Real Time Evaluation of Weld Quality during Friction Stir Welding (Industry 4.0)

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To develop an in-process real time quality monitoring system for Friction Stir Welding to predict onset breakdown and re-establish good weld

- Conventional welding techniques are prone to numerous defect like solidification cracks, porosity & hot cracking.
- FSW eliminates major causes of defects attracting manufacturers to replace conventional welding methods.
- The key parameters affecting the weld quality are axial force, temperature traverse speed and tool geometry.
- Weld quality evaluation for FSW is limited to offline methods, there is a need for an online weld quality evaluation system to save time and cost.

Present FSW machine are based on force and torque control methodologies and they have proven to be effective.

Researchers have implemented machine learning for prediction of mechanical properties of the weld.

Force and torque data show a trend when the defect is observed.

By implementation of machine learning, the defects can be predicted by observing force, torque, acoustic & temperature signal for the weld.

Weld quality can be can also be related to the Discreet Fourier Transform (DFT) of force data, it was observed that good welds had lower amplitudes at lower frequencies.

Acoustic signals measurement has proven to be efficient for evaluating the weld quality.

The graph shows Discreet Fourier Transform for the resultant force in lateral plan of weld tool.

By identification of the threshold frequency, the welds can be classified into bad and sound welds.

DFT analysis can be used to distinguish between the good and bad welds

Good welds have lower amplitude at lower frequency range

Initial Approach

- The graph shows Discreet Fourier Transform for the resultant force in lateral plan of weld tool.
- By identification of the threshold frequency, the welds can be classified into bad and sound welds.

DFT Analysis of Planar Forces on FSW Tool

Offline

- Dataset for a sound weld
- Normalization & filtration of data
- Training Machine Learning Algorithm

Online

- Force Data
- Torque Data
- Temperature Data
- Online Measurement
- Pre-trained ML Model & Optimization
- Updated Weld Input
- Control System

Block diagram for closed loop control

References