Zeid **Kootbally**

Citizenship: United States of America

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Summary

- **Over 5 years of experience in the field of autonomous vehicles.**
- **Over 12 years of experience in architecture and control systems in the field of robotics applied to manufacturing.**
- **Specific experience in knowledge representation, measurement science, and software development.**

Education

The University of Burgundy — *Dijon, France*

Ph.D., Computer Science — *2008*

- **Dissertation**: *Moving Object Predictions in Dynamic Environments for Autonomous Ground Vehicles*
- **Honors**: *summa cum laude*

The University of Burgundy — *Dijon, France*

Master's Degree (Post-graduate), Computer Science — *2004*

- **Specialization**: Artificial Intelligence and Database
- **Honors**: *magna cum laude*

Université de La Réunion — *Reunion Island, France*

Bachelor of Science — *2003*

- **Specialization**: Physics, Chemistry, Data processing, and Algorithms

Experience

University of Southern California (Senior Research Associate) — *Los Angeles, CA, USA*
National Institute of Standards and Technology (Associate) — *Gaithersburg, MD, USA*

40 h/week — *October 2022 - Present*

- Measurement Science for Automated Vehicles.
  - Development of an architecture to characterize the performance of the interaction between modules of an automated vehicle system (Cybersecurity, Artificial Intelligence, Communications, and Perception). The objective of this research is focused on developing a replicable testbed and a suite a test methods and metrics to evaluate system interaction to advance the safe operation of automated vehicles.

University of Southern California (Senior Research Associate) *Los Angeles, CA, USA*
National Institute of Standards and Technology (Associate) *Gaithersburg, MD, USA*

40 H/WEEK *August 2016 - Present*

- Measurement Science and Simulated Test Methods for Robot Agility.
  - Member of the IEEE P2940™ Standard for Measuring Robot Agility to provide quantitative test methods and metrics for assessing the agility of a robot.
  - Implemented the Agile Robotics for Industrial Automation Competition (ARIAC) in 2020, 2021, 2022, and 2022. Agility challenges and manufacturing tasks were developed in simulation to assess the agility of industrial robots.
- Machine Learning.
  - Contributed to the development of a methodology to determine the pose of a partially occluded object through the analysis of the latent space of an autoencoder.
  - Contributed to the development of a convolutional autoencoder model to generate a latent space.
  - Developed a methodology to generate synthetic data for a 3D simulated object.
- Delivery of a knowledge representation and planning infrastructure for kitting operations.
  - Developed a planning infrastructure using the Planning Domain Definition Language (PDDL) to integrate robot capabilities for kitting tasks.
  - Developed a methodology which uses PDDL actions' effects and a graph database to validate the number of objects detected by a vision system.
  - Developed a methodology to update objects in a graph database by comparing their previous poses from the graph database with the new vision data using pre-set tolerance values.

University of Maryland (Assistant Research Scientist) *College Park, MD, USA*
National Institute of Standards and Technology (Associate) *Gaithersburg, MD, USA*

40 H/WEEK *July 2013 - July 2016*

- Delivery of a robot agility performance metrics, information models, test methods and protocols to enable manufacturers to easily and rapidly reconfigure and re-task robot systems in assembly operations.
  - Integrated a graph database in pick and place control architecture to perform kitting in real time situations.
  - Developed a robot capability model that is intended to be used for: 1) helping manufacturers to characterize the different capabilities their robots contribute to help the end user to select the appropriate robots for the appropriate tasks, 2) selecting backup robots during hardware failures to limit the deterioration of the system's productivity and the products quality, and 3) limiting robots failures and increasing productivity by providing a tool to manufacturers that outputs a process plan that assigns the best robot to each task needed to accomplish the assembly.

University of Maryland (Research Associate) *College Park, MD, USA*
National Institute of Standards and Technology (Associate) *Gaithersburg, MD, USA*

40 H/WEEK *2010 - 2013*

- Development of the measurement science and standards for planning and modeling by robots so that they are able to be more quickly re-tasked and are more flexible and adaptive in manufacturing applications.
  - Developed standard representations for world knowledge and plan knowledge, and the related performance evaluation criteria.
  - Developed techniques to compare planning algorithms that utilize the developed knowledge representations to address next generation robotics for the class of manufacturing problems in the area of component placement.
  - Developed a simulated manufacturing test method that is capable of demonstrating rapid re-tasking and evaluation using our performance measures.

