Miniature Torch Speed Sensor Based Adaptive Manual Arc Welding

June 26, 2020 Workforce Development Panel Meeting via Zoom

OUTLINE

1. Previous Work

2. Team/Participating Partners and Objective

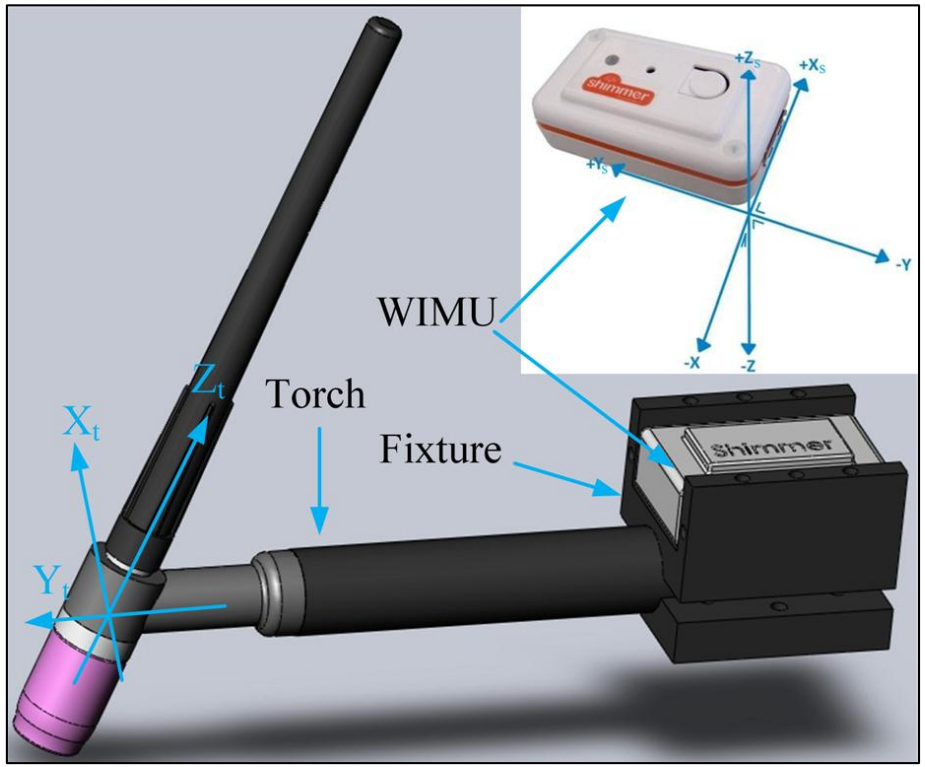
3. Progress

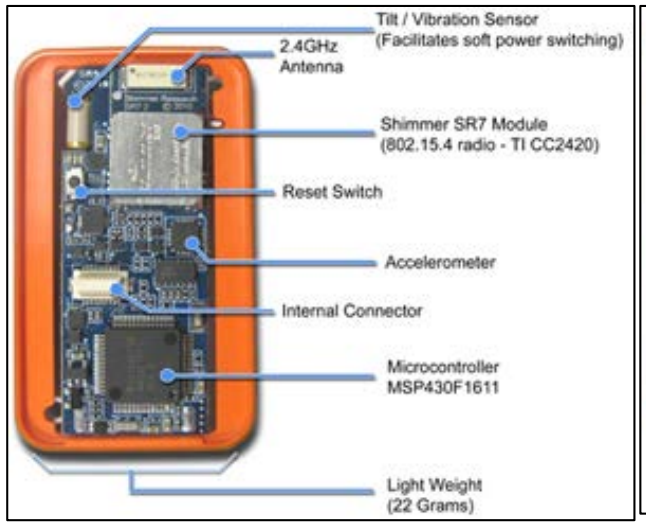
4. Next Actions

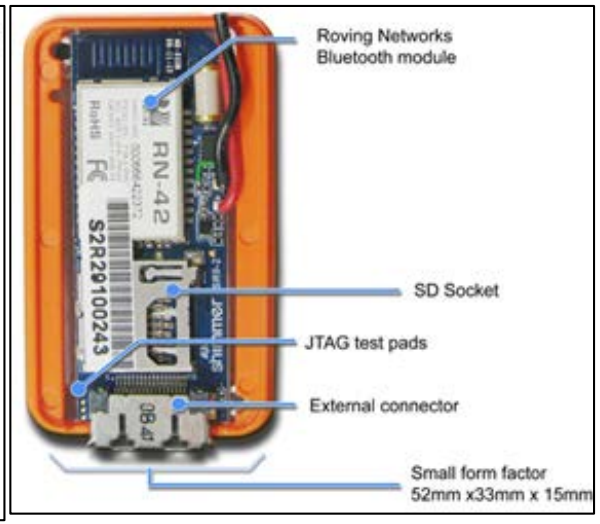
5. Benefits

Previous Work: IMU Based Method

