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The Role of Augmented Reality(AR)in Construction Project Planning and Execution

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ABSTRACT: One of the most exciting advancements in modern construction is the use of augmented reality (AR). AR technology can revolutionize how construction teams work, from design visualization and collaboration to on-site construction assistance and improved long-term maintenance. Augmented reality provides various benefits that can help companies create the world of tomorrow more efficiently and effectively. It enhances efficiency and accuracy by overlaying digital information, like 3D models and blueprints, onto the physical job site. Its roles include improving visualization for better planning, ensuring construction matches design through on-site checks, boosting safety via simulated training, facilitating remote assistance and collaboration, and streamlining maintenance and inspections by providing real-time data access.It provides a range of benefits that can help companies create the world of tomorrow more effectively and efficiently. Let's explore some of the benefits of AR in construction.Now, augmented reality can incorporate CAD and BIM data to create detailed 3D models that overlay the real world. CAD has enhanced accuracy and consistency. BIM has created more detail and collaboration.AR is the next natural step for construction innovation, and it can enhance design, construction, maintenance, and on-site management.Augmented reality can share information and data in real-time, allowing professionals from different disciplines to work together more effectively. Miscommunication and project management errors can result in higher costs and missed deadlines, which may lead stakeholders to lose confidence.AR allows workers to visualize and discuss design plans, share measurements, and track progress. More detailed data enables site managers, contractors, and superintendents to keep detailed reports and adjust work accordingly.

KEYWORDS: 3D models, BIM data, augmented reality (AR).

I. INTRODUCTION

Augmented Reality based Mobile App with gesture recognition to accurately analyze the design for assemble the construction of the building model, which provides a new way for architects and project designers to identify any design flaws and make any adjustments in just a few taps, for which the Vuforia as the cloud database is used which can handle large number of 3D models to be projected on the mobile screen and by using Zxing packages from Unity tool the real world construction materials and it can accurately measures the real world coordinate length for construction's base and people can view their inline connections inside the building. Our proposed system gives a new way for architects through Augmented Reality based mobile app will take over the advantage of possible of occurrence of errors in building construction, it projects the 3D model of the building in a procedural format to build it in a better manner.(AR) is vital for next generation of computer learning. Augmented Reality is a Medium that overlays digital information to the users view, the image of physical Surrounding is a user view. The project uses an Augmented Reality-core and that integrates with Building Information Modelling (BIM) to improve the users understanding of complex building designs and the construction process. The diagrams prepared from the Bio- environmental is scanned by phone camera and sends to the AR-core. Augmented Reality core is a platform for creating augmented reality experiences.it scans the photo and understands the environment and provide a building structure.

II. LITERATURE REVIEW

Early SHM Systems (1980s–2000s)
The earliest SHM systems primarily used wired instrumentation such as strain gauges and accelerometers connected to a central data acquisition system.These systems were limited by their high installation costs, extensive wiring requirements, and low scalability.Data collection was often manual, with limited frequency and storage capability.

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Wireless Sensor Networks (2000s–2010s)
The introduction of Wireless Sensor Networks (WSNs) in the early 2000s marked a major breakthrough.Wireless nodes equipped with microcontrollers, sensors, and transceivers enabled distributed data collection and reduced cabling complexity.
However, issues like limited power supply, synchronization, and data loss were still common.

IoT-Based SHM (2010–Present)
The convergence of IoT, cloud computing, and edge analytics revolutionized SHM. IoT allows data from diverse sensors to be collected, transmitted, and analyzed in real time using internet-connected devices.Modern SHM systems now employ low-power wide-area networks (LPWAN), machine learning, and cloud dashboards for predictive maintenance.

The reviewed literature clearly establishes IoT as a transformative technology in SHM. Modern research trends focus on integrating IoT with AI, edge computing, and digital twins for intelligent infrastructure management.However, practical deployment still faces limitations related to cost, power, and standardization—providing a strong motivation for the present study.The next chapter elaborates on the theoretical background, covering vibration theory, structural response modeling, and damage detection techniques that support IoT- based SHM frameworks.

III. RESEARCH METHODOLOGY

Augmented reality (AR) and virtual reality (VR), a kingdom-of-the-art technology for superimpos-ing information onto the real world, have recently started to have an effect on our everyday lives. In addition, AR and VR have shown a great contribution to advanced construction management in recent years. However, a comprehensive critical review of AR and VR technolo-gies in construction management is absent in the liter-ature.

This study provides a comprehensive review of a summary of using potential opportunities of AR and VR to solve a variety of construction management issues effectively and efficiently. This study found that AR is successfully used in construction project scheduling, progress tracking, worker training, safety management, time and cost management, and quality and defects management. VR is effectively used as a visualization tool, worker training technology, safety management tool, and quality and defects management tool. In addi-tion, AR and VR are used for developing a network that allows the possibility of having conferences with those who are geographically far off from each other or the construction site. This study could help to explore the potential fields of using AR and VR technologies in the construction industry effectively as advance time- and cost-saving profitable tools.

With the rise of immersive technologies, Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR) have become key tools in engineering, education, and design fields. While these terms are often used interchangeably, each technology has distinct characteristics and applications—especially in construction and project visualization.

IV. RESULTS AND DISCUSSION

Augmented reality is revolutionizing project planning by overlaying 3D models onto real-world environments (so-called digital twins). This allows architects, contractors, and clients to visualize plans before construction begins, minimizing misunderstandings and making sure everyone is aligned on project goals. Virtual walkthroughs also provide a preview of the finished project, leading to improved client satisfaction.

