



Occupational Robotics Safety and Health Extramural Research Overview

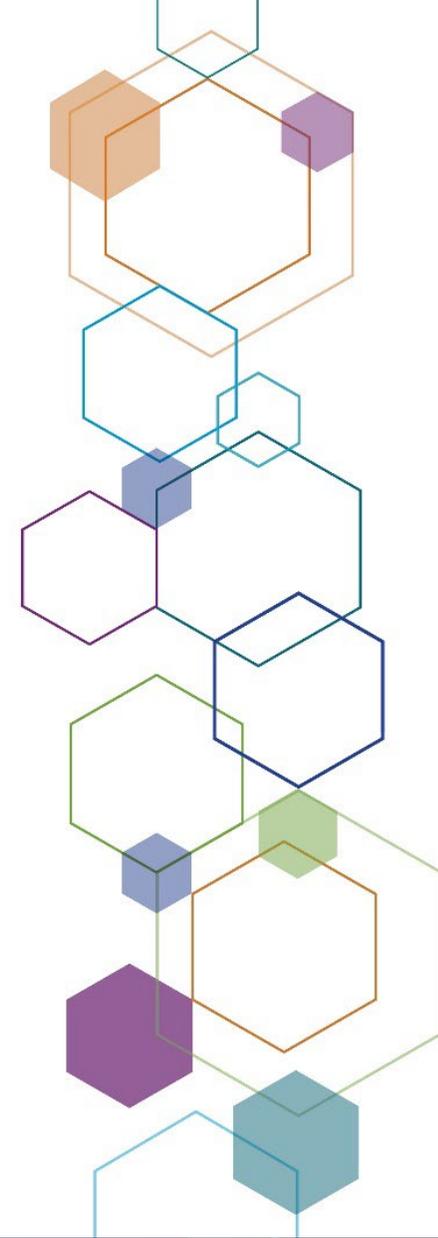
W. Allen Robison, PhD
Director, Office of Extramural Research

Board of Scientific Counselors Meeting
April 20, 2022

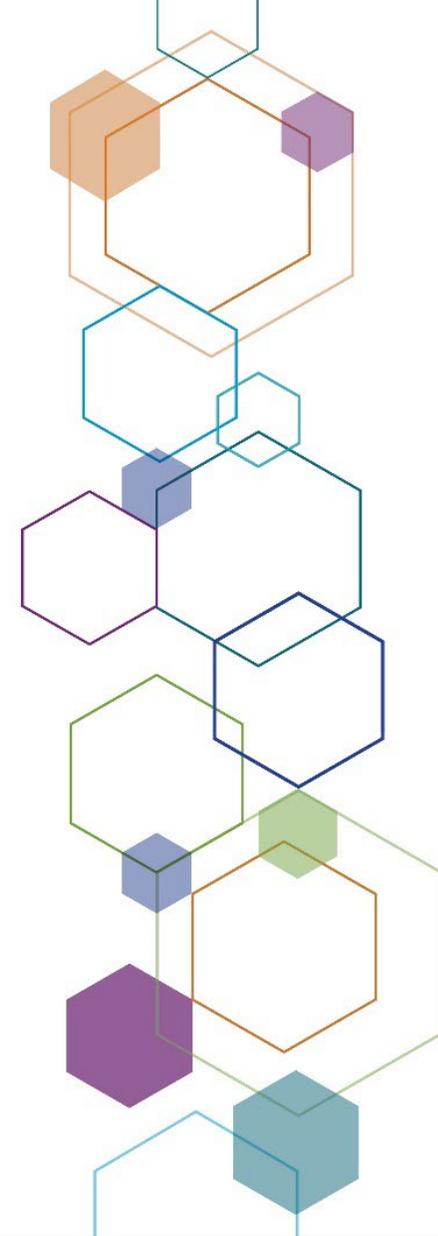


Topics

- NSF National Robotics Initiatives (NRI)
 - FY2020
 - FY2021
 - FY2022
- National Construction Center Small Studies
- Other Research

