**IIT Kharagpur**



# Activities

**Weld inspection & defect analysis**

## AI Enabled NDT for Weld Quality Inspection
### (*Collaboration: Garden Reach Shipbuilders And Engineers*)

**Problems**

Existing **MANUAL mode** of inspecting the X-ray films

- short period of time ➔ **difficult to recognize the small flaws**
- human interpretation ➔ **short of objectivity, intelligence, and consistency**
- Due to limited time ➔ **random and few are only tested**

**Result**

**Poor job quality** — **Manpower loss**

**Loss of time** (delay in reaching market)

**Defect identification accuracy : 93%**

*https://bit.ly/3oFCOZA*
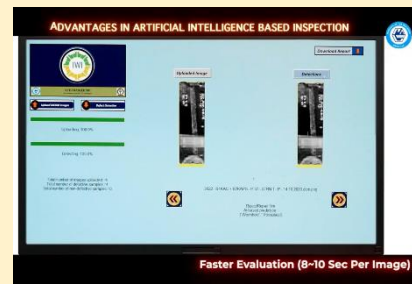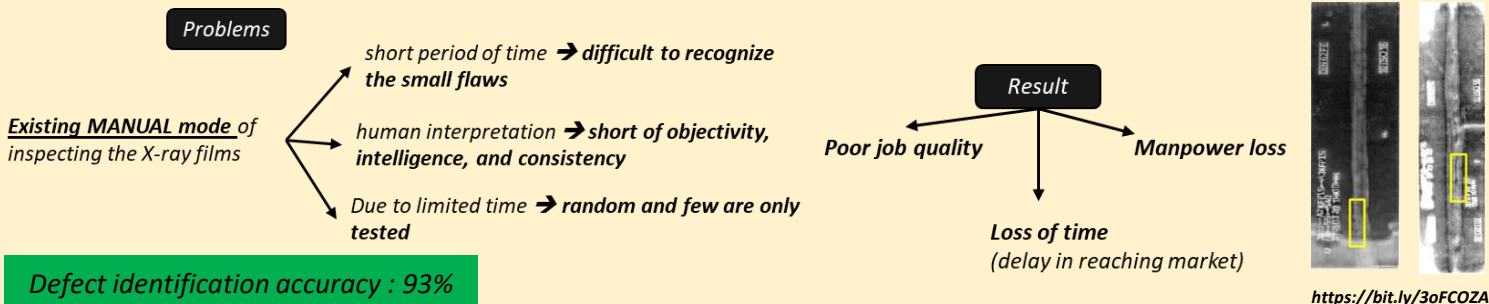


## Real-Time Online Defect Monitoring and Control of Friction Stir Welding Process
### (*Collaboration: Tata Consultancy Services*)

**Industry 4.0**



*Welded sample's surface image*

**Patent**

*A system for real time monitoring, prediction and control of weld quality in friction stir welding*
*Patent filed ref no: 202031000072*
***Jointly with Tata Consultancy Services***

## Real-time Online Defect Monitoring Friction Stir Welding Process

### Image processing



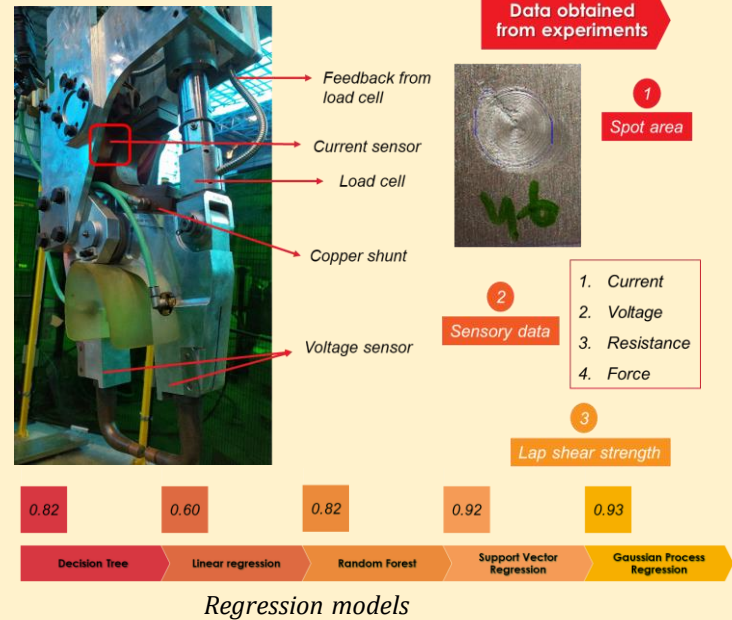Good Weld Zone — Bad Weld Zone
Direction of Weld

