Embedded Life-Cycle Management for Smart Multimaterials Structures: Application to Engine Components

MORPHO FINAL CONFERENCE

CoPropel: Next-Generation Propulsion Technology

Structural Health Monitoring (SHM) for Composite Marine Propellers

Maria Xenidou, Kyriaki Tsirka, Andreas Kalogirou, Alkiviadis S. Paipetis

Composite and Smart Materials Laboratory (CSML), Materials Engineering department, School of Engineering, University of Ioannina, 45110 Ioannina, Greece

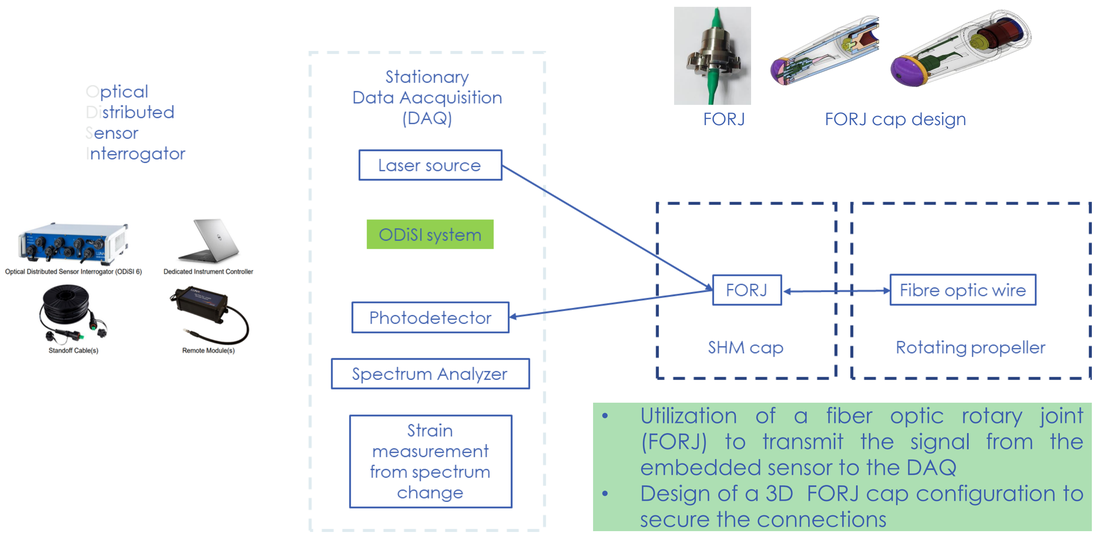
Abstract

CoPropel is a European HORIZON project that aims to revolutionize marine propulsion through the design and manufacturing of a composite marine propeller with an integrated Structural Health Monitoring (SHM) system. The utilization of SHM technologies on a marine propulsion system can contribute to increased vessel safety and operational efficiency. The embedded sensors will provide real time information regarding the structural integrity of the propeller under operational conditions enabling damage detection at an early stage and predictive maintenance strategies.

Structural Health Monitoring system

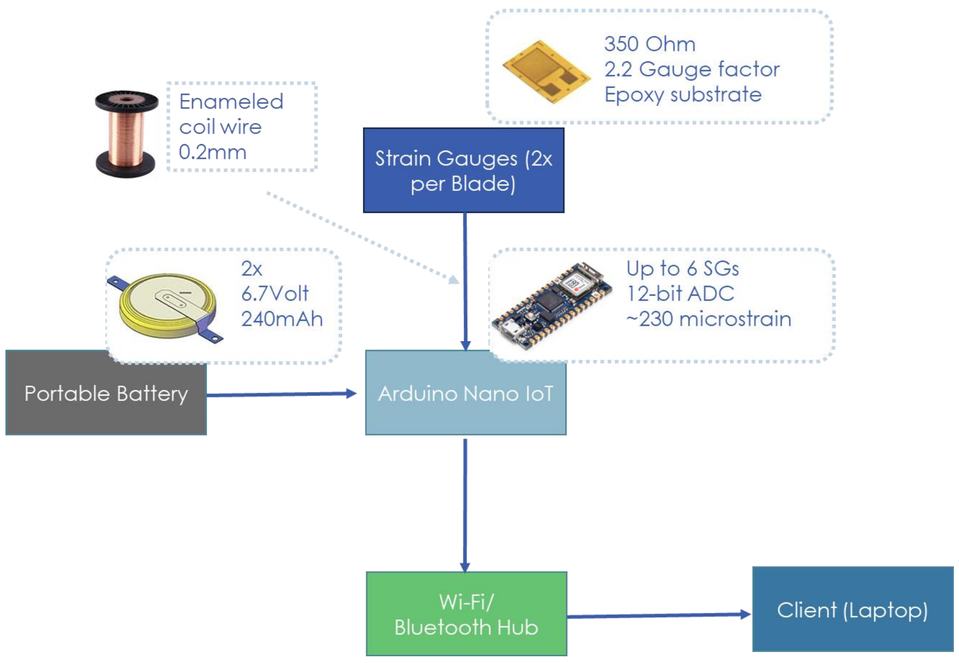
Monitoring technologies utilized in CoPropel project:

