Ministry of Science and ICT

IITP Institute of Information & Communications Technology Planning & Evaluation

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

AGREEMENT

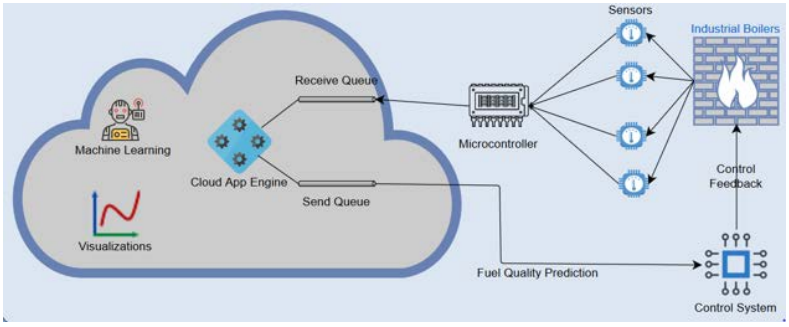
As stated above, I submit this application form to IITP that conducts "High Potential Individuals Global Training Program" supported by Ministry of Science, ICT in South Korea. IITP may disclose the information below to the public for the purpose of providing information and matching a research partnership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

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

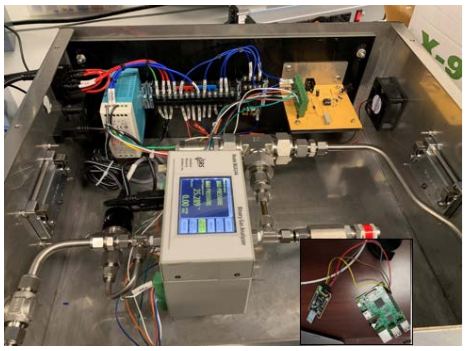
Printed Name of Chief of Research	Christopher Ryu	Date(mm-dd-yyyy)	02-13-2019
Signature of Chief of Research			

☞ ***(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	**Intelligent Combustion System with Real-time Fuel Quality and Parameters Prediction based on Big Data Analytics**						
2. Research Area	**A.I.**	**Big Data**	**Cloud Computing**	**Block Chain**	**AR/ VR**	**ICT/SW Convergence**	**Other ICT /SW**
	X	**X**	**X**			**X**	
3. Chief of research	Title	Professor		Contact	E-mail : tryu@fullerton.edu		
	Name	Christopher Ryu, Ph.D. Chan Seung Park, Ph.D.			Tel : +657-278-7231		
4. Affiliation	Name	California State University, Fullerton WC Global Energy Center at University of California, Riverside		Classification	(X) University (X) Research Institute ( ) Industry ( ) ETC.		

5. Capacity for students (5 or less)	Two	**Support for students** ***(all necessary)***	(X) Visa support (X) Research Mentoring (X) Research Space (X) Accessibility to Research equipment
6. Research Objective	To improve gas efficiency and reduce emissions in industrial combustion system, using fuel quality and optimal parameters prediction based on online learning and big data analytics		
7. Research Summary	Industries such as food, beer, beverage, baking, etc., heavily use natural gas-powered boilers. In these industries, even small improvement in fuel efficiency can significantly reduce the cost of gas consumption in their combustion systems (e.g., boilers) for daily business, which also results in reduction of criertia emissions including green house gas that help cleaner environment. The major factors that mainly affect the fuel efficiency are variations in the fuel quality of the natural gas (e.g., Wobbe Index) and use of non-optimal control parameters in a combustion system (e.g., amount of oxygen or air flow). The traditional method to measure the fuel quality requires complex, expensive, and bulky equipment that may not support real-time fuel quality measurement, which discourages many companies to economically and effectively use it. A team from California State University, Fullerton and University of California, Riverside has been working on developing an intelligent combustion system to address the above issues. The main goal of our project is to develop a system that can measure the fuel quality instantly using only a small sensor and find optimal control parameters for the combustion process based on the quality of the gas to improve fuel efficiency. Our approaches are to (1) estimate the fuel quality by measuring only the physical properties of gas such as temperature, thermal conductivity, sound velocity, and pressure (2) find an optimal setting based on the fuel quality and other control parameters (3) estimate the efficiency of the combustion equipment and (4) estimate the state-wide reduction of emissions to understand the environmental impact. Fig.1 below gives high-level illustration of our approaches:  Fig.1 For our proposed system, a sensor device that actually measures the physical properties and collects the data for analysis is critical. Fig.2 shows a prototype		

sensor we have developed for our research purpose in the past.



The device consists of four sensors to measure the physical gas properties and an IoT device for data collection. The actual size of this device is about the typical size of a personal computer. We expect that the size can be reduced to a typical controller when used for commercial use.

Fig.2

The following diagram, Fig.3, illustrates an architecture of our proposed system:

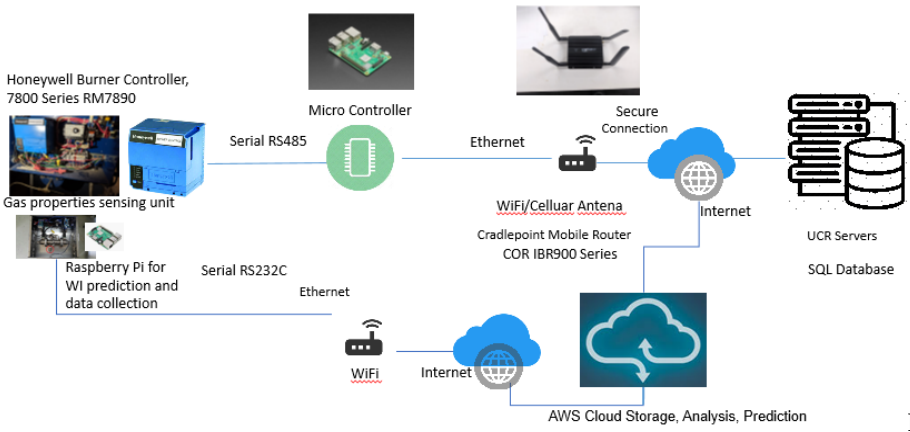


Fig.3

The physical properties of gas will be collected from the sensors and sent to an AWS cloud storage (e.g., using MQTT protocol). The collected data will be analysed in real-time by an adaptive online learning algorithm that predicts the fuel quality of the gas currently being used in a combustion system. The predicted fuel quality and control parameters will be sent to the combustion system. The combustion system will receive the data from the cloud and use it for setting optimal parameters. The combustion system will send the parameter data to the cloud storage as feedback for future refinement. The parameter data will then be saved in the cloud storage and analysed with another online learning algorithm. The estimated control parameters, along with the fuel quality data, will be sent to the combustion system. The system sets the necessary control parameters for optimal fuel efficiency. The entire process repeats.

So far, we have developed the prototype sensor device shown in Fig.2 and initial version of an online learning algorithm. There are many other elements shown in Fig.3 are not yet completed and currently being developed. We expect about 2 additional years to finish development of the entire system only for demonstration purpose with a real industry level combustion system on site. It will require several additional years to complete a fully functional system.

We prefer students with strong programming skills and reasonable background in

	mathematics (e.g., linear algebra, calculus). Students who will participate in this project will learn and experience the areas such as applications of aartificial intelligence, machine learning, statistical analysis, big data analytics, application development with AWS cloud, IoT, sensors, combustion science in industrial boilers, various properties of natural gases, and environmental issues.
8. Need for funding from Korean government	
9. Request for Korean Universities	(Example) - The selection of students studying abroad should be conducted after mutual consultation, and please cooperate as much as possible to prepare for VISA.