engineering proceedings

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Abstract

A Digital Twin for Monitoring the Construction of a Wind Farm†

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Keywords: Digital Twin (DT); Building Information Modelling (BIM); As-Built model; CAD/CAE model

Digital twins (DTs) are an emerging technology that enables interaction between physical assets and their virtual replicas. These virtual replicas enclose the geometry coming from complex modelling procedures and the dynamism coming from artificial intelligence. Nowadays, DTs' applications are found almost in every engineering area; DTs serve different purposes, e.g., testing how new devices would behave under diverse conditions or while being controlled, or monitoring existing processes and helping improve them.

The Building Information Modelling (BIM) methodology, for its part, has revolutionized and changed the construction engineering and architecture sector in recent times. BIM refers to a collaborative work methodology for the conception and management of building and civil works projects that include a digital model that centralizes all the information (e.g., geometric, costs, maintenance, etc.). BIM models are the theoretical ones resulting from the design phase where this methodology is applied. Instead, the As-Built models refer to the representation of the actual work progress at each moment and reflect the reality and evolution of the construction site through time.

With the improvement of artificial intelligence in software capabilities for 3D modelling and simulation in construction environments (BIM models) related to Computer Aided Design and Engineering (CAD/CAE) and Geographical Information System (GIS) technologies, DTs began to have a place in urban projects, land management and public infrastructure. However, until now, the use of DTs in this area has been limited, as in most cases, it is used only as a high-quality 3D digital representation without connecting to other systems, dynamic analysis, or simulation.

This work proposes the creation of a DT for monitoring the construction of a wind farm. It permits to compare the BIM model (which contains the construction specifications) and the As-Built models that represent the actual construction at different times. It allows control of deviations, regarding civil works, that may occur during construction. All the data obtained (position of the wind turbines, the platform of the footing, the trace of the road, the width of the roadway, the slope of the road, etc.) must be stored to be displayed in the most didactic way possible so that the user can clearly understand it. Then, the DT includes a connection to a database to obtain the necessary information for the 3D representation. The models' comparison must be displayed according to what the user considers

Citation: Ospina-Bohórquez,A.; Lopez-Rebollo, J..; Muñoz-Sánchez, P.; González-Aguilera, D. A Digital Twin for Monitoring the Construction of a Wind Farm. *Eng. Proc.* **2021**, *3*, x. https://doi.org/10.3390/xxxxx

Published: date

relevant in each case, e.g., delivering the BIM model and the As-Built model of a specific construction area.

The authors propose using Unreal Engine to create the interface for user interaction that includes CAD/CAE models obtained from the BIM and As-Built models corresponding to different steps during the construction. Also, using non-relational databases (MongoDB) is proposed since the data to be stored is semi-structured (not all areas of a model will have the same parameters), and the project needs are unpredictable since they can change as it progresses. The flexibility of non-relational databases will allow these variations to be captured efficiently without making significant changes to the database structure.

Author Contributions: Conceptualization and methodology, A.O.-B, J.L.-R, P.M.-S and D.G.-A; software, A.O.-B, J.L.-R and P.M.-S; validation, A.O.-B, J.L.-R, P.M.-S and D.G.-A; writing—original draft preparation A.O.-B; writing—review and editing, A.O.-B, J.L.-R, P.M.-S and D.G.-A. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest: The authors declare no conflict of interest.