Project Name Exploring multi-mode and multi-laser scanning strategies for enhanced metal additive manufacturing -

Grant Title 1S53722N

Principal Investigator / Researcher Lars Vanmunster

Description This research deals with machine adaptations and new operating procedures for increasing the building speed of an additive manufacturing process. The questions to be answered concern different strategies to optimise the process while maintaining part quality.

Institution KU Leuven

1. General Information

Name applicant

Lars Vanmunster

FWO Project Number & Title

Exploring multi-mode and multi-laser scanning strategies for enhanced metal additive manufacturing

1S53722N

Affiliation

- KU Leuven

2. Data description

Will you generate/collect new data and/or make use of existing data?

- Generate new data

Describe in detail the origin, type and format of the data (per dataset) and its (estimated) volume. This may be easiest in a table (see example) or as a data flow and per WP or objective of the project. If you reuse existing data, specify the source of these data. Distinguish data types (the kind of content) from data formats (the technical format).

Type of data	Format	Volume	Origin of data
Job file	.job, .cli	100 MB	Prepared job file (stl file sliced, hatched and with parameters)
LPBF samples	Physical object	100's	Parts built by 3D printing on the machines involved in this research
Benchmark part	Physical object, .stl	4	Part built by LPBF, as a reference per chapter, and the associated digital file
Mechanical properties data	Spreadsheet (.xlsx)	< 1 GB	Overview of measurements, information and numerical results of density, tensile tests, fatigue tests, hardness tests, ...
Tensile curves	Spreadsheet (.csv)	< 1 GB	Tensile curves generate by tensile test machine

Microscope images	Digital (.tif)	1 GB	Images of samples, hardness indentations and sample cross sections generated on an optical microscope
SEM images	Digital (.tif)	10 GB	SEM images of fracture surfaces and microstructures
µCT scans	Various, .jpg	1 TB	Raw scans and filtered data from µCT scans, and the extracted .jpg
2D roughness profile	.DAT	< 1 GB	2D profile curve generated by tactile profile measurements
3D surface profile	.plux	100 GB	3D data of surfaces scanned by 3D optical profilometer
Simulation code	Matlab script + results (.mat)	10 GB	Sets of code to simulate thermal process conditions + generated results
Build processor code	Python script (.py)	1 GB	Python code for generating scan strategies + build processor
High speed photography	Digital image (.tif, .mp4)	100 GB	Raw high speed camera images of melting process or processed into video
Intensity measurements	.foc	10 MB	Measurements of the laser intensity profile with generated dedicated sensor

3. Legal and ethical issues

Will you use personal data? If so, shortly describe the kind of personal data you will use. Add the reference to your file in KU Leuven's Register of Data Processing for Research and Public Service Purposes (PRET application). Be aware that registering the fact that you process personal data is a legal obligation.

- No

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, add the reference to the formal approval by the relevant ethical review committee(s)

- No

Does your work possibly result in research data with potential for tech transfer and valorisation? Will IP restrictions be claimed for the data you created? If so, for what data and which restrictions will be asserted?

- Yes

Potential valoristion of results will be evaluated throughout the project, and depends on the results. If and when desired, IP rights may be claimed and/or protected through patent applications or other means, in consultation with Leuven Research & Development (LRD). Sections of the final dissertation that contain protected information will be placed under embargo.

Do existing 3rd party agreements restrict dissemination or exploitation of the data you (re)use? If so, to what data do they relate and what restrictions are in place?

- No

4. Documentation and metadata

What documentation will be provided to enable reuse of the data collected/generated in this project?

1. Physical samples: Details about created parts are store in standardized spreadsheets mentioning material and machine properties/settings (including but not limited to: date of production, laser power, scan speed, powder supplier/size/material, machine, ...)

2. Tensile curves: the automatically generated results spreadsheet has an extra sheet containing operation procedure & settings. These are: which properties are measured, machine speed, controlling variables (force or displacement), measurement sensor (extensometer, AVE, thermocouple, ...) and clamp type.

3. For microscopy images, the machine automatically stores the following information: image type, dimensions, data, lighting settings, zoom, lens name and tilt angle. Sample details and names are store in accompanying spreadsheets, also listing image names. This spreadsheet also contains the operating procedure for sample preparation and picture creation. Figure naming will follow a consistent rule system (JobName_SampleCode_Magnification) that can easily be linked to the physical parts.

4. SEM images: machine automatically includes parameters such as zoom level, beam voltage, image size, image creation date. The overviewing spreadsheat (see 1 of this question) will be appended to link samples to their respective pictures. Figure naming will follow a consistent rule system (JobName_SampleCode_SEM_Magnification) that can easily be linked to the physical parts.

