

Vinod K. Kulathumani

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Computer Science and Electrical Engineering
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Research Interests

- **Wireless sensor actuator networks:** reliable and energy efficient middleware services for cyber-physical systems, smart camera networks for biometrics and surveillance, ultra low power sensor platforms using analog signal processing
- **Networked and distributed systems:** scalable protocols for mobile systems and vehicular networks , self- stabilization and fault-tolerance
- **Applications:** Intelligent transportation systems, Networked biometrics, Object tracking

Education

- Ph.D., Computer Science and Engineering
The Ohio State University, June 2008
Dissertation: Network Abstractions for Designing Reliable Applications using Wireless Sensor Networks
Advisor: Dr. Anish Arora
Major: Networking
Minors: Distributed Computing, Random Signal Analysis, Software Systems
- M.S., Computer Science and Engineering
The Ohio State University, June 2001
Dissertation: Design and Performance Analysis of an MPEG-2 Transcoder
Advisors: Dr. Wu Chi Feng / Dr. Raj Jain
Major: Networking
- B.E., Computer Technology
University of Mumbai, India, June 1999
First Class with Hons.

Work Experience

- Associate Professor
West Virginia University (August 2008 - Present)
 - Research emphasis on *application-specific networking* techniques for cyber-physical systems where applications are designed hand-in-hand with network protocols for scalability and robustness. Applied this technique for monitoring and control applications of sensor networks resulting in several research grants and publications.
 - Collaborated with researchers in several other Engineering disciplines on inter-disciplinary research projects.
 - Designed network protocols for routing, state dissemination and counting in large scale mobile and vehicular networks and showed how they can be interfaced with control applications

- Designed collaborative algorithms and developed prototypes of smart camera networks for biometrics and activity recognition
 - Collaborated in the development of an ultra-low power sensing platform that uses *analog signal processing* to gain energy-efficiency
 - Authored several peer-reviewed conference and journal publications
 - Participated in 13 externally funded research projects where my shares is about \$1.5M from different agencies (DARPA, DoE NETL, ONR, ARL, NSF CITEr, Alpha Foundation Mine Safety)
 - Developed an inter-disciplinary course on sensor actuator networks that provides hands-on programming experience in embedded systems, sensors and smart-phones
 - Advised 10 MS students (completed), 3 PhD students (ongoing), 5 MS students (ongoing) and mentored 30 undergraduate students in senior design projects
 - Consistently rated excellent in student evaluations
 - Chair of undergraduate curriculum committee of CS degree
- Co-founder, Aspinity Inc. (June 2012 – present)
 - A start-up company focused on low power sensing platforms for embedded sensing applications based on reconfigurable analog signal processing.
- Graduate Research Associate
The Ohio State University (April 2002 - June 2008)
 - Explored research problems related to fault tolerant network services for designing control and monitoring applications using wireless sensor networks.
 - Developed middleware services and application subsystems for several large scale sensor network demonstrations such as ExScal, Line In The Sand, and Catch Me If You Can (a pursuer evader tracking game).
 - Designed a scalable and fault-tolerant tracking service Trail and a light weight querying service Glance for wireless sensors networks that do not rely on any underlying hierarchical network structure.
 - Developed key software services for Kansei, a wireless sensor network testbed and PeopleNet, a mobile sensing applications testbed at The Ohio State University.
- Research Intern
Los Alamos National Labs (March 2007 - June 2007)
 - Designed and implemented a vehicle classifier for facility monitoring using acoustic and seismic sensors.
- Network architect
Nayna Networks, Milpitas, Ca (July 2001 - Oct 2001)
 - Co-Designed survivable routing software architecture for all optical switches.
- Intern, Software design engineer for test
Microsoft, Redmond, Wa (June 2000 - Sep 2000)

- Designed software to test the home networking tools in the Windows operating system.
- Graduate Teaching Associate
The Ohio State University (Sep 1999 - June 2001, Jan 2002 - Mar 2002)
 - Taught and managed the courses Computer Assisted Problem Solving for Business and Introduction to Java Programming.
 - Graded the graduate level course Computability and Unsolvability.

