Real-Time Integrated Weld Analyzer

Institute For Diagnostic Imaging And Research

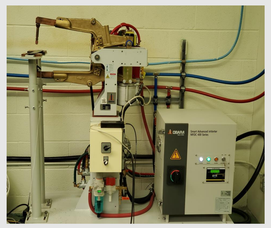
THE INSTITUTE FOR DIAGNOSTIC IMAGING RESEARCH

University of Windsor

Introduction

What is Resistance Spot Welding?

Resistance spot welding is a process in which metal plates at contact are joined by the heat obtained from resistance to electric current. Therefore, ultrasonic imaging is an excellent non-destructive testing solution. Further, the broad goals of the RIWA project is to create a predictive system using machine learning algorithms.



My Role and Responsibilities

I have been involved in various aspects of RIWA project for my four months Summer Co-op. Four of my major tasks were:

1. THST (Transducer Heat Stress Test)
2. Preparation of B scan data sets
3. Testing Ultrasonic Equipment
4. Labeling B scans

Transducer Heat Stress Test

Why do we need THST?

High current in the electrode warms up the water which further runs over the transducer. This creates thermal stress in transducer during several welds. Therefore, we need an automated system which simulates similar welding conditions and can perform thermal testing of different transducers. Followed by a micro inspection, the whole procedure would be important for quality assurance of transducer in similar conditions

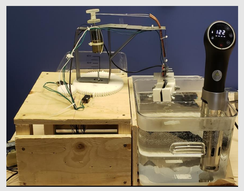
THST Construction

We built a 2 DOF crane mechanism for lifting as well as dipping the transducers in water baths at two different temperatures

Further, the microelectronics operations are governed by Raspberry Pi B+

Main components include:

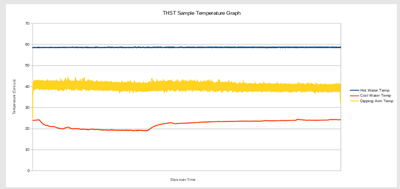
1. DC and Stepper Motors
2. Sous Vide
3. 3:2 gears, and motor drivers
4. Transformer and switches
5. Temperature sensors



Data Analysis and Results

Data

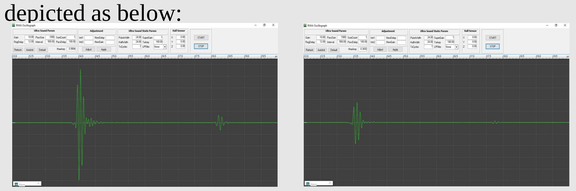
Four tests at different temperature difference were conducted. The readings of three temperature sensors are presented graphically for one of the test.



The increase in temperature of room temperature water bath is due to lateral radiation from the hot water bath. The temperature of hot water bath is steady over the entire period. The temperature sensor fitted into holder shows oscillation of temperature between 40℃ and 50℃ which in turn shows the dipping of transducers. The slow response time of temperature sensor is the reason that it does not achieve actual temperature in such short period of time.

Results

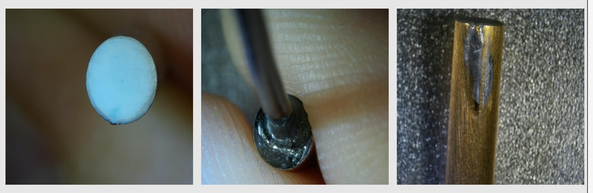
The A scan of a transducer before and after the test is depicted as below:



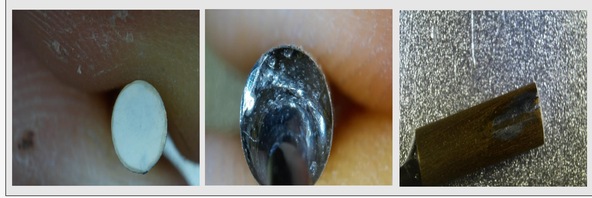
Before After

Further the micro inspection of transducer was done after each test. The images of transducer before and after test is shown below:

Before



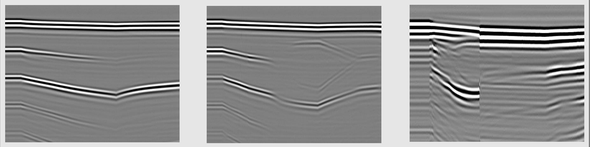
After



Preparation of B Scan Data sets

In order to train the machine learning model, large variety of B scans of welds are required

Therefore, approximately 2000 stick welds, good welds and expulsions were made for different plate thickness



Stick Weld Good Weld Expulsion

In addition, RSWA was used for non-destructive testing as well as verifying a stick weld and good weld from the weld nugget diameter

Resistance Spot Weld Analyzer (RSWA)

Testing Ultrasonic Equipment

REX (Remote Extender) and LEX (Local Extender) are two integral communication modules in generating the B scan image of a weld

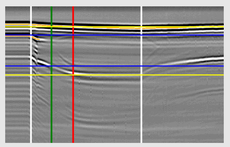
LEX REX

Therefore, 10 REX and 30 LEX modules were tested using Obara Controller. Further, they were verified by observing the A scan signal in the oscilloscope as well as their status in the RIWA client.

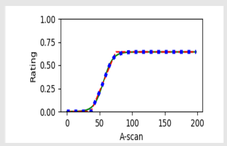
Labeling of B Scans

Labeling is the most integral part towards the goal of the RIWA project. Labeling of a b scan is done based on melting onset, saturation point, nugget diameter and distance between front and back wall.

In order to train the machine learning model, we must manually rate the welds based on features mentioned above. This is done using Machine Learning Database Manager.



Labeling B Scans



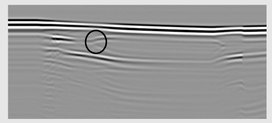
Sigmoid Fitting based on labeling

Identification of melting Onset

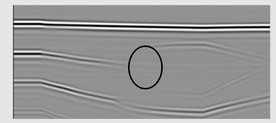
The identification of melting onset is one of the most critical aspect in order to label a B scan. Normally, it can be identified through initial forking of weld nugget.

Problem

But this phenomena occurs very rarely. It is also observed that the forking is almost invisible as plate thickness increases.



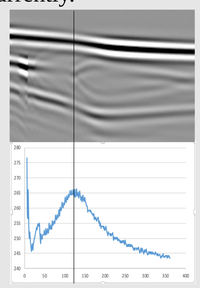
0.7-0.7 mm plates (Visible Forking)



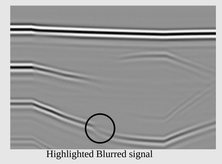
1.9-1.9 mm plates (Invisible Forking)

Solution

It is understood that the peak of resistance, weakening of signal at third interface and melting onset all occur concurrently.



Concurrence of peak of dynamic resistance and melting onset (forking)



Highlighted Blurred signal

This estimation is used in majority of B scan labeling and is proved to be a very efficient way of labeling the melting onset. In addition, till date 3500 B scans have been labeled using machine leaning database manager

Acknowledgements

Special thanks to Dr. Roman Maev and Dr. Andriy Chertov (Project Supervisor) for giving me the opportunity to work at IDIR and gain experience in the field of Applied Physics. I am also thankful to Mr. Danilo Stocco for giving me insights into weld science, Dr. Ryan Scott for helping me in labeling of B scans, Mrs. Sarah Beneteau for the co-operation and support, My THST group members Andres Parra (Project leader) and Raman Seviaryn.

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