The boundary element method as a state-space realization problem

A Data Management Plan created using DMPonline.be

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Project abstract:

The boundary element method (BEM) is a numerical method for modeling wave propagation problems. In this proposal, we address two particular problems related to the BEM, both of which are impeding the application of the BEM to our area of interest, that is, sound propagation in enclosures, i.e., room acoustics.

Firstly, the BEM is most often applied in the frequency domain, representing a steady-state solution to a wave propagation problem. However, in order to represent wave fields generated by spatiotemporally nonstationary sources, a time-domain approach is needed. Time-domain BEM has only been scarcely considered as it is prone to instability problems. Secondly, the accuracy of the BEM solution is highly dependent on an accurate formulation of the boundary conditions, hence requiring a detailed characterization of the material properties of the enclosure, which is often infeasible.

Both problems will be addressed by exploiting a formulation of the BEM that has remained underexplored in literature. The time-domain boundary integral equation from which the BEM is derived, can be rewritten into a continuous-time, discrete-space state-space model. This representation will firstly allow to understand how stability can be preserved when moving from continuous to discrete time. Secondly, it naturally leads to the formulation of a state-space realization problem that yields the perspective to estimate the boundary conditions from impulse response measurements.

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The boundary element method as a state-space realization problem
Application DMP

Questionnaire

Describe the datatypes (surveys, sequences, manuscripts, objects …) the research will collect and/or generate and /or (re)use. (use up to 700 characters)

All data used to support research findings or to validate research results will be generated by the supervisor and co-workers. It will mainly consist of documents in common electronic document formats (reports, papers), analytical and numerical simulation codes in software specific file formats (Matlab m-files, Julia, Python and C code), raw numerical data and multimedia files. The raw data will be generated as output from the simulation codes and will be exported in a variety of standard formats that can be imported in other software packages for post-processing. Metadata about the data sets with specific information about the numerical runs will be stored in associated text files.

Specify in which way the following provisions are in place in order to preserve the data during and at least 5 years after the end of the research? Motivate your answer. (use up to 700 characters)

The PIs will be responsible for implementing the DMP. They will update the DMP anytime conditions change. The DMP will be reviewed in the middle of the project, and a final review will take place at the end of the project. The data will be stored on storage facilities of the research unit during the research but also after the project has finished. The data stored in the ESAT servers has access regulated by an access control list (ACL) that grants: read-write access to the project owner read- only access to specific users The ACL is managed by the project owner. Client computers can access the data using: SMB2 (or higher) from specific IP ranges NFSv4 from specific (IT managed) systems.

What’s the reason why you wish to deviate from the principle of preservation of data and of the minimum preservation term of 5 years? (max. 700 characters)

NA

Are there issues concerning research data indicated in the ethics questionnaire of this application form? Which specific security measures do those data require? (use up to 700 characters)

NA

Which other issues related to the data management are relevant to mention? (use up to 700 characters)

NA

The boundary element method as a state-space realization problem
FWO DMP (Flemish Standard DMP)

1. 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.

				Only for digital data	Only for digital data	Only for digital data	Only for physical data
Dataset Name	Description	New or reused	Digital or Physical	Digital Data Type	Digital Data format	Digital data volume (MB/GB/TB)	Physical volume
		Please choose from the following options: • Generate new data • Reuse existing data	*Please choose from the following options:* • Digital • Physical	*Please choose from the following options:* • Observational • Experimental • Compiled/aggregated data • Simulation data • Software • Other • NA	*Please choose from the following options:* • .por, .xml, .tab, .csv,.pdf, .txt, .rtf, .dwg, .gml, … • NA	*Please choose from the following options:* • <100MB • <1GB • <100GB • <1TB • <5TB • <10TB • <50TB • >50TB • NA	
MYRiAD	Multi-array room acoustic database	Reuse existing data	Digital	Experimental	.wav	<100GB	
MIRACLE	Microphone array impulse response dataset for acoustic learning	Reuse existing data	Digital	Experimental	.wav	<100GB	
tRIRjectory	Moving dummy head and microhpone array database	Generate new data	Digital	Experimental	.wav	<100GB	

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:

MYRiAD: https://zenodo.org/records/7389996
MIRACLE: https://doi.org/10.14279/depositonce-20106

Are there any ethical issues concerning the creation and/or use of the data (e.g. experiments on humans or animals, dual use)? Describe these issues in the comment section. Please refer to specific datasets or data types when appropriate.

