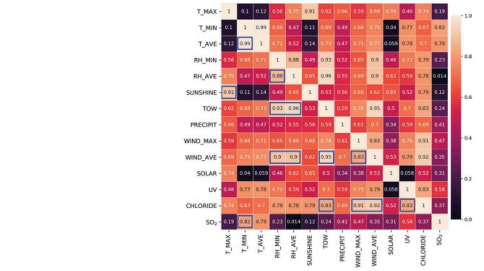
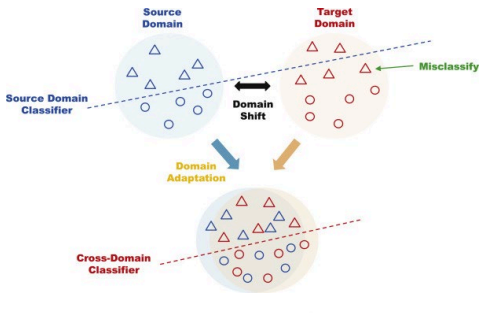
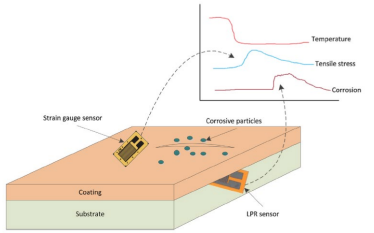
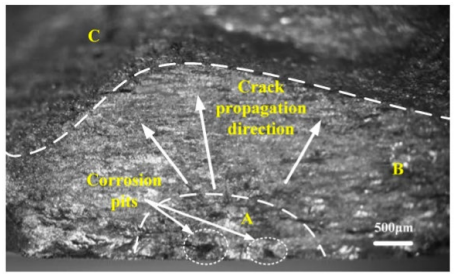
SAMAS 2: Structural Health and Ballistic Impact Monitoring and Prognosis on a Military Helicopter









CORROSION MONITORING

WP100 - Management

WP200 – Preliminary activities and requirements

WP300 – Structure evaluation for corrosion monitoring

WP500 – Algorithms for corrosion monitoring

WP800 – Experimental verification and validation for corrosion monitoring

IMPACT MONITORING

WP400 – Creation of the Digital-Twin for impact monitoring

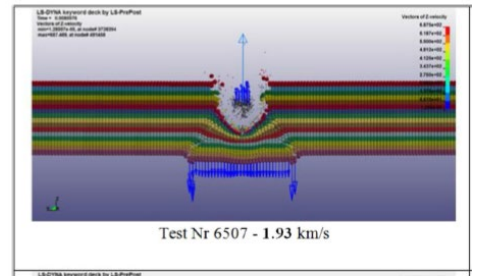
WP600 – Algorithms for impact and load monitoring

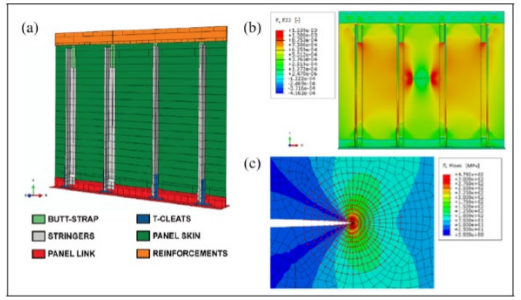
WP700 – Sensor network design for impact and load monitoring

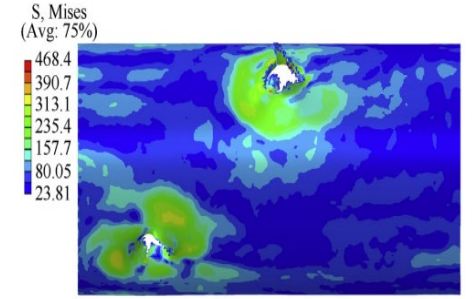
WP900 – Experimental verification and validation for impact and load monitoring

WP1000 – Digital-Twin for LCC, CBA and operational support

WP1100 – Gap analysis and exploitation roadmap

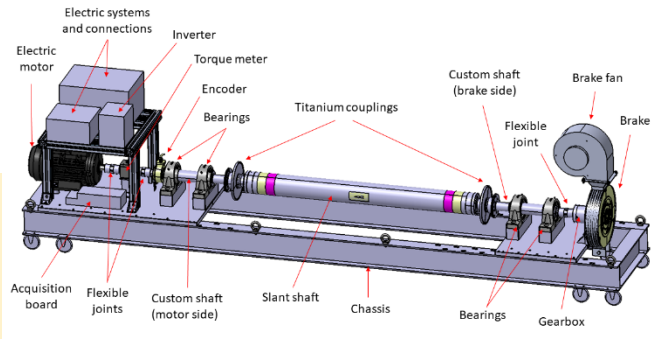






Collaboration: EU consortium (Leonardo SpA, CNR, etc.)

