Impact-Aware Manipulation by Dexterous Robot Control and Learning in Dynamic Semi-Structured Logistic Environments

Data Management Plan (update D6.3)

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www.i.am-project.eu

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Control sheet

Version history			
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Peer reviewers		
	Reviewer name	**Date**
Reviewer 1	Harshit KHURANA	26/01/2022
Reviewer 2	Alessandro SACCON	27/01/2022
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TABLE OF CONTENTS

ABBREVIATIONS

Abbreviation	Definition
DMP	Data Management Plan
DOI	Digital Object Identifier
EC	European Commission
HDF	Hierarchical Data Format
PU	Public
SEO	Search Engine Optimization
WP	Work Package

EXECUTIVE SUMMARY

This deliverable D6.5 Data Management Plan (update D6.3), is an update of the first version Data Management Plan and provides some updates regarding plan of the dataset generated in WP1 (I.Model), that is to be used by the entire consortium. Throughout the deliverable the updates are clearly shown, for the reader. Since the dataset itself is being described and published in D1.1 and succeeding D1.4, this deliverable focuses on HOW we will make dataset and repo available according to FAIR policy. D1.4 focuses on WHAT we make available (in-depth dataset). This deliverable builds upon the H2020 Online Manual on Data Management Plan, and deals with the topics of FAIR data, allocation of resources within the project dedicated to Data Management, data security, and ethical aspects. Since the I.AM. project focuses within WP1 on the generation of the I.AM. dataset, we will describe how we intend to share it and the possible re-use within and outside the consortium. Further detailed technical implementation of the dataset was described in D1.1 in M9 (September 2020), where we will explain the contents of the dataset, the location and the first description of how we ensure open access to public. Mainly changes in the location of the dataset have been processed in the project and are described in detail in this deliverable.
This deliverable will be get a final revision in M40 (April 2023) in D6.6 "Data Management Plan (second update D6.3)" and will receive updates from D1.1 and D1.4 as well.

1. INTRODUCTION

1.1. I.AM. project background

Europe is leading the market of torque-controlled robots. These robots can withstand physical interaction with the environment, including impacts, while providing accurate sensing and actuation capabilities. I.AM leverages this technology and strengthens European leadership by endowing robots to exploit intentional impacts for manipulation. I.AM focuses on impact aware manipulation in logistics, a new area of application for robotics which will grow exponentially in the coming years, due to socio-economical drivers such as booming of e-commerce and scarcity of labour.
I.AM relies on four scientific and technological research lines that will lead to breakthroughs in modeling, sensing, learning and control of fast impacts:

1. I.Model offers experimentally validated accurate impact models, embedded in a highly realistic simulator to predict post-impact robot states based on pre-impact conditions;
2. I.Learn provides advances in planning and learning for generating desired control parameters based on models of uncertainties inherent to impacts;
3. I.Sense develops an impact-aware sensing technology to robustly assess velocity, force, and robot contact state in proximity of impact times, allowing to distinguish between expected and unexpected events;
4. I.Control generates a framework that, in conjunction with the realistic models, advanced planning, and sensing components, allows for robust execution of dynamic manipulation tasks.

This integrated paradigm, I.AM, brings robots to an unprecedented level of manipulation abilities. By incorporating this innovative technology in existing robots, I.AM enables shorter cycle time (10%) for applications requiring dynamic manipulation in logistics. I.AM will speed up the take-up and deployment in this domain by validating its progress in three realistic scenarios: a bin-to-belt application demonstrating object tossing, a bin-to-bin application object fast boxing, and a case depalletizing scenario demonstrating object grabbing.

1.2. Data management plan background

The I.AM. consortium agreed to join the H2020 Open Research Data Pilot (ORDP), since the consortium had the intention to publish a publicly available impact aware manipulation dataset.

According to the I.AM. Grant Agreement article 29.3, the ORDP states that the consortium must comply with the following:

"Regarding the digital research data generated in the action ('data'), the beneficiaries must:

1) deposit in a research data repository and take measures to make it possible for third parties to access, mine, exploit, reproduce and disseminate — free of charge for any user — the following:
    (a) the data, including associated metadata, needed to validate the results presented in scientific publications, as soon as possible;
    (b) other data, including associated metadata, as specified and within the deadlines laid down in the 'data management plan'
2) provide information — via the repository — about tools and instruments at the disposal of the beneficiaries and necessary for validating the results (and — where possible — provide the tools and instruments themselves).

This does not change the obligation to protect results in Article 27, the confidentiality obligations in Article 36, the security obligations in Article 37 or the obligations to protect personal data in Article 39, all of which still apply.
As an exception, the beneficiaries do not have to ensure open access to specific parts of their research data under Point (a)(i) and (iii) if the achievement of the action's main objective would be jeopardised by making those specific parts of the research data openly accessible.
In this case, the data management plan must contain the reasons for not giving access."

In line with these ORDP guidelines, a first Data Management plan (D6.3) was produced by M6 (June 2020), showing how I.AM. would intend to comply with FAIR policy.
The first version of the I.AM. dataset was thereafter published in M9 (September 2020) as part of the effort of WP1 and made available to public on the delivery of D1.1 "Publication of I.AM. Dataset". Details on publication and availability can be found in that specific deliverable. Since the I.AM. consortium plans to grow this dataset during the project, it is a work in progress and will be continuously updated throughout the entire project till at least M36 (December 2022).

The Data Management Plan will therefore also be updated again for a last time at M40, to publish any changes in how the consortium makes the data FAIR (Findable, Accessible, Interoperable, Re-usable) and revised before each validation phase to fine-tune it to the progresses of the research.

1.3. Purpose of the deliverable

This deliverable D6.5 "Data Management Plan'' provides an update over the original data management plan (D6.3) that was published in June 2020 (M6), containing update on the implementation of the dataset generated in WP1, that being set up and used by the entire consortium and being made available to public. We describe how we shared it and how we ensure compliance with FAIR policy. The first detailed technical implementation of the dataset was already described in D1.1 in M9 (September 2020), which explains in more detail the structure and the contents of the dataset, its contact transition taxonomy, first description of its (online) location, and the first description of how we ensure open access to public.