One of the key benefits of augmented reality in construction is the ability to display real-time data on-site. Workers, engineers, and supervisors can access live project insights, track progress, and measure efficiency. AR also simplifies construction measurements, meaning tasks are completed accurately and on time. Using this data, a detailed 3D BIM model of the selected metro station is developed in Autodesk Revit, capturing major structural, architectural, and MEP components. This digital model is then linked with scheduling data from Primavera P6 or MS Project to create a 4D model, which combines time and spatial dimensions for visualizing the construction sequence. The 4D model is exported into AR-compatible software environments such as Unity 3D, Fologram, or Trimble SiteVision to develop interactive AR simulations. Through these AR applications, the construction elements are virtually overlaid onto the real project site, enabling visualization of construction stages, spatial arrangements, and service alignments directly in the field.

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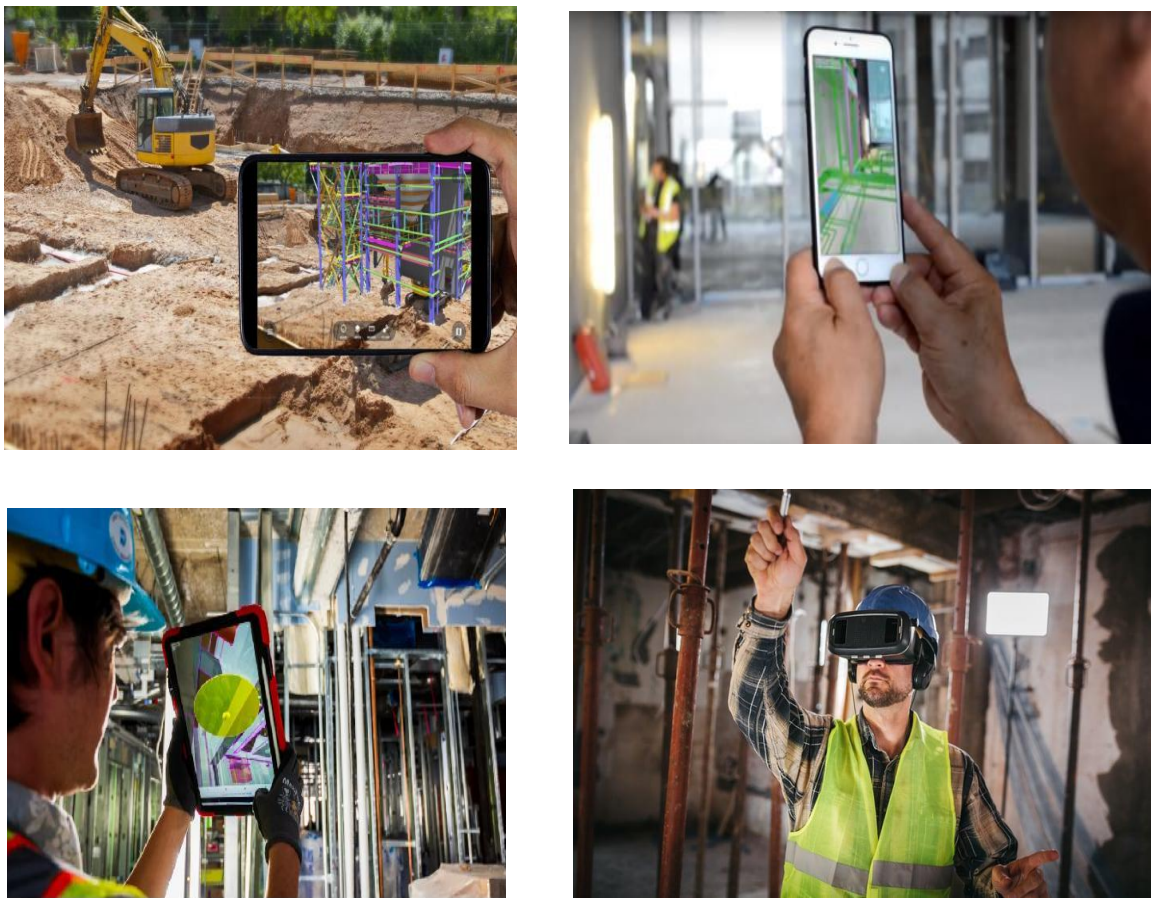

Fig 1: AR for Construction Job site Management

V. CONCLUSION

The construction sector is advancing rapidly, and AR is at the center of that change.By integrating with the latest in IoT, AI, and robotics, AR is already creating smarter jobsites and empowering workers to solve problems faster.It appeals to tech-savvy younger workers while helping experienced professionals work that much more efficiently.Forward-thinking companies are already proving that AR is a wise investment for the months and years ahead. The future of construction is set to be increasingly complex, digital, and data-driven, and Augmented Reality (AR) is positioned to become a central technology in this transformation. AR enables real-time visualization of 3D building models overlaid onto actual construction sites, allowing engineers, architects, and site workers to detect design conflicts, validate construction sequences, and plan site logistics with unprecedented accuracy. By integrating with Building Information Modeling (BIM), Internet of Things (IoT) sensors, and AI-powered analytics, AR supports precise monitoring of project progress, predictive maintenance, and resource management, thereby reducing delays, minimizing rework, and optimizing costs. Additionally, AR enhances on-site safety and training by simulating hazards and providing immersive, interactive guidance, which is particularly valuable in complex infrastructure projects such as metros, airports, and smart city developments. The technology also fosters better collaboration among stakeholders, enabling remote design reviews, progress tracking, and decision-making, which is critical in geographically distributed and multidisciplinary projects. With growing urbanization, infrastructure expansion, and the push toward sustainable, smart construction practices, AR's ability to combine digital intelligence with physical execution makes it an indispensable tool for the construction industry's future. In essence, AR is not merely a visualization tool; it represents a paradigm shift that enhances productivity, quality, safety, and communication, ensuring more efficient, cost-effective, and innovative construction practices in the years to come.

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