

# NICOLA BEZZO

*Olsson Hall 102F, Department of Systems and Information Engineering, University of Virginia  
151 Engineer's Way, Charlottesville, VA, 22902*

Tel (o): (+1) 434-924-1365

Tel (c): (+1) 505-340-8856

E-mail: [nbezzo@virginia.edu](mailto:nbezzo@virginia.edu)

Webpage: <http://www.sys.virginia.edu/nicola-bezzo.html>

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## Academic Positions

- **Assistant Professor (Cyber-Physical Systems & Robotics)**—2016-present  
*Systems and Information Engineering, University of Virginia, Charlottesville, VA USA.*
  - **Postdoctoral Researcher (Cyber-Physical Systems & Robotics)**—2012-2015  
*Computer Science, University of Pennsylvania, Philadelphia, PA, USA.*
  - **Research Assistant in Electrical and Computer Engineering (Robotics & Control Systems)**—2008-2012  
*Electrical and Computer Engineering, University of New Mexico, Albuquerque, NM, USA.*
  - **Research Assistant in Electrical Engineering (Automation & Electrical Measurements)**—2007-2008  
*Electrical Engineering, Politecnico di Milano, Milan, ITALY.*
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## Education

- **Ph.D. in Electrical and Computer Engineering (Robotics & Control Systems)**—2008-2012  
*University of New Mexico, Albuquerque, NM, USA.*
  - **Master of Science in Electrical Engineering**—2006-2008  
*Politecnico di Milano, Milan, ITALY.*
    - Degree with honor (summa cum laude).
  - **Exchange Student 1<sup>st</sup> year of Master in Electrical Engineering**—2006-2007  
*Oklahoma State University, Stillwater, OK, USA.*
    - GPA: 3.9/4.0.
  - **Bachelor of Science in Electrical Engineering**—2003-2006  
*Politecnico di Milano, Milan, ITALY.*
    - Degree with honor (summa cum laude).
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## Awards

- Recipient of the IEEE Robotics & Automation "Best Paper Award" (2016).
- Recipient of two DARPA HACMS outstanding service awards (2015, 2013).
- Recipient of the "Best Paper Award" at ACM/IEEE ICCPS, 2014 CPS Week (2014).
- Recipient of the "Outstanding Student Service Award" from the University of New Mexico (2011).
- Awarded the Gold Medal from the Politecnico School of Engineering, for best graduate student in Electrical Engineering (2010).
- N° 2 degrees with honor (summa cum laude) from Politecnico di Milano (2006, 2008).
- Recipient of the "President Honor Roll for Outstanding Academic Performance" from Oklahoma State University (2007).
- Ranked 11<sup>th</sup> among over 30.000 applicants at Politecnico di Milano Entrance Exam (2003).

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## Research Interests & Competences

- Cyber-Physical Systems, Vehicular Security Control, Attack-Resilient Control Systems.
- Multi-agent systems (ground and aerial vehicles), Control and coordination of swarms of heterogeneous robotic agents, Multi-legged robotics, Manipulators, Hardware/Software design for robotic systems.
- Motion planning under wireless communications, Wireless communication protocols, ZigBee, WLAN, Mesh networking and Routing algorithms, Diversity techniques, Graph theory.
- Hybrid systems, Linear/Nonlinear control, Optimization theory, Dynamic and switched systems, Stability analysis.
- Automatic code generation, Robotics co-design, High-level programming environment design, Verification & Validation, Run-time monitoring
- Robotic fabrication, Rapid prototyping, 3D printing and folding techniques
- Computer vision techniques – Triangulation and Trilateration, Segmentation, Pattern recognition, Edge and features detection.

