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AR Based Engineering Drawing Tool App

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Abstract
This approach brings a different perspective to T&L methods and content development which results in a better experience for students. Running international projects require the use of methods and tools to facilitate the communication of content. The process of creating the AR/VR content is time-consuming if not developed using effective design and visualization methods. Students are more accustomed to using 3D games with a high level of visual detail where a substantial amount of investment may have been available for commercial projects. However, large file sizes may limit its use as it would require high internet speeds to download the animation content which could be hosted on a website, however, many educational institutions have fast and free internet available. Development of AR/VR traditionally requires low-polygon modelling techniques but on multidisciplinary projects, teams normally use their daily-use software to generate 3D content which may limit the level of interactivity as optimization between software would reduce performance and increase file size of any developed media.

Keywords: *AR/VR- Augmented reality (AR) augments your surroundings by adding digital elements to a live view, often by using the camera on a smartphone. Virtual reality (VR) is a completely immersive experience that replaces a real-life environment with a simulated one.*
Visualization- the physical or imagining creation of images, diagrams, or animations to communicate a message.

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I. Introduction

There are concerns from Higher Education (HE) institutions and industry about the decline in standards of Technical Drawings (TD) due to the lack of understanding of basic principles and conventions that underpin the best practices. There is growing evidence that simulations/animations along with augmented and virtual reality (AR/VR) technologies can improve learners' engagement, competence, and skills; especially when compared to traditional didactic methods.

The purpose of this work is to develop and examine the overall effect as well as the impact of virtual and augmented reality -based methods and tools on the teaching and learning experience of technical drawing principles in the context of higher education settings. The development of tools and methods is based on the findings of a previous international study in three different categories covering the perception of TD education, assessing of TD knowledge and ability, and expectations of TD education.

TD has a been always an essential component in the formation of new product designers and engineers. They play an important role in communicating the technical product specifications (TPS) (i.e. material, size, shape, tolerances, etc.) for manufacturing during the new product development process. The decline in standards due to the lack of understanding of basic principles and the conventions of drafting skills that underpin these practices represent a challenge for HE institutions and the traditional teaching strategies.

Despite engineering and product design students are known to prefer visual, sensing, inductive, and active learning styles; most engineering education and in particular the teaching of technical drawing skills has relied on auditory, abstract, deductive, passive, and sequential teaching styles. This application seeks to bridge the gap between theoretical 2D engineering drawings and practical 3D visualization, thereby fostering a profound comprehension of engineering principles. It caters to a diverse spectrum of engineering disciplines, spanning from mechanical and civil engineering to architecture and beyond.

The user-friendly interface, comprehensive suite of features, and integration of AR technology collectively position this app as an invaluable tool for engineering education, professional development, and creative exploration.

II. Literature Review

Several researchers have reviewed the literature on AR and its application in the field of Architecture, Engineering, and Construction Education. Researchers have realized the new opportunities of using AR in the teaching and learning environment. Amir H. Behzadan presented the results of a project with the aim of transforming the present learning scenario in construction by designing and applying an interactive AR tool which would help students understanding the construction process, equipment, and operational safety in a much better way (Behzadan et al. 2011).

The AR book was created by combining all sheets of paper with tracker images on them. ARtoolkit was used as a platform which enables viewing of augmented information superimposing over markers with the help of Head mounted displays (HMD). The paper concluded that when properly implemented, AR has a significant impact on student achievement, increasing teacher and student interaction, and developing problem-solving skills of the student.

In another research, Behzadan and Shirazi developed an AR tool called CAM-ART. A Context-aware mobile augmented reality tool (CAM-ART) is an educational tool for the civil engineering and construction industry (Shirazi and Behzadan 2014). The developed AR tool was used in an undergraduate level course for testing and evaluating its impact on and benefits to students' learning. Students were asked to use their handheld devices (i.e. iPad, iPhone, tablets or smartphones) to achieve context-aware virtual information from the course textbook about the material presented in an ordinary way.

They formed groups to make the task more interactive and collaborative. Results concluded that AR can help provide a better learning experience and it helps to remove the barrier between technology and students in education. Also, CAM- ART provided an interactive environment and supported interaction and collaboration between students and coursework by indulging participants in a multimedia-enabled learning environment.

