Virtual House using Augmented Reality and Cost Estimation

Siddhi Patil[1], Mrunali Udata[2], Shital Konale[3], Vaishnavi Dhale[4], Prof. M. B. Chougule[5]
Department of Computer Science and Engineering[1,2,3,4,5]
Brahmdevdada Mane Institute of Technology, Belati, Solapur, India

Abstract*: Augmented and virtual technologies both play vital roles in the construction industry. Augmented technologies, however, have a higher benefit when compared to virtual. The two technology types are discussed; with their similarities and differences explained. The past, present, and future is described. Some benefits to using augmented technology are discussed. The drawbacks are mentioned, with the way to correct them detailed.*

Keywords: Augmented Reality, Virtual Reality, Construction Industry, Scheduling, Safety

I. INTRODUCTION

Augmented reality superimposes digital elements onto the real world, enhancing the user's perception and interaction with their environment. By leveraging AR, this project enables users to visualize and interact with a virtual house that can be customized in real-time. This includes the ability to place and manipulate virtual furniture, décor, and architectural elements within their physical space, thereby facilitating a comprehensive understanding of the spatial layout, aesthetics, and overall feel of the design.The primary objective of this project is to bridge the gap between conceptual designs and tangible experiences.[1,3,4] Traditional methods of home design often rely on 2D blueprints, sketches, and static 3D models, which may not fully convey the intended vision to clients. This often results in a lack of visual clarity and understanding, leading to potential misinterpretations and dissatisfaction. The use of AR in this project allows clients to actively participate in the design process, offering an immersive experience that goes beyond static representations.The "Virtual House Using Augmented Reality and Cost Estimation" project also aims to enhance customization options. Clients can experiment with different design elements, such as furniture arrangements, color schemes, and material finishes, in a virtual environment. This iterative process allows for a high degree of personalization, ensuring that the final design aligns closely with the client's preferences and requirements.Dynamic cost updates ensure that the design choices align with the budget. This transparency allows clients and stakeholders to make informed decisions without the risk of exceeding financial constraints.Clients can make real-time changes to the virtual model, experimenting with different design elements, furniture arrangements, and finishes. This iterative process ensures that the final design aligns closely with the client's preferences

1.1 Problem Definition:

Despite the advancements in technology, the traditional home design and construction process faces several challenges:

- Lack of Visual Clarity and Understanding**:** Traditional design methods, such as 2D blueprints and static 3D models, *o*ften fail to provide a comprehensive understanding of the spatial layout and aesthetics. This can lead to misinterpretations and dissatisfaction among clients.
- Uncertain Cost Implications**:** Clients frequently encounter unexpected expenses due to a lack of transparency in cost estimation. This uncertainty can lead to budget overruns and financial strain.
- Lack of Customization Options**:** Clients have limited opportunities to experiment with different design elements and configurations before finalizing the design. This restricts personalization and may not fully meet the client's preferences.
- High Costs Associated with On-Site Rework**:** Misinterpretations and changes in design during the construction phase can result in costly on-site rework, leading to project delays and increased expenses.

1.2. Overall Scenario

The complete system can be divided into two halves on basis of access levels.

- House Designing
- Cost Estimation

House Designing:

Virtual house design using augmented reality and cost estimation ensures a client- centric, collaborative, and efficient approach to creating dream homes that align with both aesthetic preferences and budget considerations. Conduct a detailed consultation with the client to understand their lifestyle, preferences, and specific requirements for the virtual house. Gather information on the number of rooms, preferred architectural styles, desired amenities, and any specific design elements. Create initial sketches and concept drawings based on the gathered requirements. Use traditional 2D sketches or digital tools to outline the basic structure, layout, and flow of the virtual house. Utilize 3D modeling software to transition from 2D sketches to a three-dimensional virtual model of the house. Incorporate basic architectural features, room layouts, and exterior elements to provide a more realistic representation. Implement augmented reality features to the 3D model, allowing clients to experience an immersive virtual walk through of their house. Use AR to overlay digital information onto the real-world environment, enabling clients to visualize the virtual house in their actual living space. Facilitate an iterative design process, allowing clients to make real-time modifications using AR tools. Gather client feedback on design elements, spatial arrangements, and overall aesthetics to refine the virtual model.

