Robotic Welding in Manufacturing Operations for Marine Buildings

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Introduction

highly complex engineering products

Human dependent activity

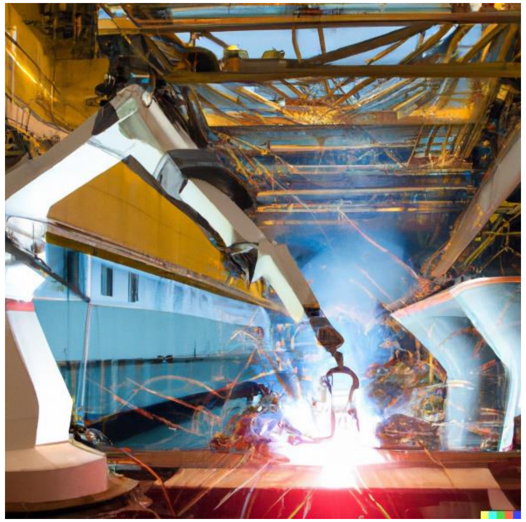
'Human error' is often cited as the problem

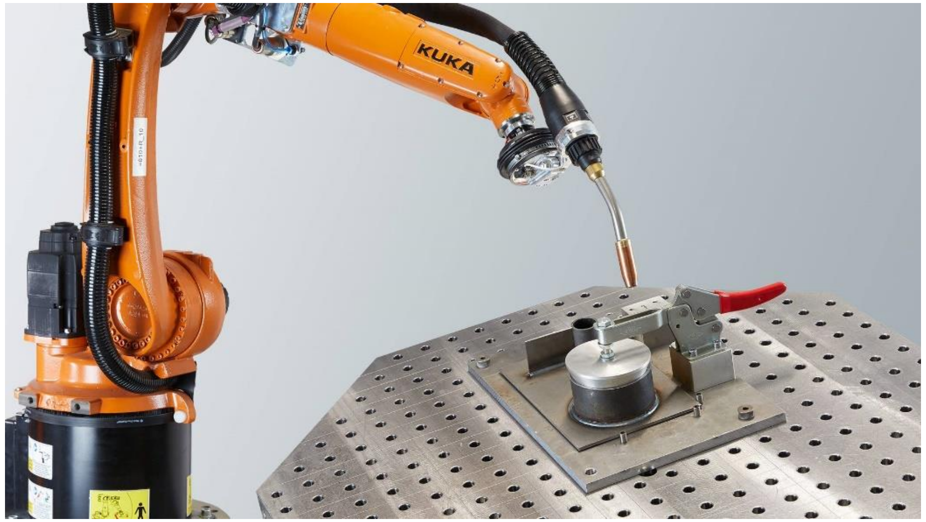
Delays in shipbuilding

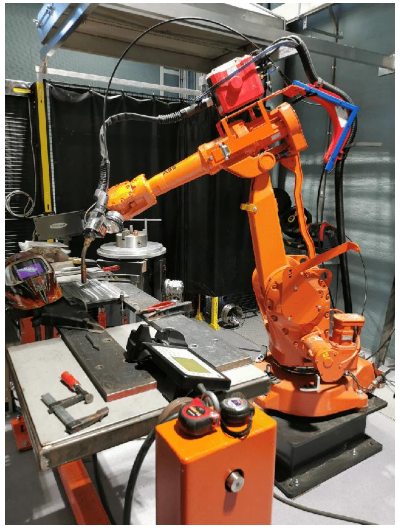
Requires a high degree of accuracy

Background

Some job can be dangerous and costly for the workers







Developed robotic welding

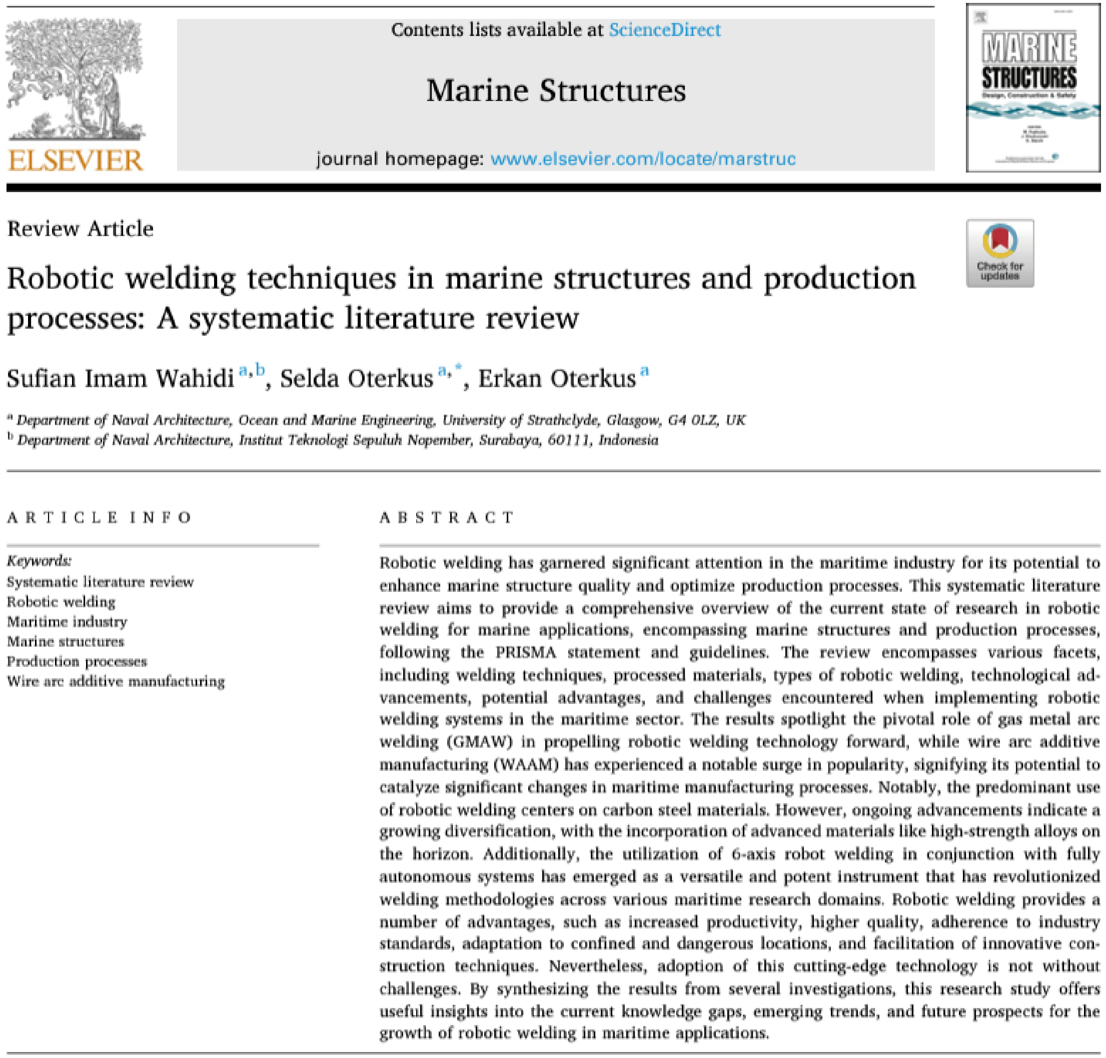
Research Question

- 1.Which welding methods are applied using robotic welding technology?
- 2.Which types of robotic welding were used in the cited research experiments?
- 3.Which materials were processed in the reported research and experiments?
- 4.What potential advantages can be derived from the utilization of the indicated robotic welding?
- 5.What are the current obstacles and deficiencies that hinder its widespread implementation in the industry?