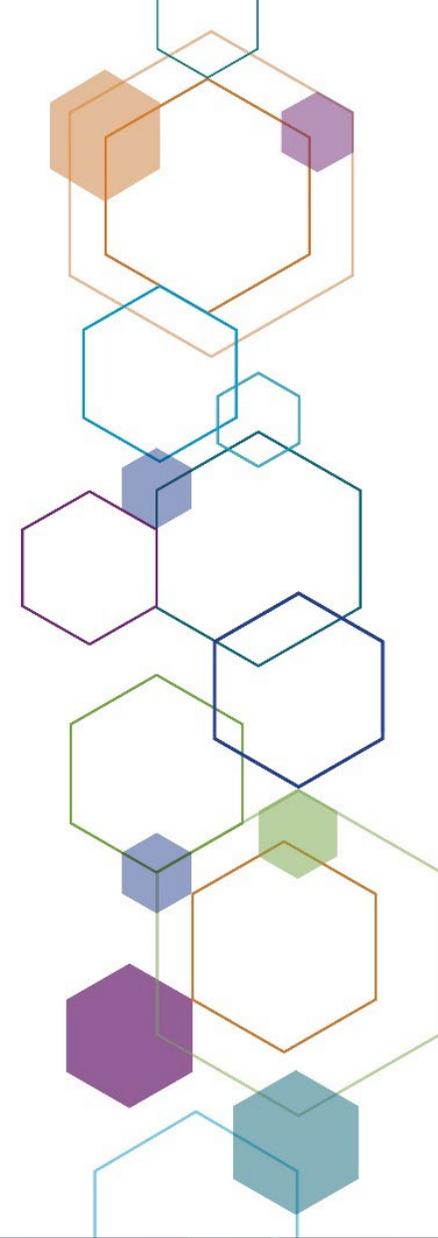


Participants in NSF National Robotics Initiative



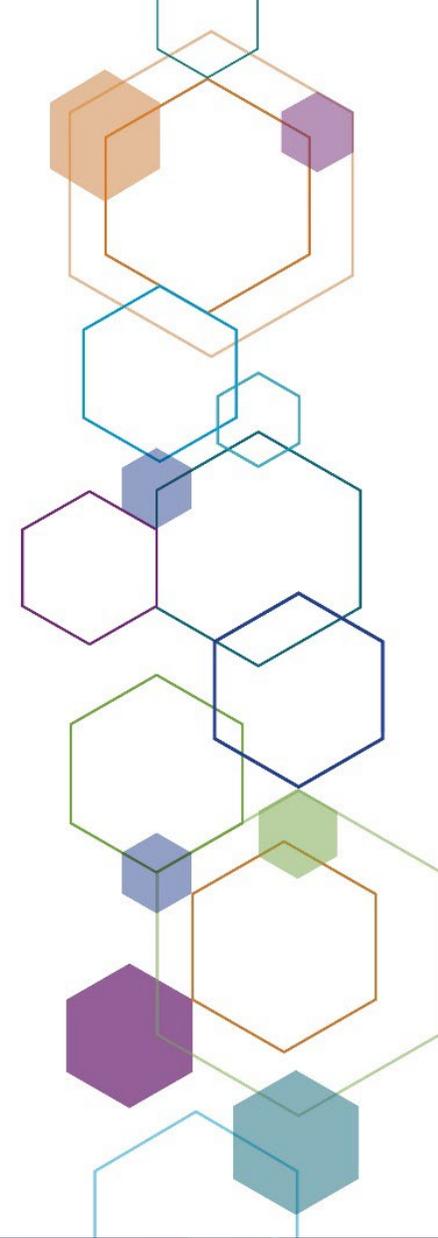
NRI Partnership is Valuable

- Advances NIOSH research portfolio in occupational robotics research.
- Leverages resources with federal partners.
- Raises NIOSH research needs among established robotics research community.

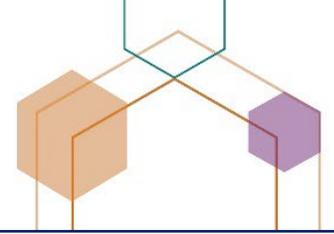


NRI 2.0 Ubiquitous Collaborative Robots

- Themes: scalability, customizability, ↓ barriers to entry, societal impact
- Project Classes
 - Foundational: focus on fundamental research
 - Integrative: innovative, collaborative, interdisciplinary
- NIOSH
 - Reduce workplace risk exposures
 - Risks of collaborative robots to workers
 - Control strategies
 - Basic/etiologic, intervention, translation, surveillance
- Published: December 2, 2019
- Receipt Window: February 12-26, 2020