Journal Publications

- G. Ranganath, V. Kulathumani, "FlocSpanner: An $O(1)$ time, self-stabilizing algorithm for spanner construction in wireless sensor networks", International Journal of Distributed Sensor Networks, 923751(14), February 2014
- R. Kavi and V. Kulathumani, "Real-time recognition of action sequences using a distributed video sensor network", Journal of Sensor and Actuator Networks, 2(3), 486—508, 2013
- V. Kulathumani and B. lemon, "Sufficiency of local feedback for sensor actuator network based control systems with distance-sensitivity properties", Journal of Sensor and Actuator Networks, 2(3), 409—423, 2013
- V. Kulathumani, A. Arora and S. Ramagiri, "Pursuit Control over Wireless Sensor Network using Distance Sensitivity Properties", IEEE Transactions on Automatic Control, Special Issue on Wireless Sensor Actuator Networks, 56(10), 2011
- B. Rumberg, D. Graham, V. Kulathumani, "Hibernets: Energy efficient sensor networks using analog signal processing", 1(3), 321—334, IEEE JETCAS, 2011
- V. Kulathumani and A. Arora and M. Demirbas and M. Sridharan, "Trail, A Distance Sensitive Network Service for Distributed object tracking", ACM Transactions on Sensor Networks, 5(2), pp.1-40, 2009
- M. Demirbas, A. Arora and V. Kulathumani, "Glance: A Lightweight Querying Service for Wireless Sensor Networks", Elsevier Journal on Theoretical Computer Science, Elsevier, 410, pp. 500-513, 2009
- M. Demirbas, A. Arora, V. Mittal, and V. Kulathumani, "A Fault Local Self-Stabilizing Clustering Service for Wireless Adhoc Networks", IEEE Transactions on Parallel and Distributed Systems, Vol. 17, No. 9, pp. 912 - 922, 2006
- Arora, P. Dutta, S. Bapat, V. Kulathumani, H. Zhang, V. Naik, V.Mittal, H. Cao, M. Gouda, Y. Choi, T. Herman, S. Kulkarni, U. Arumugam, M. Nesterenko, A. Vora and M. Miyashita, "A Line in the Sand: A Wireless Sensor Network for Target Detection, Classification and Tracking", Computer Networks Special edition, Vol. 46, No. 5, pp. 605-634, 2004
- V. Kulathumani, N. Chandhok, A. Duresi, R. Jain, R. Jagannathan, and S. Seetharaman, "Survivability in IP over WDM Networks", Journal of High Speed Networks, Vol. 10, No. 2, pp. 79-90, 2001

Refereed, Peer-reviewed Conference and Workshop Publications

- B. Rumberg, D. Graham, S. Clites, B. Kelly, M. Navidi, A. Dilello, and V. Kulathumani, "RAMP: Accelerating wireless sensor design with a reconfigurable analog/mixed-signal platform," in Proceedings of the ACM/IEEE Conference on Information Processing in Sensor Networks, Seattle, WA, April 2015, pp. 47 - 58.
- B. Rumberg, D. Graham, S. Clites, B. Kelly, M. Navidi, A. Dilello, and V. Kulathumani, "Demonstration Abstract: RAMP: Accelerating wireless sensor design with a reconfigurable analog/mixed-signal platform," in Proceedings of the ACM/IEEE Conference on Information Processing in Sensor Networks, Seattle, WA, April 2015.
- K. Parker, A. Arora, P. R. Kumar, V. Kulathumani, M. Sridharan, "Application Specific networking Patterns (ASNPs): an alternate problem formulation for MANETs", DARPA Far-Out Networking Symposium, August 2013.
- B. Rumberg, B. Kelly, D. Graham, and V. Kulathumani, "Demo Abstract: Netamorph: Field-programmable analog arrays for energy-efficient sensor networks," in Proceedings of the ACM/IEEE Conference on Information Processing in Sensor Networks, Philadelphia, PA, April 2013, pp. 309-310
- B. Kelly, B. Rumberg, D. Graham, V. Kulathumani, "Reconfigurable analog signal processing for wireless sensor networks," Proceedings of the IEEE Midwest Symposium on Circuits and Systems, Columbus, OH, August 2013
- V. Kulathumani, Y. Fallah, "An infrastructure-less vehicular traffic information service with distance sensitive precision", IEEE Vehicular Technology Conference (VTC), 2012
- B. Rumberg, D. Graham, V. Kulathumani, "A low-power programmable analog event detector for resource constrained sensing systems", International Midwest Symposium on Circuits and Systems, 2012
- F. Nicolo, S. Parupati, V. Kulathumani, N. Schmid, "Near real-time face detection and recognition using a wireless camera network", SPIE symposium on defense, security and sensing, 2012
- B. Lemon, v. Kulathumani, "Local reconfiguration algorithms for simultaneous coverage and tracking using large scale camera networks", IEEE Conference on Homeland Security and Technologies, 2011
- S. Parupati, R. Bakkannagiri, S. Sankar and V. Kulathumani, "Collaborative acquisition of multi-view face images for real-time face recognition using a wireless camera network", ICDSC 2011
- S. Ramagiri, R. Kavi and V. Kulathumani, "Real-time multi-view action recognition using a wireless camera network", ICDSC 2011
- M. Fanaei, M.C. Valenti, N. Schmid and V. Kulathumani, "Channel-aware distributed classification using binary local decisions," in Proc. SPIE Signal Processing, Sensor Fusion, and Target Recognition XX, 2011.
- B. Rumberg, D. Graham, V. Kulathumani, "Hibernets: Energy-efficient sensor networks using analog signal processing", ACM International Conference on Information Processing in Sensor Networks, (IPSN 2010), Stockholm, Sweden
- J. Frigo, E. Rosten, E. Raby, S. Brennan, V. Kulathumani, C. Wolinski, "Energy-efficient sensor node implementations", ACM International Conference on Field Programmable Gate Arrays, FPGA 2010, Monterey Ca, USA