Objectives

1. To identify and classify various robotic welding techniques employed in marine applications, including arc welding, laser welding, hybrid welding, and friction stir welding.
2. To assess the types and levels of robotic welding mentioned in the literature.
3. To explore the processed materials, including steel, aluminium, nickel-aluminium bronze, and other different metal alloys.
4. To investigate the benefits that could be achieved by using the identified robotic technologies reported in the literature.
5. To examine the challenges and limitations faced in implementing robotic welding systems in the maritime sector

Literature Review



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Review Article

Robotic welding techniques in marine structures and production processes: A systematic literature review

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Robotic welding
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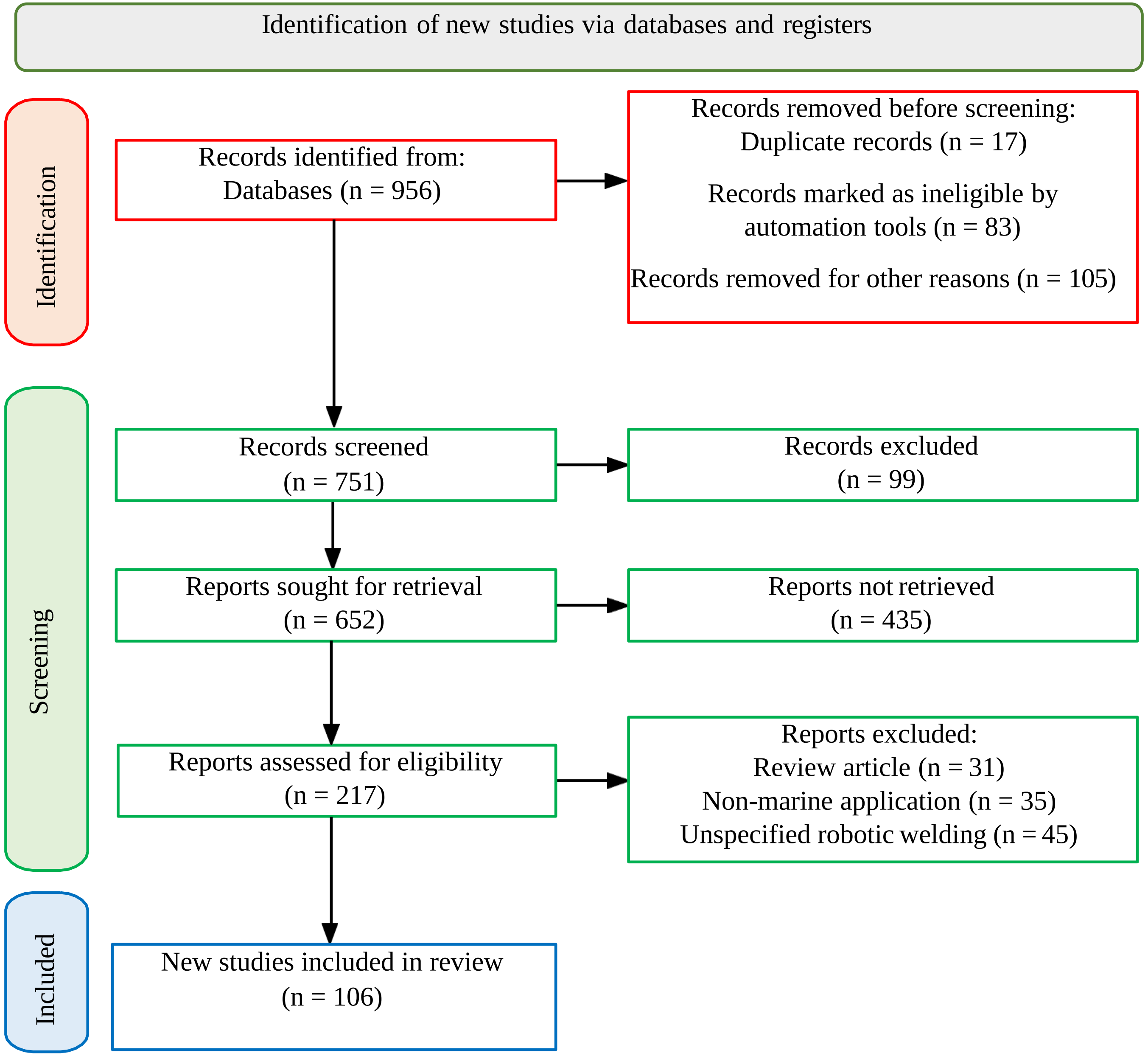
ABSTRACT

