Ministry of Science and ICT

IITP Institute of Information & Communications Technology Planning & Evaluation

APPLICATION FORM
(JOINT RESEARCH)
HIGH POTENTIAL INDIVIDUALS GLOBAL TRAINING PROGRAM)

AGREEMENT

As stated above, I submit this application form to IITP that conducts "High Potential Individuals Global Training Program" supported by Ministry of Science, ICT in South Korea. IITP may disclose the information below to the public for the purpose of providing information and matching a research partnership between your institute and a Korean university.

* IITP : Institute for Information & communications Technology Planning & Evaluation

Printed Name of Chief of Research	Heejin Jeong	Date(mm-dd-yyyy)	01-31-2020
Signature of Chief of Research			

☞ ***(Note)*** *This application is to identify the willingness to participate in this research and to find a research partnership for research institutes in Korea. Therefore, in its sole discretion, it is acceptable to contain only minimal information. (max. 3 pages)*

1. Research Title	Development of Augmented Reality-Based Intelligent Injury Prevention System in Human-Robot Collaboration						
2. Research Area	**A.I.**	**Big Data**	**Cloud Computing**	**Block Chain**	**AR/ VR**	**ICT/SW Convergence**	**Other ICT /SW**
	X				**X**		
3. Chief of research	Title	Assistant Professor		Contact	E-mail : heejinj@uic.edu		
	Name	Heejin Jeong			Tel : +1-312-355-5558		
4. Affiliation	Name	University of Illinois at Chicago		Classification	(X) University ( ) Research Institute ( ) Industry ( ) ETC.		
5. Capacity for students (5 or less)	2		**Support for students** ***(all necessary)***		(X) Visa support (X) Research Mentoring (X) Research Space (X) Accessibility to Research equipment		
6. Research Objective	The ultimate goal of this proposed research is to minimize workplace risk exposure in human-robot collaboration (HRC). The research team will identify potential risks of co-robots (or collaborative robots) to workers via eye and motion tracking technologies. The team will develop a deep learning-based intelligent system that monitors injury hazard and						

	presents hazard exposure information to human workers via augmented-reality displays. The usability and effectiveness of the system for reducing the occupational injury risks will be evaluated in a controlled experiment.
7. Research Summary	Collaborative robots have been used to interact with human workers in the workplace and to maximize work performance for the past decades. The advent of the collaborative robots has brought benefits in manufacturing by integrating human workers' capabilities (e.g., dexterity, flexibility, and problem-solving skills) and mechanical robots' functionalities (e.g., strength, endurance, and precision). However, several challenges still remain to achieve an efficient human-robot collaboration. First, safe interaction between human workers and robots must be guaranteed to prevent human injury incidents that may happen in complex and dynamic industrial environments. Furthermore, it is necessary to design intuitive user interfaces to take full advantage of the human's physical and cognitive skills. In this proposed research, the US-Korean joint research team will conduct collaborative research to reduce workers' safety risk exposures in human-robot collaboration, using emerging technologies including augmented reality, artificial intelligence, and eye and motion tracking. This research project will be carried out in three phases. Phase 1 involves a direct observatory study identifying potential risks in the following applications of collaborative robots that most commonly used in manufacturing (Murashov et al., 2016; Villani et al., 2018): (1) picking, packing, and palletizing; (2) welding; (3) assembling items; (4) handling materials; (5) inspecting products for quality. Participants will be recruited to perform simulated HRC tasks. For each task, human workers' eye-tracking data (i.e., where they look at (areas of interest) and how long/frequent they look at each of the areas of interest) and motion-tracking data (i.e., how they physically interact with robots) will be collected. Moreover, human workers' situation awareness level will be measured via the Situation Awareness Global Assessment Technique (SAGAT), a most widely used questionnaire to assess an operator's situation awareness. The collected eye and motion tracking data will be used in developing a statistical risk awareness prediction model. The collected SA data will be used to validate the risk awareness prediction model as a reference method for comparison. In Phase 2, the research team will develop an intelligent injury prevention system based on the risk awareness prediction model. This system will be designed to present human workers' injury hazard exposure (i.e., risk awareness level and potential risk severity) in real time. In addition, using deep learning-based object detection and instance segmentation methods, the system will be designed to provide AR-based visual guidance that results in fewer injury risks to the human workers. The methods enable the construction of 3D replicas of real objects (e.g., robot arm, assembly parts) with annotations. The intelligent injury prevention system will be implemented via two types of augmented reality-based user interfaces: a wearable augmented reality (e.g., Hololens2 or Magic Leap) and a project-mirror augmented reality. Phase 3 will evaluate two user interfaces in a controlled experimental environment with human subjects. There will be multiple measures to evaluate the interfaces, including task performance (e.g., task completion time, accuracy), human worker's physical load (e.g., via electromyography, head/neck motion), and cognitive load (e.g., index of cognitive activity based on pupil size, electroencephalography), preference and usability of the interfaces. The result of the evaluation would support a more efficient way to prevent occupational injury risk in human-robot collaboration.

8. Need for funding from Korean government	The proposed costs will be used to support 1 or 2 Korean graduate students who will be sent out to the University of Illinois at Chicago to research abroad for 6 to 12 months (including allowance, airfare, health insurance, and living expenses). In addition, the funds will be used for partial support of a graduate student and an hourly-paid research staff (undergraduate or master) in the UIC. The costs also include a portion of summer salary for the principal investigator in the US university. Moreover, travel costs will be requested for the PI in the Korean university to the US university for the technical support and guidance. The fringe benefit rates are negotiated with the federal government. We expect to pay each of our 30 subjects $10 for participation ($300 total). The materials and supplies include a robotic arm (e.g., Universal Robot 3), sensors, and equipment to build project-mirror augmented reality (approximately $40,000 total). The indirect costs (Facilities and Administrative Costs) are applied to Modified Total Direct Costs (MTDS) and the rate is also negotiated with the federal government. The MTDC is direct costs, less the cost of tuition, equipment, and sub-contracts, as applicable. The indirect cost used is 59.9%.
9. Request for Korean Universities	Request for the Korean university includes: one or two graduate students who have experience in deep learning-based object detection and instance segmentation methods and augmented reality technologies; technical support and guidance from PI; discussion for the future potential collaborations.