- Rayleigh fiber optic system
- Wireless strain gauges



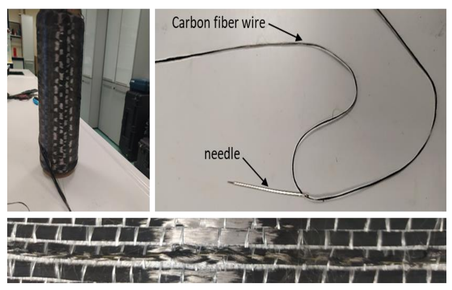
- Utilization of a fiber optic rotary joint (FORJ) to transmit the signal from the embedded sensor to the DAQ
- Design of a 3D FORJ cap configuration to secure the connections

Developed fiber optic system

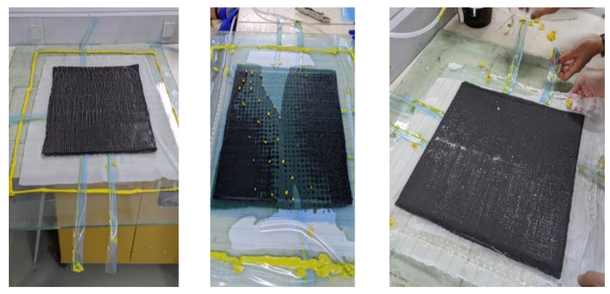


Developed wireless system

Integration of sensors into the composite material



Integration of sensor



Fabrication of composite laminate

The effect of the embedded optical fiber on the mechanical properties of the composite material was evaluated under Tensile and 3 Point bending

3 Point bending test results

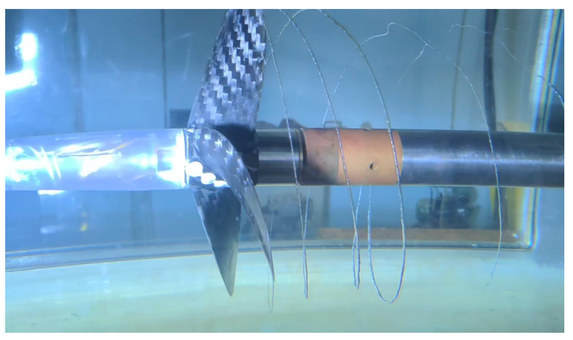
	Specimens without OF	Specimens with 4 OF
Number of samples	4	4
Average failure stress (MPa)	503	500
STDV	42	9

Tensile test results

	Specimens without OF	Specimens with 1 OF
Number of samples	5	6
Average failure stress (MPa)	1389	1353
STDV	166	129

Small scale demonstrator

The SHM system was successfully deployed on a small-scale composite propeller designed by MECA, manufactured by LRT and tested at BSHC. The sensors acquired strain under different loading scenarios and the experimental results were correlated with results from numerical simulations



(a)

(b)

Deployment of the system on the composite small-scale propeller under (a) cavitation and (b) open water hydrodynamic tests

Consortium

University of Ioannina
Loiretech
Meca
Bureau Veritas (BV)
TWI LTD
Brunel University
Bulgarian Ship Hydrodynamic Centre
Danaos Shipping Co Ltd
Bureau Veritas Solution
Glafcos

This research has received funding from the European Union's Horizon Research and Innovation Actions, under grant agreement No 101056911, project "CoPropel: Composite material technology for next-generation Marine Vessel Propellers"

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101006854