

## **D. In Situ Weld Pool Measurement Using Stereovision**

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### **Introduction**

Our goal is to develop a robotic, out-of-position welding system using GMAW for welding on pipe. To achieve this we must develop a closed-loop feedback control system for monitoring and controlling the welding process, and we must develop models of the welding process that can be used online, in real-time to make adjustments to the welding process. Most welding processes use the human as the feedback mechanism to close the loop on process control. Automated welding systems do not have a human in the loop and, as a result, most of them are open loop processes (although there may be closed-loop subsystems within the system, e.g. current control). Closed loop control for robots has been largely confined to seam tracking and weave control. Typically, automated welding systems rely on the weld seam being horizontal (in-position) to mitigate the effects of gravity.

### **Procedure**

Our welds are produced using a Fanuc 100iB 6-DOF robotic welder with a Lincoln Powerwave 455 power source, a Tregaskiss torch, and 0.035 wire. The Gas Metal Arc Weld pulsed (GMAW-p) process uses a shielding gas that is 75/25 Ar/CO<sub>2</sub>. The welds are bead-on-plate welds with the 8 mm (3/8 inch) plate in a vertical (downhill) position (out-of-position). Weld beads one hundred millimeters in length are deposited on the base metal. Welding parameters were systematically varied to determine their effect on the weld bead morphology. The following parameters were varied.

- Travel speed
- Torch angle
- Wire feed speed
- Peak current
- Background voltage
- Standoff Distance

For each experiment, the profile of the weld bead is measured.

### **Results and Discussion**

These experiments have not been completed at this time. Results will be available at the conference.

### **Conclusions**

Proper identification of the relationship between GMAW process parameters and their effect on the weld are critically important to the development of automated out-of-position welding. Automation of out-of-position welding, especially for pipe, is a tremendous challenge that will require additional sensing capability and better (and real-time) processes if we are to be successful. This work is one step in developing that goal and the results should be of interest to all those who wish to develop automated out-of-position processes.