Designing a 3D Class Tour Website using Augmented Reality Technology

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*Abstract* — *This paper presents the design and development of a website called "Binus @Malang Augmented Reality Class Tour" that utilizes Augmented Reality (AR) technology. The purpose of the website is to help students become more familiar with the layout of classrooms in the Bina Nusantara Malang campus. By scanning specific markers using a smartphone camera, users can access a 3D environment that displays virtual objects and information related to the selected classroom. The development process follows an agile methodology and involves stages such as literature review, classroom design understanding, asset creation using Blender, 3D environment design in Assemblr, marker setup, AR testing, and website development using HTML and CSS. The website provides a user-friendly interface and interactive features, allowing users to explore and interact with virtual representations of the campus classrooms. Based on measurement conducted, the optimum distance on 15.8 x 15.8 cm marker is in the range of 15 cm and 50 cm horizontally and the range of 3 cm and 46 cm vertically.*

Keywords— Augmented Reality, Marker, HTML, CSS, Blender, Assemblr World

1. INTRODUCTION

Over the years, the rapid advancement of technology has led to its increasing indispensability in our daily lives. Among the myriad technological advancements, Augmented Reality (AR) technology has emerged as a prominent element with its ability to seamlessly blend virtual objects into the real world. AR technology revolutionizes our interaction with the environment by enabling users to perceive and engage with virtual objects in real-time. Its widespread adoption can be witnessed across various domains, where it serves as a powerful tool in diverse applications. From assisting technicians in machine repairs to aiding surgeons in intricate neurosurgical procedures, and even facilitating users in embellishing their living spaces, Augmented Reality has found its way into numerous facets of life. Moreover, its immense popularity reached new heights with the advent of the widely acclaimed game, Pokémon Go.

The integration of Augmented Reality into our lives has brought about a paradigm shift in how we perceive and interact with the digital world. By seamlessly overlaying virtual elements onto the real world, AR technology enhances our understanding and engagement with the physical environment. As a result, its utilization has extended beyond mere entertainment and gaming, permeating into areas where practical applications have proven invaluable.

In the realm of machinery and equipment maintenance, Augmented Reality plays a vital role in assisting technicians and engineers. By harnessing AR technology, complex machinery can be visually augmented with digital overlays, providing real-time instructions and annotations for repair and maintenance procedures. This not only expedites the troubleshooting process but also empowers technicians with accurate guidance, reducing the risk of errors and minimizing downtime.

The field of medicine has also embraced the potential of Augmented Reality, particularly in surgical interventions. Surgeons can now leverage AR technology to enhance their precision and accuracy during intricate procedures, such as neurosurgery. By overlaying three-dimensional models of a patient's anatomy onto the surgical site in real-time, surgeons gain valuable insights and guidance, enabling them to navigate delicate structures with enhanced confidence and reduced invasiveness.

Beyond professional applications, Augmented Reality has found its way into our everyday lives, offering practical solutions, and enhancing our creative endeavors. When it comes to interior design and home decoration, AR technology has opened exciting possibilities. Users can now visualize and experiment with virtual furniture, decor, and color schemes within their own living spaces. By simply pointing to their smartphones or wearable AR devices, they can preview how various design elements would look, aiding in the decision-making process and fostering creativity.

Moreover, the pervasive success of Augmented Reality can be exemplified by the worldwide phenomenon unleashed by the game Pokémon Go. By blending the virtual world of Pokémon with the real world, the game captured the imagination of millions of players who embarked on captivating quests in search of digital creatures. This unprecedented amalgamation of virtual and physical realms not only entertained but also encouraged social interaction and exploration, demonstrating the potential of AR technology to create engaging and immersive experiences on a global scale.

As Augmented Reality continues to evolve and flourish, its impact on various aspects of our lives is undeniable. From enhancing productivity and efficiency in professional settings to empowering individuals with creative tools and captivating gaming experiences, AR technology has proven to be a transformative force. As we embrace this dynamic and rapidly evolving field, the possibilities for innovation and integration into new domains are boundless, promising a future where the boundaries between the real and virtual worlds continue to blur, enriching our lives in unimaginable ways.

