Title and Description of Sabbatical Project.

Provide a document that describes your proposed sabbatical activities. The document should include at a minimum the following components:

- *Project Abstract/Executive Summary:* A summary of the sabbatical project and outcome (150 word maximum).
- *Project Description: A detailed description of the sabbatical project with the following sections:*
  - *Introduction:* Provide an introduction to the topic/field of study.
  - *Background:* Provide information regarding previous work/activities related to the project.
  - *Outcome:* Describe the work to be completed and state the specific outcome(s) of the project. This section must address at least one of the following.
    1. The strength of the relationship between the sabbatical leave proposal involving applied or theoretical research related to professional activities and the advancement of knowledge within disciplinaryareas.
    11. The strength of the relationship between the sabbatical leave proposal involving an external, professionally-related experience/study in a business, industrial, health care, scientific or educational setting and the improvement of instructional/professional activities at the University.
    111. The strength of the relationship between the sabbatical leave proposal involving travel or advanced study and its yield in improving the quality of instruction at the University.
  - *Timeline:* Provide a timeline for the proposed project activities.

Intelligent Robotic Systems for Reducing the Cost and Ecological Impacts of Agriculture

Abstract

Agricultural practices involve the heavy use of chemical fertilizers, fungicides, insecticides, and herbicides. Broad application of such chemicals has given rise to health concerns and to resistant strains of the targeted organisms. Precision application of such chemicals provides a highly-desirable alternative to traditional broad application methodologies.

Precision application requires two basic capabilities: 1) the accurate determination of plant pathologies or deficiencies; and 2) the precise application of agricultural chemicals to the affected plants. Each capability presents several significant challenges in sensing, analytics, mapping, navigation, and manipulation.

Therefore, the goal of this sabbatical is to characterize these challenges and to begin to develop robust solutions for them. The sabbatical is essentially a starting point for an extended research program that will revolutionize sustainable agriculture practices.

Introduction

Mass treatment of field crops, fruit and tree nuts, horticulture, and vegetables increases production costs related to both chemical purchase and application. Chemicals fall into several broad categories: fungicides, herbicides, insecticides, other chemicals, and fertilizers [1]. As an example, consider that in the 2018 growing season, nitrogen fertilizer usage on corn in the state of Michigan averaged 144 lbs per acre. Other fertilizer components - phosphate, potash, and sulfur - averaged 47, 96, and 11 lbs per acre respectively. The cost of such broad application is then passed on through market prices, then to food processors/livestock feed/fuel additives, and eventually on to the consumer.

An alternative to such broad application is to utilize precise application of only those portions of the crop that have been diagnosed as being afflicted. This can be done manually, but this is a time-consuming and labor intensive process. Timely application may be critical to the success of the treatment, particularly during certain phases of growth or harvest.

The precise application of agricultural chemicals can be automated through the use of sensor-based robotic systems. Whether these systems are autonomous air vehicles or mobile manipulation platforms, recent advances in localization, sensing, and learning have the potential to revolutionize crop production.

This approach has several advantages:

- The cost of chemicals is greatly reduced when the chemical agent is applied only to those plants that exhibit the specific pathology or deficiency;
- The food produced has less overall residual chemical content, reducing the threat of negative health effects and allergic reactions. This reduces potential lawsuits resulting from such exposure;
- The reduction of specific agents such as nitrogen-rich fertilizers helps mitigate non-agricultural impacts such as Gulf of Mexico's "dead zone"[2];
- Total yield may be increased. Certain agents (e.g. fertilizers) increase yield directly,

but others (e.g. herbicides, etc.) can reduce drop yields. Untreated plants that do not exhibit the pathogens, pests, or weeds being targeted can be expected to increase yield.

Background

Key technologies to be explored include the color and textural analysis of images and video, the development ofhyperspectral techniques (particularly infrared) for plant imaging, the application of image-guided robotic positioning, the on-board chemical and pathogenic analysis, and the development of sensors, combined with deep-learning and data analytics, to improve the accuracy of diagnosis.

I have significant experience in color analysis [3] and texture-matching [4,5] that can assist in plant diagnosis. Color analysis has already been used by my proposed sabbatical host, Dr. Nikolaos Papanikolopoulos and his collaborators in the diagnosis of nitrogen deficiencies in com [6]. Texture is an alternative to color that may provide a significant indicator of plant health due to changes in the appearance of leaf and stalk structures.