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## Research Projects

- *Development of attack resilient control techniques for cyber-physical systems.* Office of Naval Research N00014-16-R-BA04 in collaboration with Prof. Insup Lee, Prof. George Pappas, Prof. Oleg Sokolsky, University of Pennsylvania, Prof. Miroslav Pajic, Prof. Mary Cummings Duke University — October 2016 - present.
- *Development of auto-tuning techniques for quadrotor aerial vehicles.* DARPA HACMS #FA8750-12-2-0247 in collaboration with Prof. Insup Lee and Prof. Vijay Kumar, School of Engineering and Applied Science, University of Pennsylvania — January 2015 - present.
- *Development of online planning techniques to guarantee safety and liveness during UAV operations.* DARPA HACMS #FA8750-12-2-0247 in collaboration with Prof. Insup Lee, Prof. George Pappas, and Prof. Vijay Kumar, School of Engineering and Applied Science, University of Pennsylvania — January 2015 - present.
- *Development of attack-resilient control theories to be used against sensors/actuator attacks on vehicular systems (ground and aerial robots, and military and domestic vehicles).* DARPA HACMS #FA8750-12-2-0247 under the supervision of Prof. Insup Lee of PRECISE Center, Department of Computer and Information Science, University of Pennsylvania — November 2012 - present.
- *Development of a high-level programming environment for robotic applications.* NSF Expedition in Computing awards EFRI-1240383 and CCF-1138967 under the supervision of Prof. Insup Lee and Prof. Vijay Kumar, School of Engineering and Applied Science, University of Pennsylvania — November 2012 - present.
- *Development of secure control strategies for multi-vehicular systems in urban/traffic environments with V2V and V2I constraints.* DOT National University Transportation Center Program grant #DTRT12-G-UTC11, under the supervision of Prof. Insup Lee and Prof. Daniel Lee, School of Engineering and Applied Science, University of Pennsylvania — November 2012 - present.
- *Development of motion planning strategies for robotic router networks under communication and sensing constraints.* NSF IIS award # 0812338, under the supervision of Dr. Rafael Fierro in Multi-Agent, Robotics, Hybrid, and Embedded Systems (MARHES) Laboratory, Department of Electrical and Computer Engineering, University of New Mexico — August 2008 - November 2012.
- *Development of an aerial and ground robotic test bed for indoor and outdoor motion planning experiments.* MARHES Lab, Department of Electrical and Computer Engineering, University of New Mexico — 2009 - 2011.
- *Development of a wireless robotic system for first responder operations.* NIOSH SBIR Project, collaboration between K&A Wireless, LLC (Dr. Jorge Piovesan) and MARHES Lab (Dr. Rafael Fierro), Department of Electrical and Computer Engineering, University of New Mexico — August 2011 - January 2012.
- *Development of a profilometer (a sensor to measure the rugosity of a surface) based on desktop mouse optical sensors.* Under the supervision of Dr. Roberto Ottoboni, Department of Electrical Engineering, Politecnico di Milano — September 2007 - July 2008.

- *Development of a high power electrical current sensor based on Rogowski coil.* Under the supervision of Prof. Roberto Ottoboni, Department of Electrical Engineering, Politecnico di Milano and ABB Italy — September 2005 - July 2006.
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## Research Group

- **PhD Students:**
    - Esen Yel (SIE)
    - Mahmoud Elnaggar (SIE)
  - **MS Students:**
    - Tony Lin (ECE)
    - Bradley Hallier (ECE)
  - **Former Students:**
    - Rahul Vasist (PRECISE Center, now Firmware Engineer at Oracle)
    - Yanwei Du (GRASP Lab)
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## Teaching Experience

- **SYS 6581/ECE 6501 "Autonomous Mobile Robots"**—Fall 2016  
*Instructor - Department of Systems and Information Engineering - University of Virginia*
  - **SYS 3062 "Discrete Event Simulation"**—Spring 2016  
*Guest Lecturer - Department of Systems and Information Engineering - University of Virginia*
  - **ECE 595 "Autonomous Mobile Robots"**—Spring 2012  
*Co-instructor - Department of Electrical and Computer Engineering - University of New Mexico*
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## Training & Work Experience

- **Graduate Research Assistant and Teaching Assistant**—fall 2008 - fall 2012  
*Department of Electrical and Computer Engineering - University of New Mexico*
  - **Research Internship in Vision and Electrical Measurements**—spring 2008  
*Department of Electrical Engineering - Politecnico di Milano (Prof. R. Ottoboni / ABB).*
  - **Research Internship with three teams:**—summer 2007  
*Department of Electrical Engineering - Oklahoma State University.*
    - Robotics (Dr. R. Fierro).
    - Metamaterials (Dr. W. Zhang).
    - THz Optoelectronics (Dr. D. Grischkowsky).
  - **Summer camp Trainer in Robotics**—summer 2007 & 2009  
*Oklahoma State Univ., Univ. of New Mexico.*
  - **Systems Analyst Internship**—summer 2004 & 2005  
*BTA Sicurezza, Vittorio Veneto, TV, Italy.*
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## Professional Activities