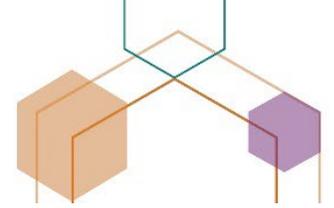


NRI 2.0 OSH Research Funded

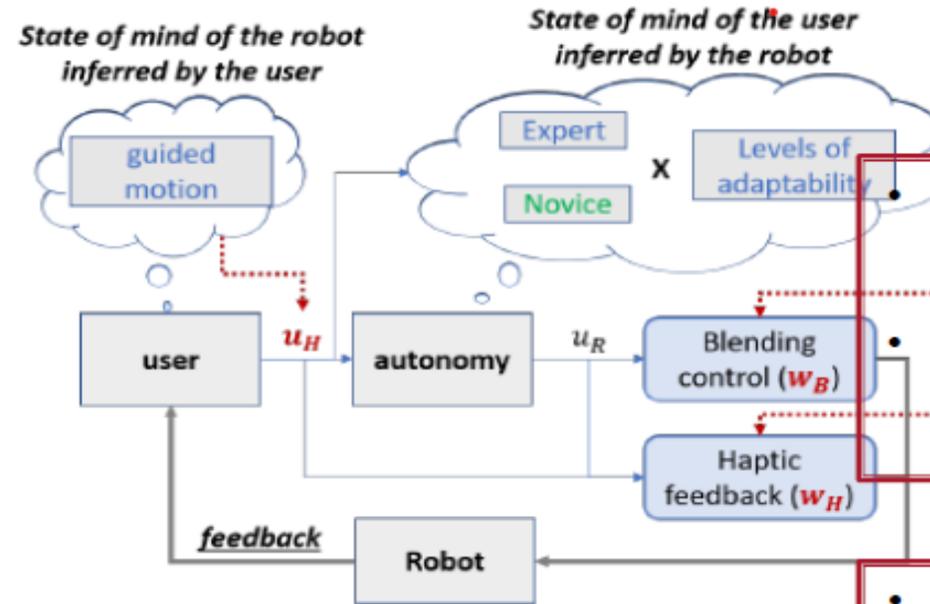
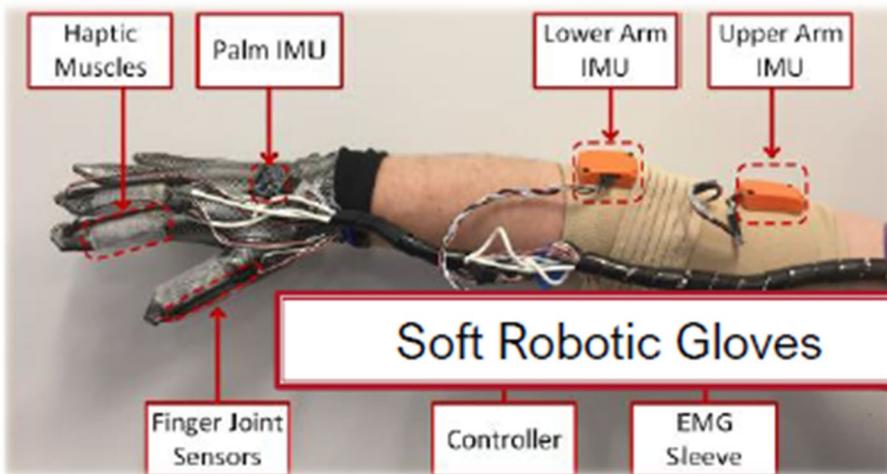


NIOSH	NSF
<p>Transparent and Intuitive Teleoperation Interfaces for Future Nursing Robots Worcester Polytechnic Institute (Li, Fu, Onal, Skorinko) Worcester State University (Telliell and Bylaska-Davies)</p>	<p>A Novel Intervention Method to Promote Workers' Safety Awareness and Mental Health during Human-Robot Collaboration NC State University (Xu, Chen, Feng, Liu, Wu)</p>
<p>Customizable Lower-limb Wearable Robot Using Soft-Wearable Sensor to Assist Occupational Workers University Illinois Chicago (M. Kim and H. Jeong) Georgia Tech (W.H. Yeo)</p>	<p>Investigating the Safety Challenges of Co-Drones in Future Construction Workplaces University of Florida (Gheisari, Hu, Jeelani)</p>
	<p>Improving Human-robot Collaboration on Assembly Tasks by Anticipating Human Actions University of Southern California (Nikolaidis and Gupta)</p>
<p>NIOSH investment (FY20-22): \$1.6M</p>	<p>NSF investment (FY20-22): \$2.3 M</p>