SAMAS 2: Impact Monitoring



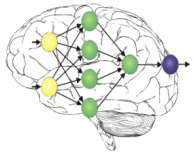
Test campaign

- Impact TESTS on a component (on laboratory)
- Dynamic GROUND tests on SIMPLIFIED TEST RIG (in healthy and damage condition)
- Dynamic GROUND tests on FULL-SCALE structure
- Technology verification by means of FLIGHT TESTS (fatigue load monitoring)

Setup of requirement and target objectives

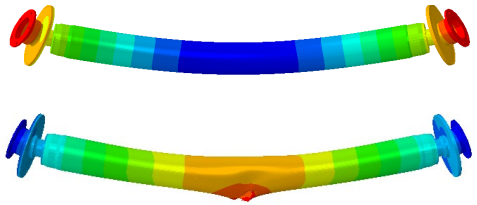
Creation of a Digital-Twin in healthy and damaged conditions

Algorithms for diagnosis and prognosis of impact damage and load monitoring

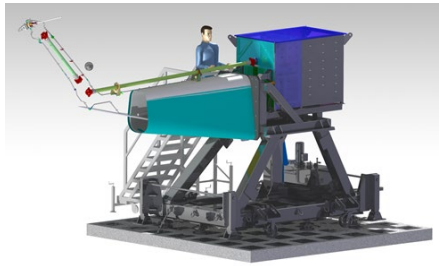


Methods for sensor network optimization

Experimental verification



Ground Test: Representative lab test will be the **BERC test rig**, able to test the tail rotor drive (in healthy and damage configurations) in operative conditions.



Flight Test: Test platform will be **Mil Mi-24 helicopter.** HUMS will be installed on representative structures (in healthy configuration) for performance evaluation in real operational condition.

Project: SAMAS 2

TITLE: Ballistic impact damage identification on a helicopter transmission shaft

- **RESEARCH BACKGROUND: In the framework of SAMAS 2, two test platforms have been developed where acceleration signals are acquired in real time before, during and after impact occurrence. Developing a data processing unit running automatically and in real time while acquiring so to identify the impact event and its location is a challenging task of the Digital Twin field, potentially addressed by ML algorithms.**

- **RESEARCH ACTIVITIES: Data processing, experimental tests, algorithms development for impact identification**

METHODOLOGY: Numerical, programming, experimental

DURATION: 9 months

CONTACTS:

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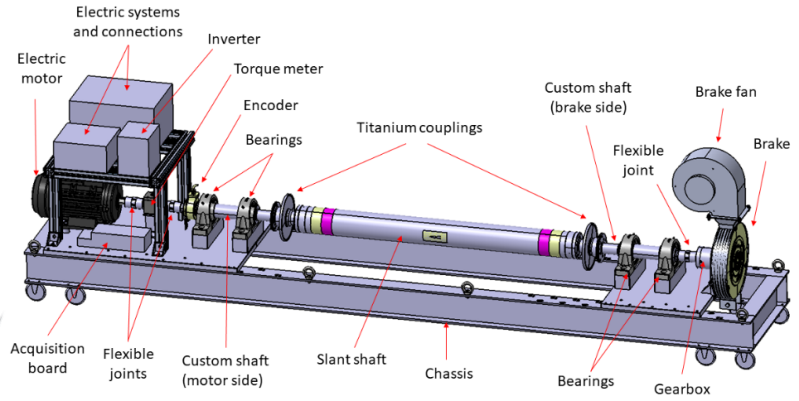
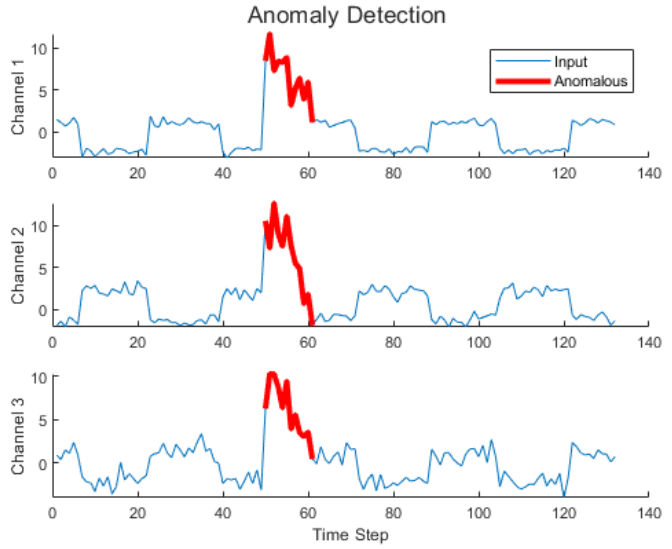
vasiliki.panagiotopoulou@polimi.it
marco.giglio@polimi.it

