

EDUCATION

- **University of Southern California** Los Angeles, CA, USA
PhD in Electrical Engineering (Concentration: Computer Engineering); GPA: 3.97 Aug. 2012 – Aug. 2018
- **Jadavpur University** Kolkata, India
Bachelor of Electronics and Tele-Communication Engineering; GPA: 3.7 (9.25/ 10) Aug. 2008 – May. 2012

ACADEMIC AREAS OF INTEREST

Internet of Things, Wireless Robotic Networks, Edge Computing, Software Defined Network, Wireless Sensor Networks, Ad-Hoc Networks, Wireless Communication, Coordinated Robotics, Cloud Computing, Artificial Intelligence, Evolutionary Computation

ACADEMIC / PROFESSIONAL EXPERIENCE

- **University of Southern California** Los Angeles, CA
Post Doctoral Research Scholar Aug 2018 - Present
- **University of Southern California** Los Angeles, CA
Research Assistant Aug 2012 - Aug 2018
 - ◇ **Wireless Robotic IoT Systems:** This umbrella projects includes many sub-projects as follows.
 - * **Survey of Networking Issues and Potential areas of Research in a Wireless Network of Mobile Robots [7]**
 - * **ARREST–A RSSI Based Approach for Relative Positioning and Tracking of a Moving Object [4, 21, 26]:** Developed a new robotic sensing system for tracking/following a moving, RF-emitting object (Leader) solely based on signal strength information. The tracking robot (TrackBot) uses a single rotating, off-the-shelf, directional antenna, *novel angle and relative speed estimation algorithms*, and Kalman filtering. A full-fledged prototype system is built for extensive real-world evaluation and to demonstrate the performance.
 - * **IRIS–A Robotic Wireless Networking Testbed:** Designed the architecture of the Intelligent Robotic IoT System (IRIS) testbed which is envisioned as an in-house, cutting-edge, open source testbed for robotic network related experimentation. Co-lead a team of six researchers to build the current version of the testbed that consists of 7 mobile easily configurable Pololu 3pi robotic nodes with IEEE 802.15.4 connectivity via an onboard OpenMote and Mbed LPC1768 devices.
 - * **ROMANO–Overlay Lightweight Communication Protocol for Unified Control and Sensing of a Network of Robots [2]:** Developed and implemented (on the IRIS testbed) the ROMANO protocol, an end-to-end overlay communication protocol for a simple unified abstraction of real-time data sharing and robotic control in a network of robots. This is a lightweight, application layer publish-subscribe protocol that is an alternative to the XML-RPC based bandwidth-heavy communication in Robot Operating System (ROS).
 - * **Robotic Router Placement Optimization Based on Practical Communication Model Including Interference [8,10]:** Theoretically modeled and simulated an optimized robotic router placement algorithm that incorporates the effect of RF interference. Moreover, modeled certain theoretical performance bounds of such systems such as interference power bound.
 - * **A Robust and Communication Efficient Computation Offloading Framework:** Contributed to the design and development of Mercury, an open-source flexible and modular sensing, communication, processing, and control pipeline where the modules can be dynamically adapted and distributed across IoT devices and resource. This system is implemented and tested for image recognition based tracking control of a Software Defined Radio (SDR) equipped drone and SDR equipped ground station.
 - ◇ **Dispersed Mobile Computing for Edge Devices [1, 3, 6]:** This project is on the cutting edge field of *Dispersed Computing* and focused on leveraging all the available computation resources in the communication path from an end device to a cloud (including processing capable routers) for timely and optimized processing of the data by jointly optimizing the computation costs and the communication overhead costs. A key challenge of this project is the implementation of a Python-based dispersed computing system that would real-time monitor the network traffic and available computation capable node resources to optimally distribute the execution of a networked set of tasks which can be represented as a Directed Acyclic Graph (DAG) task graph. My main contributions to this project involve but not limited to:

- * Design and development of a 50 node Raspberry PI 3 cluster with Kubernetes (a docker orchestration tool) support.
- * Implementation of a Kubernetes cluster of 100 carefully chosen geographically distributed cloud Virtual Machines from Digital Ocean.
- * Development of the Jupiter Orchestrator which is a Kubernetes based open-source customized docker orchestration tool for Dispersed Computing. The Jupiter tool consists of three main components of Dispersed Computing i.e, Profilers (Network and Resource), Scheduler of DAG-based tasks, and CIRCE – dispatcher of the tasks according to the scheduler outputs and handler of the inter-task communication.
- ◇ **Efficient Low Power Routing for the Internet of Things:** This project includes three sub-projects.
 - * **Heat Diffusion Collection Protocol Implementation for Energy Efficient Data Collection in any IoT Network [22]:** Developed and implemented a practical version of a theoretical Back-pressure routing algorithm called the Heat Diffusion (HD) algorithm in the Contiki OS. We refer to this algorithm as the Heat Diffusion Collection Protocol (HDCP). I analyzed its performance for a varying set of network conditions in static settings in a 100 node testbed called the Tutornet.
 - * **Distributed Hole Detection Methods in IoT and WSN[12, 13]:** Developed distributed techniques for hole detection in a WSN that are based on popular computation geometry tools such as Delaunay triangulation of the underlying communication graph and a graph's Gaussian curvature.
 - * **IoTSC Testbed:** I am also a key member of a campus-wide IoT testbed deployment initiative by the USC Autonomous Networks Research Group (ANRG) and the USC Viterbi Center for CPS and IoT (CCI). The testbed, currently referred to as IoTSC, aims to deploy 50 Raspberry Pi-based IoT boxes across the USC Park Campus for IoT related experimentation purposes. Each box is equipped with a range of sensors, such as temperature, gas, and humidity sensors, and at least three different communication stacks (Bluetooth, WiFi, and 802.15.4). Many of the nodes are also equipped with SDRs (USRP b200 mini and HackRF) and LoRa radios.

- **University of Southern California**

Los Angeles, CA

Teaching Assistant

Aug 2014 - May 2018

- ◇ **Introduction to Embedded Systems:** Spring 2017, Fall 2017
- ◇ **Wireless and Mobile Networks Design and Laboratory:** Spring 2016
- ◇ **Computer Networks:** Fall 2014, Spring 2015, Fall 2015

- **Ming Hsieh Institute**

Los Angeles, CA

Ming Hsieh Institute Scholar

Aug 2016 - Aug 2017

- ◇ **MHI Research Festival 2016:** Was part of the organizing committee of the annual research festival hosted by the Ming Hsieh Institute.
- ◇ **SHOT2:** Taken a key role in the organization of a semester-long educational seminar series called Seminars + Hackathons On Theory and Technology (*SHOT*²). The *SHOT*² program was an academic moonshot that was intended to provide participants with TED-talk-styled fundamental instruction from top experts as well as hands-on training in three of the hottest fields: Artificial Intelligence, Quantum Mechanics, and Mixed Reality. This program had around 300 participants registered with an average attendance of 60 per seminar.

- **Cisco Systems**

San Jose, CA

Summer Intern

Jun 2015 - Aug 2015

- ◇ **Openstack:** Collaborated with the lead system architect and other engineers to
 - * Integrate bare-metal servers with OpenStack for CISCO programmable fabric. This involved the design of a new system architecture for seamless deployment of bare-metals side-by-side with the Virtual Machines. This system was converted into a product later on.
 - * Participate in the discussions of the Openstack open-source community and their chat rooms to determine the right course of actions.

- **University of Southern California**

Los Angeles, CA

USC Doctoral Student Summer Institute

May 2014 - August 2014

- ◇ **Grant Proposal Writing and Publication Workshop:** Participated in a 10 weeks long event on proposal writing for NSF and other funding agencies. This involved sample proposal writing as well as peer reviewing experience.

