1997*
  Systems Software (pvt) Ltd, Lahore, Pakistan

Publications

Book

1. "Graphs, Simplicial Complexes and Beyond: Topological Tools for Multiagent Coordination," VDM Verlag, Saarbrucken, Germany, 2008. (In press)

Journal Articles

1. Abubakr Muhammad and Magnus Egerstedt, "Connectivity Graphs as Models of Local Interactions," Journal of Applied Mathematics and Computation, Vol. 168, Issue 1, September 2005, Pages 243–269.

2. Abubakr Muhammad and Magnus Egerstedt, "Feasibility, Reachability and Optimal Control of Connectivity Graph Processes," SIAM Journal on Control and Optimization. (Under revision)

3. Abubakr Muhammad and Ali Jadbabaie, "Computing Homology on Real Networks,", Submitted to ACM Transactions on Sensor Networks.

4. Abubakr Muhammad and Ali Jadbabaie, "From Consensus in Switching Graphs to Coverage in Switching Simplicial Complexes." To be submitted to IEEE transactions on Robotics.

Book Chapters

1. Abubakr Muhammad and Magnus Egerstedt, "Decentralized Coordination With Local Interactions: Some New Directions," Cooperative Control, Springer Lecture Notes in Control and Information Sciences (LNCIS), Vol. 309, 2005.

2. Abubakr Muhammad, Meng Ji and Magnus Egerstedt, "Applications of Connectivity Graph Processes in Networked Sensing and Control," Networked Embdedded Sensing and Control, Springer Lecture Notes in Control and Information Sciences (LNCIS), 2006.

3. Abubakr Muhammad and Ali Jadbabaie, "Dynamic coverage verification in Mobile Sensor Networks Via Switched Higher Order Laplacians," in Oliver Broch, (Editor), Robotics: Science and Systems MIT Press, to appear, 2007.

4. Abubakr Muhammad and Ali Jadbabaie, "Asymptotic Stability of switched higher order Laplacians and dynamic coverage", in Alberto Bemporad, Antonio Bicchi and Giorgio Buttazzo (Editors), Hybrid Systems: Computation and Control, Springer Lecture Notes in Compter Science (LNCS), 2007.

Conference Papers

1. Abubakr Muhammad and Ali Jadbabaie, "Decentralized Computation of Homology Groups in Networks by Gossip", American Control Conference, 2007.

2. Abubakr Muhammad and Magnus Egerstedt, "Control Using Higher Order Laplacians in Network Topologies," Mathematical Theory of Networks and Systems, Kyoto, Japan, 2006.

3. Abubakr Muhammad and Magnus Egerstedt, "Network Configuration Control Via Connectivity Graph Processes," American Control Conference, Minneapolis, 2006.

4. Meng Ji, Abubakr Muhammad and Magnus Egerstedt, "Leader-Based Multi-Agent Coordination: Controllability and Optimal Control," American Control Conference, Minneapolis, 2006.

5. Abubakr Muhammad and Magnus Egerstedt., "Positivstellensatz Certificates For Feasibility Of Connectivity Graphs In Multi-Agent Formations," 16th IFAC World Congress, Prague, July 4-8, 2005.

6. Vin de Silva, Robert Ghrist and Abubakr Muhammad, "Blind Swarms for Coverage in 2-D," Robotics: Science and Systems, Massachusetts Institute of Technology, Cambridge, MA, June 8-11, 2005.

7. Robert Ghrist and Abubakr Muhammad, "Coverage And Hole-Detection In Sensor Networks Via Homology," The Fourth International Conference on Information Processing in Sensor Networks (IPSN'05), UCLA, Los Angeles, CA, April 25-27, 2005.

8. Abubakr Muhammad and Magnus Egerstedt, "Connectivity Graphs as Models of Local Interactions," IEEE Conference on Decision and Control, Bahamas, December 2004.

9. Abubakr Muhammad and Magnus Egerstedt, "On The Structural Complexity Of Multi-Agent Robot Formations," American Control Conference, Boston, Massachusetts, USA, July 2004.

10. Abubakr Muhammad and Magnus Egerstedt, "Topology And Complexity Of Formations," in Proceedings of 2nd International Workshop on the Mathematics and Algorithms of Social Insects, Atlanta, Georgia, USA, December 15-17, 2003.

11. Henrik Axelsson, Abubakr Muhammad, and Magnus Egerstedt, "Autonomous Formation Switching For Multiple, Mobile Robots," in Proceedings of IFAC Conference on Analysis and Design of Hybrid Systems, Sant-Malo, Brittany, France, June 2003.