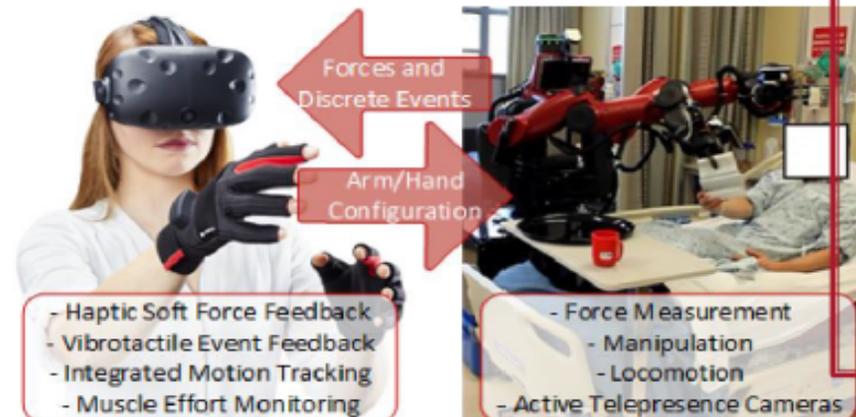
Transparent and Intuitive Teleoperation Interfaces for Future Nursing Robots



Robotic Haptic Glove



- Interactive learning via assist-as-need haptic feedback
- Principled method to achieve human-robot mutual Adaptation