Hyperspectral imaging covers a wide range of techniques that cover, in general, thermal imaging through x-ray and magnetic resonance imaging. Indeed, the proposed host institution, the University of Minnesota, has an active research project, "Improving disease detection and resistance selection using hyperspectral phenotyping," in the College of Food, Agriculture, and Natural Resource Sciences. The research is funded by the Minnesota Soybean Promotion and Research Council. My prior work in infrared biometric imaging [7] and Magnetic Resonance Imaging (MRI) [8] provides me with a solid background in hyperspectral techniques.

Prior collaboration between the host, Dr. Papanikolopoulos, mutual collaborators, and myself have resulted in a record of significant research in the area of vision-guided robotics. The most cited work from these collaborations includes applications in intelligent vehicles, robotic grasping, and the production of three-dimensional point clouds [9, 10, 11]. Each of these can be incorporated into selective and precision application of agricultural chemicals by mobile and aerial robotic platforms.

My most recent efforts include curriculum development that enables the final key technology of this proposal. I have begun teaching data analytics in our CSCI 411 Advanced Databases and Project Management course. This has led to a program proposal that is still in development for a Bachelor's of Science degree in Data Science. My Ph.D. coursework in traditional artificial intelligence combined with my developing interest in data science allows me to bring cutting-edge deep learning and "big data" techniques to bear on the challenges faced by precision agricultural robotics.

The work will also support Dr. Papanikolopoulos's United States Department of Agriculture grant *"NRI: INT: COLLAB: Cooperative Robotic Systems for Precision Agriculture and Plant Health Managemenf'* and has the potential to generate future grant proposals and funding for LSSU.

Outcomes

The impact of this sabbatical is literally on a global scale. Environmentally-friendly techniques and more efficient and cost-effective crop production are critical technologies in the survival and

practices in artificial intelligence, which is a proposed course (CSCI 335 Artificial Intelligence) to support both the B.S. Robotics Engineering and the proposed B.S. Data Science. Other potential impacts to LSSU are discussed in the following:

1. The research is heavily applied, but includes fundamental basic research as the foundation for those applications. The knowledge gained can be transferred directly to the classroom via the proposed CSCI 335 Artificial Intelligence course and through existing courses such as EGRS 215 and EGRS 430. There is also potential enhancement of other courses outside my teaching qualifications through collaboration after my return, such as BIOL 235 (which has not been offered recently) and EVRN 445 (taught by Dr. Rocheford).

   My recent interest in GPU applications to data science and vision-based robotics has already resulted in a CSCI 291 student project in the Spring of 2019. A deeper experience is this sub-field of high-performance computing will undoubtedly enhance the student skill-set and real-world experience for our majors. Dr. Evan Schemm and I have recently discussed the need for some form of high-performance computing in our curriculum. This work would certainly play a role in any such effort.

   The work will also complement LSSU' s mission and natural resources focus as well as relating to a significant driver of Michigan's economy: agriculture. The research is inherently multi-disciplinary and is expected to contribute to the research corpus in computer vision/image processing, in autonomous robotics, in food science, and in agriculture. Research output directly related to the sabbatical should include scholarly publications, grant applications, and possible patents.

11. Beyond the obvious impact on Computer Science instruction and the relationship to proposed Data Science programs, this sabbatical can have significant enhancement of our B.S. degrees in Robotics, Biology, Environmental Science, and Cannabis. There is even an opportunity to apply this research to a certificate in Cannabis Robotics that emphasizes the use of robotics in the planting, growth, analysis, and harvest of *cannabis sativa.* The new programs in cannabis have generated great interest in LSSU and we have the opportunity to be at the leading edge, worldwide, in the automation of cannabis growth and harvest.

111. My collaboration with the USDA-funded team at the University of Minnesota, combined with extended travel to collaborate on site, will give me new perspective on educational and research practices beyond LSSU's campus. Fresh ideas and approaches are critical for the improvement of my instruction. Under the proposed contract, I will deliver a public presentation on the results of my sabbatical. That presentation would be the perfect venue to help propagate such educational and research practices to the LSSU campus community as a whole.

The benefits of this sabbatical extend beyond the classroom. My colleagues will have new possibilities for collaboration at LSSU and at Minnesota. Our students will receive instruction cutting edge of technology in sensing and robotics. Students in Environmental Science and GIS will have greater access to expertise both on- and off-campus. Students interested in graduate studies in any of these programs will benefit from increased name recognition of LSSU,

specifically in their fields of study.

Perhaps more importantly will be the impact upon myself. I am in my 24th year as a faculty member. My opportunities for substantial impact in my field and in my teaching have seemed to be diminishing in recent years. I have been looking forward to applying for sabbatical as a chance for revitalization. The impact on my school and my students would be transformational. That is, they would benefit from a professor with renewed and updated skills and a revitalized commitment to the classroom and the laboratory.

