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Architectural Modelling - its Representation through Virtual Reality and Energy Analysis of a Residential Building Using Various BIM Software

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ABSTRACT

This paper focuses on one of the best methodologies that can be adopted to perform architectural modelling of a residential building, its representation through head mounted devices using the concept of virtual reality and performing energy analysis. Architectural designing is performed using Autodesk's Revit Architecture followed by rendering using Enscspe, as a medium to provide realistic view. The designed architecture is viewed using Head mounted devices (HMD's) by creating a virtual environment using Enscape as a plug-in software and the way of performing energy analysis on the designed residential building using Green Building Studio (GBS) is shown and the obtained results have been provided.

Key words: Autodesk's Revit Architecture, Enscape, HMD's, GBS

Introduction

In this era of faster development in various sectors, BIM is one of the most chosen approach in AEC industry. BIM stands for Building Information Modelling, a process that involves every aspect of a project in a structured format. In AEC industry, after planning, architectural modelling is one of the basic process that has to be done to visualize the actual design in advance through a virtual mode. Construction projects are getting harder to complete, creating surroundings that are more dynamic and complicated. Yet, due to the industry's present rapid development, standard management and monitoring systems are currently unable to keep up, which creates a number of issues with task efficiency and information transmission across project delivery phases.

As a result, digitization is being pursued by the Architectural Engineering Construction and Operations sector to enhance project management, aid trade crews, and create a more productive workplace. Because of this, the adoption of Building Information Modelling (BIM) signals a paradigm change away from conventional methods and towards an integrated and collaborative working process. Even though the aforementioned issues are getting better thanks to BIM, not all businesses can properly integrate and use it. As a result, there is a great demand for supportive tools to help BIM realise its full potential. Easy-entry technologies, such virtual reality tools, are emerging as a viable addition to the BIM methodology, making it easier to implement and apply BIM. The need to increase sustainability in the building sector has arisen as a result of the construction sector's significant contribution to resource depletion, high energy consumption, and high negative environmental impact. Building information modelling (BIM) technology is used in this study as one of the cutting-edge methods that significantly enhance sustainability. This study will look at how different design parameter options (such as orientation, window-to-wall ratios, and window glass types) affect the performance and cost of electric energy.

Literature Review

Uutilizing BIM technology to improve sustainability analyses for Iraqi construction Projects by *Farah Faaq Taha, Wadhah Amer Hatem;* 2022

This Research Aims to investigate around the impact of design parameter alternatives on electrical energy performance and electrical energy cost, study the role of BIM tools in Water usage analysis.

Energy Analysis of Residential Building Using BIM by *Abhilash Jangalve , Vijayartna Kamble;* 2016

The methodology approach is quantitative and data are collected through building simulation using Revit BIM. Advocates use of building simulation as research methodology, as it helps to improve design and predict the possible outcomes of the design alternatives.

Green Envelope as an Architectural Strategy for Energy Efficiency in a Library Building *by Azlam Ariff Sabarinah Sheikh Ahmad;* 2016

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Virtual Reality integrated Workflow in BIM –enabled projects collaboration and design review by *Reza Zaker , Eloi Coloma*

This paper talks about the application of virtual reality in AEC followed by a case study conducted to observe the findings of participants involved in it in terms of comfort, adapting to the virtual environment and scope of its collaboration with construction industry.

BIM and BEM Methodology Integration in Energy-Efficient Building Using Experimental Design *Jorge Gonzalez, Mohammad Najjar*

This article descripts the methodology of BIM and BEM integration, in addition to that this also speaks about a case study in which the authors considered a 5 different locations (countries) placing the same buildings and made the energy analysis.

Low Cost Virtual Reality environment for engineering and construction *Thomas Hilfert and Markus Konig*

This paper talks about the types of devices used to create a virtual environment of different hardware setups and software architectures and finally concludes about that usage in a low cost virtual environment with Head mounted devices is a worth consideration

Impact of Passive Energy Efficiency Measures On cooling Energy Demand in an Architectural Campus Building in Karachi, Pakistan *Mushk bughio , Muhammad Shaiob Khan*

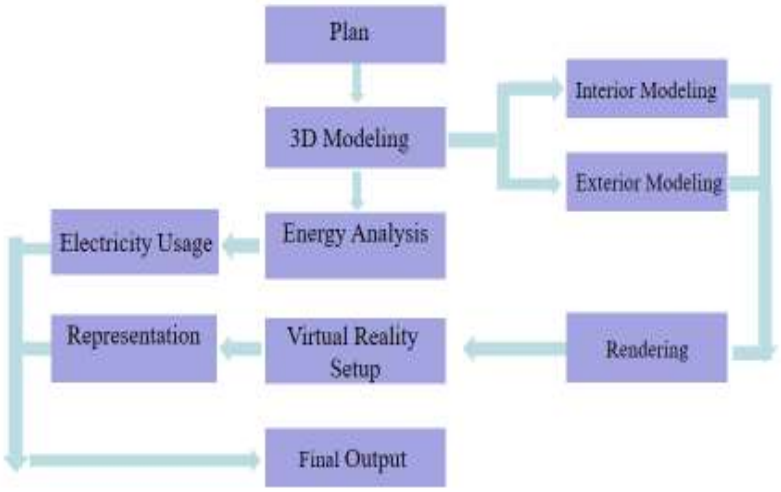
This article talks about the case study of a building located in Karachi (Pakistan), how can we utilize the environment and reduce the consumption of energy.