Simmer Inertia Measurement Unit



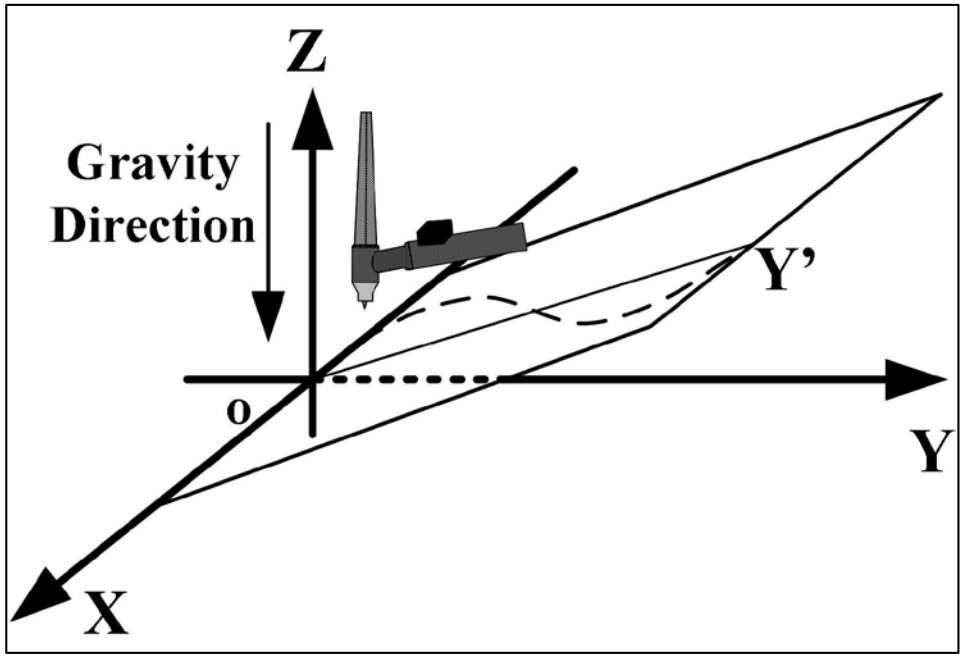


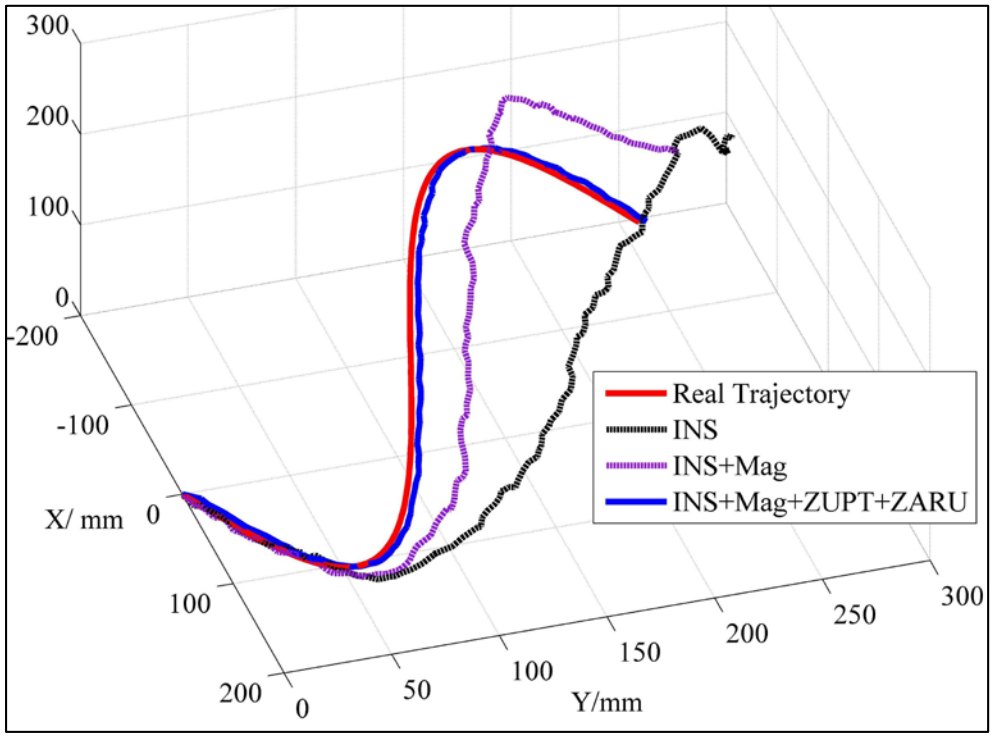


(1) tri-axial accelerometer (Freescale MMA7260Q); (2) tri-axial gyro sensor (InvenSense 500 series); (3) a magnetometer; (4) a microprocessor (MSP430F1611); (5) a Bluetooth unit.

Previous Work: Experiments and Results Analysis