National Institute of Standards and Technology (Guest Researcher) *Gaithersburg, MD, USA*

40 H/WEEK *2005 - 2010*

- Autonomous driving.
  - Developed the Prediction In Dynamic Environments (PRIDE) framework, a hierarchical multi-resolutional approach for moving object prediction that incorporates multiple prediction algorithms into a single, unifying framework.
  - Modeled human-like situation awareness capabilities for autonomous ground vehicles to describe the complex set of information that must be maintained in real-time tasks.
  - Integrated a cost-based approach with a Kalman filter approach to generate more accurate predictions of moving obstacles.
  - Developed a fuzzy logic-based approach for identifying objects of interest in the PRIDE framework.
  - Ported the PRIDE framework to manufacturing for loading and unloading materials at docking stations.
- Urban Search and Rescue.
  - Developed an ontology to analyze the performance of robots for different test methods for Urban Search and Rescue events.
- DARPA projects.
  - Contributed to the evaluation and conception of tests to measure the technical performance of devices used in the ASSIST (Advanced Soldier Sensor Information System and Technology) program.
  - Contributed to the development of innovative methods for testing and evaluating hardware and software to securely deploy off-the-shelf smartphones and applications in military field operations for the Transformative Apps (TRANSAPPS) project.
  - Contributed to the evaluation of the performance of technologies used for the TRANSTAC (The Spoken Language Communication and Translation System for Tactical Use) program.

Skills

- **Experience in path planning, navigation, and mapping for autonomous driving.**
- **Experience in the development of control systems for physical and simulated industrial robots.**
- **Experience in the development of test methods and metrics to assess the agility performance of industrial robots.**
- **Experience with the Robot Operating System (ROS) and in the Gazebo simulation software.**
- **Experience in task-level planning and motion planning.**
- **Experience in C++, Python, and Java programming languages.**
- **Experience in knowledge representation using ontologies.**
- **Experience in the development and in the implementation of control system architectures for industrial robotics.**
- **Strong analytical, problem solving, and decision making.**
- **Publications in prestigious peer-reviewed journals, books, and conferences.**
- **Fluent in English and French.**

Honors & Awards

Teaching Award

2022 **The University of Maryland**, *College Park, MD*
MAGE's Outstanding Teaching Award for the Academic Year 2021-22.

Distinguished Associate Award

2022 **National Institute of Standards and Technology (NIST)**, *Gaithersburg, MD*
Distinguished Associate Award for developing an innovative simulation-based robot agility competition that has spurred breakthrough solutions to industry's robotics challenges.

Distinguished Associate Award

2018 **National Institute of Standards and Technology (NIST)**, *Gaithersburg, MD*
Distinguished Associate Award For development of international standard and supporting messaging language to enable enhanced robot agility in manufacturing applications

Distinguished Associate Award

2013 **National Institute of Standards and Technology (NIST)**, Distinguished Associate Award For developing innovative methods for security, testing, and evaluation of hardware and software to securely deploy off-the-shelf smartphones and applications in military field operations. *Gaithersburg, MD*

Distinguished Associate Award

2012 **National Institute of Standards and Technology (NIST)**, Distinguished Associate Award For developing innovative techniques to measure the performance of automated speech translation systems leading to confident U.S. military fielding. *Gaithersburg, MD*

Teaching

ENPM663: Building a Manufacturing Robot Software System. *College Park, MD*

Lecturer at the University of Maryland *2018 – Present*

The course looks at the components of manufacturing robots, including architectures, knowledge representation, planning, control, safety, standards, and human-robot interaction.

ENPM809Y: Introductory Robot Programming. *College Park, MD*

Lecturer at the University of Maryland *2019 – Present*

The course focuses on the C++ programming language and its applications in mobile robotics.

ENPM809E: Python Applications for Robotics. *College Park, MD*

Lecturer at the University of Maryland *2019 – Present*

The course focuses on the Python programming language and its applications in mobile and industrial robotics.

Publications

Article in peer-reviewed journals

1. **Assessing Industrial Robot Agility through International Competitions** A. Downs, Z. Kootbally, W. Harrison, P. Pilliptchak, B. Antonishek, M. Aksu, C. Schlenoff, and S.K. Gupta:, *Robotics and Computer-Integrated Manufacturing*, *71*, *x*, *102113*. 2021

2. **Enabling Robot Agility in Manufacturing Kitting Applications** Z. Kootbally, C. Schlenoff, B. Antonishek, F. Proctor, T. Kramer, W. Harrison, A. Downs, and S. Gupta, *Integrated Computer-Aided Engineering (ICAE)*, *25*, *2*, *193–212*. 2018

3. **Implementation of an Ontology-based Approach to Enable Agility in Kit Building Applications** Z. Kootbally, T.R. Kramer, C. Schlenoff, and S.K. Gupta, *International Journal of Semantic Computing*, *12*, *1*, *5–24*. 2018