12. Magnus Egerstedt, Abubakr Muhammad, and X. Hu, "Formation Control Under Limited Sensory Range Constraints," in Proceeding of 10th Mediterranean Conference on Control and Automation, Lisbon, Portugal, July 2002.

13. Abubakr Muhammad, Biological Receptive Fields for Motion Detection, FAST-IEEE Student Conference on CS and IT, FISC' 98, Lahore, Pakistan, 1998.

Presentations/Invited Talks/Seminars (Selected)

- Decision and Control Seminar, CSL, UIUC — Nov 2006
- Mathematical Theory of Networks and Systems (MTNS), Kyoto, Japan — July 2006
- Systems and Controls Seminar, Georgia Tech — April 2006
- Networked Enabled Sensing and Control (NESC), Notre Dame — Sept 2005
- GRASP Lab Seminar, University of Pennsylvania, Philadelphia, PA — Sept 2005
- Department of Mathematics, Georgia Institute of Technology, Atlanta, GA — July 2005
- Information Processing in Sensor Networks (IPSN), Los Angeles, CA — Apr 2005
- Stanford University Topology Seminar, Palo Alto, CA — Dec 2004
- 43rd Control and Decision Conference, Bahamas — Dec 2004
- American Mathematical Society (AMS) Sectional Meeting, Evanston, IL — Oct 2004
- American Control Conference, Boston, MA — July 2004

Workshops/Summer Schools Attended

- Workshop on Computational Geometry, Jan 2008, Bellairs Institute, Barbados, West Indies.
- Workshop on *Application of Topology in Science and Engineering*, Sept. 2006, MSRI-Berkeley
- Summer School on *Control in Quantum Systems*, Aug, 2005, Caltech, Pasadena
- Workshop on *UAV Autonomy and Multi-Vehicle Coordinated Control*, Dec 13, 2004, Bahamas
- Workshop on *Semi-definite Programming Relaxations and Algebraic Optimization in Control*, June 29, 2004, Boston, MA

Teaching Experience

- Course lecturer, COMP-208: *Computers for Engineering*, McGill University, Winter 2008
- Reading group, *Computational topology in Science & Engineering*, McGill University, Winter 2008
- Teaching assistant, ECE-6553: *Optimal Control*, Georgia Tech, Spring 2005
- Substitute lecturer, ECE-6550: *Linear Control Systems*, Georgia Tech, Fall 2005
- Reading group, *Computational algebraic topology*, School of Mathematical Sciences, Jan 2006

Awards and Honors

- Sigma Xi Best PhD thesis from Georgia Tech for the year 2005
- Graduate-track Coordinator for Georgia Tech Robotics Initiative Workshop 2003
- Best in Session Award, American Controls Conference, Boston, 2004
- Gold medalist, SSC examination, 1992 from Lahore Board
- Silver medalist, HSSC examination 1994 from Lahore Board
- National Talent Scholarship recipient, 1990, 1992, 1994, 1995-2000 on various levels

Professional Services

- Member program committee : First International Conference on Robot Communication and Coordination (Robocomm 2007), Athens, Greece.
- Reviewer for IEEE Transactions on Automatic Control, IEEE transactions on Robotics and Automation
- Reviewer for various controls & robotics conferences and workshops (CDC, ACC, CAA, RSS, ICRA)
- Member IEEE since 1995

References

- Dr Magnus Egerstedt, Associate Professor, School of Electrical & Computer Engineering, Georgia Institute of Technology, Atlanta, GA (PhD Adviser) magnus@ece.gatech.edu
- Dr George Pappas, Professor, Department of Electrical & Systems Engineering, University of Pennsylvania, Philadelphia, PA pappasg@ee.upenn.edu
- Dr Ali Jadbabaie, Assistant Professor, Department of Electrical and Systems Engineering, University of Pennsylvania, Philadelphia, PA (Postdoc supervisor) jadbabai@seas.upenn.edu
- Dr Kostas Daniilidis, Associate Professor, Department of Computer and Information Science, University of Pennsylvania, Philadelphia, PA kostas@cis.upenn.edu
- Dr Robert Ghrist, Professor, Department of Mathematics, University of Illinois at Urbana-Champaign IL (Collaborator) ghrist@math.uiuc.edu
- Dr Patrick Hayden, Canada Research Chair in Physics of Information, McGill University, QC (Postdoc supervisor) patrick@cs.mcgill.ca