Timeline

- May - June 2020
  Initial travel to the University of Minnesota for project planning with the U of M research team.
- June - August 2020
  Initial investigation to determine the feasibility of alternate approaches to the major research issues. In particular, this time will be used to address sensing and diagnosis approaches.
- August - October 2020
  Sensing and diagnosis system prototyping will be performed, including travel to work with the team's hardware and software platforms. This work is likely to include the integration of my work in computer vision techniques for color and texture analysis with specific hardware for the USDA project. It is expected that this will involve NVidia Graphics Processing Unit implementations, including NVidia Jetson and Nano embedded systems platforms.
- October 2020 - February 2021
  Hardware prototyping and sensor-guided control development for the robotics systems. Since the USDA grant of Dr. Papanikolopoulos, et al. is centered upon a proof of concept for precision chemical application, the hardware prototype process is likely to be an extended iterative process where multiple proposed systems may be developed.
- February-May 2021
  Testing of selected prototypes in controlled laboratory environments will be conducted. The systems will be revised, enhanced, and changed as needed.
- May - August 2021
  Depending upon the success of the prior year's efforts, initial field testing at the U of M's College of Food, Agricultural and Natural Resource Sciences farms in St. Paul, MN may commence. Such testing will include travel and extended residency during the 2021 growing season.
- August - September 2021
  Return to regular faculty duties at LSSU with a proposed campus-wide presentation at the end of September.

1. National Agricultural Statistics Service, United States Department of Agriculture website, https://www.nass.usda.gov.
2. "Mississippi River/Gulf of Mexico watershed nutrient task force," *Report to Congress,* Environmental Protection Agency, 2015.
3. Schaub, H. and Smith, C. "Color snakes for dynamic lighting conditions on mobile manipulation platforms," *Proceedings 2003 IEEEIRSJ International Conference on Intelligent Robots and Systems,* 2003.
4. Smith, C."Fast tracking of natural textures using fractal snakes," *IEEE International Conference on Systems, Man and Cybernetics,* 2010.
5. Smith, C. "Anisotropic fractal snakes," *IEEE International Conference on Systems, Man, and Cybernetics,* 2014.
6. Zermas, D., Nelson, H., Stanitsas, P., Morellas, V., Mulla, D., and Papanikolopoulos, P., "A methodology for the detection of nitrogen deficiency in corn fields using high resolution RGB imagery," *under review,* 2019.
7. Ramadan, S., Abd-Alm ageed, W., and Smith, C., "Eye tracking using active deformable models," *International Conference on Vision, Graphics, and Image Processing,* 2002.
8. Abd-Almageed, W., El-Osery, A., and Smith, C., "A fuzzy-statistical contour model for MRI segmentation and target tracking," *Visual Information Processing XIII,* 2004.
9. Smith, C., Richards, C., Brandt, S., and Papanikolopoulos, N., "Visual tracking for intelligent vehicle-highway systems," *IEEE Transactions on Vehicular Technology,* 1996.
10. Smith, C. and Papanikolopoulos, N., "Grasping of static and moving objects using a vision-based control approach," *Journal of Intelligent and Robotic Systems,* 1997.
11. Smith, C. and Papanikolopoulos, N., "Computation of shape through controlled active exploration," *Proceedings of the 1994 IEEE International Conference on Robotics and Automation,* 1994.

UNIVERSITY OF MINNESOTA

November 10, 2019

Dear Provost:
I am writing to you regarding the application of Prof. Christopher Smith for a sabbatical which will be spent at the Minnesota Robotics Institute (MnRI), University of Minnesota. Let me state that I strongly support his application. I have known Chris since I 991. He is an accomplished scholar in robotics and computer vision and a real asset to any organization. Chris will be doing research at MnRI during the 2020-2021 academic year. He will be working on the use of robots for agricultural applications. Agriculture is an ideal industry for autonomous or semi-autonomous robotic systems because it involves many processes that are labor-intensive, repetitious, and rely on information that computers can interpret and respond to. It is important to note that water quality and monitoring are also connected to the broader area of agriculture.

Chris will be working on two subareas which are significant for the nation. The first is the rapidly developing field of precision agriculture. Precision agriculture encompasses technologies used to adapt farm production inputs through collected information to maximize production, quality, and sustainability. The second research focus in automated agriculture is in the physical processes of maintaining and harvesting of produce. However, research in automated agriculture has seen limited penetration into industrial practice, in part because the immediate and practical needs of farming operations are not being targeted by research. Minnesota has many organizations like the Corn and Soybean Growers Associations who have great interest in automation. Through relationships with the mentioned organizations, Chris will have an opportunity to work with them. Chris will also work on our recent USDA/NIFA award "NRI: INT: COLLAB: Cooperative Robotic Systems for Precision Agriculture and Plant Health Management."