Experiments are running





Time Series Anomaly Detection

TITLE: Ballistic impact damage identification on a helicopter transmission shaft

Up to 3400 rpm

Acquisition by:

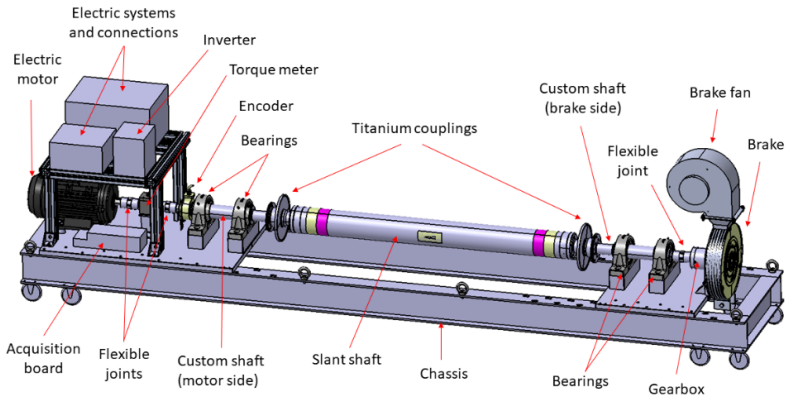
- Accelerometers
- Torque meter
- Encoder
- Current flows
- Temperature
- Etc.

SEPTEMBER 2023 (SHOOTING RANGE)

Project: SAMAS 2

TITLE: Ballistic impact damage identification using Convolutional Neural Network

- **RESEARCH BACKGROUND: Feature selection is the process of reducing the number of input variables, and thus the computational cost, when developing a predictive model with the goal to potentially improve tis performance. In most cases, raw data (i.e., accelerations) cannot be exploited directly for damage identification purposes and thus must be transformed first to knowledge, contained by features. CNN which exploits data in frequency domain could provide highly damage dependent variables and facilitate the overall diagnosis phase.**



- **RESEARCH ACTIVITIES: Data processing, experimental tests, algorithms development for impact identification**

METHODOLOGY: Numerical, programming, experimental

DURATION: 9 months

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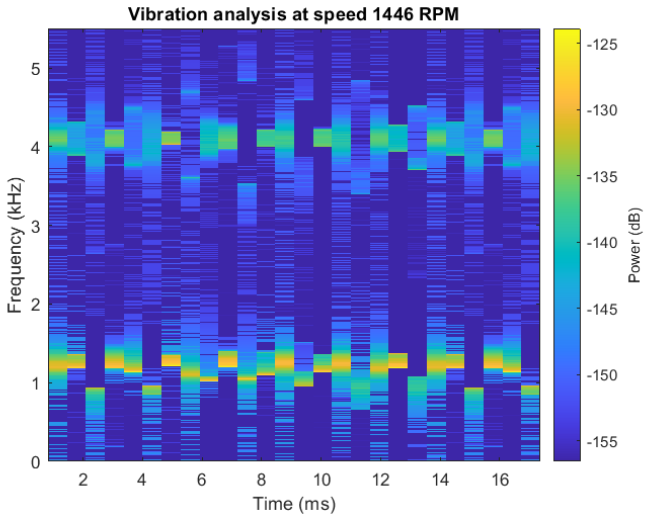
Experiments are running



Frequency response image processed by CNN

Project: SAMAS 2

TITLE: Physics Informed Neural Network for surrogate modeling and damage identification

- **RESEARCH BACKGROUND: Traditional Machine Learning algorithms tend to behave as black boxes and thus making the verification process regarding fitting difficult. Incorporating physics into the training process could increases the interpretability of the algorithm (and DTs) and establishes a more robust framework. Research on combining models in the form of physical equations with machine learning structures, potentially transforming black box models into "grey box models" is ongoing.**

- **RESEARCH ACTIVITIES: Data processing, algorithms development for impact identification**

METHODOLOGY: Numerical, analytical, programming

DURATION: 9 months

CONTACTS:
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vasiliki.panagiotopoulou@polimi.it
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