The Role of Augmented Reality in the Development of BIM for Construction Visualization

Hassan A. Mohamed and Venera Garaeva

Abstract The notion of augmented reality (AR) has been around for a long time, and the widespread availability of new mobile technology, such as Smartphone and portable devices, has aided in the realization of the concept. Various industries, including the Architecture, Engineering, and Construction (AEC) business, are taking use of the expanding possibilities that the notion of AR may provide. The use of augmented reality in civil infrastructure can help to avoid costly mistakes, increase efficiency, and save money. Building-Information-Models (BIMs) are also used in AR to provide precise 3D information about the structure for display. AR has also been investigated for Structural-Health-Monitoring (SHM), regular and problem identification, energy effectiveness evaluation, cracks examination, digging, and subterranean utility servicing. The goal of this article is to make the operation of supervising infrastructure projects a little easier. The traditional method of measuring building progress is to use paper reports, which requires a significant amount of human data collecting as well as the effort of visualizing the real progress from the paperwork. This research highlights a novel approach for utilizing Smartphones to track building progress. This is accomplished by offering a new system that includes a newly created application known as "AEC-AR". "AEC-AR" is an Android application that is utilized throughout the building phase by integrating a 4D "as-planned" phased layout including an augmented video that shows actual or projected development. The project's outcomes are then analyzed and evaluated in order to predict the potential of these and other time and cost tracking approaches in building activities.

Keywords Augmented reality (AR) · Building information modeling (BIM) · AEC industry · Construction projects tracking · Unity · Smartphone app

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1 Introduction

Portable smart phones are now being utilized for a broad array of purposes. That contains Augmented-Reality (AR) in the building environment, and the mobility and convenience of portable smart phones has encouraged academics to look into their possibilities for automated building site supervision. Simultaneously, the advantages of using building data modeling (BIM) for the architecture, development, and implementation of built assets have been widely publicized. BIM provides coordinated and consistent views and representations of the 3D model, including reliable "4D" (time) and "5D" (cost) data. Several of these advantages are related to the possibility for increased onsite operations throughput. As per Kim et al., this comprises project monitoring capabilities as well as the capacity to allow real-time communication and information sharing amongst construction stakeholders [1].

1.1 Augmented-Reality Overview

Computer-generated data like images, audio, movies, or electronic data are overlaid on actual components in Augmented-Reality. From Ivan Sutherland's first see-through head-mounted AR display in the 1960s [2] to Golparvar et al. enhanced. 's HD4AR and Mobile Augmented Reality System (MARS) [3], Augmented-Reality innovations have been utilized in a wide range of subjects and arenas, including engineering, recreation, aviation, pharmaceutics, armed services, and the automobile industries [4].

1.2 Augmented Reality (AR)

In addition, the AEC sector is embracing more AR technology to improve different phases of building projects. This powerful computer innovation offers substantial benefits to the construction projects through modeling and visualization, such as allowing the analyst to communicate directly with both real and virtual objects and monitoring construction activities by comparing the development's as-planned and as-built condition [5].

At least three layers of AR technology can assist the AEC/FM industry: visualization, extraction of data, and collaboration. [6]. Different studies have proposed various AR applications for the AEC/FM sector. Dunston and Wang suggested AR solutions for the AEC sector to support all phases of the project life cycle for built facilities [7]. Wang et al. look at the use of augmented reality in heavy machinery operation learning [8]. Golparvar-Fard et al. created a four-dimensional AR model to automate work progress tracking, data gathering, processing, and transmission during the project's building phase. [9].

To effectively deploy Augmented reality technology in AEC developments and to realize their full capacity in this sector, it is necessary to determine areas of application where AR may be utilized to improve productivity. The following questions are addressed in this study paper: Based on the applicability of AR technologies, what are the major AR application areas in the AEC industry? What are the gaps in this sector that AR technology might potentially fill? Predict how AR technology might be enhanced for future applications based on future trends.