- **Position experiment 2:** The torch is smoothly moved along the 3-D since curve.





The results of torch trajectory position estimation

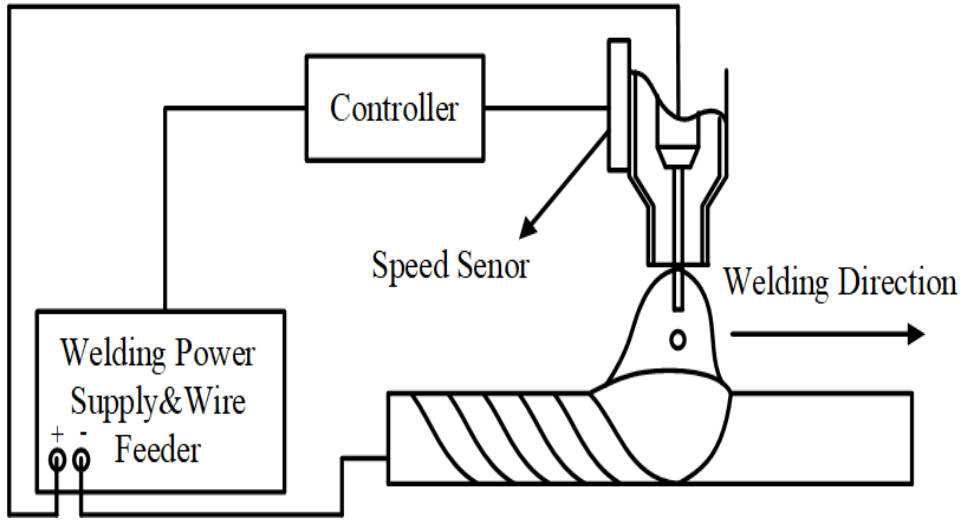
Estimation methods	Position error (% of TTD)
Kalman-based INS	> 25
INS+magnetometer	[7-16]
INS+magnetometer+ZUPT+ZARU	[0.5-1.7]

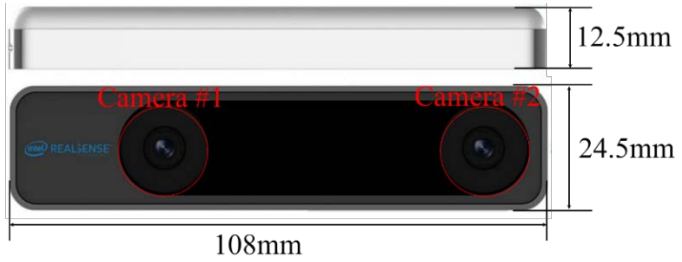
Measurement errors in Position Experiment 2