- J. Frigo, V. Kulathumani, S. Brennan, E. Rosten, E. Raby, "Sensor Network Based Vehicle Classification and License Plate Identification System", International Conference on Networked Sensing Systems (INSS), Pittsburgh, 2009
- J. Frigo, V. Kulathumani, S. Brennan, E. Rosten, E. Esch, D. Jackson, P. Majerus, A. Warniment, A. Mielke, and M. Cia. "Radiation detection and situation management by distributed sensor networks", In SPIE Proceedings on Defense, Security and Sensing, 2009
- V. Kulathumani and A. Arora, "Aspects of Distance Sensitive Design of Wireless Sensor Networks", Spatial Computing Workshop, 2008
- V. Kulathumani and M. Sridharan and R. Ramnath and A. Arora, "Weave: An Architecture for Tailoring Urban Sensing Applications across Multiple Sensor Fabrics", MODUS, International Workshop on Mobile Devices and Urban Sensing, 2008
- V. Kulathumani and A. Arora, "Distance Sensitive Snapshots in Wireless Sensor Networks", International Conference on Principles of Distributed Systems (OPODIS), 2007.
- V. Kulathumani, M. Demirbas, A. Arora, and M. Sridharan, "Trail: A Distance Sensitive Network Service for Distributed Object Tracking", European Conference on Wireless Sensor Networks (EWSN), 2007 (Acceptance rate = 13%)
- M. Demirbas, A. Arora and V. Kulathumani, "Glance: A Lightweight Querying Service for Wireless Sensor Networks", International Conference on Principles of Distributed Systems (OPODIS), 2006 (Acceptance rate = 13%)
- H. Cao, E. Ertin, V. Kulathumani, M. Sridharan and A. Arora, "Differential Games in Large Scale Sensor Actuator Networks", International Conference on Information Processing in Sensor Networks, IPSN, 2006
- E. Ertin, A. Arora, R. Ramnath, M. Nestkerenko, S. Bapat, V. Naik, V. Kulathumani, M. Sridharan, H. Zhang, H. Cao, "Kansei: A Testbed for Sensing at Scale", International Conference on Information Processing in Sensor Networks, Special Track on Platform Tools and Design Methods for Network Embedded Sensors (IPSN/SPOTS), 2006
- V. Kulathumani, P. Shankar, Y. M. Kim, A. Arora, and R. Yedavalli, "Reliable Control System Design Despite Byzantine Actuators", Fifth International Conference on Multibody Systems, Nonlinear Dynamics and Controls (MSNDC), 2005
- S. Bapat, V. Kulathumani, and A. Arora, "Analyzing the Yield of ExScal, a Large Scale Wireless Sensor Network Experiment", International Conference on Networking Protocols (ICNP), 2005
- S. Bapat, V. Kulathumani, and A. Arora, "Reliable Estimation of Influence Fields for classification and Tracking in Unreliable Sensor Networks", IEEE Symposium on Reliable Distributed Systems (SRDS), 2005
- Y. M. Kim, A. Arora, and V. Kulathumani, "On the Effect of Faults in Vibration Control of Fairing Structures", Fifth International Conference on Multibody Systems, Nonlinear Dynamics and Controls (MSNDC), 2005
- Arora, E. Ertin, R. Ramnath, P. Sinha, S. Bapat, V. Naik, V. Kulathumani et al., "ExScal: Elements of an Extreme Scale Wireless Sensor Network", 11th IEEE International Conference on Embedded and Real time Computing Systems and Applications, (RTCSA), 2005

