

Robotic Friction Stir Welding

“Towards Multidimensionality and Flexibility in FSW Using an Ind. Robot Sys.”

Recent Advances in Friction Welding and Allied Processes
Dubrovnik 2007

Towards Multidimensionality and Flexibility in FSW Using an Industrial Robot System

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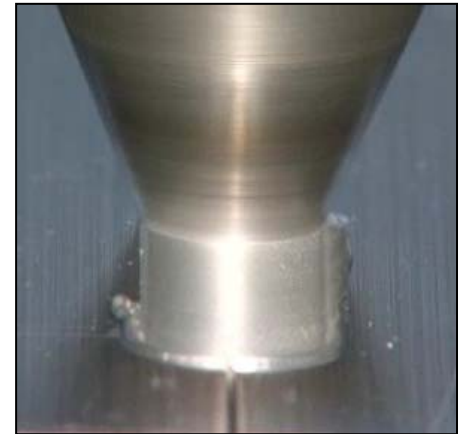


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INTRODUCTION

- ~ Friction Stir Welding (FSW) – a recent joining process
Patent 15 years ago (TWI)
Commercialized 10 years ago (ESAB)
- ~ Applications areas:
Marine, aerospace,
- ~ Characterized by high (superior) quality...
... and high repeatability
- ~ Mainly on Aluminum & Copper



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INTRODUCTION

- ~ Typically butt-joint or lap joint
- ~ Straight or circumferential
Preferably long, non-complex seams
- ~ The preferred usage reflects the most common applications
- ~ How to enlarge the application areas ?
 - 1) Multidimensionality
 - 2) Flexibility



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INTRODUCTION

- ~ Seam complexity constrained by the machines
 - 1D – 1 axis
 - 2D – 2 axes (although 4 axes is preferably)
 - 3D – 5 axes (6 in general case)
- ~ Multidimensionality equals a vast increase in machine complexity.
- ~ A typical FSW solution is a 3 axes gantry with 2 rotational axes



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INTRODUCTION

~ USING AN INDUSTRIAL ROBOT

~ ISSUES:

- + Is it strong enough (FSW require high forces) ?
- + Is it accurate enough (FSW require precision) ?
- + Is it stiff enough ?
- + Workspace complexity (strong in all directions)?

~ CHALLENGES:

- + Tool plunge capability (oscillations etc.)
- + Remain in precise contact



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INTRODUCTION

~ EXISTING SOLUTIONS

GKSS – Germany

Neos Tricept

Friction Stir Link – US

ABB IRB 7600

ESAB – Sweden

ABB IRB 7600

and a few more...



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SYSTEM IMPLEMENTATION

~ THE ESAB ROBOT SYSTEM

IRB 7600-500 2.3 modified for FSW

IRC5 Robot Control System with F.C. Options

~ THE TASK

- 1) Plan the weld using the CAD model of the object
- 2) Execute the weld in a calibrated environment
- 3) Evaluate the results



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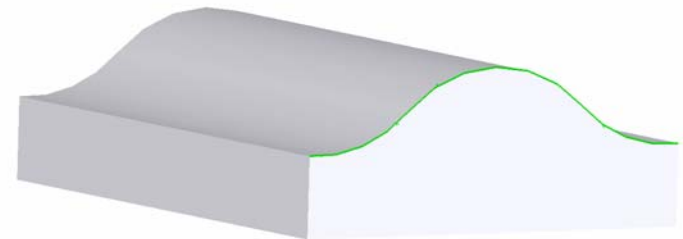
SYSTEM IMPLEMENTATION

~ PLANNING THE WELD

Path planning & Off-line programming (Complex welds)
On-line planning (Linear PtP etc.)

~ EXTRACT GEOMETRIC INFORMATION FROM CAD

Surface models to generate proper tool orientations
Contour extraction to provide reference segments
and control points



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SYSTEM IMPLEMENTATION

~ CONTROLLING THE ROBOT

Accuracy via force control

~ MONITORING

On-line HMI or external computer

~ STORING THE MEASUREMENTS

Xml format for TCP/IP transmission

Also a good file storage format



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SYSTEM IMPLEMENTATION

~ EVALUATING

The weld by visual inspection or other non-destructive method

The system based on force measurements and deviation corrections

~ POSSIBLE TO REVIEW MOTION

Reviewing the force plot in relation to the tool's location and orientation

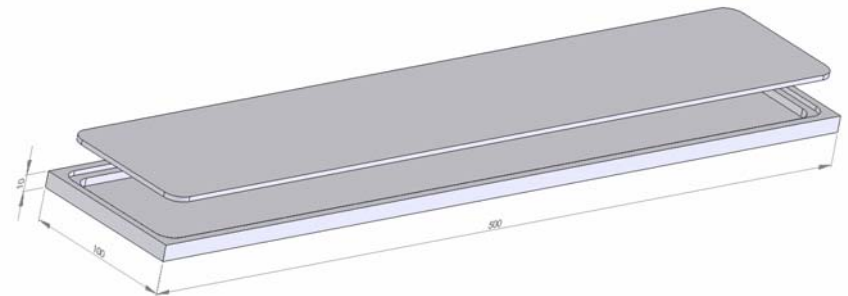


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CASE STUDY

- ~ AN EXAMPLE TO EVALUATE THE SYSTEM
- ~ LID-ON-BOX in 2D (AA5000+diecast)
- ~ A GOOD EXAMPLE WHERE
 - i) The path may be designed based on the lid's top. data
 - ii) Complex enough (8 seg. 12 control points)



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CONCLUSIONS

~ MULTIDIMENSIONALITY?

Easily provided by an industrial robot

What about the issues discussed earlier? Strong, stiff etc.
Yes, but only within a limited scope of FSW

~ FLEXIBILITY?

Off-line programming provides tool's for rapid
planning with limited efforts
HMI's allows online changes of system parameters
without extensive knowledge about robots



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