- **General Motors Research & Development**

Warren, MI

Summer Research Intern

May 2013 - July 2013

- ◇ **Cloud Computing and Application Offloading for Vehicular Networks:** Collaborated with the lead research scientist and other engineers to
 - * Investigate the opportunities and applicability of cloud computing and application offloading in a vehicular network.
 - * Develop a simple system to demonstrate a proof of concept application of computation offloading in vehicular networks.
 - * Investigate and determine the future course of actions for enabling computation offloading capabilities on GM cars.

● **Jadavpur University**

Kolkata, India

Undergraduate Student Researcher, Advanced Digital and Embedded Systems Laboratory

Aug 2010 - Aug 2012

- ◇ **Wireless Sensor Networks [18-20, 24]:** Contributed to the field of Wireless Sensor Network by developing
 - * Handoff Reduction Algorithms in WLAN, Mobile Communication Systems and Low Earth Orbit Satellites
 - * Clustering Methods in Wireless Sensor Network by Proper Utilization of the Available Energy and Predefined Parameters and Hybridization of Various Clustering Algorithms in Wireless Sensor Networks to Develop a New Improved Algorithm

● **Jadavpur University**

Kolkata, India

Undergraduate Student Researcher, Digital Control and Image Processing Laboratory

Sep 2009 - Aug 2012

- ◇ **Optimizations and Evolutionary Algorithms [14-17, 23, 25]:** Developed a set of optimization tools to contribute the field of evolutionary algorithms such as Genetic Algorithm (GE) and Particle Swarm Optimization (PSO) and applied them toward solving complex real world problems. This project involved
 - * Hybridization of Various Unimodal & Multi-modal Optimization Algorithms to Develop New Improved Algorithms
 - * Study of Various Evolutionary Algorithms in Optimizing Antenna Structures and Antenna Array Design Using Optimization Algorithms Like DE and PSO

● **Indian Institute of Science**

Bengaluru, India

Summer Internship (Undergraduate)

May 2011 - July 2011

- ◇ **Applications of Differential Evolution in solving complex decision making problems:** Developed a differential evolution algorithm based solution for timely deployment of decoys and countermeasures from a ship to avoid an incoming projectile missile. This work consists of MATLAB simulation based experiments.

● **IIT Kharagpur**

Kharagpur, India

Summer Internship (Undergraduate)

May 2010 - June 2010

- ◇ **Standardization of Process Parameters in Withering, Maceration, Rolling, Fermentation and Drying of Tea (SOP):** Studied the applications of wireless sensor network in the processing of Tea. This work includes implementation of some popular networking protocols for simulation experiments.

EXTRACURRICULAR EXPERIENCES

- **PC Member-WiSARN 2018:** Currently serving as a Program Committee member for the 11th International Workshop on Wireless Sensor, Robot and UAV Networks (WiSARN 2018), IEEE INFOCOM 2018 Workshops.
- **Mentor for Directed Research Students and Interns:** Mentored *fifteen* students including *seven* undergraduate students. Four of my mentees have co-authored in a couple of my publications. One of my undergraduate mentees has received the *best undergraduate poster* recognition at the Ming Hsieh Institute Research Festival 2017.
- **Leadership Activities:** I am one of the administrators and lead engineers of the Intelligent Robotic IoT System (IRIS) testbed which is envisioned as an in-house, cutting-edge, open source testbed for robotic network related experimentation. I am also the president of a non-academic cultural student organization at USC called “Balaka: Bengali Association of USC”. I am also the secretary of another education promoting club called “Wireless Networking Club”.
- **Organizational Activities:** I have taken a key role in the organization of many events at USC including a semester-long educational seminar series called Seminars + Hackathons On Theory and Technology (*SHOT²*). The *SHOT²* program was an academic moonshot that was intended to provide participants with TED-talk-styled fundamental instruction from top experts as well as hands-on training in three of the hottest fields: Artificial Intelligence, Quantum Mechanics, and Mixed Reality. This program had around 300 participants registered with an average attendance of 60 per seminar.
- **Review Experiences:** Served as a reviewer for many the peer-reviewed conference and journals such as IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), IEEE GLOBECOM, and IEEE Transactions on Mobile Computing.
- **Shadow PC Member (IPSN 2016):** Served as a shadow PC member in the 5th International Conference on Information Processing in Sensor Networks (IPSN 2016)

TECHNICAL SKILLS

Programming, Embedded System Design, Algorithm Design, Communication Stack Programming, Hardware Design, Wireless Networking.