This deliverable provides an update of D6.3 and D1.1 focusing on the overview of the web interface, process of data collection and location available to the consortium and public.

This deliverable will get a final revision and update in M40 (April 2023) in D6.6 "Data Management Plan (second update D6.3)" and will receive input from D1.4 then as well.

1.4. Intended audience

The dissemination level of D6.5 is 'public' (PU) – meant for members of the Consortium (including Commission Services) and the public. This document is intended to serve as an internal guideline for the entire I.AM. Consortium and provide the consortium's implementation plans regarding data management

2. I.AM. DATA REPOSITORY

This section provides the motivation for the I.AM. data repository, its current content, and target audience. The openly access repository can be reached via the URL:

https://impact-aware-robotics-database.tue.nl/

and it is constantly updated with the latest acquired datasets. In this section, furthermore, an updated vision for the repository's data structure, data collection, storage, and access is given. The section builds upon the work published in D1.1 and D6.3, focusing on re-introduction of why and what data is being collected (sections 2.1 and 2.2 below), after which the data collection, structure, and access is being described in section 2.3 (main updates with respect to D6.3 and D1.1, that make sure it complies with FAIR policy).

2.1. Purpose of the I.AM. data repository (why)

Impact-aware manipulation is a growing field within robotics and the I.AM. project aims at providing an open data repository with the following two purposes:

1) Storing of selected impact and release motion archives that are useful to develop the four key components that forms the impact-aware manipulation (I.AM.) technology, namely

   - Modeling (I.Model)
   - Learning and Planning (I.Learn)
   - Sensing (I.Sense)
   - Control (I.Control).

2) Making these impact-and-release-motion archives, that collectively form the I.AM. repository, openly available to other research institutions and companies worldwide, with the long- term goal of stimulating research, collaboration, and thus advancement in the field of impact-aware robotics for manipulation and potentially also locomotion tasks.

In this initial phase, related to the I.AM. project, the repository targets the storage of impact and release motions that are essential in the execution of the TOSS, BOX, GRAB scenarios of the I.AM. project. Additionally, the repository will allow for storage of motions with no contact transitions (free motion/constrained motions) to allow for dynamic identification of specific subcomponents such as, e.g., the bellows suction gripper used in the TOSS and BOX scenarios.

The long-term vision is to allow for the upload of external new archives, each containing selected recordings of impact-and-release motions, related to impact-aware manipulation experiments. The

archives will be requested to be complying to a to-be-defined repository policy to guarantee re-use and searchability of the stored data, ensuring that the stored data will have a value for the whole robotics community to developed, test, and compare methods related to modeling, learning, sensing, and control of impact-aware robotics systems.

2.2. Data to be collected (what)

The I.AM. data repository will contain recordings of impact-and-release motions involving known objects, robots, and well described environments. It will contain time series data related to

- object impacting the environment
- objects impacting robots
- objects impacting the environment while held by robots
- objects impacted by robots while being in contact with the environment and corresponding release motions
- objects detaching from the environment
- objects separating from a robot (in particular, its end effector)
- objects separating from the environment while held by robots
- objects separating from a robot while being in contact with the environment

A visual representation of the release and impact motions that are core to the I.AM. project, being related to the three validation scenarios, is given in Figure 1:

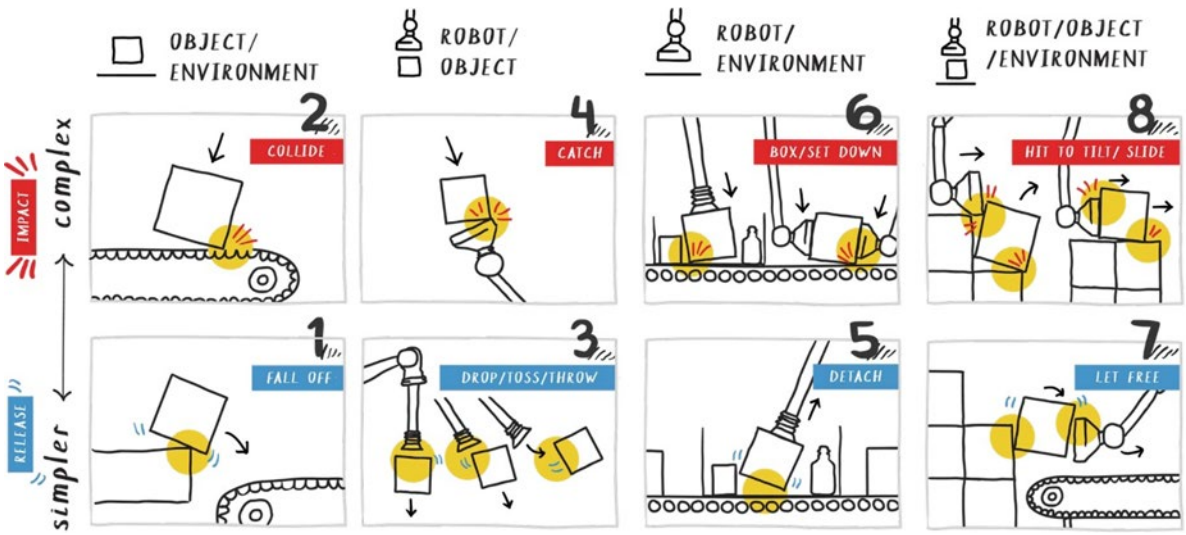

Figure 1: The qualitative I.AM. complexity metric used to cluster dynamic contact transitions in terms of increasing complexity and in terms of autonomous execution.

Each dataset of the impact-aware robotics repository, focusing on one specific type of release/impact motion and scenario, will contain multiple recordings of time-synchronized times series data, collected by means of (commercially available) sensors and robots. A representative list of sensors, by which time series data that will be collected, is the following:

- robot joint displacement sensors (digital encoders/resolvers),
- robot joint torque sensors,
- robot joint current,
- force/torque sensors,
- standard cameras / depth cameras,
- motion capture systems,
- high-speed cameras / event cameras,
- accelerometers / IMU sensors,
- pressure sensors
- robot input commands,
- any other sensors attached to objects or the environment, when required.

