BILLING CODE 4163-19-P

DEPARTMENT OF HEALTH AND HUMAN SERVICES

Centers for Disease Control and Prevention

[Docket Number CDC-2018-0046, NIOSH-313]

Occupational Robotics Research Prioritization

AGENCY: National Institute for Occupational Safety and Health (NIOSH) of the Centers for Disease Control and Prevention (CDC), Department of Health and Human Services (HHS).

ACTION: Request for information and comment.

SUMMARY: The National Institute for Occupational Safety and Health of the Centers for Disease Control and Prevention has recently established the Center for Occupational Robotics Research. NIOSH is requesting information to guide the prioritization of research to be undertaken by the Center. NIOSH is seeking input on priority gaps in knowledge on the safety and health of humans working with robotics technology, with an emphasis on worker safety and health research which is unlikely to be completed by other federal agencies, academia, and the private sector.

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DATES: Electronic or written comments must be received by [INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION DATE IN THE FEDERAL REGISTER].

ADDRESSES: You may submit comments, identified by CDC-2018-0046 and docket number NIOSH-313, by any of the following methods:

- *Federal eRulemaking Portal*: http://www.regulations.gov Follow the instructions for submitting comments.
- *Mail*: National Institute for Occupational Safety and Health, NIOSH Docket Office, 1090 Tusculum Avenue, MS C-34, Cincinnati, Ohio 45226-1998.

Instructions: All information received in response to this notice must include the agency name and docket number [CDC-2018-0046; NIOSH-313]. All relevant comments received will be posted without change to www.regulations.gov, including any personal information provided. For access to the docket to read background documents or comments received, go to www.regulations.gov. All information received in response to this notice will also be available for public examination and copying at the NIOSH Docket Office, 1150 Tusculum Avenue, Room 155, Cincinnati, OH 45226-1998.

FOR FURTHER INFORMATION CONTACT: Hongwei Hsiao, Ph.D., NIOSH Division of Safety Research, 1095 Willowdale Road, Morgantown, WV, 26505, 304-285-5910 (not a toll-free number), hhsiao@cdc.gov

SUPPLEMENTARY INFORMATION: Industrial robots have been a significant part of the workplace for decades. Within the last decade, there have been dramatic advances in robotics technology which have changed the types of work performed by robots and how robots interact with human workers. Whereas traditional industrial robots operate in cages or

cells that are off-limits to human workers, newer types of robots are designed to work in collaboration with and in shared spaces with human workers. In collaborative operation, robots work in close proximity to humans and can potentially come into contact depending on the collaborative functionality implemented into the robot system. The use of robots has been rapidly increasing in many industrial sectors, including the manufacturing, healthcare, mining, and construction sectors. The International Federation of Robotics reported that the worldwide growth of industrial robots will be at least 15% annually from 2018 to 2020, and the stock of operational industrial robots will exceed 3 million units by the end of 2020 [IFR 2017]. Within the United States, sales of robots for industrial applications were at an all-time high in 2016, and have continued to increase since 2010 [IFR 2017].

The IFR also reports that robots equipped with collaborative functionality and utilizing machine learning and artificial intelligence will lead the robotics field in the coming years, and that robots will be increasingly used by small and medium sized businesses.

Robots are changing the industrial landscape which will have significant implications for worker safety and health.

Worker safety and health may be improved through increased use of robots for work that can be dangerous to humans, including repetitive tasks which are hazardous for musculoskeletal health, and work performed in hazardous environments, such as confined spaces and work at heights. However, there also are concerns for human worker safety and health arising from the rapid advances of robotics technologies, lack of experience working closely with new and emerging types of robots in varied work settings, and the potential for unforeseen hazards and unanticipated consequences [Murashov et al. 2016]. Predicted rapid growth in availability and sales of robots designed to work in close cooperation with human workers, and continued expansion into broader industry sectors and small and medium sized businesses, may present new risks or exacerbate existing risks for many workplaces.

While the volume of robotics research being conducted by the private sector, academia, and other federal agencies is large [Robotics Virtual Organization 2016], research focusing on the implications for worker safety and health has been limited, but critical. Whereas other federal agencies and academic programs strongly support technological advances in robotics and promote use in

certain industries, NIOSH aims to focus on worker safety and well-being with its vast experience in studying worker safety in the lab and in the field. Additionally, NIOSH has knowledge and expertise on diverse characteristics of worker populations, occupations and tasks, industries, and workplace environments.