Our laboratory will provide him an office, robotic equipment, supplies, funds to buy hardware, and computational resources in order to support his work. He will be interacting with many MnRI researchers and organizations like the Corn Growers group at MN. He will be also interacting with students in my lab and be participating in our weekly research discussions.

We are looking forward to working with Prof. Smith on an exciting project. If you need any further information, please feel free to contact me.

Sincerely,

Nikolaos P. Papanikolopoulos, IEEE Fellow
MnRI Director
McKnight Presidential Endowed Professor
Email: npapas@cs.umn.edu
Phone: 612-625-0163

Dr. Christopher E. Smith, Assistant Professor

School of Mathematics and Computer Science
Lake Superior State University
650 W. Easterday Ave.
Sault Ste. Marie, MI49783
Office: (906) 635-2162
Mobile: (231) 886-4797
Email: csmithl 6@lssu.edu

Education

Ph.D. - Computer Science with a minor in Cognitive Science, University of Minnesota, Thesis title: "Visually-Guided Manipulation of Static and Moving Objects," Thesis Advisor: Dr. Nikolaos Papanikolopoulos, 1996.

M.S. - Computer Science and Engineering, University of Michigan, 1987

B.S. - Computer and Mathematical Sciences, Lake Superior State College (renamed Lake Superior State University in 1987), 1984

Research Interests

Robotics, computer vision, wireless sensor networks, medical image processing, intelligent transportation systems, virtual collaborative environments, data science/analytics

Professional Experience

2018 - Present -Associate Professor, School of Mathematics and Computer Science, Lake Superior State University, Sault Ste. Marie, MI

2012 - 2018 -Assistant Professor, School of Mathematics and Computer Science, Lake Superior State University, Sault Ste. Marie, MI

2006 - 2012-Associate Professor, Department of Computer Science, Gonzaga University, Spokane, WA

2000 - 2006 -Assistant Professor, Department of Electrical and Computer Engineering, University of New Mexico, Albuquerque, NM

1996 - 2000 -Assistant Professor, Department of Computer Science and Engineering, University of Colorado at Denver, Denver, CO

1994 - 1995 -HPC Research Fellow, Army High Performance Computing Research Center, Dr. Nikolaos Papanikolopoulos, University of Minnesota, Minneapolis, MN

1992 - 1994 - Research Assistant, Dr. Nikolaos Papanikolopoulos, University of Minnesota, Minneapolis, MN

1991 - 1992- HPC Research Fellow, Army High Performance Computing Research Center, Dr. Maria Gini, University of Minnesota, Minneapolis, MN

1989 - 1991 - Senior Software Engineer, Cellular Infrastructure Group, Motorola, Inc., Arlington Heights, IL

1987 - 1989-Software Engineer, Defense Systems Division, Northrop Corporation, Rolling Meadows, IL

1985 - 1987-Teaching Assistant, Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, MI

1984 - 1985 - Instructor, Introduction to Computing, Adult Education Services of the Consolidated Community School District, Sault Ste. Marie, MI

Grants (PI, Co-PI, Key Personnel, Faculty Sponsor)

Youth Education in Aquaculture (YEA) - NCRAC Rapid Response, $34,907 (Co-PI), 2016

Visual Servoing of an Unmanned Aerial Vehicle (Faculty Mentor) - Fund for LSSU, $458 (Faculty Sponsor), 2016

Recruiting Engineers for Aquaculture Automation - Michigan STEM Partnership, $8,000 (Co-PI), 2015 - 2016

ZagApps: Mobile Device Applications Laboratory - National Science Foundation, $133,341 (Pl), 2011-2014 (2011-2012 at Gonzaga University, 2012-2014 at Lake Superior State University)

Operator Factors and Their Effect on Waste Truck Fuel Efficiency - City of Spokane (PI), $7,500, 2009-2010

Visual Servoing using Active Deformable Models - Sandia National Laboratories, $35,000 (PI), 2004

Visual Servoing for Mobile Manipulation Applied to National Security Applications - Sandia National Laboratories, $70,000 (PI), 2001 - 2003

Endoland, VR Endoscopic Simulator - Medview, Inc., $109,980 (Co-PI), 2001 - 2002

Visual Servoing for Grasping and Object Analysis - DOE University Research Program in Robotics (URPR) subcontract through the Manufacturing Engineering Program, $45,000 (PI), 2001 - 2004