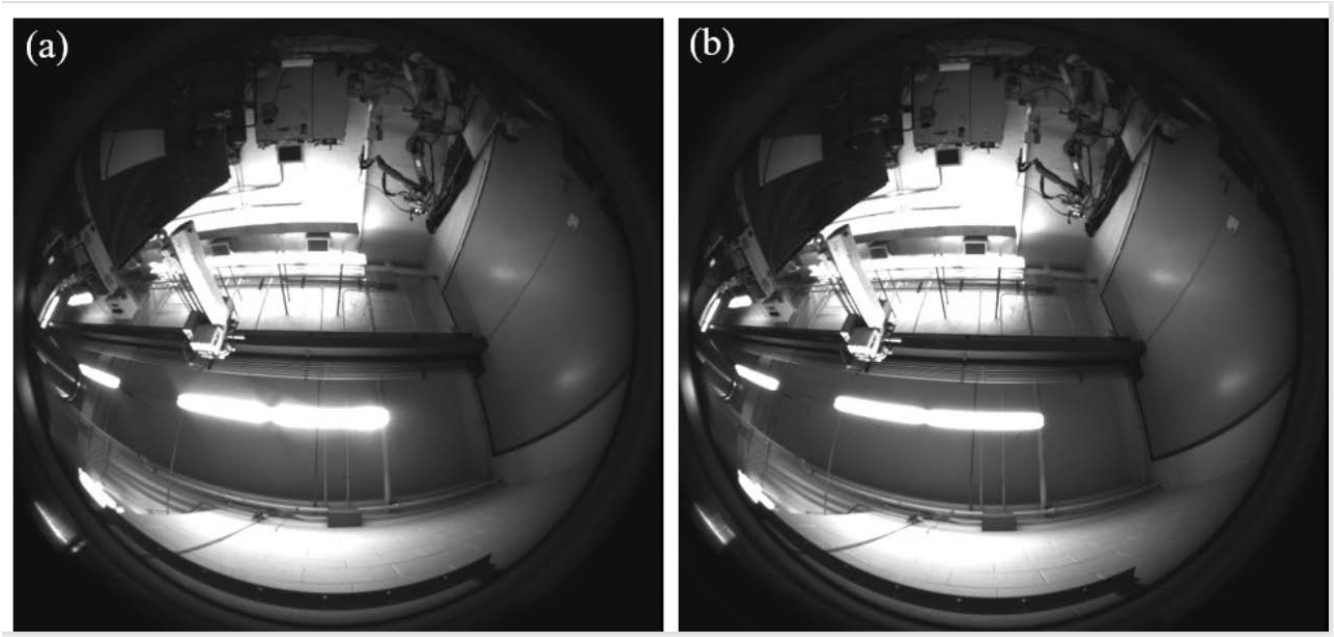
Team/Participating Partners of "Miniature Torch Speed Sensor Based Adaptive Manual Arc Welding"

- PI: YuMing Zhang - University of Kentucky
- Shipyard Application: Joe Caron - Huntington Ingalls Industries (Ingalls)
- Equipment and Commercialization Path: Todd Holverson - Miller Electric Company
- TPC: Yu-Ping Yang - Huntington Ingalls Industries (Ingalls)