- **Conferences and Workshops Organization:**
  - Program Committee Member ICCPS 2016 Demo/Poster/WiP
  - Organizer of the "Robot Makers: The future of digital rapid design and fabrication of robots" (RoMa 2014) workshop within the Robotics: Science and Systems (RSS) Conference – 2014, 2016
  - Session Co-chair at the 2016 American Control Conference (ACC) - Quadrotors and UAVs Session – Boston, MA – July 6 - 8, 2016.
  - Co-Chair of 2016 International Design Engineering Technical Conferences & Computer & Information in Engineering Conference (IDETC/SIE) - Co-design Session – Boston, MA – August 2 - 5, 2015.
  - Chair of 2014 International Symposium of Experimental Robotics (ISER) - Mechanisms Session – Marrakech/Essaouira, Morocco – June 15 - 18, 2014.

- **Reviewer for:**
    - IEEE Transactions on Automation Science and Engineering;
    - IEEE Transactions on Robotics;
    - IEEE Control Systems Magazine;
    - IEEE/ASME Transactions on Mechatronics;
    - Cambridge Robotica;
    - ACTA Press International Journal of Robotics and Automation;
    - American Control Conference (ACC);
    - International Conference on Robotics and Automation (ICRA);
    - International Conference on Intelligent Robots and Systems (IROS);
    - Conference on Decision and Control (CDC)
  - **Member of:**
    - IEEE (Control Systems Society, Robotics and Automation Society, and Communications Society).
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## Computer & Technological Skills

- **Operating Systems:**
    - Proficient in ROS, Linux, Mac OS, Unix and Windows.
  - **Computer Languages and Softwares:**
    - Proficient in C, C++, Matlab, Simulink, L<sup>A</sup>T<sub>E</sub>X, CPLEX, AutoCad, and Corel Suite.
    - Good knowledge of Python, NI LabVIEW, HTML, and USARSim.
  - **Robotics**
    - Experienced in designing and developing hardware/software platforms for ground (UGVs) and aerial (UAVs) mobile robots. Professional background in navigation, motion planning, SLAM and coordination of single and multiple robot systems. Hardware implementation of mobile sensor networks using decentralized and centralized controllers.
    - Experienced in co-design of mechanics, electronics, and software for rapid fabrication and prototyping of printable and foldable robotic systems.
    - Good background in multi-legged robotics, microcontroller design (ATOM, ATmega, Arduino microcontrollers), manipulator kinematics, computer vision and machine learning.
  - **Communication Systems**
    - Experienced in implementing wireless communication systems, ad-hoc networks, routing and mesh networking using ZigBee radios, WLAN and TCP protocols.
  - **Control Systems**
    - Experienced in linear and nonlinear control techniques, mixed integer programming, optimization control, stability analysis of switched and dynamical systems, and attack-resilient control strategy for vehicular systems.
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## Other Skills & Competences

- **G.P.L. Glider Pilot License**—I am a certified glider pilot within the Italian Civil Aviation.
- **Tennis**—I trained tennis for more than six years with good agonistic results.
- **Piano**—I played piano and attended music school for twelve years.
- **Other hobbies**—skiing, hiking, photography, artistic drawing, movies and music.
- **Social & Organizational skills**—team spirit, good ability to adapt to multicultural environments, good communication skills, precision, sense of organization and good ability in team leading.
- **Languages**—Italian (mother tongue), fluent in English, basic knowledge of French and Spanish.

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## Invited Talks & Publications

- **Selected Presentations:**

- Presentation at the 2016 Jacobs Technology Days and the Hampton Roads Unmanned Systems Opportunity Exchange *Unmanned Systems Workforce*, Hampton, VA, 22 April 2016
- Presentation at the 2015 Safe and Secure Systems and Software Symposium (S5) *A Run time Monitoring Framework for Safe Coordination of Unmanned Aerial Vehicles*, Dayton, OH, 10 June 2015
- Invited speaker at NASA Jet Propulsion Laboratory, Pasadena, CA, 12 April 2012.
- Invited speaker at USC Robotics Research Lab, Los Angeles, CA, 13 April 2012.