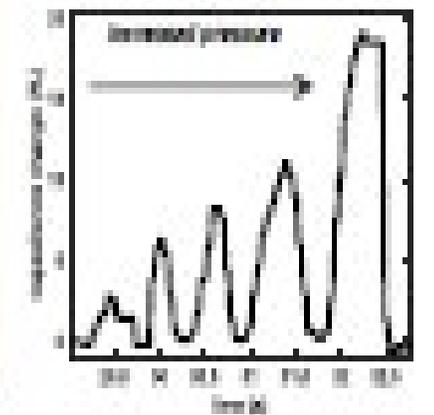
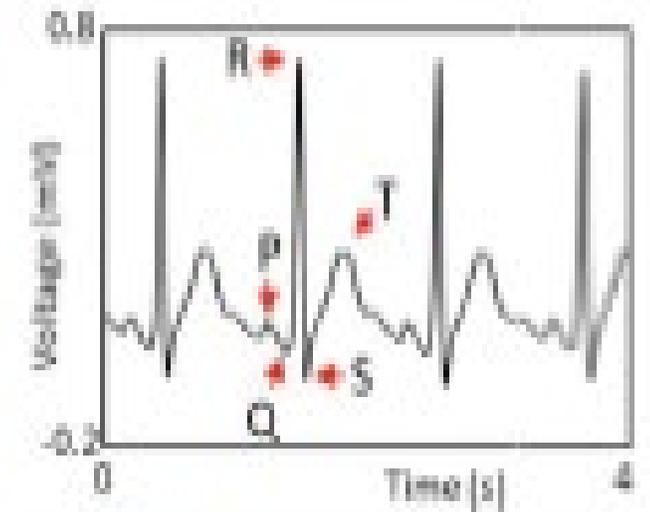
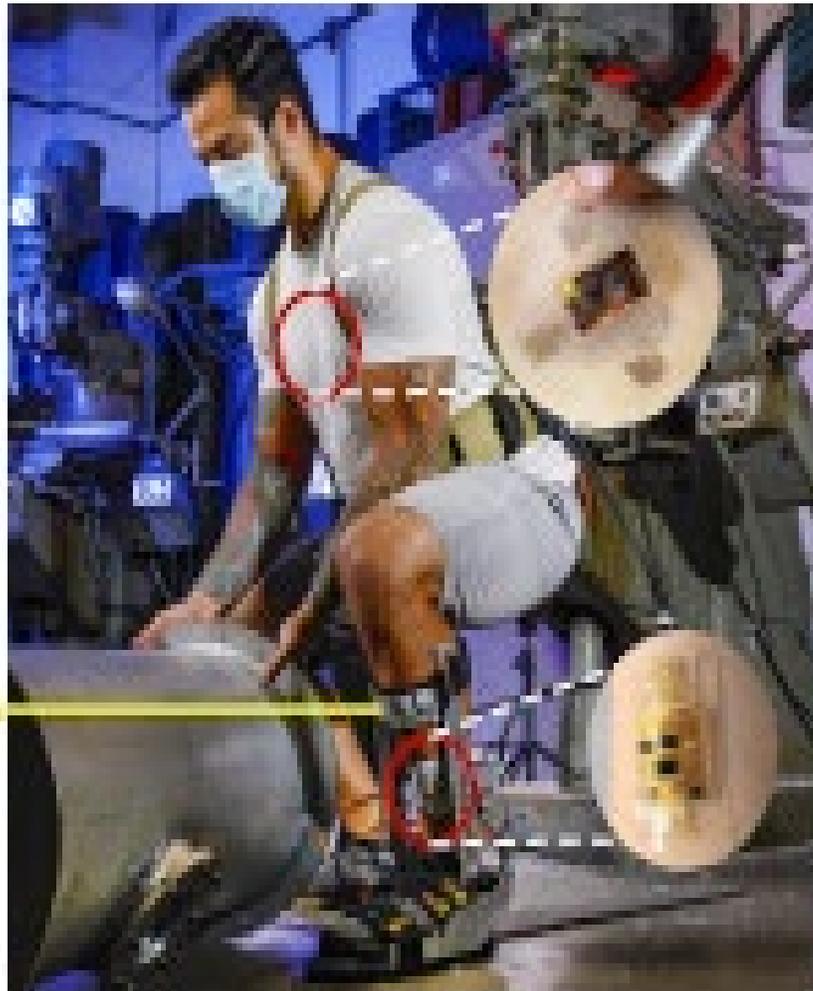
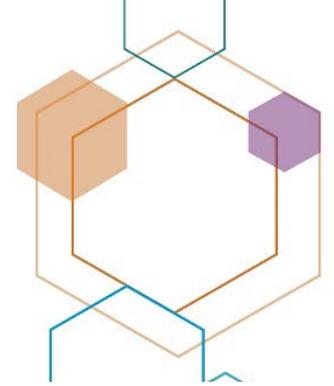
- Haptic Soft Force Feedback
- Vibrotactile Event Feedback
- Integrated Motion Tracking
- Muscle Effort Monitoring