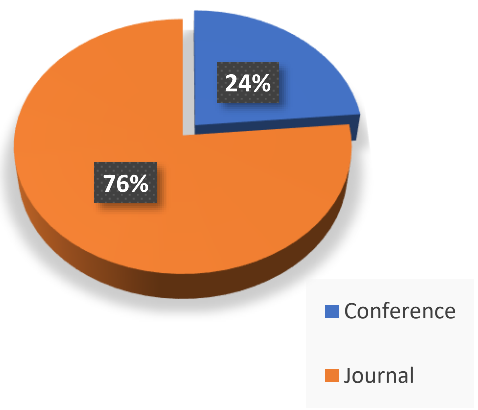
Robotic welding has garnered significant attention in the maritime industry for its potential to enhance marine structure quality and optimize production processes. This systematic literature review aims to provide a comprehensive overview of the current state of research in robotic welding for marine applications, encompassing marine structures and production processes, following the PRISMA statement and guidelines. The review encompasses various facets, including welding techniques, processed materials, types of robotic welding, technological advancements, potential advantages, and challenges encountered when implementing robotic welding systems in the maritime sector. The results spotlight the pivotal role of gas metal arc welding (GMAW) in propelling robotic welding technology forward, while wire arc additive manufacturing (WAAM) has experienced a notable surge in popularity, signifying its potential to catalyze significant changes in maritime manufacturing processes. Notably, the predominant use of robotic welding centers on carbon steel materials. However, ongoing advancements indicate a growing diversification, with the incorporation of advanced materials like high-strength alloys on the horizon. Additionally, the utilization of 6-axis robot welding in conjunction with fully autonomous systems has emerged as a versatile and potent instrument that has revolutionized welding methodologies across various maritime research domains. Robotic welding provides a number of advantages, such as increased productivity, higher quality, adherence to industry standards, adaptation to confined and dangerous locations, and facilitation of innovative construction techniques. Nevertheless, adoption of this cutting-edge technology is not without challenges. By synthesizing the results from several investigations, this research study offers useful insights into the current knowledge gaps, emerging trends, and future prospects for the growth of robotic welding in maritime applications.

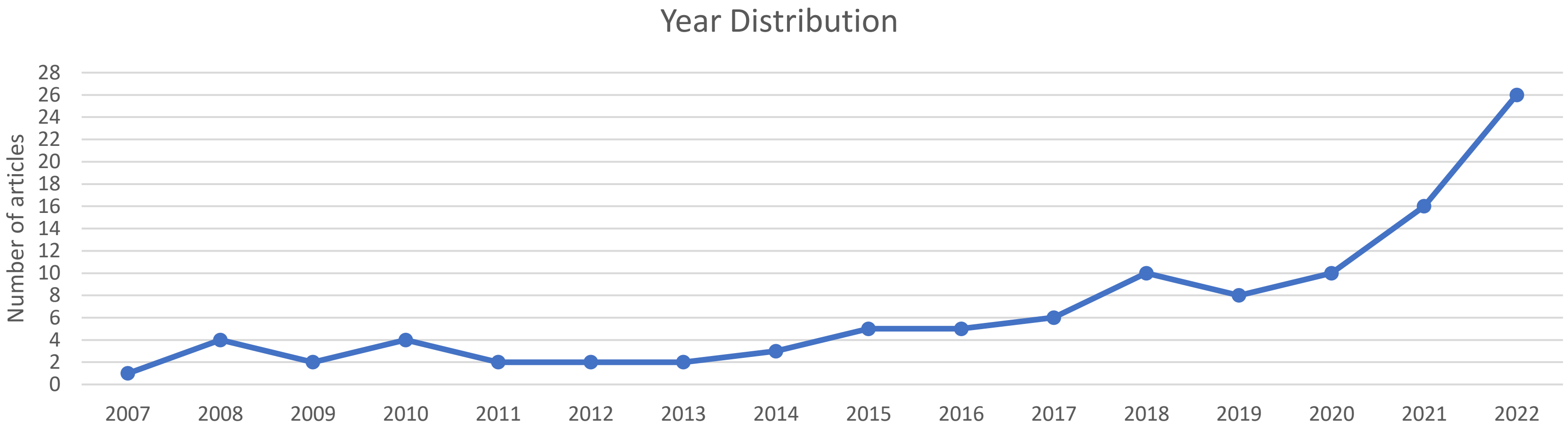


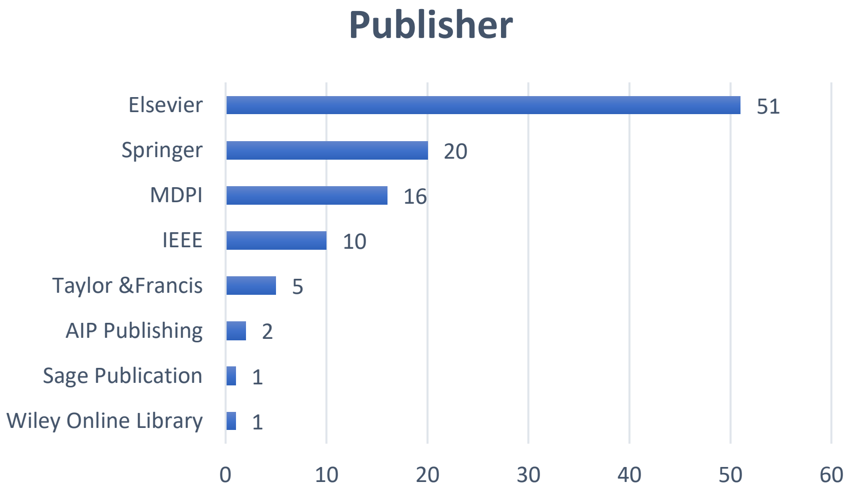
PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)

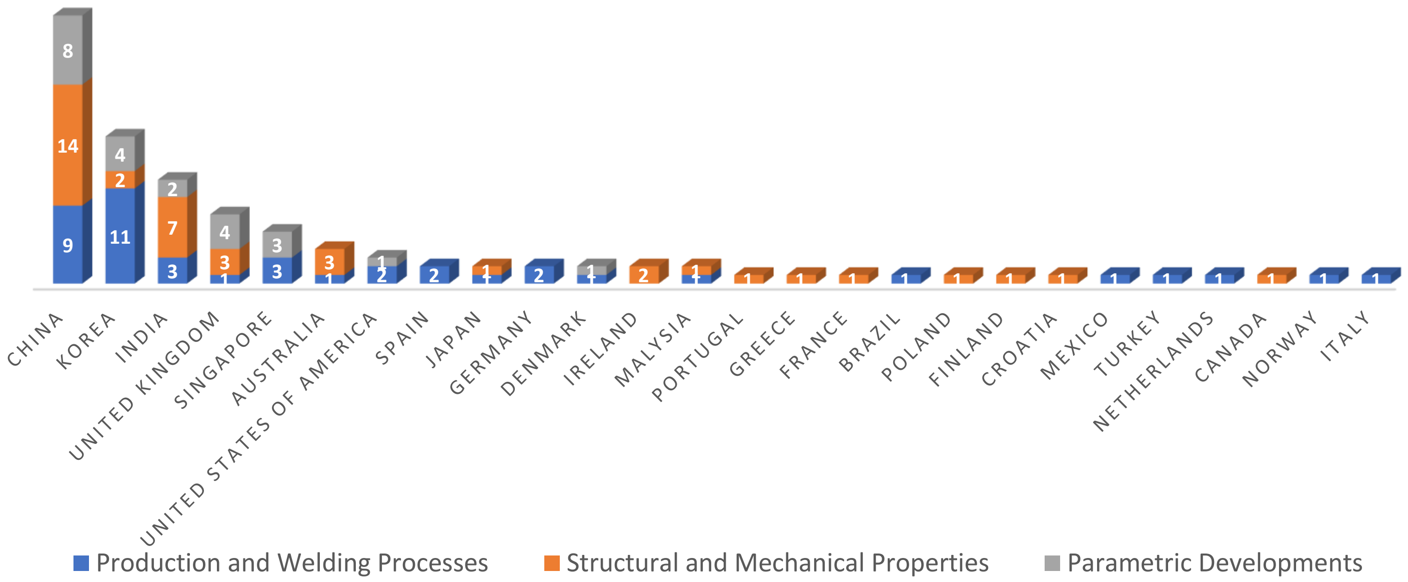
Wahidi, S. I., Oterkus, S., & Oterkus, E. (2024). Robotic welding techniques in marine structures and production processes: A systematic literature review. Marine Structures, 95(May 2024), 103608. https://doi.org/10.1016/j.marstruc.2024.103608