It is important to classify the time series data based on their primary purpose. It is essential to distinguish between two types of time series data: (1) time series data relevant for online learning, sensing, estimation, and feedback control; (2) time series data relevant for offline modelling and learning. Concrete examples of these two categories are the following: (1) joint encoder and joint torque sensor data recorded during intentional-impact experiments with expected and unexpected contact-state outcome, to be used for causal online detection and classification (I.Sense); (2) motion capture times series data used offline for non-causal data processing, for modelling and learning predictive impact models/laws (I.Model). A third type of times series data is that used for enhancing human understanding of the recordings: the concrete example is a camera recording of impact/release experiments that is synchronized with the time series data obtained by other sensors.

Together with time series data and generic data (such as exact robot and sensor models, experimental conditions), metadata will also be included in each dataset, to allow for both human and machine interpretability and search. This includes many details such as the date and time when the experiment was conducted, and identifiers for the robot that was used along with the controller type and revision identifiers, and information about the experiment.

An archive will contain several recordings of impact/release motions of the same type, with the same or on-purpose different initial conditions, inputs, and feedback gains, with the aim of assessing repeatability/variability of the impact/release motion outcome of the experiments based on nominally identical conditions as well as exploring the functional relationship between the outcome as a function of the initial conditions.

2.3. Data collection, structure, and access (how) Compliance with FAIR policy

One specific goal of the I.AM. project is to create an open-access data repository that will contain object-environment, robot-object, and robot-object-environment impact/release motion data. Having the I.AM. consortium agreed to join the H2020 Open Research Data Pilot, a preliminary Data Management Plan (DMP) has been released as D6.3 in June 2020, that has extensively covered the aspects of making the data FAIR (**f**indable, openly **a**ccessible, **i**nteroperable, **r**e-usable) and we therefore refer to D6.3 DMP for FAIR data related aspects. The focus in this section is on providing additional information with respect to D6.3 and D1.1 regarding how data is currently being collected, organized for storage, and current implementation of how to access remotely it publicly.

One specific aspect to consider is that there is currently no public repositories to store impact and release motions as well as no agreed format to store this type of information. For such a reason, a specific structure of an archive, containing several recordings, has been created for ensuring reproducibility, searchability, reusability, and human/machine interpretability of the stored data. One of the purposes of this deliverable is indeed to provide public access and description of a first version of such an archive, to allow for testing and further improvement, based on concrete experience in recording impact/release data as well as forecasting the future needs of the entire I.AM. project and beyond.

2.3.1. Data collection

Data will be collected on ad-hoc designed experimental setups, mainly at TU/e for the BOX and TOSS scenario and secondary in other partners local setups for the GRAB scenario. Data collection should have the clear purpose of serving at least one of the four objectives of the project (impact-aware modeling, learning, sensing, control). For this reason, the I.AM. partners agree to communicate to the other partners the intention to creating a new archive with the entire consortium, ideally prior/at the beginning of the start of the data collection activity, to receive feedback/suggestions on the scenarios and operational conditions to be considered, the information to be recorder, sensors to be used, etc.

During the collection of the data, it will be important to pay attention to have a clear plan on creating detailed descriptions and pictures the setup, including details such as which robot, end-effector, objects, and environment where used, which the goal of collecting all information that would allow for reproducibility of the experiments, if necessary. To this end, important information to record are, e.g., the geometry (dimension, shape) and dynamic/material properties (mass, inertia, material, etc.l) properties of the used robot(s), object(s), and environment. For commercial products (robots, end-effectors, consumer objects), it is requested to be provide/include in the dataset the model and type of product.

2.3.1.1. Data collection planning (when and who)

The time plan for data collection will follow the expected scenarios validation plan, shown in Figure 2 below. Concisely, the expectations are the following in terms of responsibility for data collection.

Responsible Partner(s):

- TOSS and BOX scenarios, mainly TU/e, with input from TUM, FRANKA EMIKA, CNRS
- GRAB scenario: mainly EPFL and CNRS for providing equipment (dual arm KUKA robot,dual Panda arms, sensor I/O logging), support for hardware and acquisition software, performing of experiments; TU/e for setting up experimental conditions and storage of collected data in agreed format with inputs from TUM, CNRS, and EFPL.

The expecting recording time (for first versions to be ready and uploaded to the database) is the following:

- First year (Dec. 2020): TOSS
- Second year (Dec. 2021): TOSS/BOX
- Third year (Dec. 2022): TOSS/BOX/GRAB