Language: C, C++, Python; **Version Control Systems:** GIT, SVN; **Application Software:** MATLAB, Contiki OS, Cooja Network Simulator, RIOT OS, MBED OS, ROS, OPNET, Wireshark, Circuit Maker Professional Edition; GNU Radio; **Hardware:** Tmote sky, Openmote, Android, ARM Mbed, USRP, Polulu 3pi, Arduino, Raspberry Pi 3

FELLOWSHIP AND AWARDS

Best PhD Student Pitch Award at MHI Research Festival	2017
Ming Hsieh Institute Scholar	2016 - 2017
NSF and SigMobile Student Travel Grant for Mobicom 2017	2017
NSF Student Travel Grant for IEEE SEC 2017	2017
USC Provost's Ph.D. Fellowship	2012 - 2016
USC Graduate School Ph.D. Fellowships Travel Award	Fall 2014
IEEE MASS 2014 Travel Grant	Oct 2014
USC Summer Institute Grant	Summer 2014
UGC Infrastructure Grant for Undergraduate Research	2011 - 2012

SELECTED ACADEMIC PUBLICATION

Book Chapters & Conference Papers:

1. Jason A Tran, **Pradipta Ghosh**, Yutong Gu, Richard Kim, Daniel DSouza, Nora Ayanian, Bhaskar Krishnamachari, "*Intelligent Robotic IoT System (IRIS) Testbed*," in **IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2018)**.
2. Pranav Sakulkar, **Pradipta Ghosh**, Aleksandra Knezevic, Jiatong Wang, Quynh Nguyen, Jason Tran, H.V. Krishna Giri Narra, Zhifeng Lin, Songze Li, Ming Yu, Bhaskar Krishnamachari, Salman Avestimehr, and Murali Annavaram, "*WAVE: A Distributed Scheduling Framework for Dispersed Computing*," USC ANRG Technical Report, ANRG-2018-01.
3. **Pradipta Ghosh**, Jason A Tran, Daniel Dsouza, Nora Ayanian, and Bhaskar Krishnamachari, "*ROMANO: A Novel Overlay Lightweight Communication Protocol for Unified Control and Sensing of a Network of Robots*," in **arXiv preprint arXiv:1709.07555**
4. Quynh Nguyen, **Pradipta Ghosh**, and Bhaskar Krishnamachari, "*End-to-End Network Performance Monitoring for Dispersed Computing*," in **International Conference on Computing, Networking and Communications (ICNC 2018)**
5. **Pradipta Ghosh**, Jason A Tran, and Bhaskar Krishnamachari, "*ARREST: A RSSI Based Approach for Mobile Sensing and Tracking of a Moving Object*," in **8th International Workshop on Wireless Networking and Control for Unmanned Autonomous Vehicles (WiUAV), GLOBECOM, 2017**
6. **Pradipta Ghosh**, Jenny Xie, and Bhaskar Krishnamachari, "*miniRadar: A Low Power IEEE 802.15.4 Transceiver Based Implementation of Bistatic Radar*," in **4th ACM Workshop on Hot Topics in Wireless (HotWireless'17), MobiCom, 2017**
7. Aleksandra Knezevic, Quynh Nguyen, Jason A. Tran, **Pradipta Ghosh**, Pranav Sakulkar, Bhaskar Krishnamachari, and Murali Annavaram, "*DEMO: CIRCE - A runtime scheduler for DAG-based dispersed computing*," in the **Second ACM/IEEE Symposium on Edge Computing (SEC), 2017**
8. **Pradipta Ghosh**, Andrea Gasparri, Jiong Jin, and Bhaskar Krishnamachari, "*Robotic Wireless Sensor Networks*," Book Chapter, in **The Philosophy of Mission-Oriented Wireless Sensor Networks**, Springer (To Appear)