In a similar research, David Fonseca tested the feasibility of AR in mobile devices for Architecture Education (Fonseca et al. 2014b). The research focused on the usability of the tool, improvement in performance of students after the use of AR, and increase in student participation. The study was done with third-year students of an Architecture and Building Engineering degree during the year 2011-2012. A course was designed which was taught in the class and then examined at the end of classes. It can be inferred from the results that AR proved to be useful in case of visualizing simple models but would be less manageable with high-level models. Students felt encouraged with the experience of AR technology and welcomed similar technologies if it improved their academic performances. Students were found more interactive in classroom.

They could understand and communicate better with the help of 3D virtual content. Thus, AR maximizes the learning process. Chen et al. conducted similar research on improving spatial skills of students using AR (Chen et al. 2011). The experiment used AR model and tangible 3D model approaches for developing teaching methods that can improve spatial ability of students in learning concepts of engineering graphics in an optimal way. The research concluded that AR helped in developing interest among students. Both AR and tangible models when used together, can bring better results.

In 2015, similar research was conducted with the same purpose of identifying Utility of AR as a pedagogical tool for student learning (Shirazi and Behzadan 2015). It used Junaio, an open-source web-based programming environment in the experiment to assemble a model building from elementary blocks. The task was performed by two groups: Group 1 used the traditional paper-based method and Group 2 used AR tool. Results with the second group were positive. They looked more autonomous during the task and required less intervention by the teacher. It assured that AR can be used with difficult-to-understand topics and courses.

III. Problem Statement

Augmented reality (AR) is increasingly being utilized in education, particularly in engineering drawing, to enhance students' learning experiences and knowledge transfer. This project reviews recent research on the application of AR in engineering drawing classrooms, focusing on articles published between 2000 and 2016. The review found that AR can enhance learning experiences and improve students' skills in dealing with complex concepts in engineering drawing.

Researchers have developed augmented reality teaching aids to support the teaching and learning process of engineering drawing. As more research is conducted on AR technology, the findings will make engineering drawing classrooms more effective, increasing the standard of teaching and learning, benefiting both educators and students.

IV. Proposed Methodology

Our proposed AR-based engineering drawing education app revolutionizes the learning experience by seamlessly integrating 2D engineering CAD drawings with immersive 3D models in an augmented reality (AR) environment. The app caters to students, professionals, and enthusiast seeking a more interactive and comprehensive understanding of engineering concepts. Through this app, users can upload their 2D engineering CAD drawings, which are then transformed into AR- compatible 3D models.The AR functionality allows users to visualize these models in a real-world context, enabling a deeper understanding of spatial relationships and design intricacies. As users hover their devices over the 2D drawings, the app generates corresponding 3D models, providing an intuitive overlay of digital information onto the physical world.

The app offers a range of features, including the ability to manipulate and interact with the 3D models. Users can rotate, and scale. Additionally, the app provides annotations and text overlays, offering contextual information and insights, and enhancing the learning process. Furthermore, the app supports collaborative features, allowing users to share their AR enhanced models with peers or instructors, enabling group discussions, feedback, and collaborative learning experiences.

This app aims to bridge the gap between theoretical 2D engineering drawings and practical 3D visualization, fostering a more profound comprehension of engineering principles. It caters to multiple engineering disciplines, from mechanical and civil engineering to architecture and more. The app's user-friendly interface, comprehensive features, and AR integration make it an invaluable tool for engineering education, professional development, and creative exploration

V. Design And Implementation

Augmented reality (AR) has been used in education especially in the process of teaching and learning. Many courses including engineering drawing has implemented this technology in order to enhance students' learning experiences as well as to maximize the transfer of knowledge. Thus, the purpose of this project is to review recent research on the application of augmented reality in engineering drawing classrooms.

In order to achieve the purpose of this paper, various electronic databases were used to find articles published between 2000 and 2016. Few combinations of keywords were used to search related articles such as augmented reality, engineering drawing, engineering education and teaching approach. Findings from the review showed that the use of augmented reality can enhance learning experiences and improve students' skills when dealing with complex concepts in engineering drawing.

