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► **To cite this version:**

Oussama Meski, Paul François, Florent Laroche. An in virtuo system linking data corpus to 3D virtual model for industry 4.0. ConVRgence, Apr 2020, Laval, France. hal-02564458

HAL Id: hal-02564458

<https://hal.science/hal-02564458>

Submitted on 5 May 2020

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An *in virtuo* system linking data corpus to 3D virtual model for industry 4.0

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Keywords: Digital Reconstruction – Virtual Reality – Knowledge Management – User Interface

Abstract

This poster deals with the possibilities offered by *in virtuo* consultation - during sessions of virtual reality immersion - of information related to the visualized environment contained in a database. First, we show the architecture of the system and how it allows us to develop a three-dimensional model and a knowledge base separately. Our use case explores the industrial possibilities of such a solution in the context of industry 4.0, allowing to contextualize the information resulting from high-speed machining monitoring.

This tool would make the use of virtual reality immersion in design or reverse engineering more effective by making data associated with a 3D model accessible at the appropriate time.

1. Introduction

In the fields of product design, reverse engineering or restitution, digital 3D modeling tools have become in many ways completely unavoidable. In recent years, virtual reality immersion has reinforced the use of 3D by allowing the virtual experimentation of study objects during their design phase [1] or as an end in itself for all types of audiences [2]. In order to democratize the use of immersive 3D in areas where the data related to a three-dimensional model have a decisive influence on the very interest of the model, our main objective was to allow access to these metadata *in virtuo*.

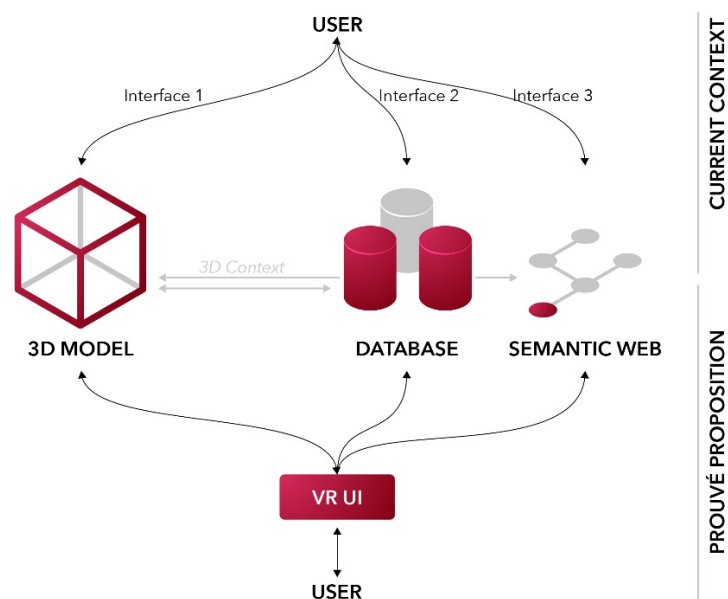


Fig. 1. Current situation regarding the different data and proposal.

Immersive interfaces are used, as previously stated, in many fields where the data processed is highly spatial or geometric. Mechanical design or architecture can therefore easily make use of immersion without having to go through abstract representations of their data. In these fields too, geometric coherence or three-dimensional aspect are the data that take precedence over others: we try to test in virtual reality the coherence of a three-dimensional model in itself. The approach we propose is hybrid since it focuses on the visualization of highly spatial data (a 3D model) - for which the immersion visit is naturally adapted - and data related to this virtual model, which can be of various formats and rather resemble a decision tree [3]. The data manipulated are on the one hand of the text, image, sound, data, graphics, etc. type and are stored in a database with metadata; and on the other hand of the "link" type between several items in a database or between an item and an object in virtual reality.

The main hypothesis we formulate is that the spatial positioning of the information and the link between it and the three-dimensional model makes it possible to judge more effectively the relevance of design choices or hypotheses. In addition, such a visualization would reveal logics related to the spatial distribution of information.

2. Development for industry 4.0

Virtual Reality allow the visualization and modelization of the business processes and products to be manufactured or maintained. Thus, it provides great operational benefits: on the one hand, virtual reality could facilitate and improve learning, and on the other hand, it could facilitate interactions between industrial production chains and their computerized management systems. Thanks to early modelling and immersion tests, all the production space can be optimally used, while the use of these technologies also makes it possible to predict maintenance or after-sales service needs [4]. Two research projects are collaborating to integrate virtual reality technologies into the production industry. The development requires a global knowledge base structured in the form of ontology, gathering all the data and knowledge circulating in the industry [5]. Moreover, through the tools of machining monitoring, we capitalize on all the data necessary to detect the appearance of a malicious phenomenon during machining: chattering, tool breakage, etc. The aim of the proposal is to provide support for the various actors in the industry in order to better understand the design process and all its potential defects while remaining in a connected, accessible and easy to handle world: the immersion in virtual reality.