Objective: IMU+Vision



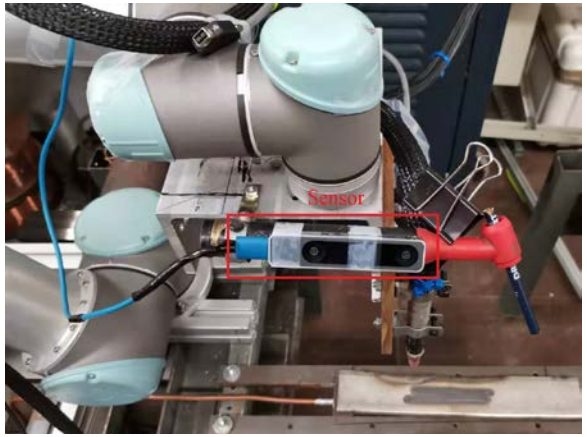


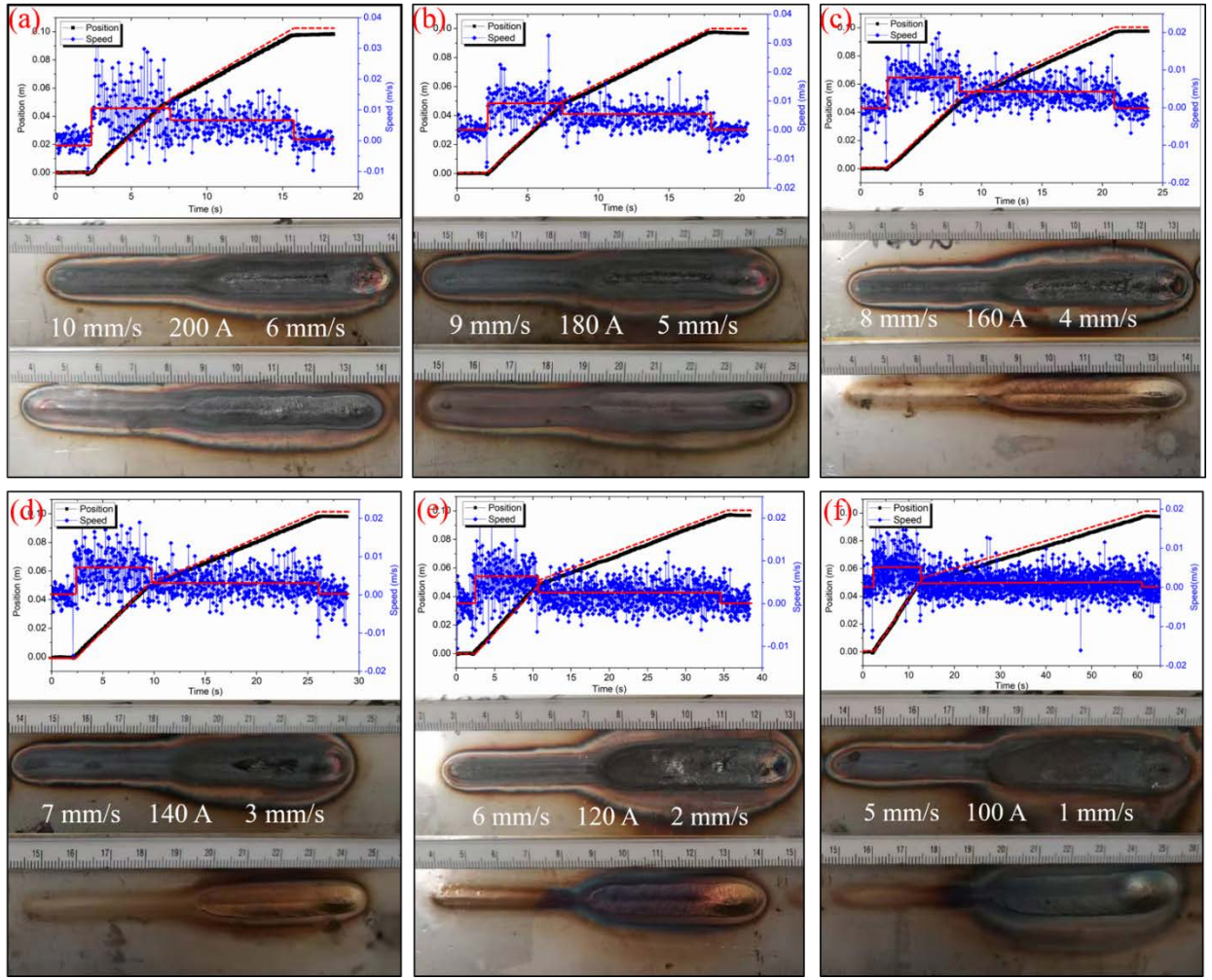


Progress: Summary

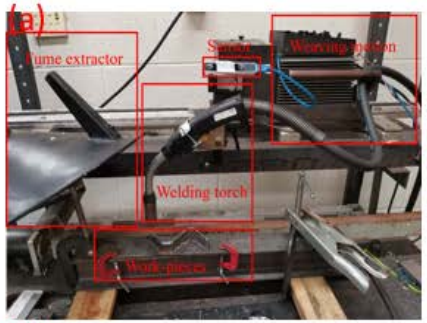
Speed Monitoring Algorithm with Verified Accuracy during Various Welding/Arcing Conditions