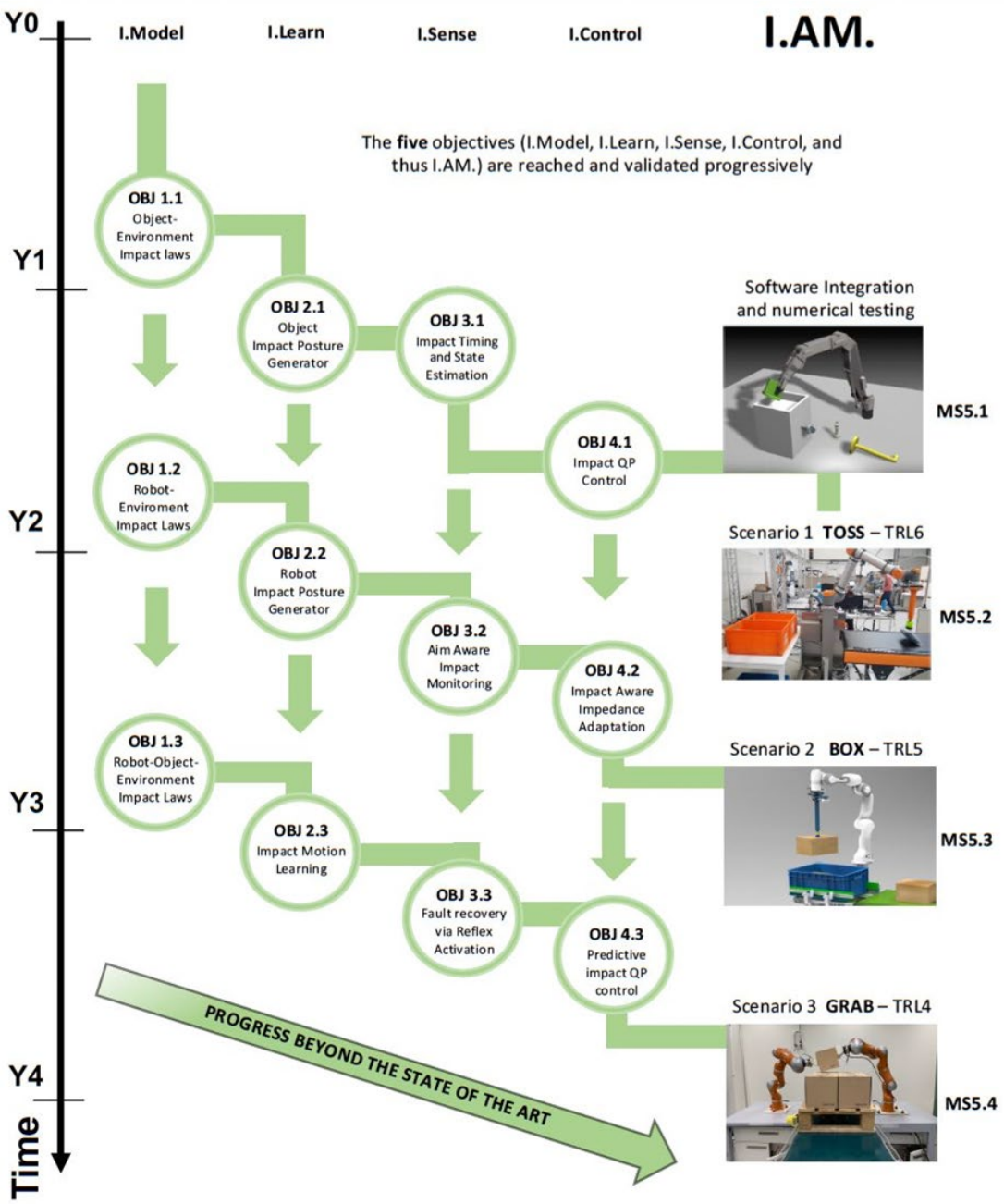

Figure 2: Time plan of the I.AM. project. Data collection plan for different type of impacts and release motions will be aligned with the project time plan.

2.3.2. Data structure

The I.AM. **repository** is built up from several archives. Each **archive** constitutes a set of coherent measurements with a specific purpose. More specifically, each archive is constituted by several **recordings**, containing **datasets**, organized in a **hierarchical structure** (folder/file type structure), and provided with **metadata** (attributes, both at folder and file level) to allow for human and

machine search and understanding. The storage of data makes use of the open-format HDF5 [1].viable alternative

The proposed structure for each archive is straightforward, being composed by a root folder and several subfolders, where each subfolder corresponds to a specific recording. At the root of the archive, the recording format of the dataset is provided (with reference to existing documentation as D1.1 deliverable or, in the future, publications describing such an format and database structure), for making the content of the archive self-explanatory to future users.

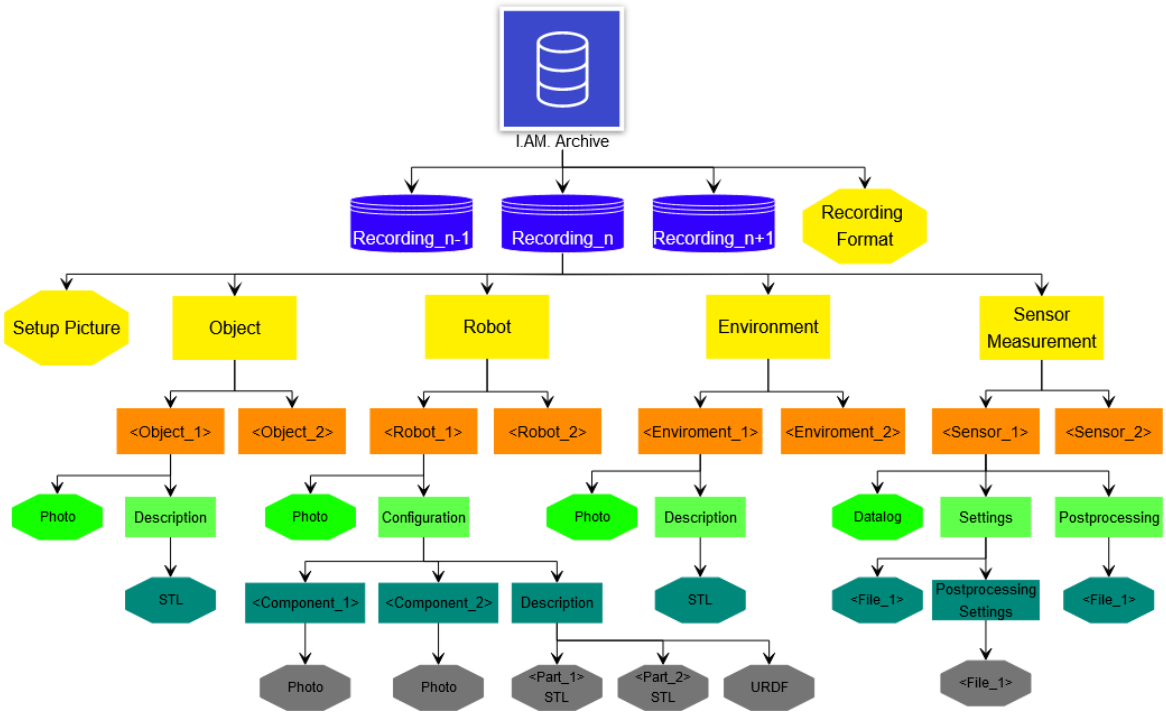

Figure 3: Structure of an I.AM. archive. Each archive contains a set of recordings, as well as a description of the recording forma. Each recording is subdivided into object, robot, environment, and sensor measurement subfolders and contains a picture of the setup used during the data recording. Details in the main text.

The entire data structure has not changed with respect to D1.1, so the detailed description of the data structure can be found therein.