9. **Pradipta Ghosh** and Bhaskar Krishnamachari, “*Interference Power Bound Analysis of a Network of Wireless Robots*,” in **Communication Systems and Networks**, LNCS 10340, 7 - 23, 2017 (Invited Paper)
10. **Pradipta Ghosh** Nachikethas A. Jagadeesan, Pranav Sakulkar, and Bhaskar Krishnamachari, “*LOCO: A Location Based Communication Scheme*,” in **Workshop on New Wireless Communication Paradigms for the Internet of Things (MadCom), International Conference on Embedded Wireless Systems and Networks (EWSN)**, 2017
11. **Pradipta Ghosh**, Raktim Pal and Bhaskar Krishnamachari, “*Towards Controllability of Wireless Network Quality using Mobile Robotic Routers*,” in **arXiv preprint arXiv:1607.07848 [cs.RO]**
12. Pedro Henrique Gomes, Thomas Watteyne, **Pradipta Ghosh** and Bhaskar Krishnamachari, “*Competition: Reliability through Timeslotted Channel Hopping and Flooding-based Routing*,” in **Proceedings of the International Conference on Embedded Wireless Systems and Networks (EWSN 2016)**, February 15-17, Graz, Austria
13. **Pradipta Ghosh**, Jie Gao, Andrea Gasparri and Bhaskar Krishnamachari, “*Distributed Hole Detection Algorithms for Wireless Sensor Networks*,” in **IEEE International Conference on Mobile Ad hoc and Sensor Systems (MASS 2014)**, October 27-30, Philadelphia, Pennsylvania, USA.
14. **Pradipta Ghosh**, Jie Gao, Andrea Gasparri and Bhaskar Krishnamachari, “*RiverSwarm: Topology-Aware Distributed Planning for Obstacle Encirclement in Connected Robotic Swarms*,” in **First Workshop on Robotic Sensor Networks 2014 (RSN2014)**, April 14, Berlin, Germany.
15. **Pradipta Ghosh**, Hamim Zafar and Ankush Mandal, “*Modified Local Neighborhood Based Niching Particle Swarm Optimization for Multimodal Function Optimization*,” in **Proceedings of Swarm Evolutionary and Memetic Computing Conference (SEMCCO) 2011**, Dec 19-21, Visakhapatnam, Andhra Pradesh, India.
16. **Pradipta Ghosh**, Hamim Zafar, Joydeep Banerjee and Swagatam Das, “*Design of Two-Channel Quadrature Mirror Filter Banks Using Differential Evolution with Global and Local Neighborhoods*,” in **Proceedings of Swarm Evolutionary and Memetic Computing Conference (SEMCCO) 2011**, Dec 19-21, Visakhapatnam, Andhra Pradesh, India.
17. Ankush Mandal, Hamim Zafar, **Pradipta Ghosh**, Swagatam Das and Ajith Abraham, “*An Efficient Memetic Algorithm for Parameter Tuning of PID Controller in AVR System*,” in **Proceedings of IEEE Hybrid Intelligent Systems (HIS) 2011**, December 5-8, Malacca, Malaysia.
18. **Pradipta Ghosh**, Hamim Zafar, Swagatam Das and Ajith Abraham, “*Hierarchical Dynamic Neighborhood Based Particle Swarm Optimization for Global Optimization*,” in **Proceedings of IEEE Congress on Evolutionary Computation (CEC) 2011**, June 5-8, 757 - 764, New Orleans.
19. Joydeep Banerjee, Souvik Kumar Mitra, **Pradipta Ghosh** and Mrinal Kanti Naskar, “*Memory Based Message Efficient Clustering (MMEC) for Enhancement of Lifetime in Wireless Sensor Networks Using a Node Deployment Protocol*,” in **Proceedings of International Conference on Communication, Computing & Security (ICCCS) 2011**, Feb 12-14, Orissa, India.
20. Joydeep Banerjee, Swarup Kumar Mitra, **Pradipta Ghosh** and Mrinal Kanti Naskar, “*An Optimized Reduced Energy Consumption (OREC) Algorithm for Routing in Wireless Sensor Networks*,” in **Communications in Computer and Information Science**, 1, Volume 192, Advances in Computing and Communications, Part 2, Pages 82-92
21. **Pradipta Ghosh**, Joydeep Banerjee, Swarup Kumar Mitra, Souvik Kumar Mitra and Mrinal Kanti Naskar, “*Sequential Multi-Clustering Protocol Using a Node Deployment Protocol for Efficient Multi-Clustering in Wireless Sensor Networks*,” in **Communications in Computer and Information Science**, 1, Volume 196, Advances in Network Security and Applications, Part 2, Pages 526-536.