4. **Industrial Robot Capability Models for Agile Manufacturing** Z. Kootbally, *Industrial Robot: An International Journal*, *Vol. 43*, *Iss. 55*, *pp. 481–494*. 2016

5. **The Canonical Robot Command Language (CRCL)** F.M. Proctor, S.B. Balakirsky, Z. Kootbally, T.R. Kramer, C.I. Schlenoff, and W.P. Shackelford, *Industrial Robot: An International Journal*, *Vol. 43*, *Iss. 55*, *pp. 495–502*. 2016

6. **Towards Robust Assembly with Knowledge Representation for the Planning Domain Definition Language (PDDL)** Z. Kootbally, C. Schlenoff, C. Lawler, T. Kramer, and S.K. Gupta, *Robotics and Computer-Integrated Manufacturing*, *33*, , *pp. 42–55*. 2015

7. **Intention Recognition in Manufacturing Applications** C. Schlenoff, Z. Kootbally, A. Pietromartire, M. Franaszek, and S. Foufou, *Robotics and Computer-Integrated Manufacturing*, *33*, , *pp. 29–41*. 2015

8. **Knowledge Driven Robotics for Kitting Applications** S. Balakirsky, Z. Kootbally, T. Kramer, A. Pietromartire, C. Schlenoff, and S.K. Gupta, *Robotics and Autonomous Systems*, *61*, *(11)*, *pp. 1205–1214*. 2013

9. **Ontology-based State Representations for Intention Recognition in Human–robot Collaborative Environments** C. Schlenoff, A. Pietromartire, Z. Kootbally, S. Balakirsky, and S. Foufou, *Robotics and Autonomous Systems*, *61*, *(11)*, *pp. 1224–1234*. 2013

10. Performance Assessment of PRIDE in Manufacturing Environments Z. Kootbally, C. Schlenoff, and R. Madhavan, *ITEA Journal of Test & Evaluation*, *31*, *(3)*, *pp. 410–422*. 2010

Book chapters

1. Agile Industrial Robots. C. Schlenoff, Z. Kootbally, W. Shackleford, F. Proctor, B. Antonishek, W. Harrison, and A. Downs, *Manufacturing in the Era of 4th Industrial Revolution*, *Volume 2: Recent Advances in Industrial Robotics*, , *pp. 7–42*. 2021

2. Enabling Codesharing in Rescue Simulation with USARSim/ROS. Z. Kootbally, S. Balakirsky, and A. Visser, *RoboCup 2013: Robot World Cup XVII. Ed. S. Behnke, M. Veloso, A. Visser, and R. Xiong. Lecture Notes in Computer Science. Springer Berlin Heidelberg*, *Vol. 8371*, , *pp. 592–599*. 2014

3. A Simulated Sensor-Based Approach for Kit Building Applications. Z. Kootbally, C. Schlenoff, T. Weisman, S. Balakirsky, T. Kramer, and A. Pietromartire, *Robot Intelligence Technology and Applications 2. Ed. by J-H. Kim, E.T. Matson, H. Myung, P. Xu, and F. Karray. Advances in Intelligent Systems and Computing. Springer International Publishing*, *Vol. 271*, , *pp. 241–257*. 2014

4. An Ontology Based Approach to Action Verification for Agile Manufacturing. S. Balakirsky and Z. Kootbally, *Robot Intelligence Technology and Applications 2. Ed. by J-H. Kim, E.T. Matson, H. Myung, P. Xu, and F. Karray. Advances in Intelligent Systems and Computing. Springer International Publishing*, *Vol. 274*, , *pp. 201–217*. 2014

5. Inferring Intention through State Representations in Cooperative Human-Robot Environments. C. Schlenoff, A. Pietromartire, Z. Kootbally, S. Balakirsky, S. Foufou, *Engineering Creative Design in Robotics and Mechatronics. Ed. by M.K. Habib and J.P. Davim. Advances in Mechatronics and Mechanical Engineering*, *Chap. 9*, , *pp. 122–151*. 2013

Full paper refereed research related publications in conferences

1. Agility Metrics in the ARIAC Competition A. Downs, Z. Kootbally, and C. Schlenoff, *International Conference on Advanced Robotics and Its Social Impacts (ARSO 2020)*, *pp. 240–245*. 2020 Oct

2. Overview of an Ontology-based Approach for Kit Building Applications Z. Kootbally, T. Kramer, C. Schlenoff, and S.K. Gupta, *IEEE International Conference on Semantic Computing - Semantic Robotics*, *pp. 520–525*. 2017 Jan

3. Performance evaluation of knowledge-based kitting via simulation T. Kramer, Z. Kootbally, S. Balakirsky, C. Schlenoff, A. Pietromartire, and S.K. Gupta, *IEEE International Conference on Automation Science and Engineering (CASE)*, *pp. 356–361*. 2013 Aug