- **Journals:**

- M. Pajic, J. Weimer, N. Bezzo, O. Sokolsky, G. J. Pappas, I. Lee, *Design and Implementation of Attack-Resilient Cyber-Physical Systems*. In IEEE Control Systems Magazine (CSM), 2017 (To Appear)
- N. Bezzo, A. Mehta, C. D. Onal, M. T. Tolley, *Robot Makers: The Future of Digital Rapid Design and Fabrication of Robots*. In IEEE Robotics and Automation Magazine (RAM), 2015, vol. 22, pp. 27-36, 2015. (Best Paper Award)
- N. Bezzo, P. Cruz, F. Sorrentino, and R. Fierro, *Decentralized identification and control of networks of coupled mobile platforms through adaptive synchronization of chaos*. In Elsevier Physica D, vol. 267, pp. 94-103, 2014.
- N. Bezzo, B. Griffin, P. Cruz, J. Donahue, R. Fierro, and J. Wood, *A Cooperative Heterogeneous Mobile Wireless Mechatronic System*. In IEEE/ASME Transactions on Mechatronics, 10.1109/TMECH.2012.2218254, vol. 19, no. 1, pp. 20-31, 2014.
- N. Bezzo, R. Fierro, A. Swingler, and S. Ferrari, *A Disjunctive Programming Approach for Motion Planning of Mobile Router Networks*. In the International Journal of Robotics and Automation (Special Issue), vol. 26, no. 1, pp. 13-25, 2011.
- N. Bezzo, K. Mohta, C. Di Franco, C. Nowzari, I. Lee, V. Kumar, and G. Pappas *Online Trajectory Replanning for Energy-efficient and Disturbance-aware UAV Operations*. In Sage Journal of Robotics Research (submitted).
- N. Bezzo, I. Lee, *Attack-Resilient Detection, Estimation, and Planning for Safety-critical Robotic Operations*. In IEEE Transactions on Robotics (in preparation).

- **Book Chapters:**

- A. Mehta, N. Bezzo, P. Gebhard, B. An, V. Kumar, I. Lee, and D. Rus, *A Design Environment for the Rapid Specification and Fabrication of Printable Robots*. Book Chapter in Springer STAR series in Robotics, 2015.
- N. Bezzo, and R. Fierro, *A Real World Coordination Framework for Connected Heterogeneous Robotic Systems*. Book Chapter in "Distributed Autonomous Robotic Systems", Springer STAR series in Robotics, vol. 104, pp.75-89, 2014.
- N. Bezzo, R. A. Cortez, and R. Fierro, *Exploiting Heterogeneity in Robotic Networks*. Book Chapter in Springer "Redundancy in Robot Manipulators and Multi-Robot Systems" vol. 57, pp. 53-75, 2013.

- **Conferences:**

- N. Bezzo, K. Mohta, C. Nowzari, I. Lee, V. Kumar, G. Pappas, *Online Planning for Energy-efficient and Disturbance-aware UAV Operations*. In IEEE International Conference on Intelligent Robots and Systems (IROS), Daejeon, South Korea, October 9-14, 2016.
- N. Bezzo, J. Weimer, Y. Du, O. Sokolsky, S. H. Son, I. Lee, *A Stochastic Approach for Attack Resilient UAV Motion Planning*. In 2016 American Control Conference (ACC 2016), Boston (MA), July 6-8, 2016.
- Y. Shoukry, P. Nuzzo, N. Bezzo, A. L. Sangiovanni-Vincentelli, S. A. Seshia, P. Tabuada, *Secure State Reconstruction in Differentially Flat Systems Under Sensor Attacks Using Satisfiability Modulo Theory Solving*. In IEEE Control and Decision Conference, Osaka, Japan, Dec. 15 - 18, 2015.
- N. Bezzo, M. Piccoli, P. Gebhard, V. Kumar, M. Yim, I. Lee, *Rapid Co-design of electro-mechanical specifications for robotic systems*. In ASME 2015 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference (IDETC/CIE 2015), Boston, MA, Aug. 2 - 5, 2015.
- N. Bezzo, J. Weimer, M. Pajic, O. Sokolsky, G. J. Pappas, I. Lee, *Attack Resilient State Estimation for Autonomous Robotic Systems*. In IEEE International Conference on Intelligent Robots and Systems (IROS), Chicago, IL, Sept. 14 - 18, 2014.