Consequently, as more research is done on the technology of augmented reality, the findings will definitely make engineering drawing classrooms more effective. Thus, the teaching AIDS developed from the research will increase the standard of teaching and learning and this process will benefit both educators and students.

The app shows list of available 2D Models of Technical Drawings which can be viewed. The app projects 3D Models of the above mentioned using Augmented Reality which can be viewed, zoom filled, zoom out etc. as per users' choice. The system must be a combination of real and virtual objects in real environment. It should align the real and virtual objects together simultaneously. It should run interactively in real time. It should be able to dynamically add 3d models and create QR codes to access this model in AR View.

Creating a use case diagram for an Augmented Reality (AR) based engineering drawing tool app can help you visualize the interactions between different actors and the system itself. Below is a simplified use case diagram for such an app. Please note that this is a high-level representation and in a real-world scenario, you might have more detailed use cases.

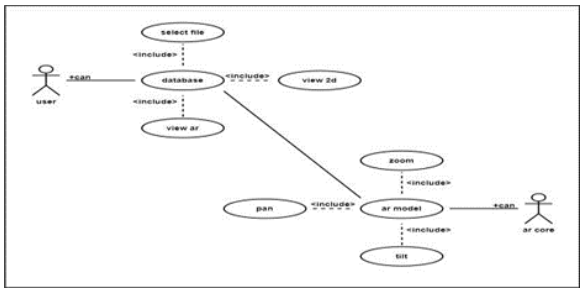


Figure 1: Use Case Diagram

a) User: The primary actor who interacts with the AR- based engineering drawing tool app.
b) Administrator: An optional actor responsible for managing user accounts, permissions, and system settings.
c) View AR Drawing (User): The user launches the app. The app activates the device's camera and AR capabilities. The user can view engineering drawings overlaid on physical objects through AR. Create/Edit

d) Drawing (User): The user can create or edit engineering drawings using the app. This includes drawing, modifying, and labeling components or objects within the AR environment. Load Existing
e) Drawing (User): Users can load previously created engineering drawings for reference or further editing.
f) Save Drawing (User): Users can save their current engineering drawing work for future use.
g) Share Drawing (User): Users can share their engineering drawings with other users or stakeholders through various sharing methods like email, messaging apps, or cloud storage.
h) Manage User Accounts (Administrator): The administrator can manage user accounts, including creating, updating, or deactivating them. The administrator can assign different roles and permissions to users.
i) Configure AR Settings (User/Administrator): Users and administrators can configure the app's AR settings, such as calibration, tracking, and display preferences.
j) Provide Feedback (User): Users can provide feedback or report issues about the app's performance or functionality.

The architecture of an AR-based engineering drawing tool app can be complex and involves several components. Below is a simplified architectural overview of such an app:

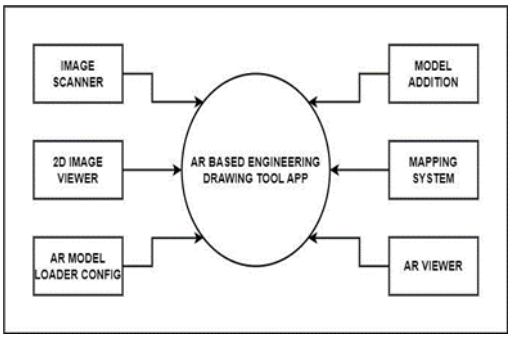


Figure 2: System Architecture

a) User Interface (UI): - The User Interface is the front-end of the application, providing a graphical and interactive platform for users to interact with AR and create engineering drawings. It includes all the required UI components.
b) AR Engine: - The AR Engine is responsible for handling augmented reality functionalities
c) Drawing Engine: - The Drawing Engine is at the core of the application, responsible for creating, modifying, and managing engineering drawings.
d) Object Recognition and Tracking: - Object recognition and tracking modules are responsible for recognizing physical objects or surfaces where drawings can be placed
e) Measurement and Analysis Tools: - This component provides measurement and analysis tools for engineers to calculate distances, angles, dimensions, and perform other engineering-related calculations.
f) Data Storage and Management: - Data storage and management modules handle the storage, retrieval, and management of user-created drawings
g) Performance Optimization: - Performance optimization components are responsible for ensuring smooth and responsive AR experiences.
h) User Authentication and Authorization: - For secure and personalized user experiences, the app can include user authentication and authorization modules.
i) User Training and Help: - This component provides user tutorials, help guides, and customer support to assist users in learning and using the app effectively.
j) Continuous Updates and Enhancements: - Regular updates and enhancements ensure the app remains up-to-date with the latest AR technologies and user needs.
k) Device Compatibility: - The app should be compatible with a wide range of AR-
l) capable devices, including smartphones, tablets, and AR headsets.