Geographical distribution and Research Focus









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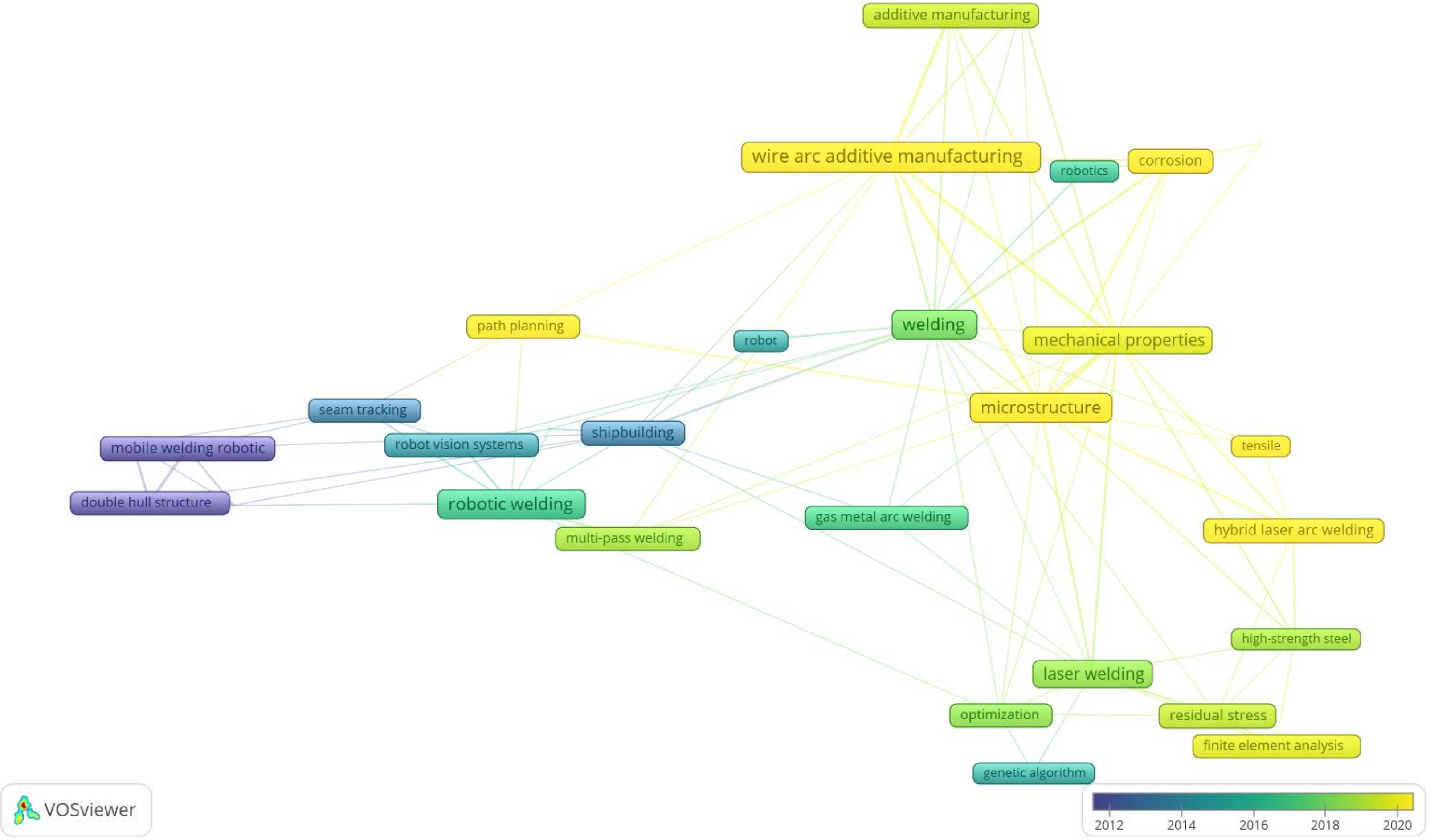
keywords co-occurrence

No	keywords	occurrences	total link strength
1	wire arc additive manufacturing	20	28
2	welding	17	28
3	microstructure	15	37
4	robotic welding	15	14
5	mechanical properties	14	33
6	laser welding	11	16
7	additive manufacturing	8	14
8	mobile welding robotic	8	12
9	shipbuilding	8	13
10	corrosion	6	12
11	hybrid laser arc welding	6	9
12	residual stress	6	9
13	double hull structure	5	10
14	gas metal arc welding	5	4
15	multi-pass welding	5	7
16	robot vision systems	5	6
17	seam tracking	5	6
18	finite element analysis	4	4
19	mechanism design	4	9
20	nickel aluminum bronze	4	9
21	optimization	4	7
22	path planning	4	5
23	flux-cored arc welding	3	2
24	genetic algorithm	3	2
25	high-strength steel	3	9
26	offline programming	3	5
27	robot	3	3
28	robotics	3	3
29	shipyard	3	7
30	tensile	3	3