2.3.3. Data access

Low-level access to the content of each archive of the I.AM. repository will be guaranteed, as mentioned in Section 2.3.2 and D6.3 Data Management Plan, by using a standard open-data format that is provided with I/O routines available in a large number of programming environments (C++, MATLAB, Python, to cite the most relevant to the I.AM. project) as well as a multi-platform generic viewer to inspect the content of the archives (e.g., the HDFview app for HDF5 format).

As described earlier in D6.3 it is the intention of the I.AM. project to publish the datasets on a platform that takes into account all the FAIR policies implementations, making the data findable, accessible, interoperable, and re-usable. The current implementation as of January 2022 is further detailed in the next section.

2.3.3.1. Database

The specific option that has been chosen in the I.AM. project to store the datasets is the "4TU.ResearchData" server [7], which provides long-term (guaranteed at least 15 years) archive for storing and reusing research data in the technical sciences (see Figure 4). The 4TU.ResearchData service is comparable with the European initiative Zenodo [9], that was initially considered as a viable option for data storage. The 4TU.ResearchData allows the datasets to be stored as netCDF [2] or HDF5 [1] files, which complies with the data structure as described in D1.1. Since TU/e is part in the 4TU alliance in the Netherlands, institutional support for implementing this database is provided by colleagues within the TU/e and 4TU directly (TU Delft, UTwente, Wageningen University), making implementation and getting support extremely convenient and fast.

The 4TU Research Data complies with FAIR policy by employing (1) dataset versioning, (2) keywords, (3) licencing and (4) DOI. More specifically, about (1) versioning: every time an updated version of the dataset is uploaded, it gets a new unique identifier. Versioning is important as it allows to correct minor mistakes occurred during uploading, while clearly showing the history of modifications. Regarding (2) keywords, each dataset is provided with keywords that improving findability. Keywords used in the impact-aware datasets are, e.g., suction cup, impact, robotics. The 4TU Research Data server provide also (3) licencing, clearly indicating how the data can be used and distributed (currently, the suggested license is Attribution-Non-Commercial-Share Alike 4.0 International (CC BY-NC-SA 4.0), that grant the right of using the data for non-commercial purpose, as long attribution is provided to the creators of the dataset. Finally, regarding the availability of a (4) Digital Object Identifier (DOI) for each dataset, each (version of the) dataset is provided with a unique code, that can be used both to access the data via the DOI website (https://doi.org) and to refer to the specific dataset in, e.g., scientific publications.

As of September 2020 (M9 of the project), a first version of the a dataset for the TOSS scenario was made publicly available on this platform, as already described in D1.1. A single dataset can be visualized using the 4TU Research Data server web interface as in Figure 4. All datasets are actually collected in a 4TU Research data server collection accessible, again via the 4TU Research Data server web interface at the address

https://data.4tu.nl/collections/Impact-Aware_Robotics_Datasets/5405187

However, as explained in the following subsection, an ad-hoc web interface, independent from the 4TU Research data server web interface has been created to access all such datasets constituting the impact-aware robotics database. Such a new and ad-how web interface is accessible as

https://impact-aware-robotics-database.tue.nl

and constitutes the primary intended way to access the dataset collection. Such a web interface is detailed in the following section and was a key activity which required adequate IT investment from TU/e with the collaboration of 4TU research data server IT personnel.