Cost Estimation:

Cost estimation involves considering various factors related to design, materials, labor, and other elements. Consider the cost implications of different materials for construction, finishes, flooring, and other elements. Use AR to allow clients to visualize and choose materials, providing real-time cost estimates for each selection[8,9].Evaluate the cost of specific architectural features such as custom-designed elements, unique building shapes, or intricate details. Provide clients with cost breakdowns for incorporating these features into the virtual house design. Estimate costs for interior fixtures, including lighting, plumbing fixtures, cabinetry, and other built-in elements. Integrate a feature that allows clients to choose and visualize different fixtures with associated costs. Consider the integration of smart home technologies and their associated costs. Provide clients with estimates for features such as home automation systems, security systems, and energy-efficient technologies. Evaluate the costs and potential savings associated with implementing energy-efficient features. Provide clients with insights into the long-term financial benefits of energy-efficient design choices.

1.3 Requirement Specification

- **AR Development Platform/Framework:** ReactNative (allows you to build natively-rendered mobile apps for iOS and Android), Viro React (an open-source platform by Viro Media built to develop AR/VR applications with React Native.)
- **3D Modeling Software:** Figma (to create, share, and test designs for websites, mobile apps, and other digital products and experiences).
- **Programming Languages/Library:** Javascript, typescript and React.
- **Database:** MongoDB.

II. LITERATURE REVIEW

The "Virtual House Using Augmented Reality and Cost Estimation" project builds upon existing research and technological advancements in the fields of augmented reality (AR), interior design, architecture, and cost estimation. *This* literature review examines key studies, technologies, and methodologies that have informed the development of this project, highlighting the gaps and opportunities that our project aims to address.

AR in Interior Design and Architecture: Augmented reality has gained significant traction in interior design and architecture due to its ability to enhance visualization and user interaction. According to Lin (2018) in "Augmented Reality Use in Construction – A Case Study of the Industry," AR technology allows users to visualize construction projects in a real-world context, improving comprehension and decision- making.[5,7] This study underscores the potential of AR in reducing errors and enhancing client satisfaction by providing a realistic preview of the final outcome. In another study, Azuma et al. (2001) in "Recent Advances in Augmented Reality" discuss the evolution of AR technology and its applications across various industries. The paper highlights the benefits of AR in providing interactive and immersive experiences, which are crucial for fields that rely heavily on spatial visualization, such as interior design and architecture.

Visualization and User Experience: The effectiveness of AR in improving user experience and visualization has been well- documented. Billinghurst and Kato (2002) in "Collaborative Mixed Reality" explore how AR can facilitate collaborative design processes by allowing multiple users to interact with virtual objects in a shared physical space. This capability is particularly relevant to our project, which aims to provide a collaborative platform for clients and designers to co-create virtual home designs. Furthermore, a study by Hou et al. (2013) in "Exploring the Use of Mixed Reality to Facilitate Design Communication in the Building Industry" demonstrates that AR can significantly enhance design communication between stakeholders. The study found that AR reduced the likelihood of misunderstandings and design errors, leading to more efficient project execution and higher client satisfaction.

Cost Estimation in Construction Projects: Accurate cost estimation is a critical component of any construction project. Idan and Dheyab (2020) in "Estimate Costs Management in Construction Projects" emphasize the importance of transparent and dynamic cost estimation tools.[2] Their research highlights the challenges faced by traditional cost estimation methods, such as static budgets and unforeseen expenses, which can lead to project delays and budget overruns. Our project aims to address these challenges by integrating real-time cost estimation with AR-based design visualization. By providing users with dynamic cost updates based on their design choices, our system ensures that clients can make informed decisions without exceeding their budget.

Existing AR Applications and Tools: Several AR applications and tools have been developed to aid in interior design and architecture. For instance, *the IKEA* Place app allows users to place virtual furniture in their homes using AR, providing a realistic preview of how the items will look in their space.[6] This application has demonstrated the practical benefits of AR in helping users make better purchasing decisions and avoid costly mistakes.Similarly, the Houzz app offers AR features that enable users to visualize home decor and furniture in their real environment. These applications have paved the way for more sophisticated AR solutions, such as our project, which aims to provide a comprehensive virtual home design and cost estimation platform.