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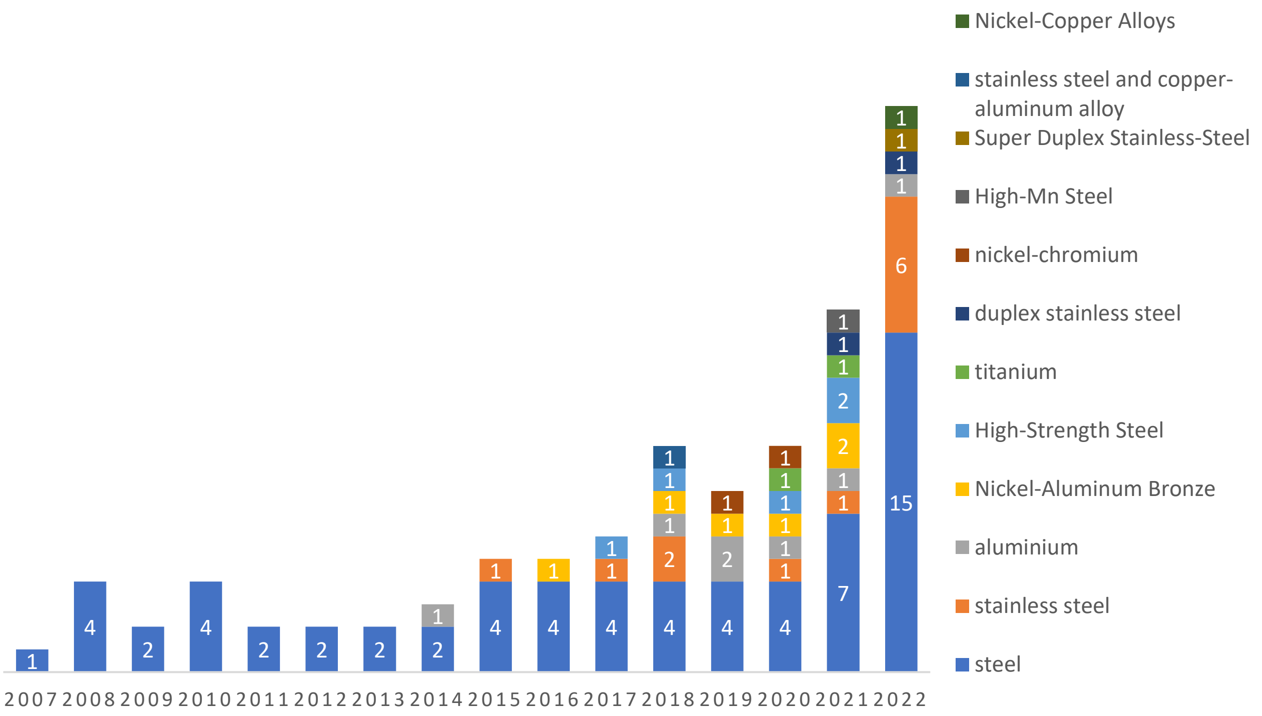
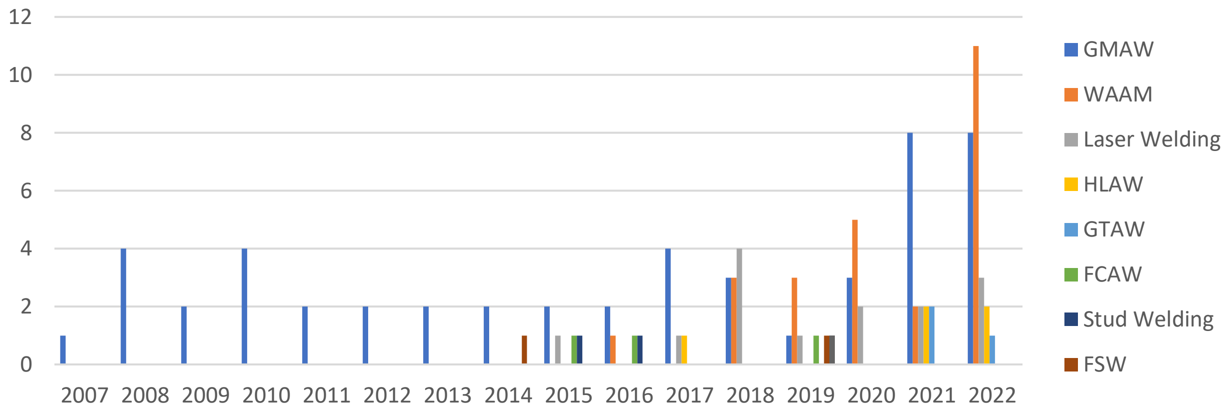
Types of robotic welding technologies and the processed materials

Robotic Welding Technology	Processed Material	Article
Gas Metal Arc Welding GMAW (50)	steel	39
	stainless steel	4
	high-strength steel	3
	aluminum	2
	nickel-aluminum bronze	1
	duplex stainless steel	1
Wire Arc Additive Manufacturing WAAM (25)	steel	8
	nickel-aluminum bronze	5
	stainless steel	4
	aluminum	2
	nickel-chromium	2
	super duplex stainless-steel	1
	duplex stainless steel	1
	stainless steel & copper-aluminum alloy	1
	nickel-copper alloys	1
Laser Welding (14)	steel	8
	stainless steel	3
	titanium	2
	high-strength steel	1
Hybrid Laser Arc Welding HLAW (5)	steel	3
	high-MN steel	2
	high-strength steel	1
Flux-Cored Arc Welding FCAW (3)	steel	3
Gas Tungsten Arc Welding GTAW (3)	aluminum	1
	steel	1
	stainless steel	1
Stud Welding (2)	steel	2
Friction Stir Welding FSW (2)	aluminum	2
Submerged Arc Welding SAW (1)	steel	1
Grand Total		106