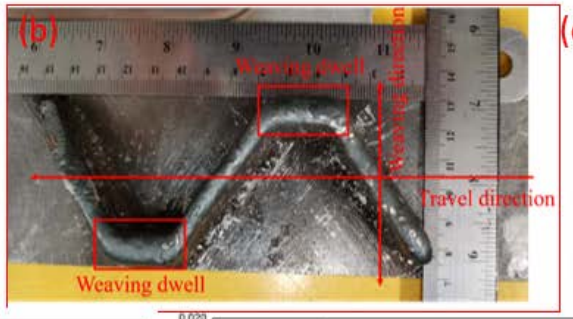
Progress: Robotic Verification - GTAW

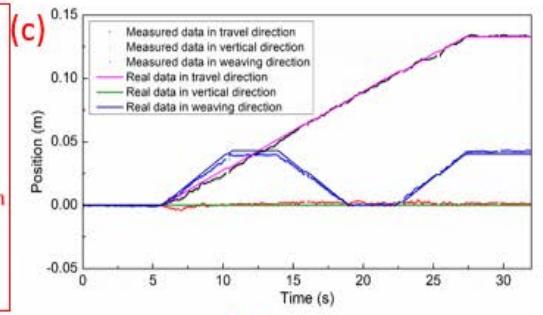


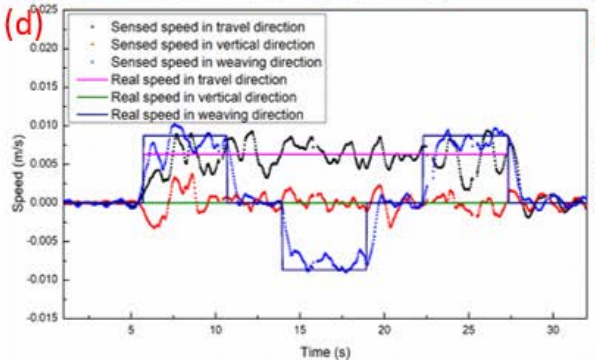


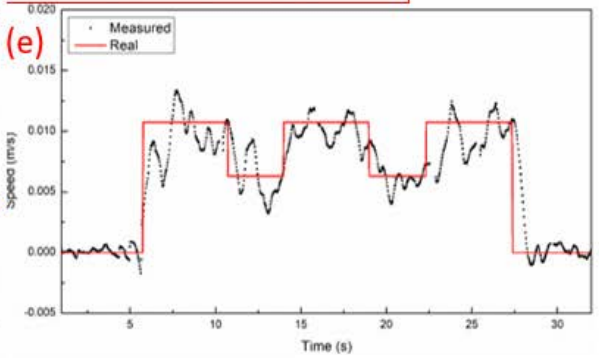
Progress: GMAW







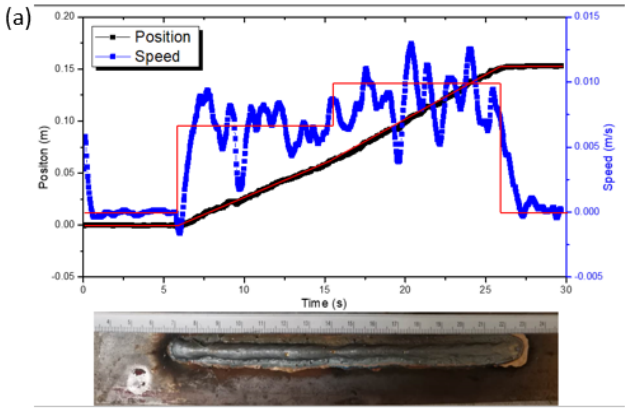


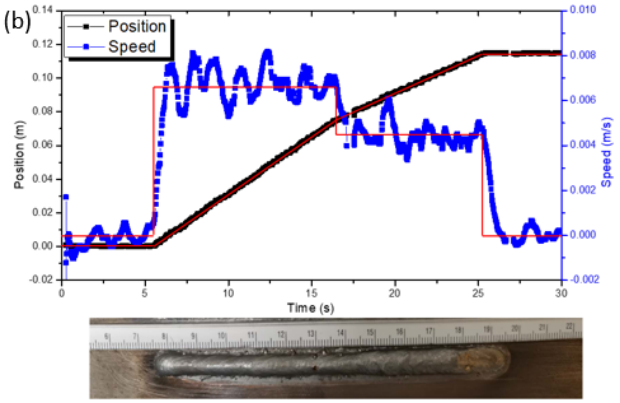


(f)