4. USARSim/ROS: A Combined Framework for Robotic Control and Simulation S. Balakirsky and Z. Kootbally, *ASME/ISCIE 2012 International Symposium on Flexible Automation*, *pp. 101–108*. 2012 Jun

5. An Industrial Robotic Knowledge Representation for Kit Building Applications S. Balakirsky, Z. Kootbally, C. Schlenoff, T. Kramer, and S.K. Gupta, *Proceedings of the 2012 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, *pp. 1365–1370*. 2012 Oct

6. Prediction in Dynamic Environments for Autonomous On-Road Driving R. Madhavan, Z. Kootbally, and C. Schlenoff, *9th International Conference on Control, Automation, Robotics and Vision (ICARCV'06)*, *pp. 1–6*. 2006 Dec

7. PRIDE: A Hierarchical, Integrated Prediction Framework for Autonomous On-road Driving C. Schlenoff, R. Madhavan, and Z. Kootbally, *Proceedings 2006 IEEE International Conference on Robotics and Automation (ICRA)*, *pp. 2348–2353*. 2006 May

Abstract refereed publications in conferences and workshops

1. Runtime Verification of the ARIAC Competition: Can a Robot be Agile and Safe at the same time? A. Ferrando, Z. Kootbally, P. Piliptchak, R.C. Cardoso, C. Schlenoff, and M. Fisher:, *The 7th Italian Workshop on Artificial Intelligence and Robotics*, *7–11*. 2020 Nov

2. Performance Assessments of Android-powered Military Applications Operating on Tactical Handheld Devices B. Weiss, L. Fronczek, E. Morse, Z. Kootbally, and C. Schlenoff, *Proc. SPIE 8755, Mobile Multimedia/Image Processing, Security, and Applications*, . 2013 Jun

3. **Functional Requirements of a Model for Kitting Plans** S. Balakirsky, Z. Kootbally, T. Kramer, R. Madhavan, C. Schlenoff, and M. Shneier, *Proceedings of the Workshop on Performance Metrics for Intelligent Systems*, *pp. 29–36*. 2012 Mar

4. **Ontology-based State Representation for Intention Recognition in Cooperative Human-robot Environments** C. Schlenoff, A. Pietromartire, Z. Kootbally, S. Balakirsky, and S. Foufou, *Proceedings of the 2012 ACM Conference on Ubiquitous Computing. UbiComp'12*, *pp. 810–817*. 2012 Sep

5. **Fuzzy-logic-based Approach for Identifying Objects of Interest in the PRIDE Framework** Z. Kootbally, C. Schlenoff, and R. Madhavan, *Proceedings of the 8th Workshop on Performance Metrics for Intelligent Systems*, *pp. 17–24*. 2008 Aug

6. **Performance Evaluation of Cost-based vs. Fuzzy-logic-based Prediction Approaches in PRIDE** Z. Kootbally, C. Schlenoff, R. Madhavan, and S. Foufou, *SPIE Defense and Security Symposium*, . 2008 Apr

7. **A Brief History of PRIDE** Z. Kootbally, C. Schlenoff, and R. Madhavan, *Proceedings of the 2007 Workshop on Performance Metrics for Intelligent Systems*, *pp. 40–47*. 2007 Aug

8. **Driver Aggressivity Analysis within the Prediction in Dynamic Environments (PRIDE) Framework** C. Schlenoff, Z. Kootbally, and R. Madhavan, *Proceedings of the 2007 SPIE Defense and Security Symposium*, . 2007 May

9. **Prediction in Dynamic Environments via Identification of Critical Time Points** Z. Kootbally, C. Schlenoff, and R. Madhavan, *Military Communications Conference (MILCOM 2006)*, *pp. 1–7*. 2006 Oct

Technical reports

1. **Software Tools for XML to OWL Translation** T.R. Kramer, B.J. Marks, C. Schlenoff, S. Balakirsky, Z. Kootbally, and A. Pietromartire, *National Institute of Standards and Technology*. *Internal*, NISTIR 8068. Gaithersburg, MD, USA. 2015 Jun

2. **Metrics and Test Methods for Industrial Kit Building** S. Balakirsky, T. Kramer, Z. Kootbally, and A. Pietromartire, *National Institute of Standards and Technology*. *Internal*, NISTIR 7942. Gaithersburg, MD, USA. 2013 May

Theses

- **Moving Object Predictions in Dynamic Environments for Autonomous Ground Vehicles** Z. Kootbally, *University of Burgundy*, Dijon, France. 2010 Dec.