- No

Will you process personal data? If so, briefly describe the kind of personal data you will use in the comment section. Please refer to specific datasets or data types when appropriate.

- 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.

- Yes

The work that will be carried out in the project has potential for commercial valorisation, however, this potential lies in the methods and algorithms that will be developed and not in the datasets that will be generated.

Do existing 3rd party agreements restrict exploitation or dissemination of the data you (re)use (e.g. Material/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

2. 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).

The equipment used to generate and record the sound signals will be detailed in a rich text document. Pictures of the experimental setup will be included in this document as well. This document will be published along with the data.
All source and microphone positions used for the sound generation and recording will be accurately measured and their 3-D coordinates will be saved in a CSV file. For sources and microphones that follow a dynamic spatial trajectory during the recordings, the 3-D coordinates of a set of positions along the trajectory will be saved in a CSV file along with the corresponding time stamps. These CSV files will also be published along with the data.

Will a metadata standard be used to make it easier to find and reuse the data? If so, please specify (where appropriate per dataset or data type) which metadata standard will be used. If not, please specify (where appropriate per dataset or data type) which metadata will be created to make the data easier to find and reuse.

- Yes

We will use standard AES69-2022.

3. Data storage & back-up during the research project

Where will the data be stored?

The data generated in the course of the project will be stored on storage facilities of the research unit.

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

- Yes

The research unit provides sufficient storage facilities for our current needs.

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

The storage used by the research unit is backed up daily. The backup process is managed by the IT division of the department (ESAT). For all data stored in the department's servers, access is regulated by an access control list (ACL) that grants read-write access to the project owner and read-only access to specific users. The ACL is managed by the project owner. Client computers can access the data using: SMB2 (or higher) from specific IP ranges NFSv4 from specific (IT managed) systems.

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

The storage facilities of the research unit are currently available at no cost.

4. Data preservation after the end of the research project

Which data will be retained for at least five 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)?

- Shared network drive (J-drive)
- Large Volume Storage (longterm for large volumes)

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

The storage facilities of the research unit are available for the researchers for free.

5. Data sharing and reuse

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

- Yes, in an Open Access repository

The dataset labeled above as tRIRjectory (temporary name) will be made available as open data. The data that will be made available consist of room impulse response measurements (WAV format), loudspeaker and microphone signals (WAV format) and metadata (SOFA format of AES69-2022 standard).

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

NA

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 in the comment section 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.

Zenodo

When will the data be made available?

As soon as the data have been measured and processed, and the metadata have been finalized. Estimated date: September 2024.

Which data usage licenses are you going to provide? If none, please explain why.

CC-BY 4.0 (data)

Do you intend to add a PID/DOI/accession number to your dataset(s)? If already available, you have the option to provide it in the comment section.

- Yes

Yes, a PID will be added upon deposit in a data repository.

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

No data sharing costs are expected (Zenodo).

6. Responsibilities

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

The PIs (Toon van Waterschoot, Randall Ali) will be responsible for data documentation and metadata.

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

The IT division of the department (ESAT) will be responsible for the data storage and back-up during the project.

Who will manage data preservation and sharing?

The PIs (Toon van Waterschoot and Randall Ali) will be responsible for the data preservation and reuse.

Who will update and implement this DMP?

The PIs (Toon van Waterschoot and Randall Ali) bears the end responsibility of updating and implementing this DMP.