University Programs Control Shell Software Grant - RTI, Inc., $50,000 (PI), 2000 - 2005

Raytheon Instructional Laboratory - Raytheon (Co-PI), $190,000, 1999

Lockheed Martin Sun Laboratory - Lockheed Martin, $240,00 (Co-PI), 1999

Bicycle Counter - Minnesota Department of Transportation, $20,000 (PI), 1997-1999

User Controlled Web Camera - Faculty Advisor, OSCAR, University of Colorado at Denver, $1,000 (Faculty Sponsor), 1997

Pentium-Based Computer Laboratory - SITFAC Grant, University of Colorado at Denver, $17,500 (Co-PI), 1996

Course Developmental Award - College of Engineering, University of Colorado at Denver, $1,000 (PI), 1996

Junior Faculty Development Award - University of Colorado at Denver, $2,900 (PI), 1996

Awards and Honors

Professor of the Year-University of New Mexico IEEE Student Chapter, 2002 - 2003

Runner-up, College of Engineering Teaching Award- College of Engineering, University of Colorado at Denver, 1997-1998

Departmental Service Award - Department of Computer Science, University of Minnesota, 1996

Doctoral Dissertation Fellowship - University of Minnesota Graduate School, 1995

Research Contribution Award - Department of Computer Science, University of Minnesota, 1994

Award for Academic Performance - Department of Computer Science, University of Minnesota, 1992

Rackham Graduate School Block Grant -University of Michigan, 1987

Cum Laude Graduate - Lake Superior State College, 1984

Mathematics Department Outstanding Student Award - Lake Superior State College, 1984

President's Achievement Scholarship - Lake Superior State College, 1981 - 1984

State of Michigan Competitive Scholarship - Lake Superior State College, 1981

Etta S. Kinnee College Scholarship - Pickford High School, 1981

Service

University

Faculty Association Executive Committee (LSSU)-2017 - Present

Faculty Association President (LSSU)- 2018 - 2019

Criminal Justice Search Committee - 2019 - 2019

Early/Middle College Committee (LSSU)-2017 - 2018

Presidential Search Committee (LSSU)- 2017 - 2018

Women in Technology Summer Camps (LSSU)-2016 - Present

General Studies Committee (LSSU) -2016 - Present

Grants and Contracts Work Group (LSSU)-2016 - Present

FIRST Robotics District Event Volunteer (LSSU)- 2016 - Present

FIRST Robotics Kick-off (LSSU)- 2014 - Present

Admissions Director Search Committee (LSSU)- 2015 - 2016

Upward Bound Career Day (LSSU)-2015

Leadership Camp Lunch (LSSU)-2015

University Restructuring Committee (LSSU)-2015

Faculty Senator (GU)-2008 - 2011

Academic Subcommittee of the Faculty Senate - 2008 - 2011

Research Council (GU) - 2007 - 2009

Faculty Senate President (UNM) - 2005 - 2006

Faculty Senate President Elect (UNM) - 2004 - 2005

Faculty Senate Operations Committee (UNM) - 2004 - 2006

Dean's Council (UNM)-2004 - 2005

University Planning Council (UNM) - 2004 - 2005

Governmental Relations Committee (UNM) - 2003 - 2006

Faculty Senator (UNM) - 2002 - 2006

School/College

Computer Science Search Committee (LSSU) - 2016 - Present

ACM Faculty Advisor (LSSU)-2014 - Present

EUP College Night (LSSU)- 2012, 2014 - 2016

Mathematics Search Committee (LSSU)- 2012 - 2013, 2017 - 2018

Computer Science Search Committee (GU) - 2008 - 2009

Computer Engineering Search Committee (GU)-2006 - 2007

College of Engineering Ph.D. and Research Committee (UCD)- 1998 - 2000

College of Engineering Criteria and Standards Committee (UCD)- 1998 - 2000

Dean's Ad Hoc Committee on the Institute of Technology Computing Service Fee (UMN)- 1994

Departmental

ABET Coordinator (GU) - 2008 - 2009

ACM Faculty Advisor (GU) - 2007 - 2009

IEEE Student Chapter Faculty Advisor (UNM) - 2003 - 2006

IEEE Computer Society Faculty Advisor (UNM)- 2000 - 2006

Computer Use Committee (UNM)- 2001 - 2005 (Chair)

Undergraduate Committee (UNM)- 2000 - 2001, 2003 - 2006

ACM Faculty Advisor (UCD) - 1998 - 2000

Criteria and Evaluation Committee (UCD)- 1998 - 2000 (Chair)