- J. Weimer, O. Sokolsky, N. Bezzo, and I. Lee, *Towards Assurance Cases for Resilient Control Systems*. In IEEE International Conference on Cyber-Physical Systems, Networks, and Application (CPSNA), Hong Kong, China, August 25 - 26, 2014. (*Invited Paper*)
- A. Mehta, N. Bezzo, P. Gebhard, B. An, V. Kumar, I. Lee, and D. Rus, *A Design Environment for the Rapid Specification and Fabrication of Printable Robots*. In International Symposium on Experimental Robotics (ISER), Marrakech/Essaouira, Morocco, June 15 - 18, 2014.
- M. Pajic, J. Weimer, N. Bezzo, P. Tabuada, O. Sokolsky, I. Lee, and G. J. Pappas, *Robustness of Attack-resilient State Estimators*. In ACM/IEEE International Conference on Cyber-Physical Systems (ICCPs), Berlin, Germany, April 14 - 17, 2014. (**Best Paper Award**)
- J. Weimer, N. Bezzo, M. Pajic, O. Sokolsky, and I. Lee, *Attack-Resilient Minimum Mean-Squared Error Estimation*. In American Control Conference (ACC), Portland, OR., June 4, 2014.
- M. Pajic, N. Bezzo, J. Weimer, R. Alur, R. Mangharam, N. Michael, G. J. Pappas, O. Sokolsky, P. Tabuada, S. Weirich, and I. Lee, *Towards Synthesis of Platform-aware Attack-Resilient Control Systems*. In 2nd ACM International Conference on High Confidence Networked Systems (HiCoNS), Philadelphia, PA., April 9-11, 2013, pp. 75-76.
- N. Bezzo, F. Sorrentino, and R. Fierro, *Decentralized Estimation of Topology Changes in Wireless Robotic Networks*. In American Control Conference (ACC), Washington D.C., June 17-19, 2013, pp. 5919-5924.
- N. Bezzo, M. Anderson, and R. Fierro, *A Real World Coordination Framework for Connected Heterogeneous Robotic Systems*. International Symposium on Distributed Autonomous Robotic Systems (DARS), Baltimore, MD, November 8-11, 2012.
- N. Bezzo, and R. Fierro, *Decentralized Connectivity and User Localization Via Wireless Robotic Networks*. In IEEE Global Communications Conference (GLOBECOM), Wi-UAV, Houston, TX, December 5, 2011, pp. 1285-1290.
- N. Bezzo, Y. Yuan, R. Fierro, and Y. Mostofi, *A Decentralized Connectivity Strategy for Mobile Router Swarms*. In the 18<sup>th</sup> World Congress of the International Federation of Automatic Control (IFAC), Milan, Italy, August 30, 2011, pp. 4501-4506.
- N. Bezzo, and R. Fierro, *Swarming of Mobile Router Networks*. In American Control Conference (ACC), San Francisco, CA, July 1, 2011, pp. 4685-4690.
- N. Bezzo, and R. Fierro, *Tethering of Mobile Router Networks*. In American Control Conference (ACC), Baltimore, MD, June 30, 2010, pp. 6828-6833.
- N. Bezzo, K. Mohta, C. Nowzari, I. Lee, V. Kumar, G. Pappas *Online Planning for Energy-efficient and Disturbance-aware UAV Operations*. In 2016 IEEE International Conference on Intelligent Robots and Systems (IROS) (submitted)
- S. Park, N. Bezzo, K. Karydis, V. Kumar, I. Lee, *A Runtime Auto-tuning Framework for quadrotor UAVs* . In IEEE International Conference on Intelligent Robots and Systems (IROS) (in preparation)
- N. Bezzo, P. Gebhard, I. Lee, *ROSLab: A hierarchical and modularized framework for the rapid programming and synthesis of robotic applications* . In IEEE International Conference on Intelligent Robots and Systems (IROS) (in preparation)