- M. Demirbas, A. Arora, V. Mittal, and V. Kulathumani, "A Fault-Local Self-Stabilizing Clustering Service for Wireless Ad Hoc Networks", IEEE Transactions on Parallel and Distributed Systems, 2005
- Duresi, R. Jain, N. Chandhok, R. Jagannathan, S. Seetharaman, and V. Kulathumani, "IP over WDM Networks", Proceedings of IEEE Global Telecommunications Conference, (Globecom), Volume 4, pp. 2144-2149, 2001

Book Chapters

- K. Parker, M. Sridharan, A. Arora, V. Kulathumani, J. Brown, R. Correa, et. al., "Scaling Mobile Ad Hoc Networks: Alternate Semantics for Local Routing Combined with Leveraging Small Amounts of Global Capacity", Free eBook/Technical report, August 2013. <https://samraksh.com/learning/far-out-networking>
- V. Kulathumani, S. Parupati, A. Ross, R. Jillela, "Collaborative face recognition using a network of embedded cameras", Distributed Video Sensor Networks, Springer-verlag, 2011

Other Publications

- V. Kulathumani, "Network Abstractions for Designing Reliable Applications Using Wireless Sensor Networks", Ph.D. thesis, The Ohio State University, June 2008
- V. Kulathumani, "Implementation and Performance Analysis of MPEG-2 Transcoder", Masters thesis, The Ohio State University, June 2001
- V. Kulathumani and A. Arora and M. Demirbas, "Trail, A Distance Sensitive Network Service for Distributed object tracking", Technical report, The Ohio State University, OSU-CISRC-7/06-TR67
- V. Kulathumani, "Voice over IP: Products, Services and Issues", a Survey report, The Ohio State University, Jan 2000 (http://www.rajjain.com/cis788-99/voip_products/index.html)
- S. Seetharaman, A. Duresi, R. Jagannathan, R. Jain, N. Chandhok, and V. Kulathumani, "IP over Optical Networks: A Summary of Issues", IETF Draft, draft-osu-ipo-mpls-issues-02.txt, April 2001

Posters

- M. Sridharan, E. Ertin, V. Kulathumani and A. Arora, "Robust Routing and Tracking in Constrained Mobility Scenarios", ACM Sensys, Demonstration and poster, 2006
- M. Sridharan, V. Kulathumani and A. Arora, "Locality Specific and Mobility Centric Sensor Network Applications", ACM Sensys, Demonstration and Poster, 2006
- Arora, R. Ramnath, E. Ertin, P. Sinha, S. Bapat, V. Naik, V. Kulathumani et al., "Project ExScal", Int'l Conference on Distributed Computing in Sensor Systems (DCOSS), 2005

Invited Talks

- Distributed computing principles for design of robust cyber-physical systems, Seminar presented to the IEEE ACM student chapter, West Virginia University, October 2011

- Scalable and reliable wireless sensor network systems, Graduate seminar series EE/CS 796, West Virginia University, August 2008
- Wireless sensor networks – overview and some projects, Senior design class, West Virginia University, September 2008
- Vehicular Classification using Sensor Networks, Seminar series, Los Alamos National Labs, June 2007
- Extreme Scale Sensor Networks, Seminar series, Los Alamos National Labs, May 2007