Creating a comprehensive data flow diagram (DFD) for an AR-based engineering drawing tool app requires an in-depth analysis of the system's functionalities and data interactions. Here is a simplified DFD for such an app, highlighting the main data processes and components.

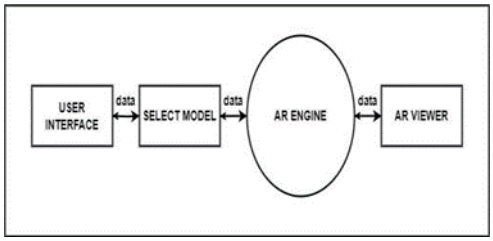


Figure 3.1: Data Flow Diagram Level 0

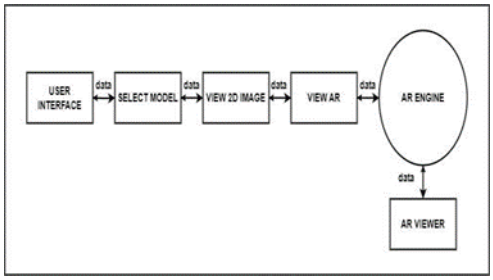


Figure 3.2: Data Flow Diagram Level 1

The operating system used in this project is Android. The minimum version required for installation of this app is Android 5.0. Once the app is installed the user can view the list of engineering(technical) drawings prefeed in the system. The user has to select the desired drawing and press on continue.

The unity engine now gets initialized and sets it for Augmented Reality View. The 3D Model of the drawing selected can then be viewed in AR. User can interact with the 3D AR Model using the buttons provided on the interface. The system also has an updated feature in order to upload new models and create QR in order to access the linked models in AR View.

VI. Result And Discussion

Augmented reality (AR) has been used in education especially in the process of teaching and learning. Many courses including engineering drawing has implemented this technology in order to enhance students' learning experiences as well as to maximize the transfer of knowledge. Thus, the purpose of this project is to review recent research on the application of augmented reality in engineering drawing classrooms. In order to achieve the purpose of this paper, various electronic databases were used to find articles published between 2000 and 2016.

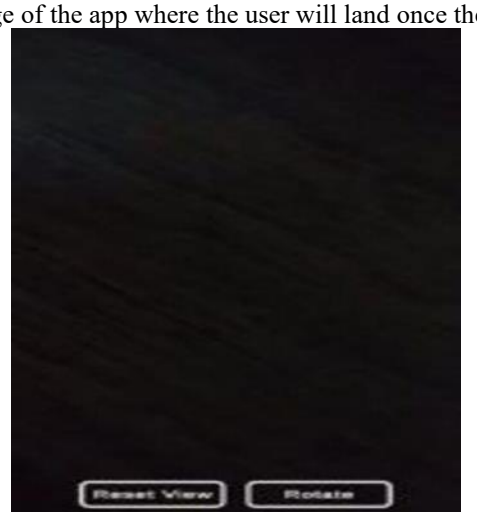
Few combinations of keywords were used to search related articles such as augmented reality, engineering drawing, engineering education and teaching approach. Findings from the review showed that the use of augmented reality can enhance learning experiences and improve students' skills when dealing with complex concepts in engineering drawing. Various researchers have produced augmented reality teaching AIDS to support the teaching and learning process of engineering drawing

Consequently, as more research is done on the technology of augmented reality, the findings will definitely make engineering drawing classrooms more effective. Thus, the teaching AIDS developed from the research will increase the standard of teaching and learning and this process will benefit both educators and students. Augmented reality (AR) technology is a cutting technology.

