



**INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS**

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Programme of Study : Ph.D.

Thesis Title:
WELD QUALITY MONITORING AND DEFECT IDENTIFICATION IN FRICTION STIR WELDING PROCESS

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Key words for description of Thesis Work : Friction stir welding; Monitoring; Weld quality; Defect detection; Fractal dimension; Wavelet transform; Hilbert-Huang transform; Current signal; Speed signal; Vertical force; Transverse force; Torque; Strain gauge; Image processing

SHORT ABSTRACT

Post weld evaluation is significant in production process for ensuring better quality products in less time. The available evaluative methods offers reliability but with high operating costs and requires expertise. Moreover, the available methods are offline and add to the production time increasing the cost of production. The present research work develops methodologies for friction stir welding process for effective post weld evaluation with quality monitoring and defect identification with appreciable accuracy and reliability. The work uses real time information extracted from process signals as vertical force signal, torque signal, current signals from main spindle motor and welding motor, tool rotational speed signal and temperature signal. The work also delivers quality monitoring methodology with top surface images of the welded samples which is not being attempted earlier. The information extracted from real time process signals are processed in time and time frequency domain with statistical computations and implementing sophisticated signal processing tools such as wavelet transform and Hilbert-Huang transform. Apart from these techniques the well known fractal theory has also been implemented to analyze the signals in time domain. The signal information extracted in terms of signal features combined with process parameters are used as the input to train, validate and test artificial intelligent models for the prediction of ultimate tensile strength of the joints. Artificial neural network models and support vector regression models are developed for strength prediction among which support vector regression outperforms in terms of prediction accuracy with maximum of 99.95%. It has also been observed that the models accuracies increases by an average of 4% with the inclusion of signal features in the input spaces of the models than the models developed with only process parameters. Along with the quality prediction; the research work also delivers four new methodologies for identification of internal defects with the features extracted from vertical force signal, torque signal, temperature signal and tool rotational speed signal. Qualitative indicators are developed for identification of defective welds from defect free welds. The developed methods deliver threshold for classifying defective welds and defect free welds. With the developed methods a user of friction stir welding process can have a single window solution for quality monitoring and defect detection during the welding process. The developed methodologies will provide the first line of action for bringing industrial solutions in developing monitoring tools for friction stir welding process.