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Five years after: The London Charter revisited

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Abstract

The present paper proposes to add some principles to the London Charter, a Charter concerning the use of 3D visualization for Cultural Heritage. The proposed new principles aim at guaranteeing the presence of documentation on the provenance of digital objects acquired by means of a machine, on the accuracy of the acquisition and on the "soft" transformation they have undergone.

Categories and Subject Descriptors (according to ACM CCS): K.4.m [Computing Milieux]: Computers and Society—Miscellaneous

1. Introduction

The London Charter for the use of 3-dimensional visualisation [?], [?] in the research and communication of cultural heritage seeks to establish what is required for computer visualisation to be, and to be seen to be, as intellectually rigorous and robust as any other research method. The Charter was established in February 2005 during a workshop at King's College, London, and has been reviewed several times since then to the present version 2.1. It is available in English, Italian, Spanish and German.

The London Charter states six simple principles to guarantee the transparency of the creation and use of computer-based visualization in Cultural Heritage research, practice and communication. It provides guidelines about Implementation, Aim and Methods, Research Sources, Documentation, Sustainability, and Access.

The adoption of a Charter for computer-based visualization in Cultural Heritage derived from the necessity of guaranteeing a transparent production of models availing of computer visualization, without relying on the deceptive confidence inspired by computers.

The Charter originates from a debate open about 10 years ago and the consideration that the use of computers to visualize Cultural Heritage objects conveys authoritativeness to the outcome both as it is the result of "scientific" processing and because of its photorealism. Neither of these two aspects is immune from human interpretation, often hidden behind the data and the assumptions on which the visual model is based, so they are no more reliable (although much more attractive and communicative, and potentially more powerful) than text descriptions just because they are based on computer processing and visualization.

An increased use of machine-produced data, such as the outcomes of high resolution digital photography used to generate the texture of visual models, or the use of 3D scanners to generate them from scratch, in our opinion creates now the need for additional specifications in the Charter, providing guidelines concerning machine-generated computer visualization models as far as Provenance, Accuracy and Transformation are concerned. Without archiving metadata about the creation of the digital object and the accuracy that was available, it might happen that deception surreptitiously leaks into models basing their credibility on the mere fact that they were created by a machine and are therefore more reliable than human-made ones.

2. The need for guidelines

Consider for example the model created by 3D scanning a monument. It is implicitly assumed that the quality of the model depends only by the precision of the equipment, in this case the resolution. So, it is assumed that a scanner with a resolution of a micron produces a pretty good model, while one with a resolution of 1 cm produces a less precise one. In fact, as physicists very well know, one component of the measurement error is the instrument error, which is a constant. But, more precise instruments do not necessarily give

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more accurate measures. There is indeed a number of other factors that may affect the overall quality of the outcome: the environmental conditions (some open-field scans are better done in the night, to avoid reflection effects caused by solar light); the ability of the operator; the material (non-reflective ones behave better than highly reflective ones, e.g. metals); and more. Also the goal of the original scan must be considered when planning further use. For example, the 3D model of the head of a statue scanned for creating an "accurate" communication multimedia may be unsuitable for planning restoration, where the precision level is necessarily higher.

So, using the most precise instruments will put us on the safe side? Not necessarily. Not only because it is the combination instrument-object that counts, but also because a complicate instrument may be difficult to use and generate more easily random human errors.

Since it is not the goal of the Charter to avoid errors, but only to give the user enough information to support the appropriate level of confidence, all the above information must be recorded and accompany the model.

Another example concerns the use of digital photos to create the texture of 3D models. Here the process involves data capture (taking the picture) and transformation (storing data e.g. in JPEG format). Since the storage format may be lossy, important details may be lost without notice. This is well known to photographers who prefer to store pictures in RAW format, i.e. with no computer-generated distortion.

Finally, there are complex interactions when a scanned object is incorporated in a virtual reconstruction. In this case it is necessary to document not only why the object fits in the model (e.g. because it was found in the remains and then moved to a museum), but also how accurate is the scan and its placement in the virtual world.

In conclusion, using machine-created 3D models does not eliminate the necessity of adopting particular attention and appropriately documenting the creation of such models to guarantee the transparency of the creation process and the reliability of the final visual outcome.

3. Provenance

The provenance of artefacts has always a great importance. It places the object in the right context and supports its authenticity. Due to past lesser care in recording provenance, many museum objects contribute less to the knowledge of the Past than others, for which the original context has been properly documented. Also in science, the reproducibility of experiments (and hence the scientific reliability of results) relies on the documentation of the conditions in which they were carried out. This also affects re-use and further scientific progress, by identifying the limits of applicability of the scientific results. Digital replicas of cultural objects, from collection items to monuments and historic sites, take from both aspects. As cultural objects, their provenance places them in the correct context and guarantees their correspondence to the physical original, within the limit of digital reproduction. As the outcomes of a technological process, their scientific value depends on the recorded information of the process that generated them. For these reasons it has been suggested that standards for documenting cultural heritage such as CIDOC-CRM are extended to include provenance information [**?**] and the 3D-COFORM EU project [**?**] supports this approach.