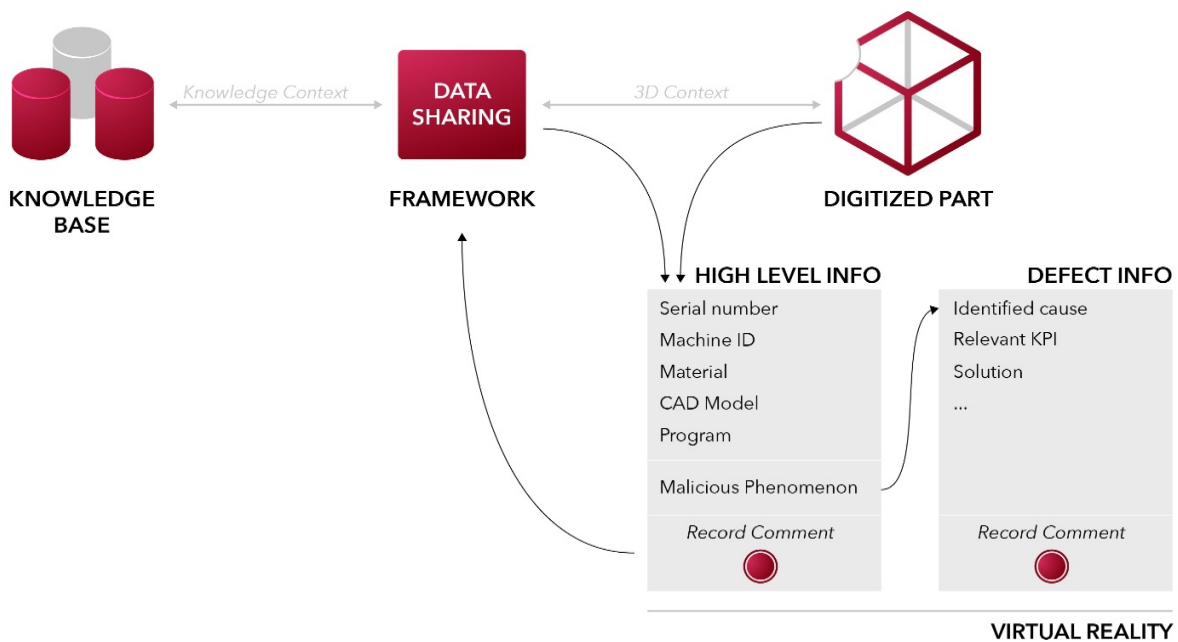


Figure 2: Framework concept to exploit ontologies using virtual reality technologies.

Figure 2 details the principle of our scientific proposal to develop a framework that allows a new way of exploiting ontologies using virtual reality technologies. The challenge is being able to recover all the knowledge concerning a mechanical part in a given three-dimensional context (a part, a portion of a part, a defect) and which can be of a very different nature and type: product data, process, etc. The part in question may be a model or physical object identifiable by its serial number.

By using virtual reality immersion, a 3D digital copy of the part (either from the source CAD file or from a digitization), a digital twin, can be analyzed and put into its manufacturing context at the same time. The user is then able to easily consult all the knowledge and KPIs (Key Performance Indicators) concerning a specific part. In addition, the user can also hierarchically access all the knowledge of the database related to the part (type of machine, details of a machine, etc.). In the example of a defect, it is therefore possible to access the details of the occurrence of a malicious phenomenon during the machining of the part (a chattering, a tool failure, a collision, etc.) and to know its causes and solutions.

Another very important aspect that this system can cover is the possibility of commenting on your immersive experience, and communicating a diagnosis, some remarks or suggestions for improvement or even preventive solutions to deal with the appearance of a given phenomenon. These comments, in audio or text form after automatic transcription, could be reintegrated directly into the ontology and can therefore enrich the overall knowledge base.

This immersion experience and its integration into the industrial environment would thus increase competitiveness and improve productivity from the design phase.

3. Conclusions and perspective

In this paper, we have presented a virtual reality tool allowing the in virtuo consultation of relational and spatialized data. This tool allows users to work more efficiently in virtual reality immersion by adding interactive levels of information to visible and manipulable objects. We have shown the interest of such a tool for two completely different use cases - heritage and industry 4.0 - although the same system must be adapted to meet the specific expectations of these domains and their existing professional tools.

Of course, the question arises of access with this system to non-spatialized data. Indeed, we have insisted in this paper on the need to select a virtual object to display this information, but the design or reflection phase may require access to non-spatializable data (concepts, historical information, etc.). We are therefore convinced of the interest of developing a post-immersion experience in which other interactions would be possible.

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