**Improvement in the weld quality**
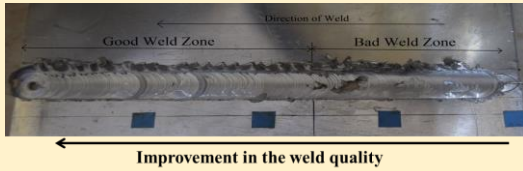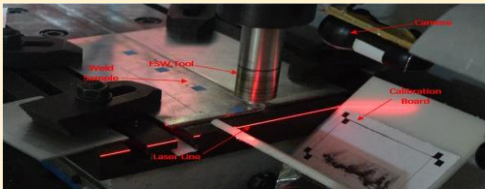
### Patent

*Real time surface defect analysis and correction in friction stir welding process by image processing Patent filed ref no: 201831035477*

## Quality Monitoring in Resistance Spot Welding (*GM*)



Feedback from load cell
Current sensor
Load cell
Copper shunt
Voltage sensor

**Data obtained from experiments**

1. Spot area
2. Sensory data
   1. Current
   2. Voltage
   3. Resistance
   4. Force
3. Lap shear strength

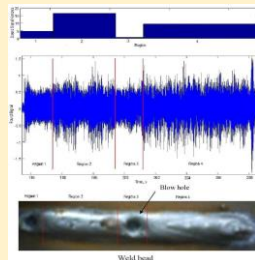| 0.82 | 0.60 | 0.82 | 0.92 | 0.93 |
|------|------|------|------|------|
| Decision Tree | Linear regression | Random Forest | Support Vector Regression | Gaussian Process Regression |

*Regression models*

## Unique Study on Sound in Welding

- Arc sound signal was processed in time and frequency domain
- Sensor signals were correlated with various metal transfer modes in P-GMAW
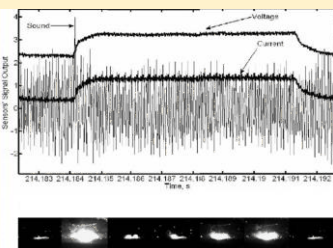


*Variation of arc shape with pulse voltage*



*Relationship of arc sound kurtosis with HAZ grain size for different pulse frequency*

## DL Based Weld Line Detection and Gap Measurement

- Robotic welding still relies on human intervention with teach-and-play programming
- Also the real-time change in weld path or gap cannot be considered, which results in bad quality weld
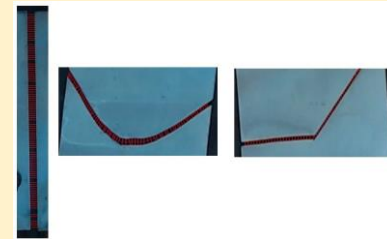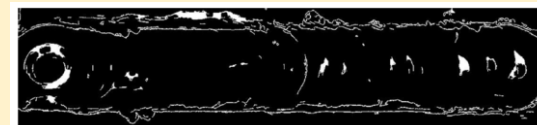


*Detected weld gap*

*Deviation:*
*Less than 1 mm (in length)*
*Less than 0.1 mm in gap*

## Offline Weld Quality Monitoring of FSW

- Making the use of various image processing techniques to identify surface defects
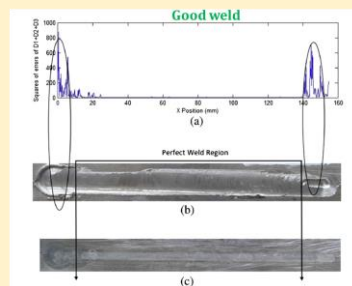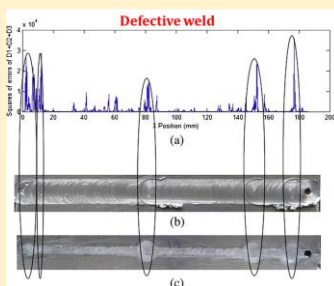- Defects like surface groove, void on weld surface



*Original weld image*



*Processed image*

*Ravi Ranjan et al., 2016, Classification and identification of surface defects in friction stir welding: An image processing approach*



Using force and torque signal, and discrete wavelet transform

*(a) Plot of square of errors of detail coefficients D1+D2+D3, (b) front side of weld, and (c) rear side of weld*

*Ujjwal kumar et al., 2015, Defect identification in friction stir welding using discrete wavelet analysis*