Grievance Committee (UCD)- 1996 - 1998 (Chair 1997 - 1998)

Undergraduate Committee (UCD)- 1996 - 1998

ABET/CSAB Accreditation Committee (UCD)- 1996 - 1998

Faculty Search Committee (UCD) - 1996 - 2000 (Chair Search, 1999 - 2000)

Equipment Committee (UCD) - 1997 - 2000

Faculty Search Committee (UMN) - 1993 - 1994

Computer Science Graduate Student Association President (UMN) - 1993 - 1994

ACM Student Chapter Vice-Chair (LSSU)- 1983 - 1984

Professional

ACM International Collegiate Programming Contest Site Coordinator, *Association for Computing Machinery*- 2014, 2016-2018

Program Committee, *IEEE International Conference on Systems, Man, and Cybernetics* - 2011

Associate Editor, *IEEE Transactions on Education* - 2007 - 2009

Best Experimental Paper Committee/Judge, *IEEEIRSJ International Conference on Intelligent Robots and Systems* - 2005

Program Committee, *IEEEIRSJ International Conference on Intelligent Robots and Systems* - 2005

Program Committee, *IEEE International Conference on Robotics and Automation* - 2004

Associate Editor, *IEEE Transactions on Systems, Man, and Cybernetics - Part A* - 2002 - 2004

Program Committee, *IEEE International Symposium on Computational Intelligence for Robotics and Automation* - 2003

Program Committee, *IEEE International Conference on Robotics and Automation* - 2002

Program Committee, *IEEE International Symposium on Computational Intelligence for Robotics and Automation* - 2001

Robotics Competition Judge, *AAAI-99 Annual Meeting*- 1999

Local Arrangements Committee, *IEEE International Conference on Robotics and Automation* - 1996

Reviewer- Artificial Intelligence, Rich and Knight, revised third edition
Digital Ima2:e Processing, Castleman, revised second edition
IEEE Control Systems Magazine
IEEE Robotics and Automation Magazine
IEEE Transactions on Robotics
IEEE Transactions on Systems, Man and Cybernetics
IEEE Transactions on Image Processing
Image and Vision Computing Journal
Image Communication
Journal of Integrated Computer-Aided Engineering
Journal of Intelligent Systems
Journal of Intelligent & Robotic Systems
Journal of Robotic Systems
Mathematical and Computer Modeling-An International Journal
IEEE International Symposium on Computational Intelligence for Robotics and Automation
IEEE International Conference on Computer Vision and Pattern Recognition
IEEE International Conference on Robotics and Automation
IEEEIRSJ Conference on Intelligent Robotics and Systems
AAA! Student Paper Session

Community

Applying to College, Pickford Community Library-2018, 2019

Maker Fest, Pickford Community Library-2017

First Robotics Mentor, Sault Area High School - 2013 - 2017

Making and Learning, Pickford Community Library and the University of Michigan School of Information Science - 2016

4-H Science Day Mentor -2012 - 2015, 2016

Sault Middle School Career Day at LSSU - 2015

Community Meeting on Chippewa County Broadband Connectivity - 2014

Robotics Session, Girls Scouts of America- 2010

Lego Robotics Club Mentor, Odyssey Program, Spokane Public Schools - 2010

First Robotics Mentor, Lewis and Clark High School- 2008 - 2010

Design Competition Judge, Lewis and Clark High School - 2008

Science Crawl, UNM/Museum of Natural History-2004

Sandia High School Student Mentor - 2003 - 2004

Regional Science Fair Judge, School of Engineering Scholarship Award-. 2002 - 2005

Career Enrichment Center Student Mentor - 2002 - 2003

Departmental Tour Host, San Felipe Pueblo-UNM ECE-2002

Robotic Turtle Consultant, Tom Stoppard's *Arcadia,* Denver Theater Company - 1997

Professional Society Membership

Institute of Electrical and Electronics Engineers (Member 1992, Senior Member 2011)

Association for Computing Machinery (Member 1995)

Publications

Journal Publications

W. Abd-Almageed, A. El-Osery, and C. Smith, "Estimating time-varying densities using a stochastic learning automaton," *Soft Computing,* l 0(11):1007-1020, September, 2006

W. Abd-Almageed, and C. Smith, "Active deformable models using density estimation," *International Journal of Image and Graphics,* 4(3):343-361, July 2004

N. Papanikolopoulos and C. Smith, "Issues and experimental results in vision-guided robotic grasping of static or moving objects," *Industrial Robot,* 25(2):134-140, 1998