This article provides a comprehensive overview of augmented reality technology in the construction industry. The goal of this study was to look at the benefits of employing portable smart phones on infrastructure projects by combining BIM and AR in a platform that provides customers to track, amend, and visualize development cost and time progress. The premise of the study is that when portable mobile devices are coupled with other technologies, they provide a strong system for BIM construction progress monitoring. Monitoring and evaluation, according to Iyer and Jha, is a crucial component in completing construction projects on schedule and on budget [10]. As a first approach towards better building progress assessment on the job site, a system is presented that allows project managers to spot performance discrepancies, which will help them make better decisions. The hypothesis is evaluated by constructing, analyzing, and evaluating the current plan of the highlighted apps on a real construction project with qualitative input from interviews. To learn more about the participants' views and opinions, a semi-structured interview approach was employed.

2 Methods

2.1 Methodology

This feature article emphasizes on innovative augmented reality solutions to assist bridge the gap between online and physical world information (AR). AR is a method of displaying cyber information over physical images and altering it through interactions with real-world items. Sensors, like as the camera on a mobile device, are utilized in AR systems to derive information about user interactions with the actual environment. Such derived data can then be used on connected devices like Smartphone or tablets to help visualize information about real-world shapes, like outlined areas of a construction project image, or infer interactions with virtual information, such as inferring the shape change of a virtual 3-D model created by cutting it around the customer with something like a knife. In a variety of areas, such as health, building, entertainment, engineering, and computing, AR has showed great potential in addressing cyber physical system visualization and interaction problems. While AR's potential and widespread use, substantial research hurdles remain, including sensor-noise, accurate location, interruption, data acquisition, complicated information presentation, and computing complexity. This feature article examines

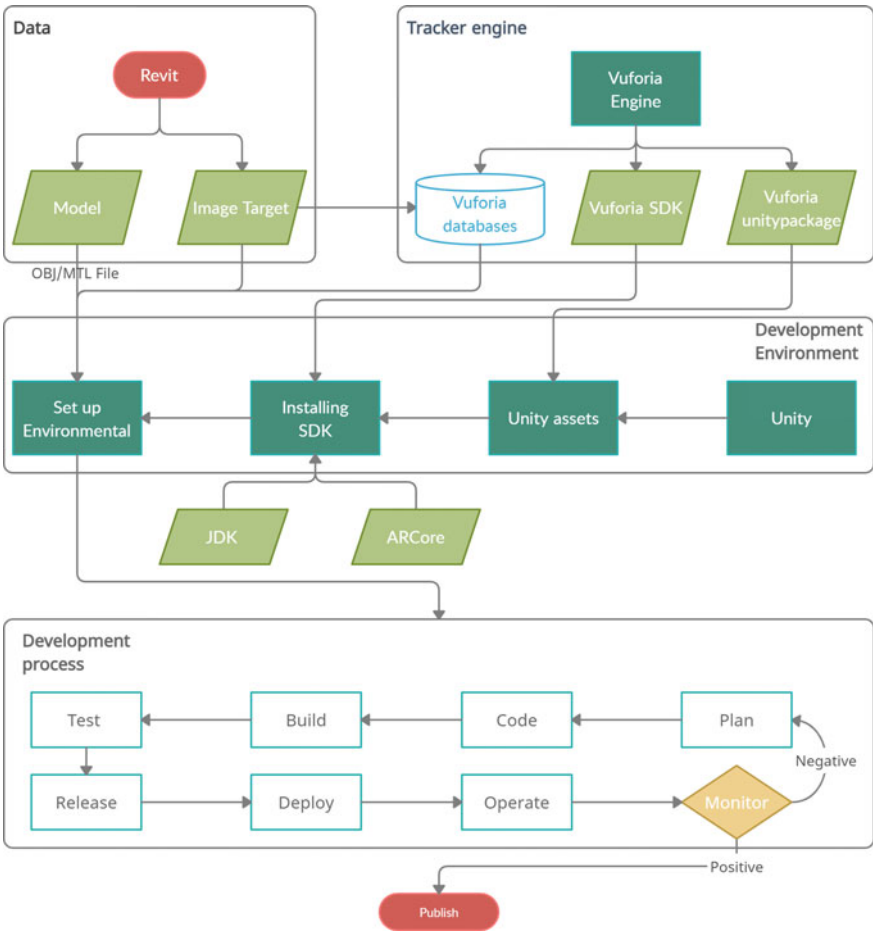

Fig. 1 Methodology flowchart

AR research applications and advancements in the underlying computer vision, indoor/outdoor mapping, and interpersonal communication technologies that enable these implementations.