Gaps and Opportunities: Despite the advancements in AR technology and its applications, there are still several gaps that our project aims to address.

Integrated Cost Estimation: While existing applications focus primarily on visualization, they often lack integrated cost estimation features. Our project aims to bridge this gap by providing real-time cost updates, ensuring that design choices align with the client's budget.

Customization and Personalization: Many AR applications offer limited customization options. Our project emphasizes high levels of personalization, allowing users to experiment with various design elements and configurations in a virtual environment.

Collaborative Design: Current AR tools often lack features that facilitate collaborative design processes. Our project aims to provide a platform where multiple users can interact and co- create virtual home designs, enhancing communication and decision-making.

III. FINDINGS

Virtual House Using Augmented Reality and Cost Estimation offer new and exciting benefits to the construction industry being discussed in following paragraphs.

Enhanced Visualization and Design Communication: AR technology allows users to visualize virtual elements, such as furniture, finishes, and architectural details, overlaid onto their physical environment. This immersive experience

enables homeowners, architects, and designers to better understand how design choices will look and feel in real life, facilitating more informed decision-making and improved design communication.

Real-time Cost Estimation: Integrating cost estimation algorithms into Virtual House applications provides users with instant feedback on the financial implications of their design decisions. By dynamically adjusting design parameters and material selections, users can explore various options while staying within budget constraints. This real-time cost estimation feature promotes financial transparency and empowers users to make cost-effective choices throughout the design process.

Streamlined Design Iterations: Virtual House applications enable users to iterate on designs rapidly and efficiently. By visualizing design changes in real-time using AR, users can quickly assess the impact of modifications on both aesthetics and costs. This iterative approach accelerates the design process, reduces the need for costly revisions, and ultimately leads to more satisfying outcomes for homeowners and clients.

Improved Collaboration and Client Engagement: AR- based Virtual House applications facilitate collaboration among stakeholders by providing a shared platform for design exploration and feedback. Clients can actively participate in the design process, offering input and preferences in real-time. This collaborative approach fosters greater client satisfaction, as their vision for their dream home is accurately translated into the virtual environment.

Optimized Resource Allocation: By integrating cost estimation features into Virtual House applications, resources can be allocated more efficiently. Users can prioritize design elements based on their cost implications, ensuring that budget allocations align with project priorities. This optimization of resources helps to minimize waste and maximize the value of the construction project.

IV. OUTPUT

Following are the images of output of project
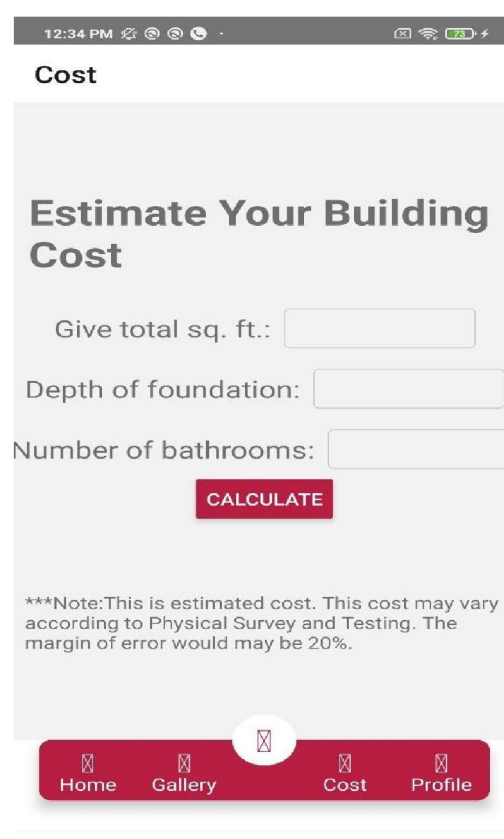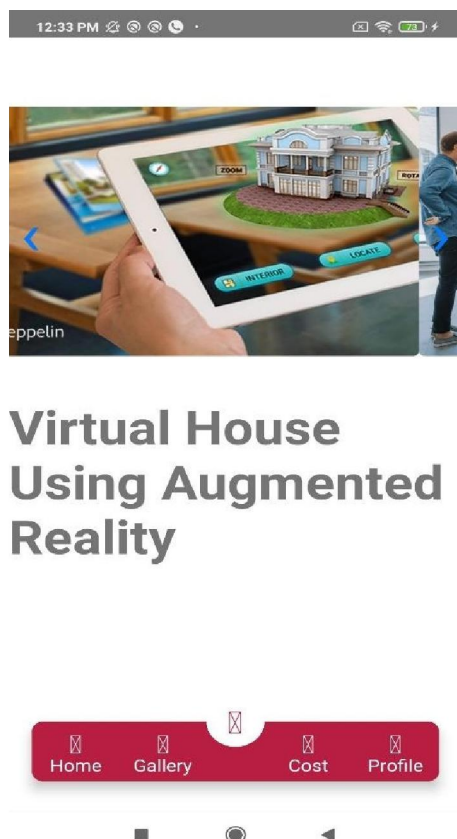
V. CONCLUSION