Grants

- V. Kulathumani, “Framework for ASNPs in an open systems context”, The Samraksh Company (DARPA subcontract for Fixed wireless at a Distance project), Oct 2014 - Mar 2017, Total award: \$282,607
- V. Kecojevic, v. Kulathumani, B. Cukic, A. Nimbarte, “Integrated surface mining safety system”, The Alpha Foundation for Improvement of Mine safety and Health, Jan 1 2014 – Dec 31 2015, Total award: \$743,911 (Kulathumani: \$260,000)
- E. Sabolsky, D. Bhattacharya, V. Kulathumani, D. Graham, “Smart Refractory Sensor Systems for Wireless Monitoring of Temperature, Health, and Degradation of Slagging Gasifiers”, DOE NETL Crosscutting Research on Development of Novel Architecture for Optimization of Advanced Energy Systems, Oct 1 2013 – Sep 30 2016, Total award: \$1,300,000 (Kulathumani: \$300,000)
- V. Kulathumani, “Scalable networking abstractions for infrastructure augmented mobile ad-hoc networks”, The Samraksh Company (DARPA subcontract for Fixed wireless at a Distance project), July 2013 - June 2014, Total award: \$68,982
- V. Kulathumani, “Integrated simulation framework using ns-3 for evaluation of wireless network based multi-agent applications”, NASA Space Grant Consortium, May 2013-April 2014, Total award: \$10,000
- V. Kulathumani, Scaling of dynamic peer-to-peer mobile networks through application specific networking patterns, The Samraksh Company (DARPA Phase I subcontract), Sep 2012 - May 2013, Total award: \$29,161
- N. Schmidt, V. Kulathumani, X. Li, M. Valenti, B. Woerner, Intelligent surveillance systems using smart camera networks, DoD EPSCOR, Jan 2010 - Dec 2012, Total award \$986,248 (Kulathumani: \$197,000)
- B. Cukic, L. Hornak, A. Ross, D. Adjero, V. Kulathumani, WVU Partner Proposal: DHS Center of Excellence in Border Security and Immigration, June 2010-June 2013, Total award \$125,173 (Kulathumani: 20%)
- M. Gautam, B. Woerner, D. Carder, E. Sobolsky, N. Schmid, V. Kulathumani, D. Graham, M. Valenti, X. Li, D. Reynolds, “Advanced communications for wireless sensor networks”, Army Research Labs, Sep 2010 – Dec 2012, Total award: \$2,720,000 (Kulathumani: \$302,222)
- B. Cukic, L. Williams, A. Ross, M. Culp, J. Dawson, D. Adjero, G. Doretto, V. Kulathumani, “CITeR Co-Design initiative”, July 2010 – December 2012, Total award: \$3,000,000 (Kulathumani: \$83,454)

- D. Graham and V. Kulathumani, Energy-Efficient Acoustic Sensing Systems, West Virginia University Research Corporation, Jan 2010 - March 2011, Total award \$21,500
- V. Kulathumani and A. Ross, Collaborative acquisition of face images using a wireless sensor network, NSF Center for identification Technology research (CITeR), Jan 2009 - Dec 2009, Total award \$50000 (Kulathumani: \$35000)
- B. Cukic, L. Hornak, A. Ross, D. Adjero, V. Kulathumani, WVU Partner Proposal: DHS Center of Excellence in Border Security and Immigration, Jan 2009 - Dec 2009, Total award \$137000 (Kulathumani: \$10000)

Teaching, advising and outreach

- Developed a new course on wireless sensor actuator networks
 - Students learn elements of distributed computing and apply it in context of large scale networked applications
 - **Hands-on programming** on sensor mote platforms, smart phones and using ns-3 network simulator
 - Class projects have led to **inter-disciplinary research projects** and journal publications
- **Introduced hands-on WVU network tour, router configuration** and wire-shark lab assignments in introductory course on networking
- Consistently **large enrollment and high SEI scores** in all courses taught (>4.25)
- Advising record
 - 9 M.S. students graduated with thesis
 - 2 M.S. student graduated with problem report
 - 4 ongoing PhD students and 1 ongoing MS Thesis students
 - 12 MS students completed with coursework
 - Committee member for 8 MS and 3 PhD students graduated
 - Mentored 5 undergraduate senior design projects (about 30 students)
- Developed programs on mote platforms (TelosB, Micaz) and used them as hands-on, interactive tools to highlight problems of distributed computing (synchronization, consensus, scheduling) in an intuitive manner during **outreach and recruiting programs**
 - Demonstrated during **high school visitations by students in PULSAR search** collaboration with the National radio Astronomy Observatory
 - Demonstrated during **summer camp program for female high school students** organized by the College of Engineering and Mineral Resource's *Engineers of Tomorrow: Transition to Engineering* program that focuses on attracting and retaining female and minority Appalachian high school students to STEM career
- **Chair of CS undergraduate curriculum committee**
 - Led the unification of ECAS and ENG tracks for Computer Science degree, and the formation of a new degree requirements with several concentration areas