2.2 Development of App and Experimentation

The hunt for a framework through which to build a viable augmented reality app took a long time. A variety of Smartphone and Tablet-based solutions, applications, and methodologies were tested to see how effective they might be in providing a usable design visualization solution. After some searching, a suitable application

named "AEC-AR" was discovered that met the majority of the research's needs. AEC-AR is primarily intended for construction and engineering visualization in the AEC sector. When compared to other programs created for the same purpose, AEC-AR is easier to use and set up. As AR data, it enables 2D pictures, 3D models, audio, and video that are given a location-specific position. During early testing, it was discovered that while the process of generating and deploying bespoke AR content remained a rather complicated effort, it was still much simpler than some of the other apps examined. The way the app is developed using different techniques and coding is explained in the following Fig. 1.

The above figure shows that the Revit file or model has been exported to unity, which modifies the materials of the model and files. With the use of these, the Vuforia has been used in the coding of the app to detect the images which are uploaded using a Smartphone or handheld device app like tablet. This Vuforia connect the model to the image in unity to put the model on the image whenever detecting in reality. The Revit, Unity, Vuforia, ARCore SDK and Microsoft Visual Studio has been used to write the coding of the app in C# format. Furthermore, to build the app for Android devices support Android Studio has been utilized.

3 Results

The AEC AR Smartphone app was created utilizing unity methods in accordance with the project implementation approach. With the aid of some extra software from the Unity Asset Store, this app was created utilizing the Unity platform's application. It makes it easier for beneficiaries to communicate with one another. The project's many experts can utilize augmented reality to exchange project information. To make the execution sound, some supply information (technicians) while others receive it (workers/builders/city councils). Manuals, assembly instructions, and other materials might be supplied to guarantee that the design is followed. The following Fig. 2, represent the layout of the screen which shows how it look.

The buttons on the right side allow the user to control whatever parts of the building they wish to see (architectural, structural, and MEP). The program allows you to demonstrate a piece of a structure using Cut Plan, and you may change its placement and angle from the left side of the app.

After finishing the creation of the augmented reality AR application and testing it on many devices to ensure that it works properly and that it does not clash with any other applications, as shown in Fig. 3.