We propose therefore to incorporate in the London Charter a statement concerning Provenance, i.e. to state that *machine-produced cultural objects used in computer-based visualization must incorporate provenance information, including among others information about the instruments used to create them, the environmental conditions, the procedure, the human operator and the original aim and scope of their original production*.

It must be noted that most of the above data may be generated automatically when creating the object, because it is information that is available at that time for machine access and may be automatically stored together with the actual digital object.

4. Accuracy

The accuracy of machine-generated cultural objects has been already discussed in the previous examples. It depends on the precision of instruments as well as on the operating conditions and on the operator. It is also influenced by the original goal of the acquisition: for example, the colours of the photo of a painting need to be finely calibrated to be accurate, those of the picture of a statue don't. The need of knowing the accuracy of a machine-generated visual cultural object suggests to state that *machine-produced cultural objects used in computer-based visualization must incorporate accuracy information, including among others information about the instruments, the environmental conditions, the procedure, the human operator and the original aim and scope of their original production*.

Information about the instrument gives implicitly the instrument error, the other information enables to accept or reject the digital object in different visualization frameworks. Although very similar to Provenance paradata, accuracy is more focused on measurements and all the boundary conditions that may affect precision – including the observer's goal, as their behaviour influences the environment in which the experiment (= machine generation of the digital object) takes place. However, the Accuracy requirement may be possibly part of the statement concerning Provenance.

5. Transformation

In general, no machine-generated visual model is used "as is". There is always a series of transformations to clean it, to enhance some features and to reduce complexity. For example, the latter transformation may optimize the statistical error induced by reducing the detail to use a less complex visual model and improve performance or other desired features. But, statistical quality is not the same as necessary quality: some important details may be lost, for example a small crack in a visual model used to design restoration activity. This determines the need to guarantee that information about the Transformation undergone by the digital object is recorded by stating that *cultural digital objects used in computer-based visualization resulting from other digital objects via computer transformation, as processing, simplification and format change, must incorporate transformation information, such as software used, formats, procedures and parameters, as well as the characteristics of the machine used for the transformation*.

Also Transformation information is part of the Provenance information, but it is related to a different event, generating digital objects from opther digital objects, while Provenance information, as stated above, concerns the very creation of the digital object by means of a mechanical device "operating" on a physicall object, like a camera or a 3D scanner.

6. An example

Consider the following example. A collection of ancient vases is being digitized and the 3D replicas will be made available to scholars for research. For this use, it is paramount to know how reliable the 3D models are for individual research goals. It makes a difference if a researcher is studying the style or if restoration is involved, for the latter a great accuracy being necessary. In any case, researchers need to know how reliable the 3D models are and if analyzing the 3D replicas can be a valid substitute for direct inspection of the originals.

For each item the operation involves capturing the data with a particular technology, let us assume 3D scanning, and processing the raw data to generate a usable model.

So provenance data will need to answer question such as the following:

- Which are the "things" involved: original (physical) object and digital object(s)
- How did data capture take place? Paradata include the following:
  - The type and model of machine used for the digitization, linked to its engineering characteristics;
  - The type and model of auxiliary machines used (e.g. illuminators, screens, etc.);
  - How these machines were calibrated (e.g. for colours);
  - How were their parameters set for the data capture;
  - The place and time where data were captured;
  - The environmental conditions (light, temperature, etc.);
  - The person who did the job and the organization in charge of it;
- If the digital objects were post-processed after machine capture, which kind of processing was performed, with which software and with which parameters. For example, if a simplification was carried out, the parameters and principles used should be recorded.

All the above information should accompany any outcome of the sequence of steps leading from the original to the 3D model. Note that one original may correspond after data capture to several digital objects, for example the scans of parts of it. These parts may be recomposed into a 3D digital replica. In such a case, information on the sequence of operations leading to individual digital objects (e.g., turntable rotation of the original of a given angle with a vertical axis) should be documented as well.

At the end of the process, the resulting 3D model will be accompanied with a consultable documentation about the data capture procedure that will ascertain their degree of credibility as replicas. In the future, protocols will be available for guaranteeing researchers that for a given investigation a specific data capture process, as documented by paradata, enables the use of 3D models as an alternative to direct inspection.

7. Conclusions

We are aware that prescribing additional conditions for using machine-generated digital objects in computer visualization might jeopardize a widespread adoption of such a fruitful technology in the Cultural Heritage sector. It is important, however, that such objects do not reintroduce in a subtler way the same potential deception that the London Charter aims at preventing for human-created digital objects. Furthermore, recent research aims at generating this information in an automatic way when the digital object is created or transformed. For example, the 3D-COFORM project has adopted the CIDOC-CRM dig extension and is creating 3D tools that incorporate provenance information in this format.

If the use of photos as visual aid to documentation and communication of Cultural Heritage has been pacifically accepted for a century because it was assumed that they always were faithful replicas of the originals, the power of current and forthcoming visual technology is so high that it necessitates the adoption of measures, such as those sketched above, to avoid even bona-fide falsification.

After undergoing the London Charter refinement and approval procedure, if accepted the above requirements will generate additional specifications to its Principles or possibly add new ones to the list. In any case, they will extend the Charter coverage to a wide class of visual objects and improve the credibility of digital methods in the Cultural Heritage sector. Actually, there is no good reason to trust machines more than humans, if it is uncertain whether they were properly used.

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