an updated version

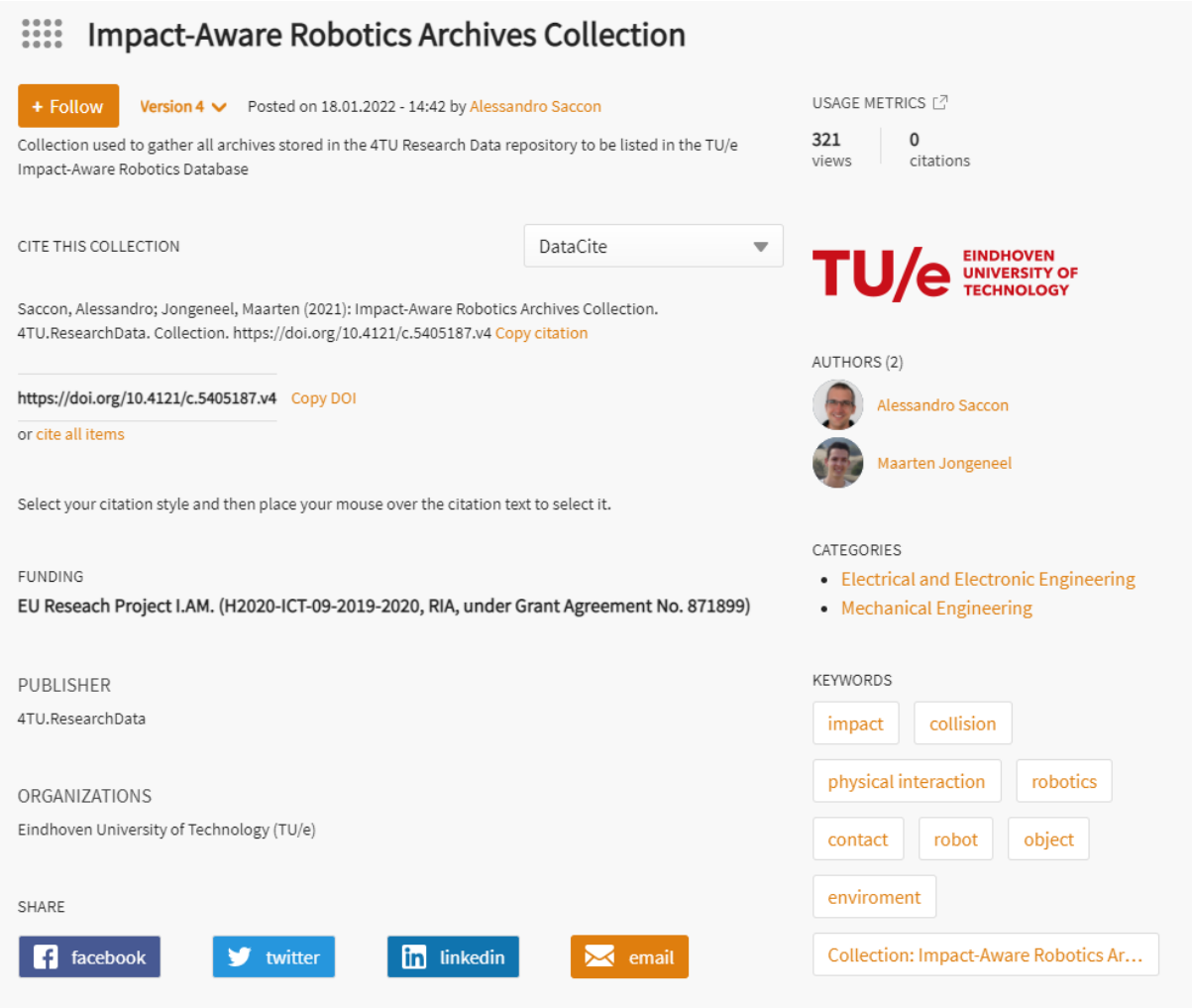

Figure 4: 4TU web interface showing the latest version (version 4 here shown) of the Impact-Aware Robotics Databaseauthors,. Such an interface is mainly intended to be used by the Impact-aware robotics database manager (currently, TU/e) to include new dataset in the database. An ad-hoc web interface provide access to the same dataset collection has been created by the TU/e and it is shown in Figure 5. Such a new web interface is tailored to impact-aware dataset, allowing to search specific content within then.

2.3.3.2. Searchable web interface hosted on TU/e server

The 4TU Data Server web interface is a generic interface to collect and provide access to scientific dataset from different disciplines. As also shown in Figure 4, it can also be used to visualize

collection of datasets that share similar content and purpose. Building on top of this possibility of creating collections of datasets, an ad-hoc web interface we have implemented by the TU/e, making it easier to a generic user to explore the content of the database. As mentioned previously, the interface is accessible via the URL

https://impact-aware-robotics-database.tue.nl/.

and a recent screen shot is provided in Figure 5.

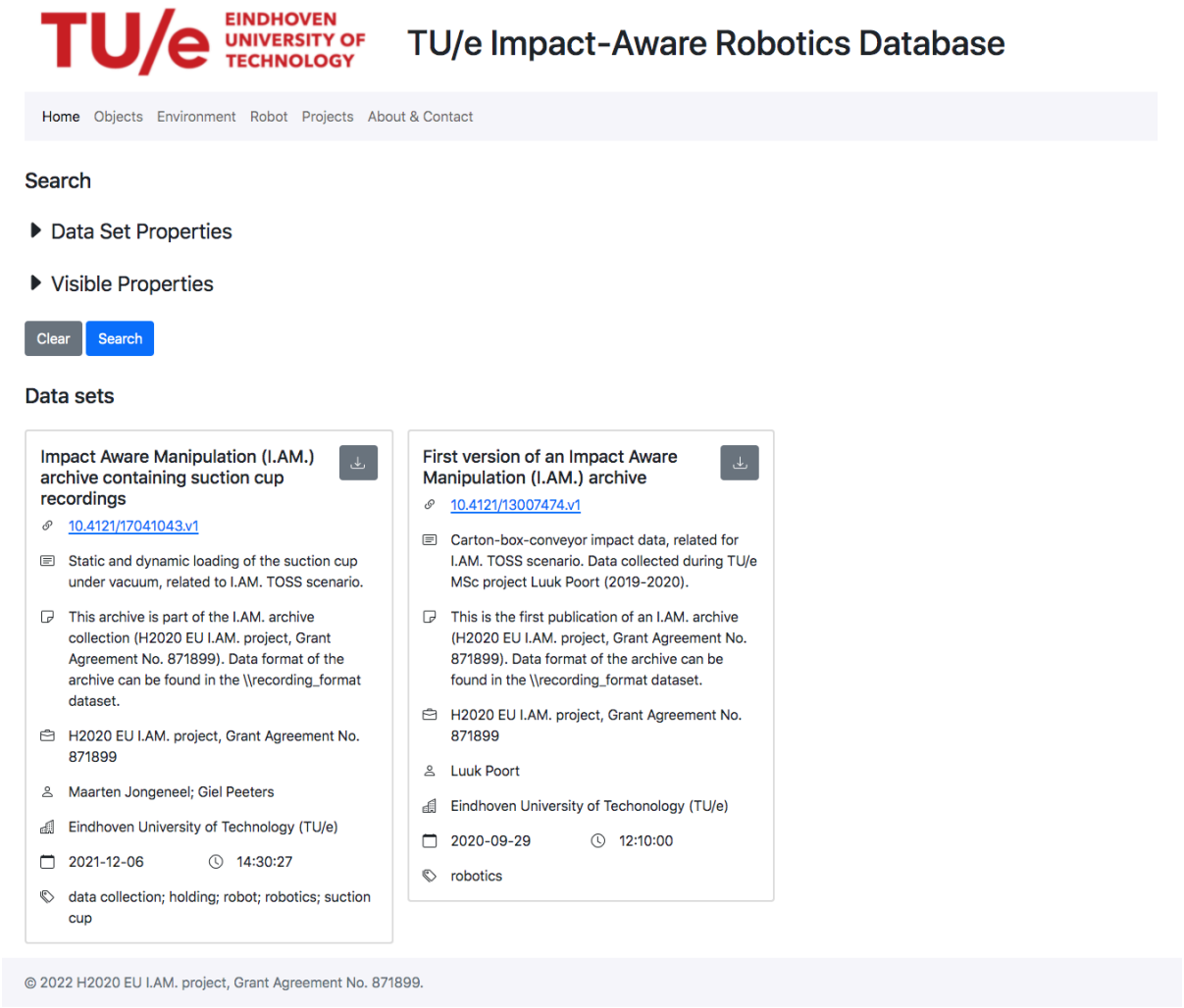

Figure 5: Web interface for searching within the separate archives, accessible via https://impact-aware-robotics-database.tue.nl/

The interface was inspired and follows the good practice of existing European initiatives, to well-established repositories in the robotics and automotive field [3], [4], [5], as already mentioned in the I.AM. deliverable D1.1.