- Force Measurement
- Manipulation
- Locomotion
- Active Telepresence Cameras

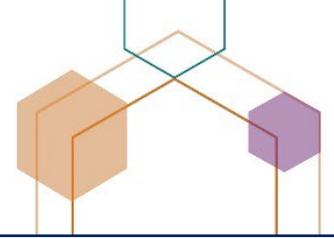
- Evaluate the usability of interface for nursing assistance tasks
- Evaluate the nursing workers' perception and acceptance of interface and nursing robot technologies

Customizable Lower-limb Wearable Robot Using Soft Wearable Sensor to Assist Occupational Workers

Customized exoskeleton example and soft wearable electronics



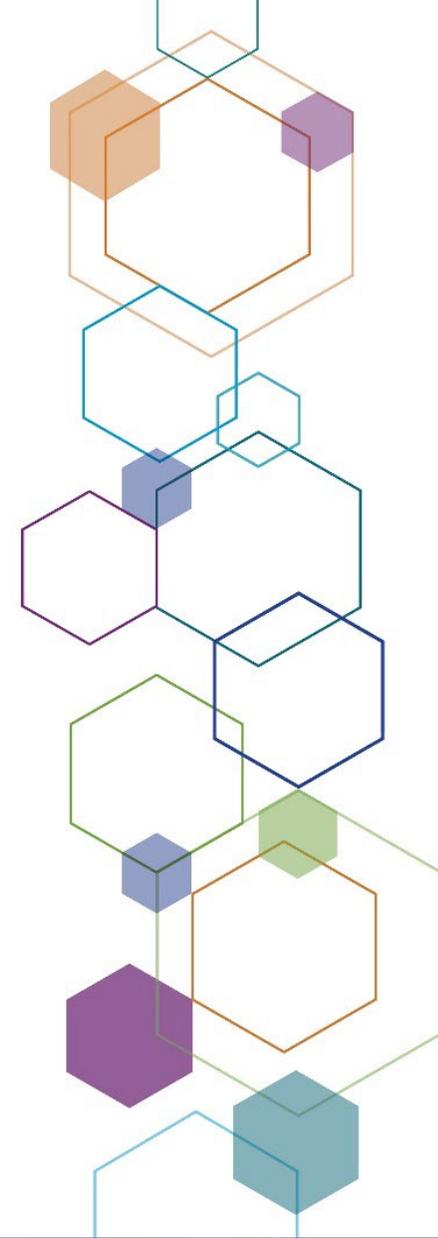
Progress for Grants Funded in FY2020



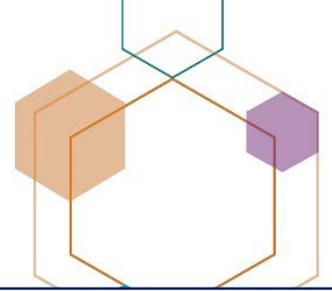
Transparent and Intuitive Teleoperation Interfaces for the Future Nursing Robots	Customizable Lower-limb Wearable Robot Using Soft-Wearable Sensor to Assist Occupational Workers
Prototype of robotic haptic glove and developed augmented reality feedback; pilot, experimental, human movement and simulation studies.	Preliminary results from controlled human subject experiment.
Findings incorporated into several robotics courses; Fall 2021 research project course to engage nursing students in the development of tele-nursing interfaces.	Graduate and undergraduate student engagement and presentations to high school students.
Journal articles and juried conference papers.	Presentations: joint TWH/ERC seminar, HFES and Tech Forums.
Papers in preparation or under review.	Papers in preparation or under review.

NRI 3.0 Innovations in Integration of Robotics

- NIOSH research needs:
 - Integration of robotics for reducing workplace exposures
 - Physical risks and sociotechnical challenges of robotics technologies
 - Evaluate different risk control strategies
- Published: February 4, 2021
- Multi-year Receipt Windows
 - 2021: April 19 - May 3
 - 2022: February 8 - 22



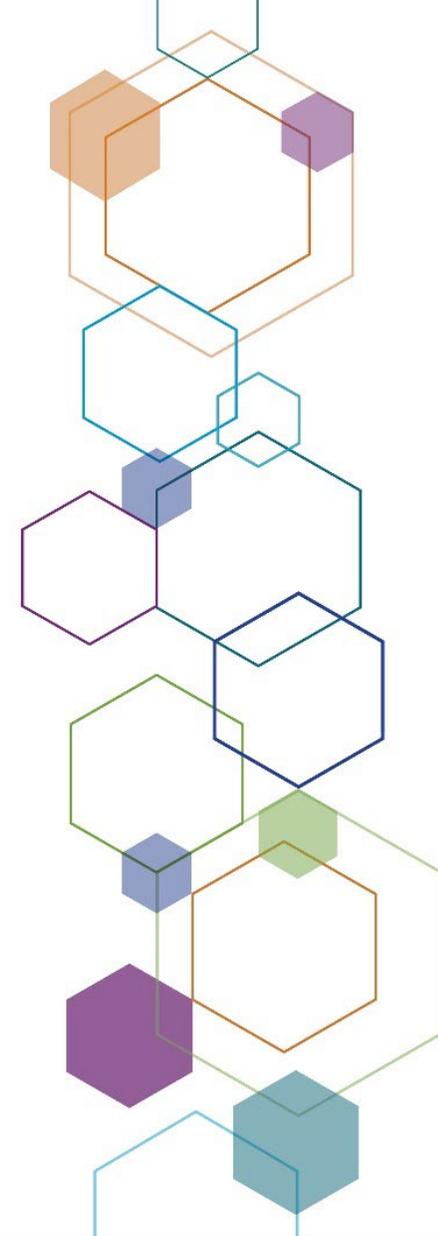
NRI 3.0 FY2021 OSH Research



NIOSH	NSF
Application receipt was completed very late in FY2021 (May 3). As a result, peer review and secondary were not completed prior to CDC deadlines for obligating funds.	Dispersed Autonomy for Marsupial Aerial Robot Teams University of Colorado-Boulder (Frew, Argrow, Sunberg) University of Nebraska-Lincoln (Houston)
Funding decisions were postponed until FY2022 and are pending implementation of a final FY2022 budget.	
NIOSH investment (FY22-25): TBD	NSF investment (FY21-24): \$1.5 M