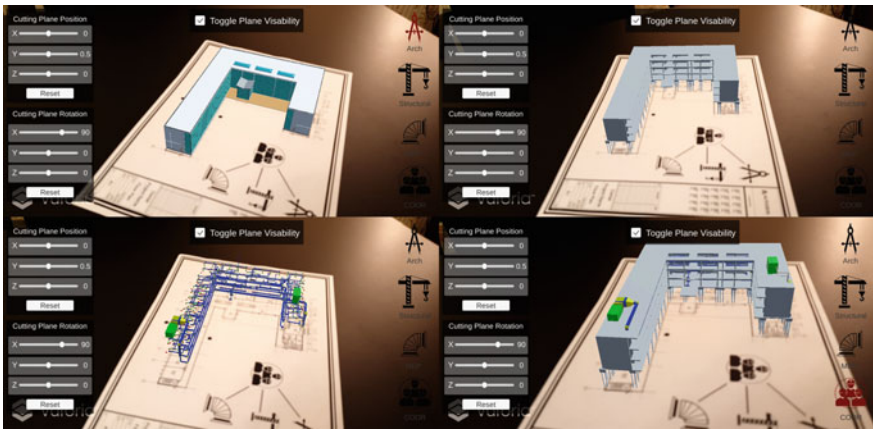

Fig. 2 Screenshots of using the app

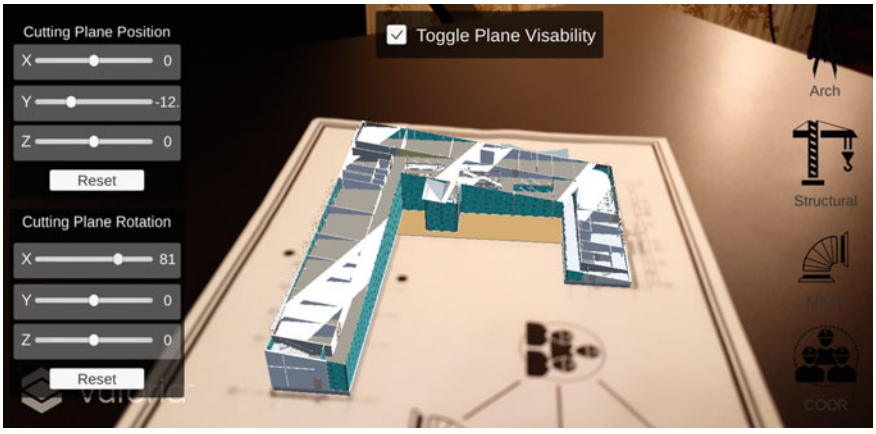

Fig. 3 UI of application

4 Discussion and Conclusions

The potential for AR technology to completely transform how we design, build, run, and monitor the AEC sector has been demonstrated. However, data generation, storage, administration, interchange, and sharing must all be integrated effectively. The loss of enthusiasm in Augmented Reality technology and the process of designing and translating complicated solutions into augmented reality in the literature prompted this study. This article covers the whole process of creating an AR app, as well as the software required for the development process that is suited for each project and organization. The combination of BIM and AR may enhance the performance of AEC projects in terms of time, cost, quality, and safety, as well as

affect the sales and advertising of building materials and complicated solutions in the construction industry. This integration is helpful for both the entire origin and particular sections of the origin.

The sample project implementation and development approach provided in this article offers a feasible, simpler, and more transparent alternative. Recent academic articles, results of discussions with academic and experienced specialists, and experiences of professors in the field were used in a case study project demonstrating complex solutions in construction using AR technology to identify the strengths and weaknesses of the proposed system. It makes it easier for beneficiaries to communicate with one another. The project's many experts can utilize augmented reality to exchange project information. To make the execution sound, some supply information (technicians) while others receive it (workers/builders/city councils). Manuals, assembly instructions, and other materials might be supplied to guarantee that the design is followed. Enhancing quality assurance in the on-site inspection phase, augmented reality offers several advantages, since people in charge can foresee possible discrepancies and make choices accordingly.

Housing is on display before you buy it. The advantages of augmented reality for potential buyers and investors are unrivalled. From visiting a home before to purchase and imagining what life may be like in the future to being able to adopt reforms and finish options for future improvements, we've got you covered. During the building period, there is a higher level of safety awareness. Better judgments may be made while executing the occupational health and safety risk prevention strategy before construction using augmented reality visualization. As a result, users may see how the various essential safety aspects should be positioned in the individual project ahead of time. See it before you create it. Augmented reality (AR) lets you avoid mistakes by seeing 3D BIM/VDC information before you construct it in reality. Track progress, AR makes it simple and easy to keep track of the building progress. Show progress, AR allows you to see phases of your building process in Autodesk Revit® using data from your BIM/VDC model. Mix and match models. In one view, you may merge different 3D BIM models. Presentation on a tabletop Place a scaled model on a table for a clear viewpoint, such as during design reviews. Projects are completed on time and on budget. BIM has already been shown to reduce project delivery time and keep projects under budget. This will be made much easier by combining AR and BIM. You might use augmented reality to walk around a full-scale BIM model to build the most efficient construction timetable and develop a site logistics plan for staging spaces, material and supply delivery, and equipment storage.

The amount of stakeholder acceptability, their knowledge of the relevance of AR, the usability of the software, and the acceptance of paying additional expenditures for hardware, software, and training are all obstacles from the users' perspective. Each of these categories poses a barrier for AR understanding and acceptability in the future, which is critical to increasing the efficiency of AR use in the AEC sector.

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