

The Department of Mechanical Engineering  
College of Engineering and Applied Sciences  
Stony Brook University  
**Mechanical Engineering Seminar**



**YuMing Zhang**

**James R. Boyd Professor, Department of Electrical and Computer Engineering  
University of Kentucky**

**Lecture Title: Extracting Human Intelligence from Complex Operations  
with Demonstration in Intelligent Welding**

**Friday, April 1, 2016 at 1:30 PM, Room 173 Light Engineering Building**

**Abstract**

Precision welding is an example of complex operations where adjustments are made by welders based on their observations on the dynamic change of the weld pool surface. As a big challenge in precision welding, the weld pool has a specular mirror surface that disqualifies the traditional method of diffuse reflection-based laser triangulation. An innovative method has thus been developed using the mirror surface advantageously to reflect the laser pattern away from the arc, simultaneously elegantly eliminating the arc illumination problem. To allow operators to freely demonstrate their skills, a human-robot collaborative system has been established where an operator carries a virtual tool, similarly as operating an actual tool, without a sensor. The movement is measured at the virtual system and then followed by a robot which carries the sensor and performs the actual operation. The measured operation result is displayed to the operator at the virtual site such that the operator can observe the change in the operation result to adjust his/her tool movement and other processing parameters. The true intelligence of the operator is thus contained in and can thus be extracted from the resultant data. To further extend the ability to unconfined environments, a wireless ultra-compact inertial measurement unit (IMU) including gyro, acceleration, and magnetic sensors has been attached to a manually operated tool to monitor its movement and orientation. To ensure the ultra-high precision needed for precision joining and other precision complex operations, the foundation has been established to self adaptively cross calibrate the sensors by detaching the quasi-stationary moments and to use advanced Kalman filtering algorithm to compute from noisy sensor signals.

**Biography**

Dr. YuMing Zhang has been with the University of Kentucky, Lexington, Kentucky, USA since 1991 where he was promoted to Professor of Electrical Engineering in 2005. He received his BS and MS degrees in control major from Harbin Institute of Technology (HIT) where he also finished his PhD degree in welding major in 1990. His research in machine intelligence and advanced controls with application in welding has been funded, primarily by the NSF and Navy, for \$6 million as PI and 1.5 million as co-PI. His research in this area has brought him 180 peer-reviewed journal publications and 8 US patents. His recognitions include numerous awards from the American Welding Society (AWS), The Institution of Mechanical Engineers (United Kingdom), International Federation of Automatic Control (IFAC), as well as plenary speaker in numerous international conferences. Four of his PhD students won the prestigious Henry Granjon Prize on behalf of the US from the International Institute of Welding (IIW) against winners from other IIW member countries. YuMing Zhang is currently one of the two Lead Principal Reviewers (editors) for the peer-reviewed papers in the AWS's Welding Journal, and an Associate Editor for IEEE Transactions on Automation Science and Engineering and SME Journal of Manufacturing Processes. He is also a Fellow of the AWS, the ASME, and the SME.

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