Abstract

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

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Digital twins (DTs) represent an emerging technology that can allow interaction between physical assets and their virtual replicas. These virtual replicas enclose the geometry derived from complex modelling procedures and the dynamism derived from artificial intelligence. Nowadays, DT applications are found in almost every engineering area, DTs serve different purposes, e.g., they test how new devices behave under diverse conditions or while being controlled, and monitor existing processes to help them improve.

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 used 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 theoretical and are derived 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 in artificial intelligence, in terms of 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 now 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, they are only used for 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 draws a comparison between the BIM model (which contains the construction specifications) and the As-Built models that represent the actual construction at different times. It also helps to control 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 in order 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 model comparison must be displayed according to what the user considers relevant in each case, e.g., delivering the BIM model and the As-Built model in a specific construction area.

The authors propose using the Unreal Engine to create an interface for user interaction that includes CAD/CAE models obtained from the BIM and As-Built models corresponding

to different steps during the construction. Furthermore, the use of non-relational databases (MongoDB) is proposed since the data to be stored are semi-structured (not all areas of a model will have the same parameters), and the project needs are unpredictable since they can change alongside progression. The flexibility of non-relational databases can allow these variations to be efficiently captured without making significant changes to the database structure.