C. Smith, S. Brandt, and N. Papanikolopoulos, "Eye-in-hand robotic tasks in uncalibrated environments," *IEEE Transactions on Robotics and Automation,* 13(6):903-914, 1997

C. Smith and N. Papanikolopoulos, "Grasping of static and moving objects using a vision-based controlapproach," *Journal of Intelligentand Robotic Systems: Theory and Applications,* 19:237-270, 1997

C. Smith, C. Richards, S. Brandt, and N. Papanikolopoulos, "Visual tracking for intelligent vehicle-highway systems," *IEEE Transactions on Vehicular Technology,* 46(4):732-743, 1996

Refereed Conferences

C. Smith, "Anisotropic fractal snakes," *Proceedings of the IEEE International Conference on Systems, Man, and Cybernetics,* 2014

P. Gilfeather-Crowley, C. Smith, and S. Youtsey, "Connecting visually-impaired people to friends through wireless sensor networks," *Proceedings of the IEEE International Conference on Systems, Man, and Cybernetics,* 2011

H.J. Min, N. Papanikolopoulos, C. Smith and V. Morellas, "Feature-based covariance matching for a moving target in multi-robot following," *Proceedings of the Mediterranean Conference on Control and Automation,* 2011

R. Tomkins, T. Jones, R. Nertey, C. Smith, and P. Gilfeather-Crowley, "Reconfiguration and management in wireless sensor networks," *Proceedings of the IEEE Sensor Applications Symposium,* 2011

C. Smith, "Fast tracking of natural textures using fractal snakes," *Proceedings of the IEEE International Conference on Systems, Man, and Cybernetics,* 2010

C. Smith and H. Schaub, "Efficient polygonal intersection determination with applications to robotics and vision," *Proceedings of the IEEE/RSJ International Conference on Intelligent Robot and Systems,* 2005

W. Abd-Almageed, A. El-Osery and C. E. Smith, "A fuzzy-statistical contour model for MRI segmentation and target tracking," *Proceedings of SPIE,* July 2004

W. Abd-Almageed, A. El-Osery and C. E. Smith, "A hybrid fuzzy-statistical contour model," *SPIE Defense and Security Symposium,* April, 2004

H. Schaub and C. Smith, "Color snakes for dynamic lighting conditions on mobile manipulation platforms," *Proceedings of the IEEEIRSJ International Conference on Intelligent Robot and Systems,* 2003

W. Abd-Almageed, A. El-Osery, and C. Smith, "Non-parametric expectation maximization: a learning automata approach," *Proceedings of the IEEE International Conference on Systems, Man, and Cybernetics,* 2003

W. Abd-Almageed, C. Smith, and S. Ramadan, "Kernel snakes: non-parametric active deformable models," *Proceedings of the IEEE International Conference on Systems, Man, and Cybernetics,* 2003

S. Ramadan, W. Abd-Almageed, and C. Smith, "Eye tracking using active deformable models," *Proceedings of the Indian Conference on Computer Vision, Graphics, and Image Processing,* 2002

W. Abd-Almageed and C. Smith, "Mixture models for dynamic statistical pressure snakes," *Proceedings of the International Conference on Pattern Recognition,* 2002

W. Abd-Almageed and C. Smith, "Contour migration: solving object ambiguity with shape-space visual guidance," *Proceedings of the IEEE/RSJ International Conference on Intelligent Robot and Systems,* 2002

W. Abd-Almageed and C. Smith, "Hidden Markov models for silhouette classification," *Proceedings of the World Automation Congress 2002,* 2002

D. Perrin and C. Smith, "Rethinking classical internal forces for active contour models," *Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition,* 2001

J. Dukesherer and C. Smith, "A hybrid Hough-Hausdorff method for recognizing bicycles in natural scenes," *Proceedings of the IEEE International Conference on Systems, Man, and Cybernetics,* 2001

J. Wetherbie III and C. Smith, "Large-scale feature identification for indoor topological mapping," *Proceedings of the IEEE International Conference on Systems, Man, and Cybernetics,* 2001

C. Smith and D. Perrin, "HOLDeR: a layered system for vision-guided robotics," *Proceedings of the IEEE International Conference on Systems, Man, and Cybernetics,* 2000

D. Perrin, C. Smith, and N. Papanikolopoulos, "Depth extraction for contours by monocular eye-in-hand systems", *Proceedings of the 8th IEEE Mediterranean Conference on Control and Automation,* 2000

D. Perrin, 0. Masoud, C. Smith, and N. Papanikolopoulos, "Using fast statistical dynamic contours for grasping occluding contours", *Proceedings of the 8th IEEE Mediterranean Conference on Control and Automation,* 2000

