

Abubakr Muhammad

Assistant Professor of Electrical Engineering
School of Science and Engineering, Lahore University of Management Sciences, Pakistan

Bio

- **Date of Birth:** December 19, 1976 **Nationality:** Pakistan **Marital Status:** Married
- **Current Address :** LUMS SSE, Sector U, DHA, Lahore Cantt 54792, Pakistan
- **Tel:** +92(42)572 2670 **Email:** abubakr@lums.edu.pk
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Research Interests

- **Disciplines:** applied mathematics; electrical engineering; computer science
- **Focus Areas:** networked networks; computational algebraic topology; quantum information sciences; robotics; systems & control; sensor networks

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 appointments

- **Assistant Professor of Electrical Engineering** *Dec 2008–present*
LUMS School of Science & Engineering, Pakistan
- **Postdoctoral Research Fellow** *Nov 2007–Nov 2008*
Quantum Information Processing Group *and*
Center for Intelligent Machines (CIM), McGill University, Canada
- **Postdoctoral Researcher** *Jan 2006–June 2007*
General Robotics, Sensing & Perception Lab (GRASP),
University of Pennsylvania, Philadelphia, PA, USA
- **Research Assistant** *Aug 2001–Dec 2005*
Center for Research in Embedded Systems (CREST),
Georgia Institute of Technology, Atlanta, GA, USA

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

Visiting Positions

- **Visiting Scientist in Physics** *July 2007–Oct 2007*
School of Science & Engineering, LUMS, Lahore, Pakistan
- **Visiting Researcher** *Dec 2005–Jan 2006*
School of Mathematical Sciences, GCU, Lahore, Pakistan
- **Visiting Researcher** *Dec 2004*
Department of Mathematics, Stanford University
- **Visiting Researcher** *June 2004*
Department of Mathematics, University of Illinois, Urbana-Champaign

Publications

Book

1. “Graphs, Simplicial Complexes and Beyond: Topological Tools for Multiagent Coordination,” VDM Verlag, Saarbrücken, Germany, 2008.

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, “Can you hear the shape of a network?,” preprint. (Submitted to *ACM Transactions on Sensor Networks*)
4. **Abubakr Muhammad** and Ali Jadbabaie, “From Consensus in Switching Graphs to Coverage in Switching Simplicial Complexes,” preprint. (To be submitted to *IEEE transactions on Robotics*)
5. Kamil Bradler, Niculus Dutil, Patrick Hayden and **Abubakr Muhammad**, “Conjugate Degradability and the Quantum Capacity of Cloning Channels.” preprint.

Book Chapters

1. **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, 2007.
2. **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 Computer Science (LNCS), 2007.
3. **Abubakr Muhammad**, Meng Ji and Magnus Egerstedt, “Applications of Connectivity Graph Processes in Networked Sensing and Control,” *Networked Embedded Sensing and Control*, Springer Lecture Notes in Control and Information Sciences (LNCIS), 2006.
4. **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.

Conference Papers

1. **Abubakr Muhammad**, “Sensor Selection and Motion Planning in Robotic Sensor Networks Under Communication Constraints”, Control and Decision Conference (CDC), 2008.
2. **Abubakr Muhammad** and Ali Jadbabaie, “Decentralized Computation of Homology Groups in Networks by Gossip”, American Control Conference, 2007.
3. **Abubakr Muhammad** and Magnus Egerstedt, “Control Using Higher Order Laplacians in Network Topologies,” Mathematical Theory of Networks and Systems, Kyoto, Japan, 2006.
4. **Abubakr Muhammad** and Magnus Egerstedt, “Network Configuration Control Via Connectivity Graph Processes,” American Control Conference, Minneapolis, 2006.
5. Meng Ji, **Abubakr Muhammad** and Magnus Egerstedt, “Leader-Based Multi-Agent Coordination: Controllability and Optimal Control,” American Control Conference, Minneapolis, 2006.
6. **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.
7. 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.
8. 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.
9. **Abubakr Muhammad** and Magnus Egerstedt, “Connectivity Graphs as Models of Local Interactions,” IEEE Conference on Decision and Control, Bahamas, December 2004.
10. **Abubakr Muhammad** and Magnus Egerstedt, “On The Structural Complexity Of Multi-Agent Robot Formations,” American Control Conference, Boston, Massachusetts, USA, July 2004.
11. **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.
12. 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.
13. 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.
14. **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)

- 7th McGill-INRIA Workshop on Computational geometry, Barbados Jan 2008
- 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

Teaching Experience

- Lecturer, COMP-208: *Computers for Engineering*, McGill University, Winter 2008
- Reading group coordinator, *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

Awards and Honors

- Sigma Xi Best PhD dissertation award from Georgia Tech for the year 2006
- 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.
- Member program committee : Second International Conference on Robot Communication and Coordination (Robocomm 2009), Odense, Denmark.
- Member, organizing committee, Eighth Canadian Summer School on Quantum Information, Montreal, 2008.
- Reviewer for IEEE Transactions on Automatic Control, IEEE transactions on Robotics, IEEE transactions on Information theory.
- Reviewer for various conferences and workshops (CDC, ACC, CAA, RSS, ICRA, SODA).
- Member IEEE since 1995.
- Member American Mathematical Society (AMS).
- Member Society for Industrial and Applied Mathematics (SIAM).

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

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
- Dr Vijay Kumar, Professor, Department of Mechanical Engineering, University of Pennsylvania, Philadelphia, PA kumar@me.upenn.edu
- Dr Gregory Dudek, Professor and Chair of Computer Science, McGill University, QC (Postdoc supervisor) dudek@cim.mcgill.ca