Honors and Awards

- Outstanding New Researcher of the Year (2009-2010), College of Engineering and Mineral Resources, West Virginia University

- Student Travel Grant, International Conference on Networking Protocols (ICNP 2005)
- First Runners up in the Business Plan Competition for the Business Concept Oconnect, a solution based on intelligent, all optical switches Fisher School of Business, The Ohio State University, June 2001
- Graduate Teaching Assistantship, The Ohio State University, (1999-2001)
- Seventh in the State Merit List, Higher Secondary Examinations, Mumbai, India (June 1995)

Professional Activities

- Referee for ICDSC 2012, ICDSC 2013, ICDSC 2014, Sensors (2014), IEEE Transactions on Vehicular Technology (TVT), ACM Sensys 2003, ACM Sensys 2005, ACM Sensys 2010, Transactions on computers (2010), MILCOM (2010), ACM Principles of Distributed Computing (PODC) 2007, ACM Transactions on Autonomous and Adaptive Systems (ACM TAAS), ICC 2009, IPSN 2008, OPODIS, High Assurance Systems Engineering (HASE 2005), RTSS, SSS, DCOSS 2007, IPSN 2009, IPSN 2010, SAC 2010, Euro-Par 2011, Euro-Par 2012, Euro-Par 2013, Elsevier Neural networks Journal, InderScience Journal, Journal on Sensors, Information Processing Letters, Elsevier Adhoc networks Journal, Journal of Computer communications
- Reviewer for DoE proposals on Cyber-security for Energy Distribution Systems (CEDs 2010 and CEDs 2013)
- Program committee member: ACM SAC 2010, ACM SAC 2009, SSS 2012, ICDSC 2012, ICDSC 2013
- Program Co-chair: IEEE WETICE 2009, IEEE WETICE 2010
- Departmental committees
 - Chair, CS Under Graduate Curriculum Committee [Sept 2010 – present]
 - Faculty Search Committee [Sept 2010 – present]
 - CEMR library committee [Aug 2008 – present]
 - LCSEE Computer systems area committee [Aug 2008 – present]
 - LCSEE P&T committee [Aug 2009 – Aug 2011]
- Served as student representative in the computer committee in the CSE department (Sep 2003 - June 2004)
- Student volunteer, ICDCS 2005
- Served on Council of Graduate Students Committee (Sep 2002 - June 2003)

Technical Skills

- Experience in systems development
 - Designed and implemented middleware services and applications for wireless sensor networks using mote platforms (MICA, MICA2, XSM, TELOS), stargates, IEEE 802.11b radios, Chipcon radios, TinyOS, nesC and Emstar
 - Developed prototype wireless smart camera surveillance systems for biometrics and activity recognition; utilized Microsoft Kinect sensor for human anthropometric data acquisition in real-time

- Developed hands-on demonstration prototypes of sensor actuator network systems using embedded robot platforms (Garcia, Create iRobot) and Android based smart phones.
- Developed networking software using TCP and UDP sockets, HTTP
- Developed control application simulations using MATLAB
- Research Tools
 - Formal Methods: I/O Automata, Guarded Commands
 - Others: ns-3 network simulator, TOSSIM, Prowler, MATLAB, LATEX, CVS, Git
- Networking standards and protocols
 - Wireless networks: IEEE 802.15.4, IEEE 802.11 AODV, DSR etc.
 - Others: TCP, UDP, OSPF, BGP, WDM, VOIP etc.
- Programming Languages: C, nesC, C++, Java, MPI, Pascal
- Operating systems: TinyOS, Linux, Android, UNIX, Windows

Personal Data

- Born on November 7, 1977
- Citizen of USA