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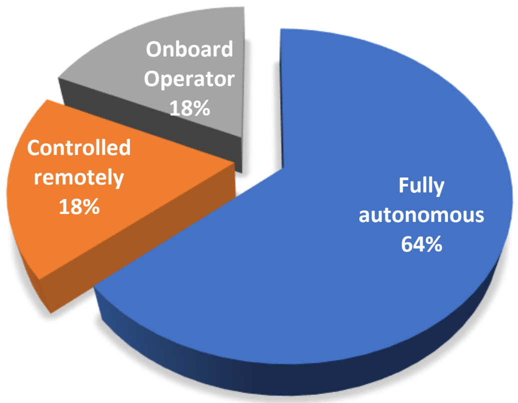
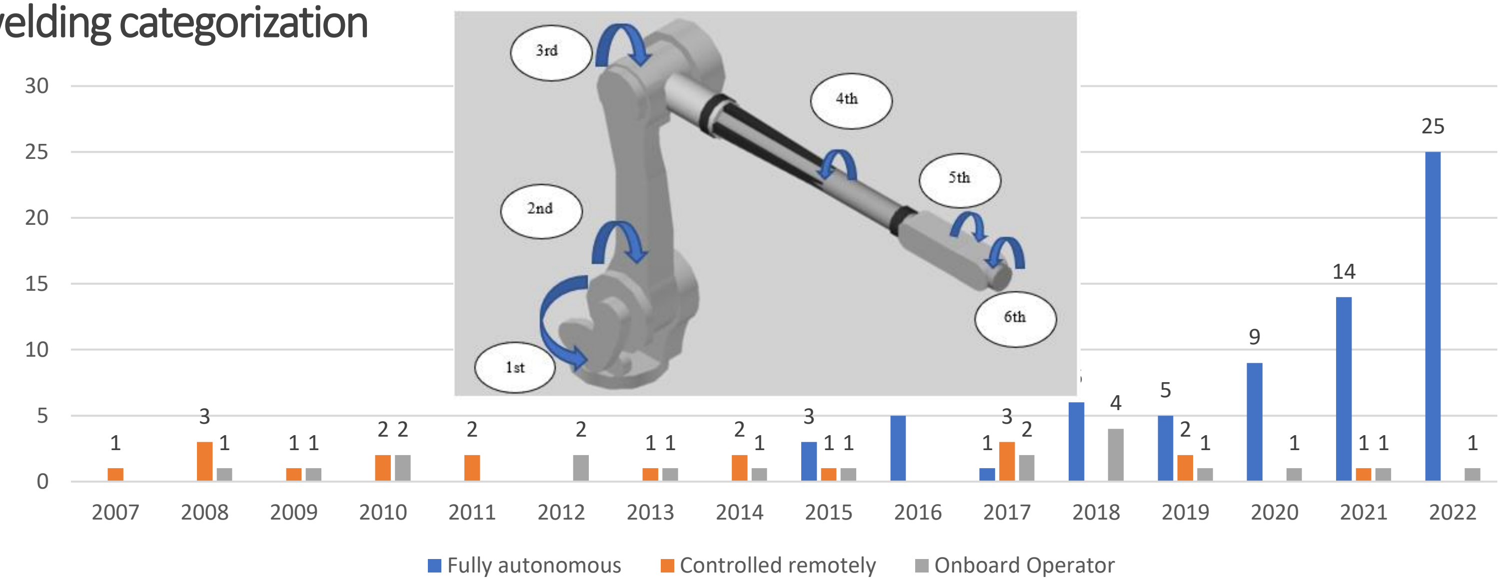
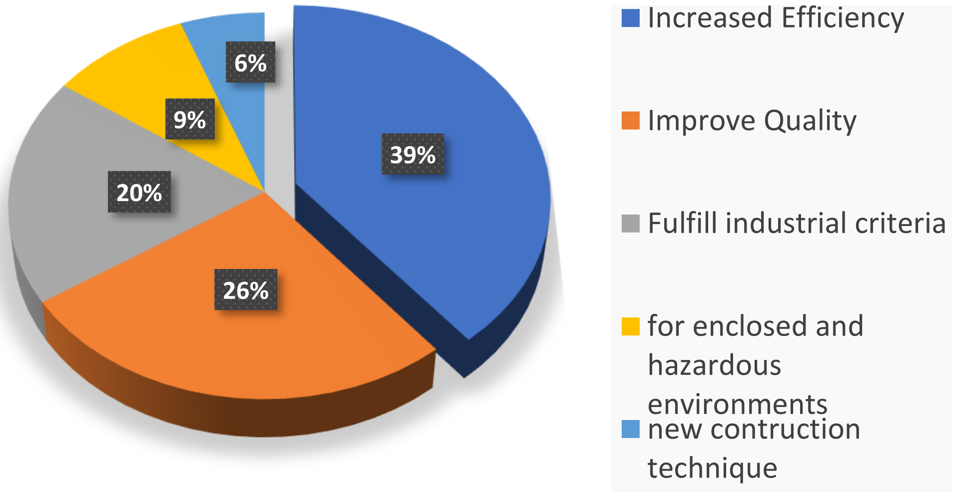


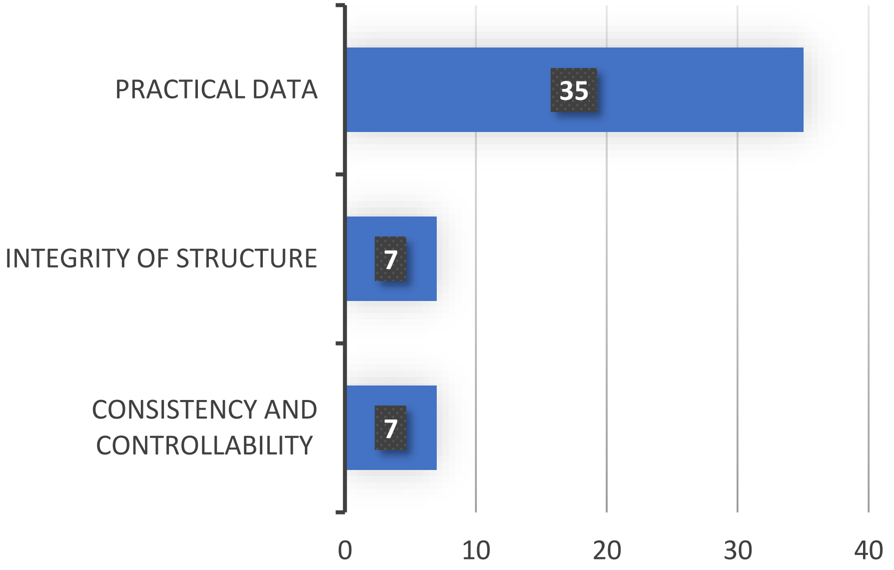
Robotic welding categorization



Benefits



Challenges



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Research Progress

Initial findings

Journal of
Marine Science and Engineering

MDPI

Article

Simulation of a Ship's Block Panel Assembly Process: Optimizing Production Processes and Costs through Welding Robots