D. Perrin, C. Smith, 0. Masoud, and N. Papanikolopoulos, "Unknown object grasping using statistical pressure models," *Proceedings of the IEEE International Conference on Robotics and Automation,* 2000

D. Perrin, 0. Masoud, C. Smith, and N. Papanikolopoulos, "Snakes for robotic grasping," *Proceedings of the 1999 European Control Conference,* 1999

C. Smith and N. Papanikolopoulos, "Using computer vision to guide robotic grasping," *Proceedings of the 1997 International Symposium on Industrial Robots,* 18:13-18:27, 1997

C. Smith and N. Papanikolopoulos, "Vision-guided robotic grasping: issues and experiments," *Proceedings of the IEEE International Conference on Robotics and Automation,* 3203-3208, 1996

C. Smith and N. Papanikolopoulos, "Theory and experiments in vision-based grasping," *Proceedings of the 34th IEEE Conference on Decision and Control,* 4053-4058, 1995

C. Smith and N. Papanikolopoulos, "Using vision-based control techniques for grasping objects," *Proceedings of the IEEE International Conference on Systems, Man, and Cybernetics,* 4434-4439, 1995

C. Richards, C. Smith, and N. Papanikolopoulos, "Vision-based intelligent control of transportation systems," *Proceedings of the 10th IEEE International Symposium on Intelligent Control,* 519-524, 1995

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Presentations, Seminars, and Colloquia

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"Arduino Programming and Making," *Making and Learning Workshop: Picliford Community Library,* July 2016

"Arduino Aquaponics," *Aquaculture Challenge Kick-Off,* February 2016

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"Computer Vision," *Mathematics and Computer Science Field Day,* October 2014

"Anisotropic fractal snakes," *IEEE International Conference on Systems, Man, and Cybernetics,* San Diego, CA, October 2014

"Fractal Mathematics Applied to Texture Tracking in Video Streams," *Annual Meeting of the Michigan Section of the Mathematical Association of America,* Sault Ste. Marie, MI, 2013

"Connecting Visually-Impaired People to Friends through Wireless Sensor Networks," *IEEE International Conference on Systems, Man, and Cybernetics,* Anchorage, AK, October 2011

"Segmentation and Tracking of Natural Patterns Using Fractal Snakes," *IEEE International Conference on Systems, Man, and Cybernetics,* Istanbul, Turkey, October 2010

"Virtual Collaborative Environments for Distance Education," *2008 E-Learning Research and Development,* Shanghai, China, March 2008

"Robotics," *Mathematics Engineering Science Achievement Competition,* Spokane, WA, December 2007

"Snake Charming: Improving the Performance of Parametric Active Deformable Models," *Gonzaga University,* Spokane, WA, March, 2006

"Efficient Polygonal Intersection Determination with Applications to Robotics and Vision," *IEEE/RSJ International Conference on Intelligent Robot and Systems,* Edmonton, AB, August 2005

"Key Research Challenges for Vision-based Guidance, Tracking and Robotic Grasping," *Toyota Technical Center,* Ann Arbor, MI, April, 2005

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"Contour Migration: Solving Object Ambiguity with Shape-Space Visual Guidance," *IEEEIRSJ International Conference on Intelligent Robot and Systems,* Lausanne, Switzerland, October, 2002

"Current Research in Active Deformable Models," *UNM Imaging Workshop,* Albuquerque, NM, July, 2002

"Robotics," *Gifted Mathematics and Science Class,* San Felipe Pueblo, NM, 2001

"A Hybrid Hough-Hausdorff Method for Recognizing Bicycles in Natural Scenes," *IEEE International Conference on Systems, Man, and Cybernetics,* Tucson, AZ, October, 2001

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"HOLDeR: A Layered System for Vision-Guided Robotics," *IEEE International Conference on Systems, Man, and Cybernetics,* Nashville, TN, October, 2000

"Vision-Guided Robotics: Combining Computer Vision and Robotics Via Control," *Mathematics and Computer Science Colloquia, Colorado School of Mines,* Golden, CO, February, 1997

"Vision-Guided Robotics," *Engineering Research Seminar, University of Colorado at Denver,* Denver, CO, December 1996

"Vision-Guided Robotics," *Department of Computer Science Colloquia, University of Colorado at Boulder,* Boulder, CO, November 1996

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"Vision-Guided Robotic Grasping: Issues and Experiments," *IEEE International Conference on Robotics and Automation,* Minneapolis, MN, April 1996

"Theory and Experiments in Vision-Based Grasping," *34th IEEE Conference on Decision and Control,* New Orleans, LA, December 1995

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