In September 2017, NIOSH established the Center for Occupational Robotics Research (CORR), https://www.cdc.gov/niosh/topics/robotics/default.html. The Center's mission is to provide scientific leadership to guide the development and use of robots in the workplace that enhance worker safety, health, and well-being. The Center covers traditional fixed and caged robots, current and emerging robot systems (e.g., robots equipped with collaborative functionality, co-existing and mobile robots, powered exoskeletons/exosuits, drones, and off-road autonomous vehicles), and future robots utilizing artificial intelligence. The Center will conduct and encourage research on robotics as engineering controls to improve workplace safety, as well as robots as potential hazards to worker safety and well-being, including psychosocial impacts from humans working closely with robots. The Center will not address non-powered

exoskeletons, algorithms that do not involve machine movement (e.g., software bots that write news stories), and robot functions and efficiency. The Center will work in partnership with academic researchers, trade associations, robot manufacturers and integrators, employers using robotics technology, labor organizations, and other federal agencies. The Center aims to fill gaps in worker safety and health knowledge that are unlikely to be addressed independently by other federal agencies, academia, and the private sector.

The Center for Occupational Robotics Research has nominally identified research needs to be addressed by the Center. These research needs are consistent with robot-related research goals included in the recently finalized NIOSH Strategic Plan: FYs 2019-2023, but are more detailed. The research needs are organized by the four research types conducted by NIOSH: basic/etiologic, intervention, translation, and surveillance. NIOSH is seeking feedback on potential refinements to these research needs that address important worker safety and health knowledge gaps that have not been addressed, and how the identified research should be prioritized. The identified research needs follow.

Basic/etiologic: This type of research builds a foundation of scientific knowledge to base future interventions. Most laboratory research falls into this category, as well as exposure assessment. Robot-related injuries occur as a result of complex interactions of multiple risk factors which can be characterized as: human-related, robot-related, and task-related and environmental. Research needs in this area include:

- Identification of human worker risk factors and refinement and development of science-based requirements and pain and injury thresholds for human worker contact with robots in the workplace. The factors include workers' cognitive capability, physiological characteristics, biometrics, and anthropometry, and may have different implications associated with different types and characteristics of robotics technologies. This line of research also includes friction and shear injury thresholds from exoskeleton contact with body regions and joint hyperextension risks associated with wearable robots.
- Study of human workers' acceptance to working with and alongside robots and its impacts on human-robot interaction and worker safety and well-being. This

includes workers' attitudes, trust, and perceived safety.

- Measurement of worker's situational awareness, which refers to an ability to identify, process, and comprehend environmental information, and its impacts on human-robot interactions under normal and abnormal operating conditions. This research includes evaluation of existing situational awareness research methods and tools for application to varied robotics technologies and work environments.
- Study of safe, intuitive, and useful robot technologies and engineering features of collaborative and co-existing robot systems (e.g., enhanced robot sensors, mobility and navigation systems, adaptation and self-learning systems, design and programming of autonomous robots, automation operation assistance systems, and cyber-social-physical security) for hazard exposure assessments, field inspections, and incident investigations.
- Study of interface and safety communication features of robots with collaborative functions, powered exoskeletons (i.e. wearable robots), service robots, and other interactive robots that may cause human

injuries from sources such as unintended contact, collision, vibration, and overexertion.

- Identification of task-related and environmental risk factors that are specific to certain industrial sectors that have a high prevalence of robots (e.g., manufacturing), or in which robotics technology is beginning to be introduced (e.g., mining, healthcare, services, construction, agriculture, public safety, and wholesale sectors).
- Study of hazardous situations outside normal operating conditions, such as robot breakdowns and malfunctions and unexpected changes in the environment.