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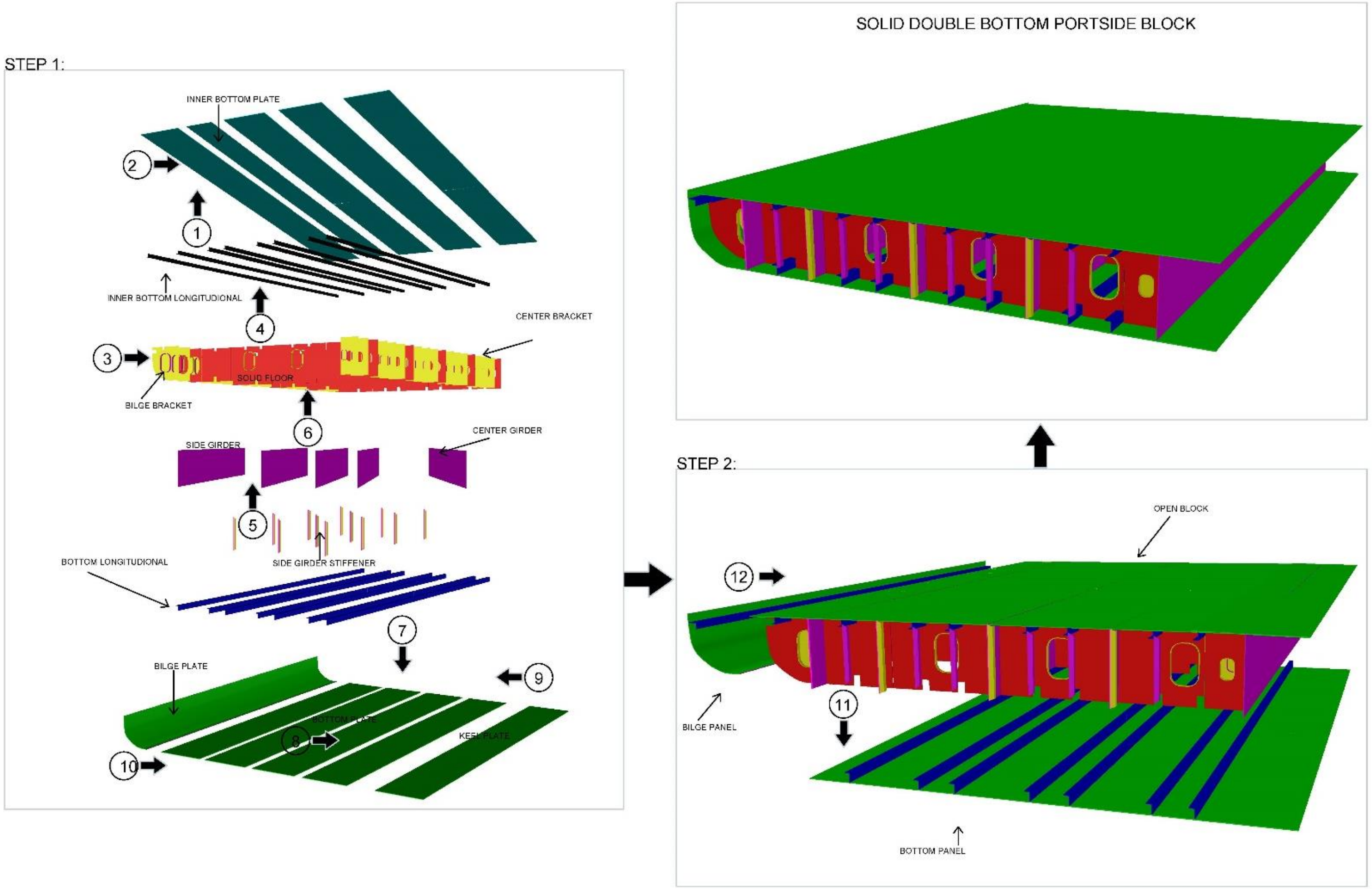
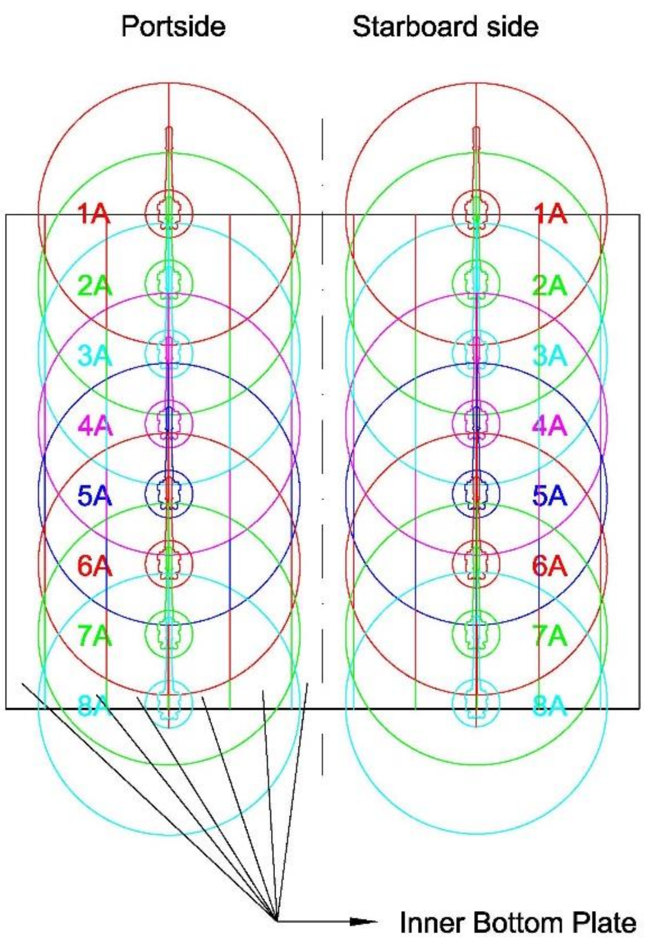
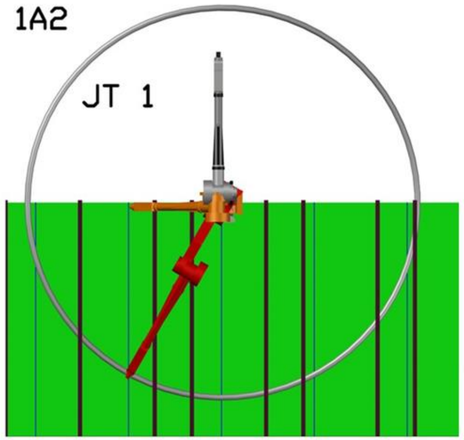
Abstract: Conventional welding techniques for complex structures often rely on human involvement, which can be prone to errors when deviations from the planned process occur. In contrast, robotic welding is highly precise and effective, particularly in the assembly of complex structures such as double-bottom ships. Therefore, this paper presents a comprehensive technical and economic analysis comparing robotic welding to conventional welding in the assembly process of a ship's block panels. The study aims to evaluate and compare the strategies employed in robotic welding and conventional welding, with a specific focus on the ship double-bottom context. Furthermore, an economic value analysis is conducted to assess the cost effectiveness of each approach. The analysis reveals that robotic welding can achieve a significantly faster welding speed, completing the process approximately 3.85 times quicker compared to conventional methods. Moreover, the ratio of electricity and man-hours between robot welding and conventional welding is 1:2.75. These findings highlight the potential for cost savings by implementing robotic welding processes. The analysis reveals a significant difference in operational costs, highlighting the efficiency and cost effectiveness of robotic welding compared to conventional methods.