5. µCT scans: A txt document will explain the operating/data processing procedures (e.g. filters used). The final procedure will be exported and stored with the data.

6. 2D/3D roughness profiles: The machine settings file can be exported and stored with the generated data. This contains the following info: type of tip, scan lenght, speed, measurement separation, ... When processing the data, the code used will be stored together with the original data.

7. Results from simulation are programmed to store the settings and parameters in a separate variable structure.

8. High speed photography: a metadata file will need to be created manually. This will contain camera settings (e.g. shutter speed, image size, ...) and info about the actual experiments (e.g. laser power, speed, ...)

9. Intensity measurements. Fixed operation procedure is described in a txt file. This includes device installation and location procedure, measurement device settings and machine settings

Will a metadata standard be used? If so, describe in detail which standard will be used. If no, state in detail which metadata will be created to make the data easy/easier to find and reuse.

- No

An own-defined standard spreadsheet is created for the storage of information about a build job. This format can be appended with sheets referring to specific test procedures. This allow a clear link between a sample (and it's production parameters) and the tests performed on this sample (and the relevant test parameters)

5. Data storage and backup during the FWO project

Where will the data be stored?

1. The most used (smaller) datasets are stored on a PC that syncronizes permanently to a 2 TB OneDrive provided by the university

2. Larger volume datasets can be stored on university provided large volume storage disks.

How is backup of the data provided?

1. The data is permanently syncronized to the cloud via OneDrive, acting as an online back up
2. Offline backup creation will be performed regularly

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

2 TB will be sufficient for everything except µCT data, that can be stored on the large volume data storage

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

The expected cost for data storage during the project is not expected to exceed €100/year, which will be covered either by the FWO bench fee or AM research group financial reserves. This is on top of the 2 TB of free, backed up storage space that KU Leuven researchers are provided via OneDrive.

Data security: how will you ensure that the data are securely stored and not accessed or modified by unauthorized persons?

No sensitive data will be created in this project.

Separate file sharing folders are provided by the university, ensuring no shared access to the data, unless specifically required.

Belnet Filesender is used to send large amounts of data to others

6. Data preservation after the FWO project

Which data will be retained for the expected 5 year period after the end of the project? In case only a selection of the data can/will be preserved, clearly state the reasons for this (legal or contractual restrictions, physical preservation issues, ...).

No data requiring restrictions on data preservations will be generated, thus all data can be stored for the required 10 years.

Where will the data be archived (= stored for the longer term)?

The data will be stored on the university's central servers (with automatic back-up procedures) for at least 10 years, conform the KU Leuven RDM policy.

What are the expected costs for data preservation during the retention period of 5 years? How will the costs be covered?

- The KU Leuven offers backed up cold storage of data at €99,55/TB/year. The expected cost for cold storage of the data after the project is therefore not expected to exceed €100/year, which will be covered by the AM research group financial reserves. If the amount of data to be stored exceeds 2 TB, additional storage will be purchased and covered by the AM research group financial reserves.

7. Data sharing and reuse

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

- No

Which data will be made available after the end of the project?

1. Build processor code (see section 3) will only be shared after approval of Materialise, as they provide the starting code on which the BP is based
2. All other data can be uploaded in a suitable repository

Where/how will the data be made available for reuse?

- In an Open Access repository
- Upon request by mail

1. The data will be shared on the KU Leuven Research Data repository (known as RDR), which can be found here: https://rdr.kuleuven.be

2. The repository has limited space for fee-less sharing of data. Hence, the largest file types (µCT data) will only be available upon request.

When will the data be made available?

1. In case the data is used for a publication, the data will be made available for use after the final publication

2. In other cases, the dataset will be made available after the public defence of the FWO SB fellow's thesis dissertation

Who will be able to access the data and under what conditions?

1. The datasets will be made available under a CC-BY-NC-4.0 license, meaning free sharing and adaptation of data is allowed provided that they give appropriate credit to the creators, but commercial use is prohibited.

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

1. The datasets are believe to stay within the 50 GB free limit of the RDR, meaning that no extra costs are expected.

2. in case a larger set of data is created, part of the allocated project budget can be used to cover these costs

8. Responsibilities

Who will be responsible for data documentation & metadata?

Lars Vanmunster - FWO fellow

Who will be responsible for data storage & back up during the project?

Lars Vanmunster - FWO fellow

Who will be responsible for ensuring data preservation and reuse ?

Bey Vrancken - PI / PhD promotor

Brecht Van Hooreweder - co-PI / PhD co-promotor

Who bears the end responsibility for updating & implementing this DMP?

The PI bears the end responsibility of updating & implementing this DMP.