Journal Papers:

21. **Pradipta Ghosh**, Jason A Tran, and Bhaskar Krishnamachari, “*ARREST: A RSSI Based Approach for Mobile Sensing and Tracking of a Moving Object*,” in **IEEE Transactions on Mobile Computing (TMC)**, Under Review (Publisher: IEEE, Impact Factor (2016): 3.822).
22. **Pradipta Ghosh**, He Ren, Reza Banirazi, Bhaskar Krishnamachari, and Edmond Jonckheere “*Empirical Evaluation of the Heat-Diffusion Collection Protocol for Wireless Sensor Networks*,” in **Elsevier Computer Networks**, Volume: 127, Page(s): 217-232, 2017. (Publisher: Elsevier, Impact Factor (2016): 2.516)
23. **Pradipta Ghosh**, Swagatam Das and Hamim Zafar, “*Adaptive differential evolution based design of two-channel quadrature mirror filter banks for sub-band coding and data transmission*,” in **IEEE Transactions on Systems, Man, and Cybernetics, Part - C**, Volume: 42, Issue: 6, Page(s): 1613-1623, 2012. (Publisher: IEEE, Impact Factor (2016):2.493).
24. **Pradipta Ghosh**, Joydeep Banerjee, Shelly Sinha Chowdhury and Swagatam Das, “*Design of non-uniform circular antenna arrays — an evolutionary algorithm based approach*,” in **Progress In Electromagnetics Research B**, Vol. 43, 333-354, 2012. (Publisher: EMW Publishing, Impact Factor (2010): 3.745).
25. **Pradipta Ghosh** and Swagatam Das, “*Synthesis of Thinned Planar Concentric Circular Antenna Arrays — A Differential Evolutionary Approach*,” in **Progress In Electromagnetics Research B**, Vol. 29, 63-82, 2011. (Publisher: EMW Publishing, Impact Factor (2010): 3.745).

Patents:

26. **Pradipta Ghosh** and Bhaskar Krishnamachari, “*ARREST: A Rssi Based Approach For Relative Positioning And Tracking Of A Moving Object*,” provisional patent, 2017-18, Application number 62/420,451

ACHIEVEMENTS

- Invited Poster as Outstanding Graduating Student at the 2018 Information Theory and Applications Workshop
- Received the Best Graduating Ph.D. Student Pitch award at MHI Research Festival 2017
- Research Proposal was accepted in the NeTS Early Career Workshop 2017
- Selected as one of the five MHI Scholars. Only 4-5 students are selected from a competitive process each year from the department
- Research was featured in USC News
- Accepted for Ph.D. program at USC with 4 years of the prestigious USC Provost’s Fellowship
- Ranked 55th (General) in Engineering in WBJEE (2008) among about 1,00,000 students.
- Ranked 168th (General) in Medical in WBJEE (2008) among about 60,000 students