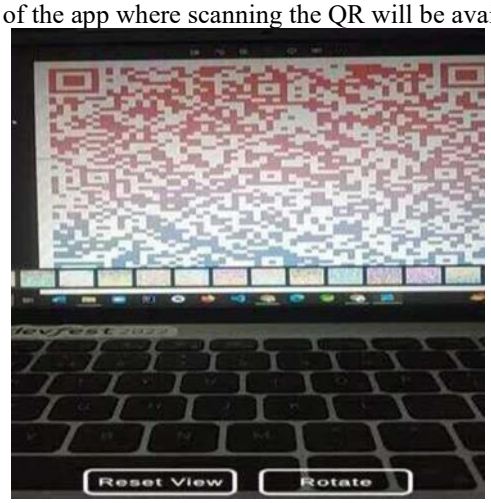
It can enhance the perception of reality and provide more information of the real world. AR technology is used in many fields, like medical, industry, and education. In this project, AR is introduced into engineering drawing course. Engineering drawing course is difficult to learn as it is a knowledge that students rarely contact with. To have a close contact with the models and the views, a convenient AR application (AR app) is proposed in the paper.

With the help of the AR app, virtual models and real views are combined well. The models can be moved and rotated by touching the screen. Thus, it is convenient for students to use mobile phone to study engineering drawing effectively. The interactive teaching environment enhances students' spatial thinking and cultivates their sense of innovation.

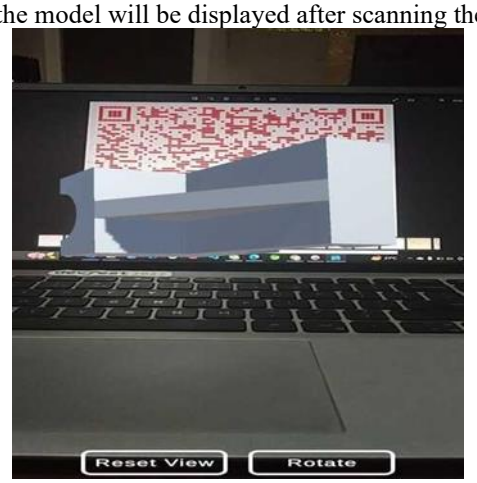
1. Main Page: This is the main page of the app where the user will land once they open the app.



2. QR Scanning: This is the Page of the app where scanning the QR will be available.



3. Output: This is the page where the model will be displayed after scanning the QR code.



VII. Conclusion

This study has identified the potential of introducing the use of Mobile Augmented Reality in the teaching and learning of orthographic projection among engineering students. The use of this technology has been seen as promising teaching and learning tools to increase students interests as well as brought a positive impact on their learning outcomes. This approach, which utilized a Mobile Augmented Reality technology, was chosen due to the promising potential of this technology usage among the 21st-century citizen.

It can provide students with a flexible learning experience as well as promotes self-directed learning. Its ease of use helps students to learn more quickly and effectively, and the novelty of this technology increases students interests towards learning itself. This study provides an evaluation of the use of app among respondents in order to show their perceptions and acceptance of the use of MAR in teaching and learning.

It can be seen from the results which indicate that respondents positively agreed that it could fulfil all the constructs, which include ease of use, concept understanding, visualization aid and intention of usage. It is hoped that these findings will encourage more researcher to further integrate MAR in teaching and learning to improve the quality of education and enhance students' understandings.

VIII. Future Scope

Future work for an AR-based engineering drawing tool app can focus on expanding capabilities, improving user experience, and addressing emerging trends. Here are some areas to consider for future development:

1. Enhanced AR Features: Explore more advanced AR features, such as better object recognition, tracking, and occlusion handling for an even more seamless AR experience. Integrate AR Cloud technology for persistent, shared experiences, allowing multiple users to interact with the same drawings in real time.
2. 3D Modeling and Visualization: Add support for 3D modeling and visualization, enabling users to create and manipulate 3D objects in the AR environment alongside 2D drawings.
3. Machine Learning and AI Integration: Incorporate machine learning and AI algorithms for automated object recognition, text extraction from images, and intelligent assistance in drawing creation and analysis.
4. Cross-Platform Compatibility: Ensure compatibility with a wide range of AR devices, including headsets, smart glasses, and mobile devices, to expand the user base.
5. Cloud Integration and Collaboration: Enhance collaboration features by integrating cloud-based services for real-time collaboration, secure data storage, and version control.

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