Bridging the gap between digital-twin based damage identification and failure prognosis for critical structures, through automated and online measurements enabled by unmanned vehicle swarms.

A Data Management Plan created using DMPonline.be

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Funder: Bijzonder Onderzoeksfonds

Template: KU Leuven BOF-IOF

Grant number / URL: 3E220129

ID: 199343

Start date: 01-12-2022

End date: 30-11-2026

Project abstract:

Modern industrial structures are increasingly complex in terms of geometry and materials. More specifically, the usage of composite and complex additively manufactured structures implies a greater range of possible structural damage modes for which the structure has to be frequently and thoroughly inspected. The massive cost implied by scheduled inspection techniques has led to intense industrial interest towards novel structural health monitoring (SHM) technologies which are by definition 'automated' and 'online'. A structure having permanently attached sensors however with the required accompanied power units, cables and processing equipment significantly adds to the complexity and cost of the holistic system, sometimes even resulting in technologies focusing on monitoring the SHM equipment. With the intense development and reduced cost of aerial and underwater unmanned vehicle (UV) technologies, a large portion of the SHM research is focusing on structural monitoring without permanently attached equipment. The initial attempts have focused on visual inspection for surface-visible damage, with sensing approaches that can provide more accurate damage information (i.e. ultrasound and vibration) not having being investigated. This research and training programme (PhD1) will investigate for the first time if UV measurements (both aerial and underwater) can provide accurate damage identification capability, or if the additional measurement uncertainty implied by the nature of removable sensors destroys the valuable information in the data. The developed tools will lead to robust structural damage localization and identification, as well as to effective estimation of major reliability indices such as the Remaining Useful.

Last modified: 09-05-2023

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Research Data Summary

List and describe all datasets or research materials that you plan to generate/collect or reuse during your research project. For each dataset or data type (observational, experimental etc.), provide a short name & description (sufficient for yourself to know what data it is about), indicate whether the data are newly generated/collected or reused, digital or physical, also indicate the type of the data (the kind of content), its technical format (file extension), and an estimate of the upper limit of the volume of the data.

Dataset name / ID	Description	New or reuse	Digital or Physical data	Data Type	File format	Data volume	Physical volume
		Indicate: N(ew data) or E(xisting data)	Indicate: **D**(igital) or **P**(hysical)	Indicate: **A**udiovisual **I**mages **S**ound **N**umerical **T**extual **M**odel **SO**ftware Other (specify)		Indicate: <1GB <100GB <1TB <5TB >5TB NA	
Numerical data	simulation for civil and mechanical structures	N	D	N/M	Abaqus file; Ansys file; Comsol file	<1TB	
Experimental data	data from vibration and non-contactless test, i.e., ultrasonic and UAVs	N	D	I/S	Matlab file; text file;	<100GB	
System identification algorithms	modal analysis and identification	N	D	N/SO	Matlab file; python file	<1GB	
Model updating algorithms	model updating for high fidelity models	N	D	N/SO	Matlab file; python file	<1GB	
Damage identification algorithms	detection, localization, qualification for damage	N	D	N/SO	Matlab file; python file	<1GB	
Data analysis scripts	transformation of the numerical data to analytical data	N	D	N/SO	Matlab file; python file	<1GB	

If you reuse existing data, please specify the source, preferably by using a persistent identifier (e.g. DOI, Handle, URL etc.) per dataset or data type:

N/A

Are there any ethical issues concerning the creation and/or use of the data (e.g. experiments on humans or animals, dual use)? If so, refer to specific datasets or data types when appropriate and provide the relevant ethical approval number.

- No

Will you process personal data? If so, please refer to specific datasets or data types when appropriate and provide the KU Leuven or UZ Leuven privacy register number (G or S number).

- No

Does your work have potential for commercial valorization (e.g. tech transfer, for example spin-offs, commercial exploitation, …)? If so, please comment per dataset or data type where appropriate.

- No

Do existing 3rd party agreements restrict exploitation or dissemination of the data you (re)use (e.g. Material or Data transfer agreements, Research collaboration agreements)? If so, please explain in the comment section to what data they relate and what restrictions are in place.

- No

Are there any other legal issues, such as intellectual property rights and ownership, to be managed related to the data you (re)use? If so, please explain in the comment section to what data they relate and which restrictions will be asserted.

