

Borsa di studio e di ricerca

Borsa di studio dal titolo

“Construction Digital Twin CDT. Enhancing efficiency and safety of building construction & reconstruction projects through Digital Twin and Building Information Modelling / Il Gemello digitale per la costruzione. Il miglioramento dell’efficienza e della sicurezza dei cantieri di costruzione e recupero edilizio con il Building Information Modelling ed il Gemello Digitale”

Research Project objective

The research aims at the potential detection for the development of Digital construction job site management tools and its analysis through BIM and Virtual and Augmented Reality, based on the use of the Construction Digital Twin (CDT). The aim is to study digital methods and tools for the management of the building construction, refurbishment, deep renovation and reconstruction processes, with a view to making the construction sector increasingly competitive, safe and efficient, taking advantage of innovations in the digitization of the process with digital technologies, BIM, CDT and Virtual and Augmented reality techniques. The research is carried out in three phases, one of analysis of literature and background works, one of application of project and process management methods, also including Construction Digital Twin (CDT) and one of analysis and discussion of the results. Specific objectives are the production of at least one VQR research product (i.e. scientific article or conference paper).

Research Work Description

Workspaces on construction site change three-dimensionally over time, and every single activity requires the availability of a number of resources. Available resources are also variable, and need a plan addressing workspaces so that there will be no interference or overlapping between activities.

In this context, the search for effective planning and scheduling of activities and resources of the construction process, together with their optimal spatial distribution, has stimulated

the development of *Lean Construction* methodologies and planning and scheduling techniques based on the localization of activities and resources (*Location-Based Management System*). The spread of BIM (*Building Information Modeling*) strategy has made available three-dimensional models of buildings and construction stages, based on a dataset of activity times and costs that makes it easy to create a construction animation and economic evaluation of the construction stages(4D BIM and 5D BIM). The two-dimensional layout of the construction site, and the related project schedule, can be integrated by a three-dimensional representation and an animation that simulates the complete construction phase.

For the complete development of these methodologies, a collaborative virtual platform is needed. The Virtual platform creates the virtual environment for sharing BIM and project control models, other data and also creating a Construction Digital Twin CDT that interacts with the re-construction process. In this context, virtual prototyping is considered one of the most interesting innovations of the current moment. Virtual reality systems can be non-immersive, semi-immersive, fully immersive and can help design and project management coordination.

Methodology

The research is carried out in three steps, one of analysis of literature and of background work, one of application in the IT laboratory and one of analysis and discussion of results.

Step 1. Analysis of literature.

The "Virtuality continuum" of Milagram and Kishino and the available technologies are analyzed, focusing on augmented reality (AR) and virtual reality (VR) methods and tools. The types of Construction Digital Twins are classified according to the type of interaction between the virtual and real-physical environment.

Step 2. IT laboratory and experimentation

The IT laboratory phase is divided into several objectives: to draw up practical guides for the use of VR/AR devices in the construction sector, aiming at improving project safety and efficiency, to identify useful programs and applications and IT platforms and to test, through practical cases, the advantages and disadvantages deriving from the use of these technologies, with particular focus on the platforms for Construction Digital Twin.

Applications used in this phase include Visual Live and Trimble Connect, while the devices used for testing are HTC Vive and HoloLens 2.

Step 3. Discussion of results.

The presentation of the results obtained through scientific articles aims to highlight the effectiveness and challenges encountered in the application of VR and AR for the modeling of the refurbishment, deep renovation and reconstruction processes for an existing building subject to recovery, offering insights to improve efficiency and safety during the design, construction and management phases of construction project. In particular, the application of the Digital Twin technology for Construction (Construction Digital Twin) is explored in its application potential. The research also aims to provide practical and strategic indications for the adoption of these technologies in the construction sector, thus contributing to the digital transformation of the construction sector.