NRI 3.0 FY2022 and Beyond

- FY2022
 - 180 applications received February 8 – 22
 - 26 OSH applications, 9 responsive to NIOSH requirements
 - NSF-NIOSH review panel scheduled May 16 – 17
- Beyond
 - NRI retires (12-year program)
 - NIOSH invited to participate in Foundations Research in Robotics Program
 - <https://beta.nsf.gov/funding/opportunities/foundational-research-robotics-robotics>
 - Accepting full proposals on continuous basis since August 2020

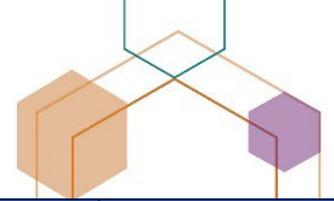


National Construction Center Small Studies



Project title	Investigator/Institution	Start Date End Date	Funding	Outputs
Using unmanned aerial systems (UAS) for automated fall hazard monitoring in high-rise construction projects	Masoud Gheisari, Ph.D., University of Florida Behzad Esmaili, Ph.D., George Mason University Abbas Rashidi, Ph.D., University of Utah	8/16/2018 8/15/2019	\$30,000	Final Report CPWR Key Findings Publication Presentations
Nebulizer-retrofitted drone deployment at residential construction sites	Rodney G. Handy, Ph.D., CIH University of Utah	6/1/2020 5/31/2021	\$29,996	In process
Protocol for assessing human-robot interaction safety risks	Chukwuma A. Nnaji, Ph.D., University of Alabama John A. Gambatese, Ph.D., Oregon State University	7/1/2020 6/30/2021	\$29,961	In process 1 publication
A practical model for measuring and mitigating safety hazards generated by using UAS in construction	Yelda Turkan, Ph.D., Oregon State University	8/15/2020 8/14/2021	\$30,000	In process
Safety challenges of UAV integration in the construction industry: Focusing on workers at heights	Idris Jeelani, Ph.D.; Masoud Gheisari, Ph.D. University of Florida	1/04/2021 1/04/2022	\$29,710	Study in Progress
			\$149,667	

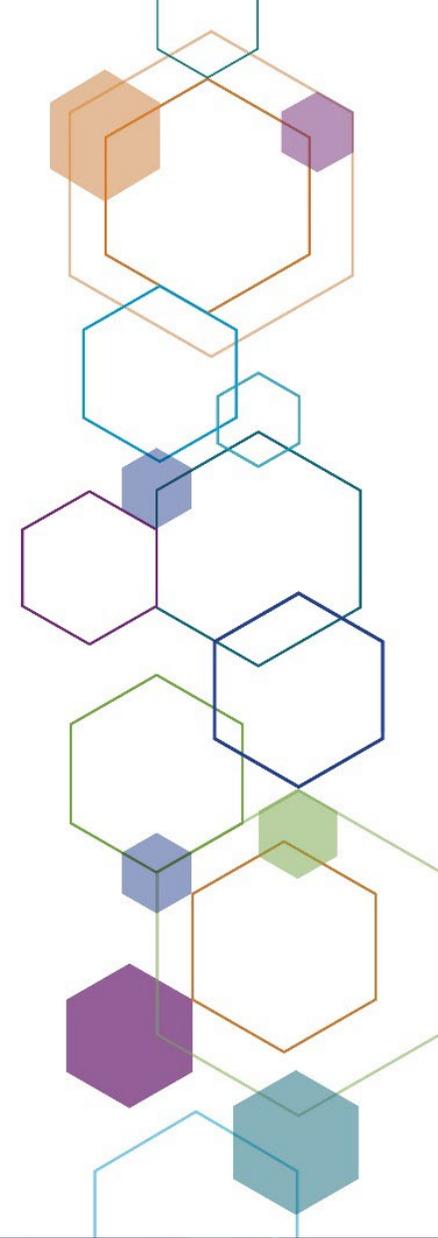
Grants Relevant to Robotics Safety and Health