Augmented technology has rapidly advanced over the past two decades, emerging as a vital tool complementing virtual technology. It provides users with real-time insights into their surroundings, offering a dynamic view of construction processes and final project outcomes. This capability is particularly valuable in Virtual House applications, where users can visualize and interact with virtual elements overlaid onto their physical environment, facilitating informed decision-making and enhanced design visualization. One of the key benefits highlighted in the review is the ability of augmented technology to improve safety training effectiveness. By providing real-time views of job site situations, augmented reality enhances hazard awareness and reduces the risk of on-site accidents. This aspect is crucial in the construction industry, where safety is paramount, and effective training can mitigate potential risks.

Despite its promising potential, augmented technology faces challenges and barriers, including technological limitations and adoption hurdles. However, these barriers are gradually being overcome through continuous advancements in technology and increasing acceptance among users. With each generation becoming more tech-savvy, augmented reality is poised to play an increasingly critical role in construction practices. Looking ahead, the review suggests a bright future for Virtual House applications leveraging augmented reality and cost estimation features. As augmented technology continues to evolve, these applications are expected to revolutionize the home design process. They offer users unprecedented levels of visualization, customization, and cost transparency, empowering homeowners, architects, and designers to create personalized and cost-effective designs that exceed expectations.

Clients can actively engage with and explore their future homes in a realistic 3D environment, leading to better communication, reduced misunderstandings, and increased satisfaction. The iterative design process empowers clients to

make real-time modifications, ensuring that the final design aligns closely with their preferences. Advanced cost estimation tools integrated with the virtual design platform provide clients with real-time insights into the financial implications of design choices. The client - centric approach of virtual house design ensures that clients have a more active role in the decision-making process, leading to increased satisfaction with the final outcome.

REFERENCES

[1]. Augmented Reality for Building Maintenance and Facility Managemen, Xiaohua Jin, Qi Chen, Chengyu Li

[2]. Cost Estimation of Construction Projects Using Augmented Reality and Building Information Modeling, Chul-Soo Lee, Soo-Yong Kim

[3]. Augmented Reality for Interactive Visualization of Construction Schedule Simulation, Wei Wang, Yulin Lyu, Yimin Zhu

[4]. Augmented Reality-based Mobile Interactive Guide for Construction Projects, Jinho Lee, Martin Fische.

[5]. Augmented Reality for Construction Site Monitoring and Control, Javad Majrouhi Sardroud, Soheil Salehi, Amir H. Behzadan

[6]. Augmented Reality for Enhancing Building Information Modeling Data Quality in Construction Projects, Hyunbo Cho, Seokho Chi, Jin-Kook Lee

[7]. Augmented Reality for Building Construction Progress Monitoring, Chao Huang, Wenzhong Shi, Shuaicheng Guo

[8]. "Cost Estimation of Construction Projects Using Machine Learning Techniques", A. R. Chandrasekaran, S. Prakash

[9]. "Cost Estimation of Construction Projects Using Artificial Neural Networks", S. P. Chaurasia, S. C. Jha