Ministry of Science and ICT

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	Debra F. Laefer	Date	01-30-2020
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	Reinforcement Learning for Robotic Placement of a New Structural Steel Connection						
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	Professor		Contact	E-mail : debra.laefer@nyu.edu		
	Name	Debra Laefer			Tel : +1+929-248-2706		
4. Affiliation	Name	New York University		Classification	(x) University ( ) Research Institute ( ) Industry ( ) ETC.		
5. Capacity students	2		**Support for students**		(X) Visa support (X) Research Mentoring (X) Research Space (X) Accessibility to Research equipment		
6. Research Objective	To pioneer the automated placement and connection of structural steel members on construction sites using a simplified steel connection that is produced through advanced manufacturing techniques (laser cutting, plasma cutting or water jet with a 3-dimensional robotic arm)						
7. Research Summary	The project will use reinforcement learning and optimal control as the basis for training a robotic system to autonomously place and secure a structural steel connection. This will require planning complex sequences of movements and learning motor coordination using visual (2D and 3D) information. An example of the connection is shown in a beam-beam arrangement https://www.youtube.com/watch?v=zRWl5qpAjNc To achieve this, the connection's inventor Prof. Debra Laefer at New York University (https://engineering.nyu.edu/faculty/debra-laefer) is teaming up with her colleague Prof. Ludovic Righetti, Head of the Machines in Motion Laboratory (https://engineering.nyu.edu/faculty/ludovic-righetti), to offer an exciting research opportunity for either 1 student for 12 months or 2 students for 6 months to help pilot this work. The student will have round the clock access to a state of the art robotics space with high performance manipulators, mobile robots, and motion capture systems. We envision starting with a column-column connection. In this arrangement, there is only one connection that needs to be made (as opposed to a beam-beam connection, which requires left and right sides nearly simultaneously). Achieving this is likely to require mastering the following initial steps using the geometry of a standard I-beam and a single robotic arm. The main challenges to this are (1) the precise autonomous detection of columns; (2) planning the sequence of movements and online execution of behaviors using visual feedback to ensure high accuracy; and (3) mastering visual-motor coordination through reinforcement learning. The main initial tasks are listed below: 1. Automatically detect the position, orientation and (possibly) skewness of the already erected column using 3D sensors and high-resolution cameras 2. Automatically detect the "to be erected" column 3. Compute sequences of movements to re-orient the column, lift it, and rotate it to a fully vertical position, while avoiding obstacles (ground, other column, etc.) 4. Execute the sequences of movements using robust action-perception loops to ensure precision and repeatability 5. Position the two columns and interlace the teeth If these tasks are achieved, the next face will be undertaken, which will require a second robotic arm. In the second phase the "to be erected" column will be braced, side plates will be affixed to the flange edges that are toothed, and securing bolts will be affixed. This phase will require the acquisition of more complex manipulation skills and tool use. The NYU team will provide visa assistance, assistance in securing housing, desk space, laboratory access, training in machine learning and robotics.							

8. Need for funding from Korean government	The Korean construction market is well known to be more open to innovation than most, especially in the area of structural systems. Additionally, Korea has been a recent leader in the fields of robotics and advanced manufacturing. Thus, funding is requested to explore the opportunity to integrate newly simplified structural steel connections into a robotics-based workflow for on-site assembly. Today, the closest work in this area relates to the laying of masonry units and the tying of reinforcing bars. The tremendous complexity and variety of traditional bolted and welded structural steel connections has largely precluded their inclusion for a more automated solution, until now. We hope that by early partnerships in Korea that this technology will be earlier and more widespread adoption in the construction industry
9. Korean University Request	- The selection of students studying abroad should be conducted after mutual consultation, and please cooperate as much as possible to preparation of the Visa. We anticipate a weekly to semi-monthly call to report on the student progress on the project and anticipate joint publication(s) and press releases on this exciting project