The web interface is linked to the specific 4TU.Research Data collection

https://data.4tu.nl/collections/Impact-Aware_Robotics_Datasets/5405187

via web crawlers that fetch the content of the collection (set of datasets) and create internally an index which is then displayed as a set of rectangular mini pages (see bottom of Figure 5) containing essential metadata such as title of the dataset, DOI, description, associated project, author, institution, time of creation, and keywords. The DOI as well as the download icon, can be clicked to either go to the corresponding 4TU Research Data server web interface or download the archive (typically, of size of 1-2 GB). As a concrete example, by clicking the link in a dataset box (in Figure 5, e.g., the DOI hyperlink 10.4121/13007474.v1), the user is rerouted to the dataset specific 4TU Research Data server website (Figure 6).

As mentioned earlier, the I.AM. consortium is suggesting to opt for the CC BY-NC-SA 4.0 license to ensure open accessibility, findability, and re-usability. Each separate archive, however, can be given a different license, more or less restrictive, depending on the IP (Internet Protocol) that is linked to the data and author requirements.

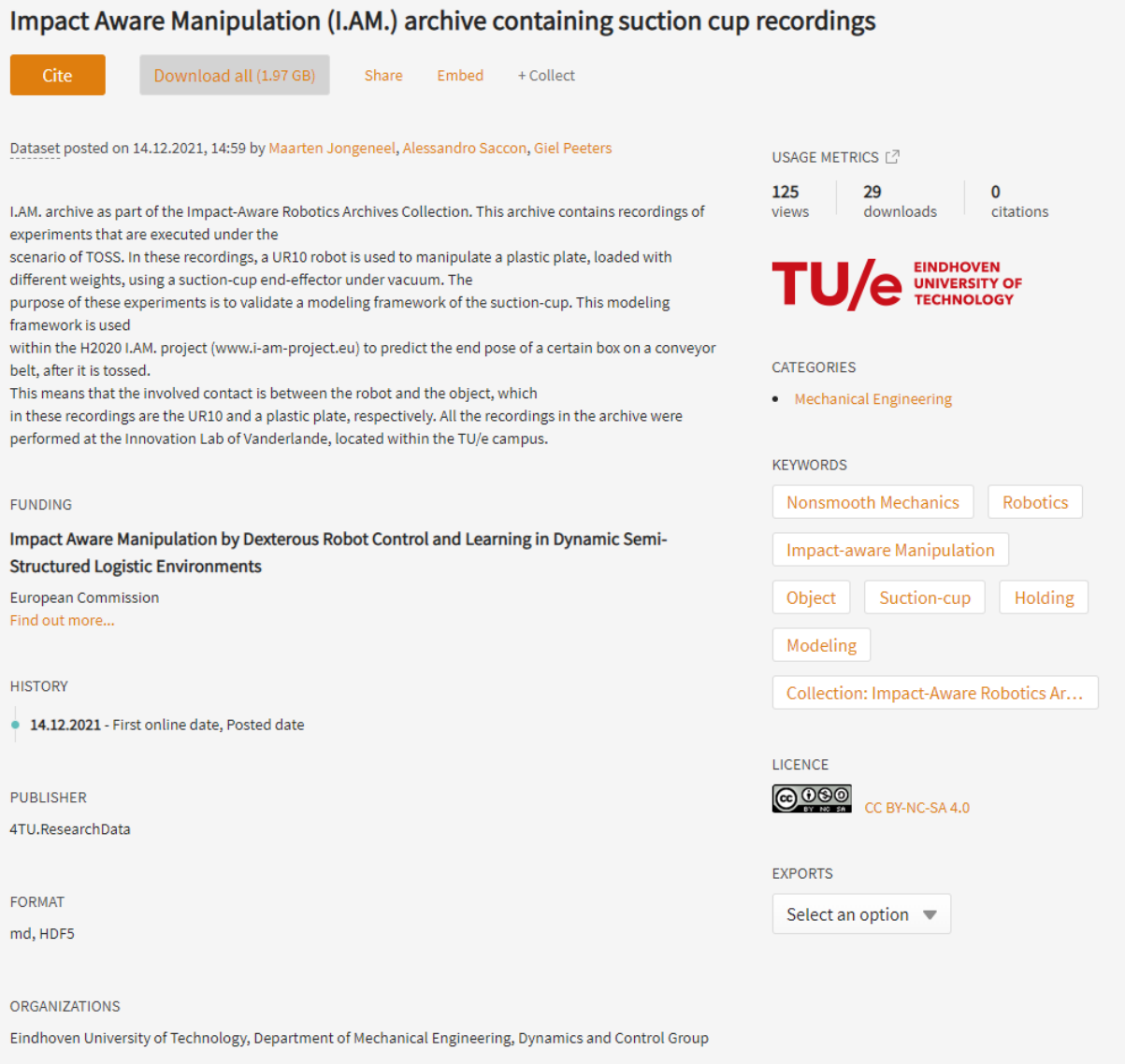

Figure 6: 4TU database showing the latest dataset that is linked to the web interface, also showing license, data format and again keywords.

One additional feature of the Impact-Aware Robotics database web interface developed by TU/e and that is not available in the generic 4TU Research Data server is the possibility to make specific queries within the complete collection. The search interface can be accessed by expanding the Dataset and Visible Properties ribbons, shown in Figure 5 obtaining the searching interface provided in Figure 7. When the user enters a text in one of the search boxes, suggestions are provided corresponding to the entered text, helping to assess if, e.g., the type of object/robot/environment or type of impact/release motion is already present in the database.