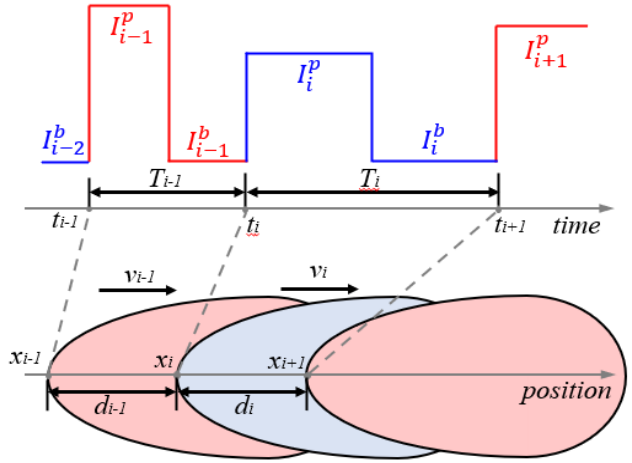
Speed sensing error

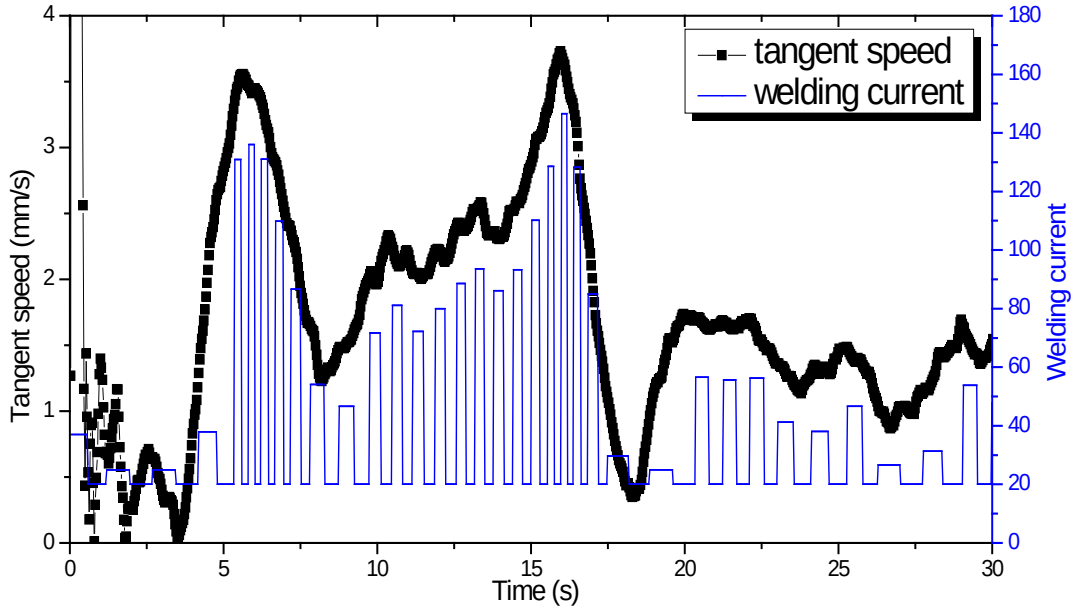
Direction	RMSE (mm/s)
Travel	1.86
Vertical	1.10
Weaving	2.08
Main	2.13





Progress: Manual Pulsed GTAW





Next Actions:

1. Adaptive Control of Wire Feed Speed in Semi-Automatic FCAW in Fillet Joint

Realized by a control system includes (1) a power source which can receive command in real-time from the computer (that processes the sensor data to obtain the travel speed) to adjust the feed speed, (2) the monitoring system, (3) a computer system with data acquisition system to read data from the monitoring system and send command signals to the power source, and (4) control algorithm that coordinate the actions and determine the adjustment from the wire feed speed per the torch speed.

The development will be carried by the University of Kentucky. The University of Kentucky has several such power sources made by Miller Electric and will use a newer model from Miller Electronic if available.

2. Trial and Demonstration at Ingalls

3. Sensor attached to glove

4. Demonstrate to shipyards and Miller for Possible Commercialization: FCAW, GMAW, GTAW, Pipe (Making Welds Like Orbital Systems)

Benefits:

1. Make quality welds with less training
2. Automated detection of weld length and position
3. Records for locations of possible defects (for example lack of penetration)
4. Assured weld size and heat input; records of heat inputs for different welds/weld segments
5. Directions for welder improvements/trainings

Question?