- **Workshops:**

- N. Bezzo, Y. Du, O. Sokolsky, and I. Lee, *A Markovian Approach for Attack Resilient Control of Mobile Robotic Systems*. In Second International Workshop on Robotic Sensor Networks (RSN), Seattle, Washington, April 13, 2015.
- O. Sokolsky, M. Pajic, N. Bezzo, and I. Lee, *Architecture-Centric Software Development for Cyber-Physical Systems*. In First Workshop on Cyber-Physical System Architectures and Design Methodologies (CPSArch), New Delhi, India, October 17, 2014.
- L. Feng, A. L. King, S. Chen, A. Ayoub, J. Park, N. Bezzo, O. Sokolsky, and I. Lee *A Safety Argument Strategy for PCA Closed-Loop Systems: A Preliminary Proposal*. In Medical Cyber Physical Systems Workshop (MedicalCPS), Berlin, Germany, April 14, 2014.
- J. Weimer, N. Bezzo, M. Pajic, G. J. Pappas, O. Sokolsky, and I. Lee, *Resilient Parameter-Invariant Control with Application to Vehicle Cruise Control*. In Workshop on Control of Cyber-Physical Systems, Johns Hopkins University, Baltimore, MD, March 2013.
- N. Bezzo, and R. Fierro, *Mobile Robotic Routers Networks*. In Workshop on Frontiers of Real-World Multi-Robot Systems: Challenges and Opportunities, Duke University, Durham, NC, October 10-11, 2011
- N. Bezzo, P. Cruz, I. Palunko, T. Appel, D. Galarowicz, and R. Fierro, *The MARHES heterogeneous multi robot test bed* . In 1st Southwest Workshop on Cyber-Physical Systems, University of Arizona, Tucson, AZ, March 10-11 2011.

- **Demos:**

- N. Bezzo, J. Park, A. King, P. Gebhard, R. Ivanov, I. Lee, *Demo Abstract: ROSLab – A Modular Programming Environment for Robotic Applications*. Demonstration at the 5th ACM/IEEE International Conference on Cyber-Physical Systems (ICCCPS, CPSWEEK 2014), Berlin, Germany, April 2014.
- M. Pajic, N. Bezzo, J. Weimer, O. Sokolsky, N. Michael, G. J. Pappas, P. Tabuada, and I. Lee, *Synthesis of Platform-aware Attack-Resilient Vehicular Systems*. Demonstration at the 4th ACM/IEEE International Conference on Cyber-Physical Systems (ICCCPS, CPSWEEK 2013), Philadelphia, Pennsylvania, April 2013.

- **Thesis and Reports**

- PhD Thesis, *Coordination Strategies for Connected Robotic Networks*
- MS Thesis, *Low-Cost CMOS Non-Contact Profilometer*
- BS Thesis, *A Sensors Array for the Measurement of Electrical Currents (in italian – Array di Sensori per la Misura di Correnti Elettriche)*
- SBIR Report – N. Bezzo, J. Piovesan, R. Fierro, *Path Planning of Mobile Routers via Antenna Diversity*, Marhes Laboratory, School of Electrical Computer Engineering, University of New Mexico

- **Software Artifacts**

- *ROSLab*: a high-level programming environment for robotic applications  
<http://precise.github.io/ROSLab/>
- *EMLab*: a high-level co-design environment for PCB electro-mechanical specifications (to appear).

- **Funding**

- *Development of Control-Aware Cyber Techniques for Attack-Resilient Industrial Control & Combat Systems*; \$ 320,000; 10/01/2016 – 09/30/2019
- *Fully Autonomous Secure and Safe Transport (FASST)*; \$ 75,000; 08/29/2016 – 05/15/2017
- *Cybersecurity Analysis - Cooperative Adaptive Cruise Control*; \$ 75,000; 08/29/2016 – 05/15/2017
- *Graduate Curriculum in Robotics and Society*; \$ 58,000; 06/09/2016 – 05/15/2017
- *Attack-Resilient Autonomous Vehicles DARPA High-Assurance Cyber Military Systems (HAMCS) Program subcontract*; \$ 50,000; 01/01/2016 — 02/28/2017