Intervention: This type of research engages in the development and evaluation of a solution to an occupational safety and health problem or the improvement of an existing intervention. Intervention is a broad term that includes engineering controls, personal protective equipment, training, and fact sheets and other written materials intended to inform and change worker behavior. There are two primary thrusts to this area of occupational robotics research: 1) evaluation of robotics technologies as preventive measures for existing workplace hazards and 2) development and evaluation of interventions to reduce

robot-related injury incidents and improve the safety and well-being of human workers working with robotics technologies. Specific research needs in this area include:

- Collection and analysis of differences in fatalities, injuries, and near-miss incidences between workplaces using robotics technologies and similar workplaces without robotics technology.
- Evaluation of robotics technologies as interventions for preventing existing hazards and resulting injuries in the workplace such as musculoskeletal disorders.
- Evaluation of training that helps workers acquire skills, knowledge, and abilities needed to work with robots in complex and dynamic industrial environments.
- Study of the effectiveness of existing safety standards, certifications, and regulations for industrial robot safety (e.g., ISO/TS 15066, ANSI/RIA R15.06, ISO 10218.01, ISO 10218.02, UL1740) in ensuring the safety and well-being of human workers.
- Research on new workplace interventions to improve the safety and well-being of human workers working with robotics technologies, including engineering controls and administrative controls. Research may address

costs and benefits, such as an assessment of the costs of the intervention and impacts on productivity.

Translation: This type of research discovers strategies to translate research findings and theoretical knowledge to practices or technologies in the workplace. This type of research seeks to understand why available, effective, evidence-based interventions are not being adopted, and to facilitate the use of existing or newly developed interventions. Occupational robotics research needs in this area include:

- Research on aids and barriers to employers using long established safety procedures for protecting workers from traditional industrial robots.
- Development and evaluation of plain-language guidance on preventing robot-related injuries to workers.
- Development and evaluation of dissemination strategies to facilitate the use by employers and other stakeholders of existing and new guidance.
- Study of awareness and acceptance of organizations to using evidence-based resources to implement robot safety management programs.

Surveillance: Surveillance is a public health term for the ongoing and systematic collection, analysis, and interpretation of data on health outcomes (e.g., injuries and illnesses) and contributors (e.g., behaviors or actions), and the dissemination of these data to those in position to take action. Surveillance research includes development of new methods, tools, and analytic techniques. Current worker injury data systems do not include detailed information on how a robot-related fatality or injury incident occurred. There is case-based information from investigations of worker injury deaths conducted by NIOSH and the Occupational Safety and Health Administration (OSHA). However, these investigation findings are limited to the traditional industrial robots, and do not address emerging robotics technologies. Additionally, case-based information may not be representative of all robot-related fatalities. Occupational robotics surveillance research needs include:

- Development of surveillance methods and/or analytic techniques to identify and monitor robot-related injury incidents and risk factors, and quantify the burden of occupational injuries using existing data systems.

- Case-based investigations of fatalities, injuries and near-miss incidents involving new robotics technologies to understand multi-faceted contributors to the incident.

Background: The purpose of the Request for Information is to seek input on priority research areas that NIOSH will address through the Center for Occupational Robotics Research.

Information Needs: NIOSH is seeking feedback on potential refinements to the four broad research areas identified above, any additional knowledge gaps not addressed by these research areas, and how the research areas should be prioritized. Commenters are asked to focus on research areas that NIOSH has comparative advantage in, compared to other federal agencies, academia, and the private sector (i.e., worker safety and well-being as opposed to robot technologies and production). When possible, NIOSH asks that commenters provide data and citations of relevant research to justify their comments. NIOSH is also seeking recommendations for key scientific articles addressing worker safety and health and robotics that should guide our research activities.

References:

Endsley M and Jones D [2013]. Designing situational awareness: an approach to user-centered design. Boca Raton, FL, CRC Press.

International Federation of Robotics (IFR) [2017]. Executive summary world robotics 2017 industrial robots. [https://ifr.org/downloads/press/Executive_Summary_WR_2017_Industrial_Robots.pdf].

Murashov V, Hearl F, Howard J [2016]. Working safety with robot worker: recommendations for the new workplace. J Occup Environ Hyg *13*(3):D61-71.

Robotics Virtual Organization [2016]. A roadmap for U.S. Robotics: from internet to robotics (2016 Edition). [https://robotics-vo.us/node/562].

Dated: May 8, 2018.

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[FR Doc. 2018-10165 Filed: 5/11/2018 8:45 am; Publication Date: 5/14/2018]