- No

Documentation and Metadata

Clearly describe what approach will be followed to capture the accompanying information necessary to keep data understandable and usable, for yourself and others, now and in the future (e.g. in terms of documentation levels and types required, procedures used, Electronic Lab Notebooks, README.txt files, codebook.tsv etc. where this information is recorded).

For finite element simulation data, modeling steps such as material and geometric parameter setting, constraint setting, load application, etc. will be described in a detailed numerical calculation report.
For experiments, the measurement setup, data acquisition parameters, data processing steps, and file structure will be described in a detailed measurement report.
These reports contain all the details needed to repeat simulations and experiments (if required), process and interpret the data.
Readme files describing the organization and content of the Matlab and Python scripts are provided. Each file is clearly documented in the code via inline comments. The results of the processing are described in separate reports and publications.

Will a metadata standard be used to make it easier to find and reuse the data?
If so, please specify which metadata standard will be used.

If not, please specify which metadata will be created to make the data easier to find and reuse.

- Yes

RDR KU Leuven

Data Storage & Back-up during the Research Project

Where will the data be stored?

- OneDrive (KU Leuven)

The numerical model data and result data, acceleration, displacement, and image data obtained from field test measurements, model updating and damage identification algorithms, data processing algorithms, etc. will be stored in OneDrive.

How will the data be backed up?

- Standard back-up provided by KU Leuven ICTS for my storage solution

Is there currently sufficient storage & backup capacity during the project?

If no or insufficient storage or backup capacities are available, explain how this will be taken care of.

- Yes

How will you ensure that the data are securely stored and not accessed or modified by unauthorized persons?

Folders are shared with only relevant persons and colleagues.

What are the expected costs for data storage and backup during the research project? How will these costs be covered?

The use of KU Leuven OneDrive for Business is free of charge.

Data Preservation after the end of the Research Project

Which data will be retained for 10 years (or longer, in agreement with other retention policies that are applicable) after the end of the project?

In case some data cannot be preserved, clearly state the reasons for this (e.g. legal or contractual restrictions, storage/budget issues, institutional policies...).

- All data will be preserved for 10 years according to KU Leuven RDM policy

Where will these data be archived (stored and curated for the long-term)?

- KU Leuven RDR

What are the expected costs for data preservation during the expected retention period? How will these costs be covered?

N/A

Data Sharing and Reuse

Will the data (or part of the data) be made available for reuse after/during the project?
Please explain per dataset or data type which data will be made available.

- Yes, as restricted data (upon approval, or institutional access only)

The data including numerical and experimental data, data processing algorithms and scripts, pertaining to published case studies will be made available upon request through dedicated share links.

If access is restricted, please specify who will be able to access the data and under what conditions.

Members of our own research group and colleagues having the required link.

Are there any factors that restrict or prevent the sharing of (some of) the data (e.g. as defined in an agreement with a 3rd party, legal restrictions)?

Please explain per dataset or data type where appropriate.

- No

Where will the data be made available?

If already known, please provide a repository per dataset or data type.

- KU Leuven RDR (Research Data Repository)

When will the data be made available?

- Upon publication of research results

Which data usage licenses are you going to provide?

If none, please explain why.

- Other (specify below)

To be determined later.

Do you intend to add a persistent identifier (PID) to your dataset(s), e.g. a DOI or accession number? If already available, please provide it here.

- No

What are the expected costs for data sharing? How will these costs be covered?

N/A

Responsibilities

Who will manage data documentation and metadata during the research project?

PIs: Dimitrios Chronopoulos, Dirk Vandepitte, Konstantinos Gryllias
PhD researcher: Chen Fang

Who will manage data storage and backup during the research project?

PIs: Dimitrios Chronopoulos, Dirk Vandepitte, Konstantinos Gryllias
PhD researcher: Chen Fang

Who will manage data preservation and sharing?

PIs: Dimitrios Chronopoulos, Dirk Vandepitte, Konstantinos Gryllias
PhD researcher: Chen Fang

Who will update and implement this DMP?

PIs: Dimitrios Chronopoulos, Dirk Vandepitte, Konstantinos Gryllias
PhD researcher: Chen Fang

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