A multiuser shared virtual environment for facility management *Yangming Shi, Jing Du, Sarel Lavy, Dong Zhao*

This paper talks about implementing multi user virtual environment for facility management using photon unit networking

Methodology

The below depicted flow chart as been adopted to take over the project and results have been obtained based on it.



Methodology – Flowchart

Architectural modelling

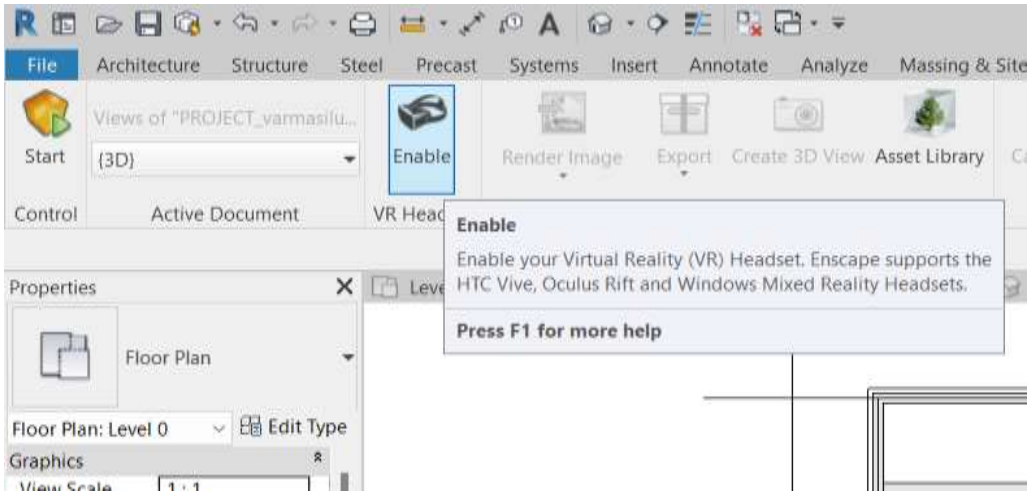
- Interior and exterior modelling is performed using Autodesk Revit software.
- The plan is understood and drawn with basic walls, windows, doors, floor, ceiling, roof and staircase in level 0.
- The same is obtained in three dimensional view to which modelling is done to provide a realistic using various families.
- Families are imported from external source namely ‘BIM Object’ in addition to the available families in Revit.
- Arrangement of electrical appliances, floor tiles, modelled ceilings, textures and paints is done in a detailed way approaching towards a real time view.

Visuals of Architectural designing using Revit Architecture and Enscape for rendering

Visualization using virtual reality

- Virtual reality is used to visualize the built environment in a realistic way
- This is achieved using Head Mounted Device (HMD)
- The model developed in Revit software is rendered using a plug in named Enscape'.
- Enscape is also utilized to create a virtual environment.
- This BIM based VR environment tool is used to bring remotely located stake holders, building occupants, designers, contractors and facility managers together to walk through in the same virtual building.
- 'Oculus Rift' and 'HTC vive' are two types of HMD's that can be used to plug.
- A walk through can be produced and played on other type of HMD's alternatively.
- A multiuser VR environment can be created using cloud networking techniques.

Head mounted device



Virtual reality plug-in in Enscape

Energy analysis

- Energy analysis here is performed using Autodesk's Green Building Studio (GBS).
- It gives a report of the electrical energy consumption and the its cost based on unit rate.
- An analytical model is created for the building created in Revit and a 'gbXML' file is exported and is used to run in GBS to obtain the report.
- The orientation and location of the building have been considered as influencing parameters for the electrical energy consumption.
- The climatic conditions are obtained from the location provided and the same are used to produce a final report containing electrical end and fuel end use.

Conclusions

- Interior and exterior modelling of the residential building can be completed with full fledged detailing of architectural elements using Revit Architecture and Enscape for rendering.
- The various ways for creating a VR environment have been studied and HMD is arranged for reviewing the process.
- Virtual walkthrough video can be prepared to review the environment in a regular HMD as an alternative in the absence of 'Oculus Rift' or 'HTC vive' for direct plug in.
- Energy analytical model is created for the building in Revit and gbXML file is exported and is used to run in GBS
- A report has been obtained in GBS and trails are being made by varying orientation and various other factors to determine the optimum electrical energy consumption.

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