Title	Institution	PI Name	Start	End	Notes
2016 U.S. Fire Service Technology Summit	National Fallen Firefighters Foundation	Kelly	8/1/2016	7/31/2017	Conference
Western Agricultural Safety & Health Conference: Prevention through Design in New Technologies (“Robotic innovation is most successful in strawberries and apples/tree fruit”)	University of Washington	Fenske	9/30/2018	9/29/2019	Conference
Rocky Mountain Center for Occupational and Environmental Health Pilot Project: Improvement of human safety in fault-tolerant human and robot collaboration using convex optimization and receding horizon control	University of Utah	Hegmann	7/1/2013	6/30/2018	ERC
Rocky Mountain Center for Occupational and Environmental Health: Subproject: Probabilistic Posture Modeling Enhances the Ergonomics and Safety of Human-Robot Collaborations	University of Utah	Merryweather	7/01/2018	6/30/2023	ERC
Southern California ERC Robotics in the workplace workshop	University of California-Los Angeles	Robbins	7/1/2017	6/30/2022	ERC
North Carolina ERC Pilot projects: Analysis of osha severe injury reports involving robots; Factors Affecting Trust in High-Vulnerability Human-Robot Interaction Contexts	University of North Carolina-Chapel Hill	Nylander-French	7/1/2017	6/30/2022	ERC
Western Mining Safety and Health Training Resource Center: An Integrated Approach	University of Arizona	Burgess	9/1/2017	8/31/2020	Miner Training Western US
Potential Ergonomic Benefits of Personal Collaborative Robots in Strawberry Harvesting	University of California-Davis	Pinkerton	9/30/2016	9/29/2022	Ag Center
A Citizen-Science Approach to Occupational Hazard Assessment Provisional Patent Application (US 63/148,952) <i>A High-Throughput, Robotic System for Analysis of Aerosol Sampling Filters</i> submitted March 2021.	Colorado State University	Volckens	9/1/2019	8/31/2023	R01
Research, Technological Innovations and Human Factors for Effective Miner Self-Escape from Underground Mine Emergencies	Missouri University of Science and Technology	Frimpong	9/1/2021	8/31/2025	Mining
Design and Demonstration of Intelligent Mines Evacuation and Mine Rescue System	New Mexico Institute of Mining and Technology	Roghanchi	9/1/2021	8/31/2025	Mining

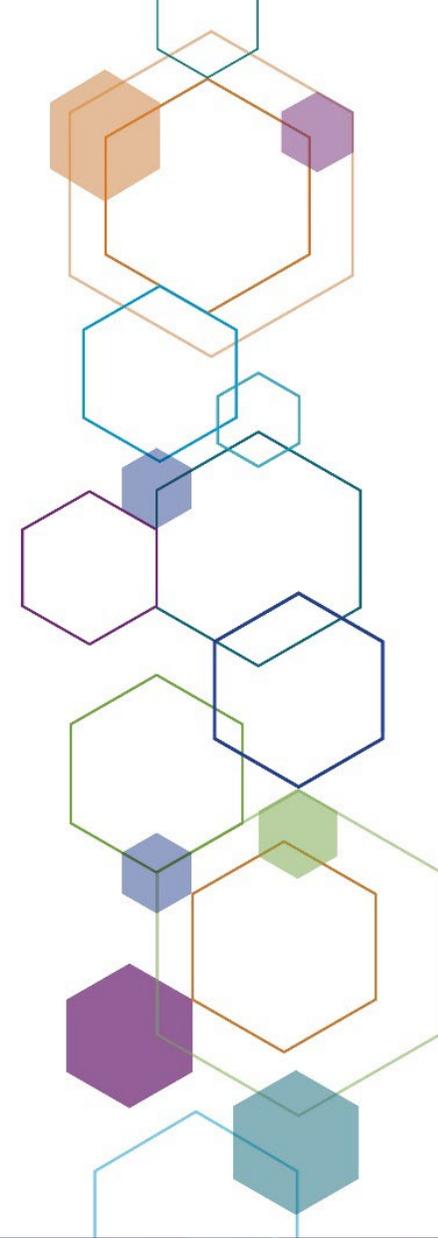
NIOSH Extramural Robotics Research Portfolio

1. Broad in nature.
2. Industry sectors include Agriculture, Construction, Healthcare, Manufacturing, Mining, and Public Safety.
3. Involves Centers for Agricultural Safety and Health, Education and Research Centers, and the National Construction Center.
4. Includes pilot research projects, investigator-initiated grant research, and conferences / scientific meetings.
5. Strong collaborations include NSF/NRI and NCC Small Studies.
6. Multiple paths support occupational robotics research and partnerships.
7. Research area continues to grow and emerge.



Acknowledgements

- Office of Extramural Programs
 - Sharon Chiou, PhD
- Center for Occupational Robotics Research
 - Dawn Castillo, MPH
 - Jacob Carr, PhD
 - Marvin Cheng, PhD
- Office of the Director
 - Frank Hearl, PE





Thank you