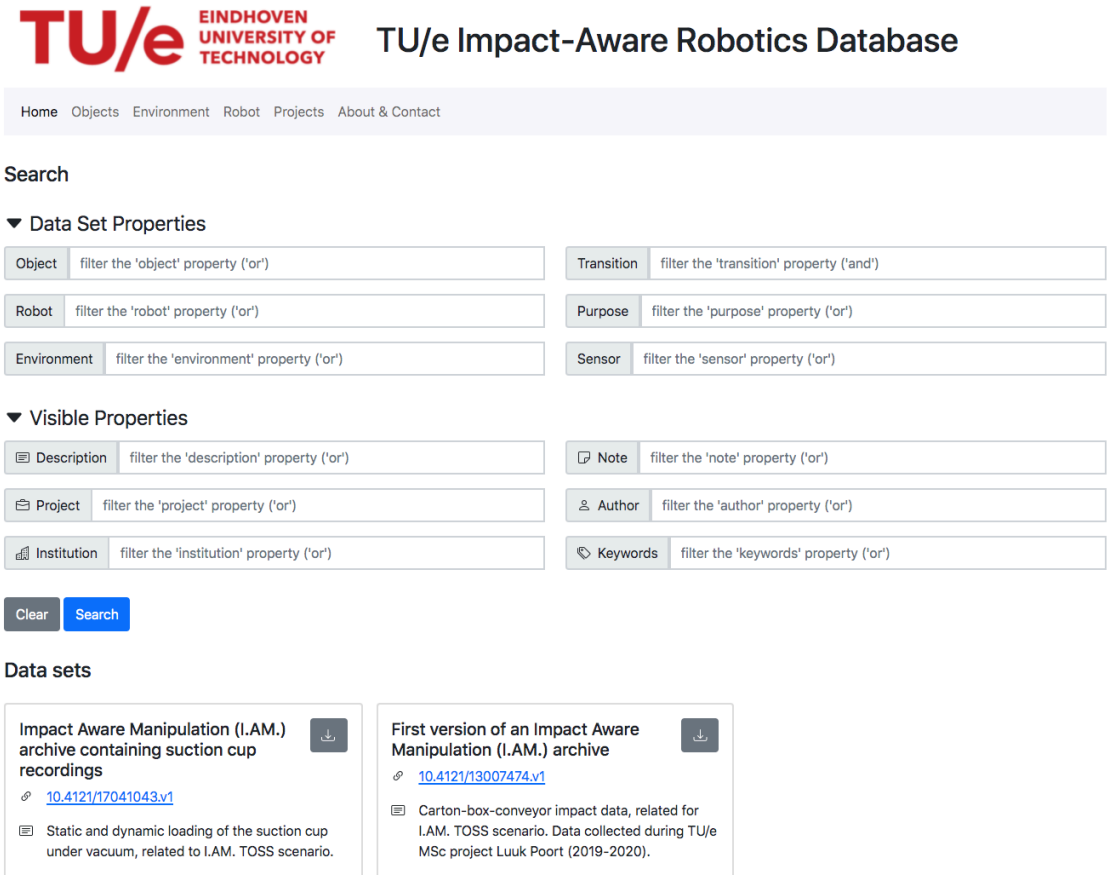

Figure 7. Searchable dataset and visible properties within the TU/e Impact-Aware Robotics Database by means of the newly developed web interface, which fetches and process the metadata of all the datasets contained in the impact-aware robotics collection stored in the 4TU Research Data server. The functionality allows for searching for specific datasets within the collection and will become an important way to search through the database particularly helpful as the number of datasets will grow in the coming years.

The web interface is still in development and will be further enriched with description of the intention of the database, images of object, robots, environment present in the database, project funding the initiative, and so on. fine-tuned based on the dataset from the other scenarios (BOX and GRAB). In particular, a link to the I.AM. project website (http://i-am-project.eu/) will be made available shortly to ensure that visitors will be redirected immediately to the current main source of funding of the initiative.

The web server also provides, for each archive, a link to an OPeNDAP link (via so called THREDDS server) which allow the users to access the specifc dateset via the OPeNDAP protocol, using software such a Python or MATLAB, without the need of downloading the entire dataset but rather inspect only its root or specific recordings, for selective data-retrieval.

Regarding the data access protocol we have opted for the open data access protocol (openDAP) [6].

Based on this protocol, we have created a web interface that provides also the opportunity to search the desired dataset, based on specific data set properties that the user can fill in

3. CONCLUSION

This deliverable D6.5 provides an updated description of the I.AM. repository structure and the implementation towards the final I.AM. database that is to be released by end of 2023.

The I.AM. taxonomy is currently being used to classify impact and release motions (dynamic contact transitions) and allow for effective search of recordings containing specific motions within the entire repository. This deliverable shows the current implementation of the publicly available database and web interface, making the dataset findable, accessible, interoperable, and re-usable.

The project will continue till M48 (December 2024) and this deliverable (Data Management Plan) will be updated in M40 (April 2023) to publish any changes in 'how' the consortium makes the data FAIR (Findable, Accessible, Interoperable, Re-usable), by focusing on I.AM. repository's web interface and data access protocol to allow for open access of the dynamic contact transition recordings.

The update of the D1.1 I.AM. Publication of Dataset will on the other hand focus more on 'what' will be published still, by outlining the recordings for all three TOSS, BOX, and GRAB scenarios, the further updated version of the I.AM. taxonomy and I.AM. repository structure.

4. REFERENCES

[1] The HDF Group, "The HDF5 Library & File Format," [Online]. Available: https://www.hdfgroup.org/solutions/hdf5/. [Accessed June 2020].

[2] "netCDF," [Online]. Available: https://www.unidata.ucar.edu/software/netcdf/docs/. [Accessed September 2020].

[3] "KIT Whole-Body Human Motion Database," [Online]. Available: https://motion-database.humanoids.kit.edu/. [Accessed September 2020].

[4] "CMU Graphics Lab Motion Capture Database," [Online]. Available: http://mocap.cs.cmu.edu/. [Accessed September 2020].

[5] "The KITTI Vision Benchmark Suite," [Online]. Available: http://www.cvlibs.net/datasets/kitti/raw_data.php. [Accessed September 2020].

[6] "OPeNDAP protocol," [Online]. Available: https://www.opendap.org/. [Accessed September 2020].

[7] "4TU.ResearchData," [Online]. Available: https://data.4tu.nl/. [Accessed September 2020].

[8] "Creative Commons Licenses," [Online]. Available: https://creativecommons.org/licenses/?lang=nl. [Accessed September 2020].

[9] "Zenodo," [Online]. Available: https://zenodo.org/. [Accessed 2020].