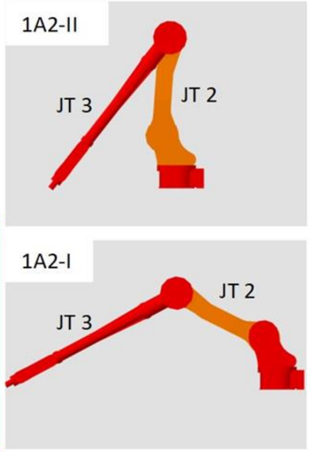
Keywords: ship production; block panel; robotic welding; ship structure; welding cost

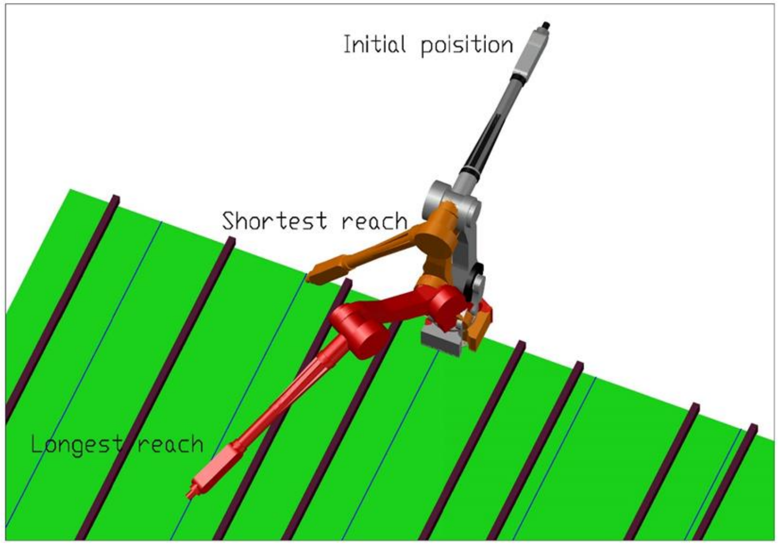


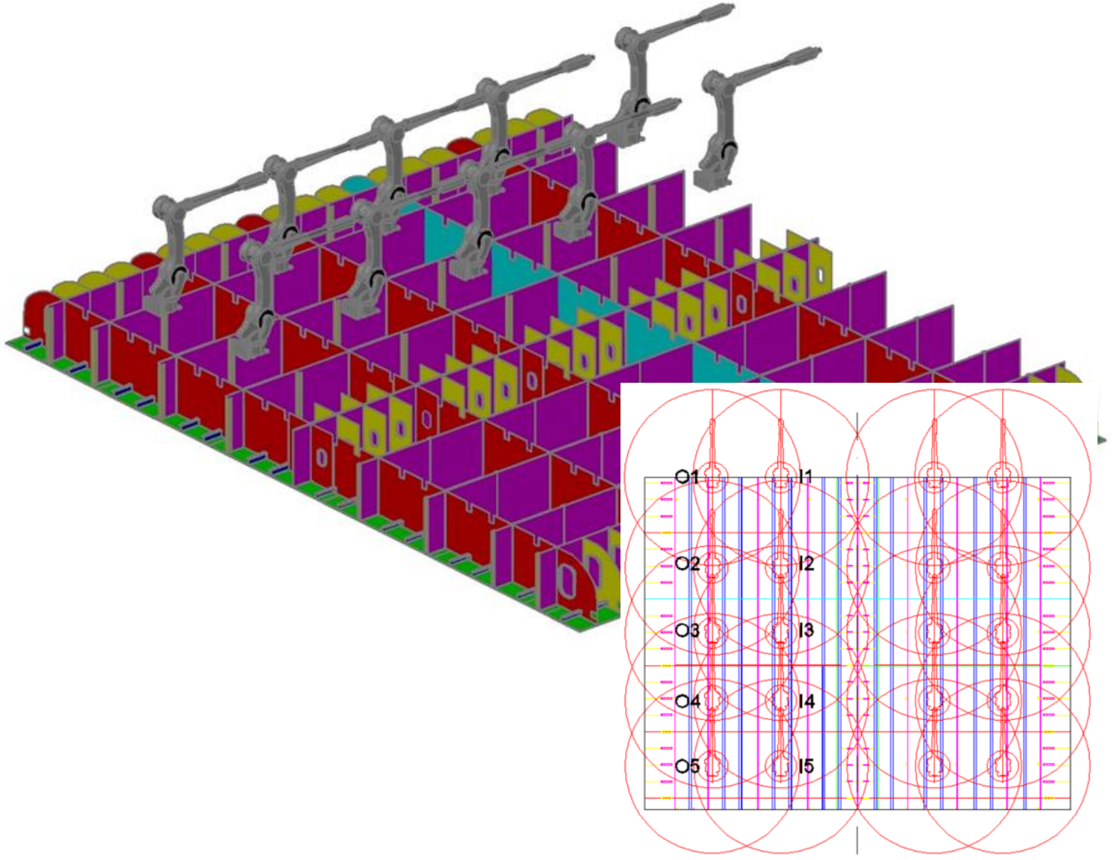
Technical analysis for joining the panel using welding robot











Conventional Welding (1 man)	=	67.1216212	hrs
Robotic Welding (1 robot)	=	17.419544	hrs
1	:	3.8532	

No	Items	Cost (GBP)	
		Conventional	Robot
1	Electricity	100.82	37.81
2	Man Hours (MH)	1916.15	696.78
	Total	2,016.97	734.59

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Conclusion

- Literature studies that have been carried out show that there is a lot of research related to the use of robotic welding in marine.
- Because of its ability to handle complex structures, robotic welding is advantageous in shipbuilding.
- Robot welding offered substantial cost savings compared to conventional welding.
- Implementing robotic welding processes can lead to cost reduction, operational optimization, cost-effectiveness, and a competitive advantage for companies in the industry.





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Thank you