MIR MARINE & MARITIME INTELLIGENT ROBOTICS

Co-funded by the Erasmus+ Programme of the European Union

UNDERWATER INTERVENTION FOR PIPELINE INSPECTION

Introduction

- Subsea pipelines are critical for transporting oil, gas, and other resources.
- Ensuring their integrity is vital for economic and environmental reasons.
- Traditional inspection methods are labor-intensive, costly, and often risky due to harsh underwater environments.
- There is a growing need for more efficient, safe, and cost-effective solutions.

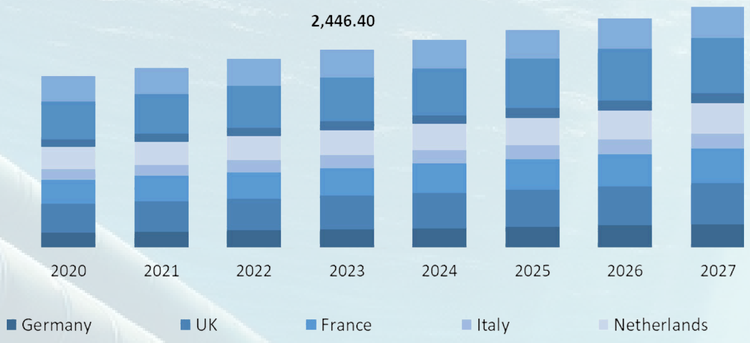

Fig 1: European pipeline service market (in USD).

Fig 2: Pipelines on Norwegian continental shelf

Motivation

- Preventing leaks and failures to protect marine ecosystems. [SDG 14]
- Reducing inspection costs and time for energy sector benefits. [SDG 7,9]
- Enhancing accuracy and reliability with AUVs and robotics. [SDG 9]
- Autonomous technologies conduct inspections with minimal disturbance to marine life, preserving biodiversity and marine habitats. [SDG 14]

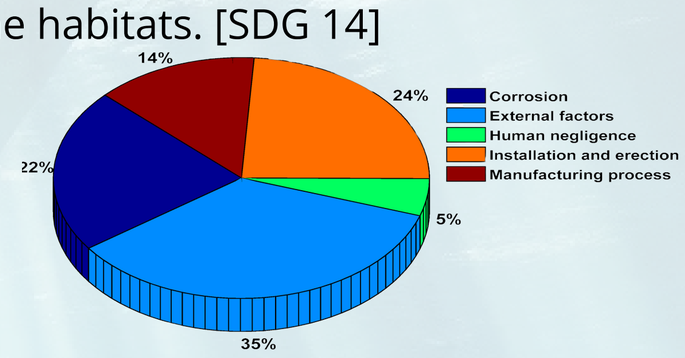

Fig 3: Statistics of the sources of pipeline failure [1].

State of the Art

EU FP7 ARROWS Project

- Focused on archaeological site exploration [2].
- Demonstrates potential for pipeline inspection.

SAFESCAN Initiative

- Combining AUVs and ROVs for comprehensive underwater inspections [3].
- Shows promising results in terms of autonomy and accuracy.

Challenges

- Limited by depth, duration, and risk.
- Limited availability of specialized tools for underwater repair and intervention tasks.
- Require surface vessels and operators, costly and complex.
- Difficulty in performing real-time maintenance and repair during inspections.
- Safety concerns in harsh underwater environments and limited accessibility to deep or hazardous areas.

Research Focus

- Develop robust algorithms for precise AUV navigation [4].
- Enhance data integration and interpretation for accurate defect detection [5].
- Innovate AUV manipulation abilities for minor repairs and maintenance.

Proposed Contributions

- Create advanced machine learning models for real-time anomaly detection.
- Integrate and test an inspection prototype using latest sensors with AUV.
- Conduct extensive field trials to validate real-world performance and reliability.

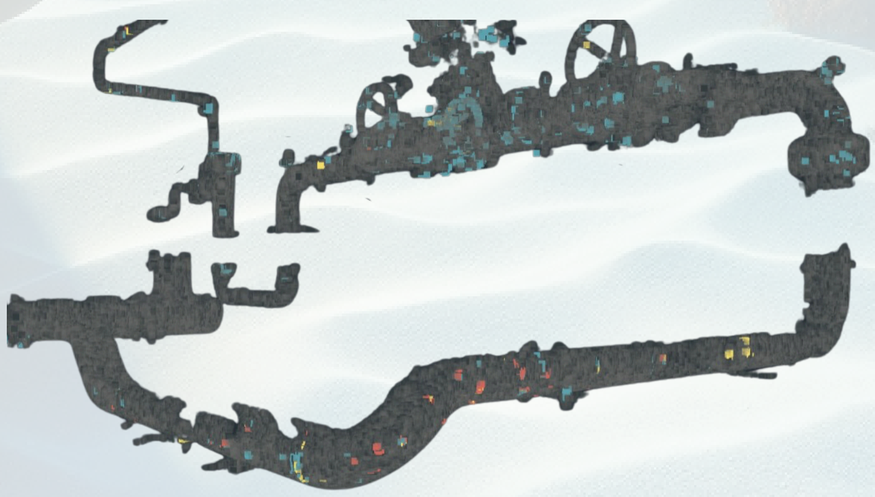

Fig 4: Classification of Corrosion Inspection Masks by Degree. C1 represents light corrosion, C2 indicates moderate corrosion, and C3 denotes heavy corrosion, as per standard corrosion degree criteria.

References

1. Bolotina, I.; Borikov, V.; Ivanova, V.; Mertins, K.; Uchaikin, S. Application of phased antenna arrays for pipeline leak detection. J. Pet. Sci. Eng. 2018, 161, 497–505.
2. Allotta, Benedetto, et al. "Archaeology oriented optical acquisitions through MARTA AUV during ARROWS European project demonstration." OCEANS 2016 MTS/IEEE Monterey. IEEE, 2016.
3. Arndt, Nicholas, et al. "Amgen Strategic Plan-Part." (2018).
4. Liu, Yixu, et al. "Experimental Analysis of Deep-Sea AUV Based on Multi-Sensor Integrated Navigation and Positioning." Remote Sensing 16.1 (2024): 199.
5. Verma, Ankur, Ayush Goyal, and Soundar Kumara. "Machine learning-assisted collection of reduced sensor data for improved analytics pipeline." Procedia CIRP 121 (2024): 150-155.

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