# Literature review

## Related Works

* "PERANCANGAN APLIKASI ROOM 3D DESIGN DENGAN MENERAPKAN TEKNOLOGI AUGMENTED REALITY (AR)"

This article designed an application called Room 3D Design that utilizes augmented reality (AR) technology. The application, Room 3D Design, is designed to assist users in visualizing room designs for renovation or interior design purposes. The creation of this application involves six stages of multimedia development methods. The tools and applications used include Unity 3D for application implementation, Blender 3D for object modeling, and Vuforia Software Development Kit for augmented reality implementation. [1]

* Augmented Reality for 3D House Design Visualization from Floorplan Image

This journal explores the utilization of smartphones' augmented reality capabilities to enhance the visualization and understanding of 3D house designs. The research focuses on developing an augmented reality application that leverages the smartphone camera's ability to capture floorplan images as markers. These images are then processed by a server-side application, employing deep learning and integer programming techniques to detect corner positions and generate accurate 2D coordinates. The client application on the smartphone utilizes these coordinates to create a 3D house model using Unity 3D. By overlaying the model onto the floor plan image marker using Vuforia, the application provides users with an immersive experience of exploring and interacting with the design. [2]

* Interior Design in Augmented Reality Environment

The article introduces the application of augmented reality (AR) technology in interior design. It discusses the advantages of AR in the architectural design and construction fields, particularly in the context of interior design. The authors propose using an AR environment as a new working environment for architects to facilitate collaborative discussions and convenient design work. They present a method for applying AR technology to interior design, where users can view and interact with virtual furniture in a real-world environment using a dynamic and flexible user interface.

The article also explores the general concepts of augmented reality technology, including its combination of computer graphics with the real world and its applications in various fields such as entertainment, education, medicine, military training, engineering, and manufacturing. It emphasizes the importance of tracking systems in AR to align virtual objects with real-world objects accurately.

The hardware and software components of the proposed AR system for interior design are described, including the use of CAD applications, ARToolKit library, 3D databases, cameras, and displays. The authors discuss the interaction method of occlusion-based markers for tangible AR, which allows users to detect and interact with virtual objects using predefined markers[3].

## Some Components of this website includes:

1. *Augmented Reality*

Augmented Reality (AR), often abbreviated as AR, is an advanced technology that seamlessly integrates virtual objects or entities into the physical world, creating a three-dimensional environment that appears in real time. By leveraging AR, users can interact with these virtual objects as if they were tangible and present in their immediate surroundings, enabling real-time engagement and manipulation. [4]

## Marker

In Augmented Reality technology, a marker is a distinct image utilized for scanning to trigger the display of virtual objects. The marker-based approach in Augmented Reality combines advanced Computer Vision and image processing technologies to extract relevant information directly from the marker image. Through the tracking and image processing processes, the marker enables the generation of real-time 3D virtual objects.

By employing Computer Vision techniques, the system analyzes the visual data captured by the camera and identifies the marker image's unique features and patterns. This process involves detecting, tracking, and interpreting the marker's position and orientation in relation to the camera's viewpoint. Once the marker's position and orientation are determined, the system can accurately overlay virtual objects onto the real-world environment.

The image processing technologies employed in marker-based Augmented Reality play a crucial role in extracting and interpreting the information contained within the marker image. These techniques involve various algorithms and computations that analyze the marker's visual characteristics, such as its color, shape, and texture. The extracted information is then used to establish a correspondence between the real-world environment and virtual objects.

After the tracking and image processing stages are completed, the marker serves as a reference point for the system to superimpose the virtual objects onto the user's view. This enables the seamless integration of virtual and real-world elements, allowing users to perceive and interact with the generated 3D virtual objects in real time.[5]

## HTML

HTML, or Hypertext Markup Language, is a fundamental programming language used to create web pages that can be accessed over the internet to display various information. HTML is the result of collaboration between the World Wide Web Consortium (W3C) and the Web Hypertext Application Technology and Working Group (WHATWG). HTML5 is the fifth revision of HTML, initially published on October 28, 2014, and remains widely used to this day. [6]

## CSS

Cascading Style Sheets, often referred to as CSS, serves as a fundamental web design language utilized to exert control over the visual appearance and customization of web pages created using markup languages. It is widely employed in conjunction with HTML, forming an inseparable partnership to craft captivating and interactive web experiences.

CSS empowers developers and designers with a rich array of tools and capabilities to manipulate various elements of a webpage. By leveraging CSS, web professionals can dictate the layout, typography, colors, spacing, and overall stylistic attributes of HTML elements. This comprehensive control over presentation allows for the creation of aesthetically pleasing and user-friendly interfaces.

Furthermore, CSS introduces a cascading mechanism, wherein multiple style rules can be applied to a single HTML element. This hierarchy of styles grants developers the flexibility to define global stylesheets affecting the entire website, as well as specific stylesheets tailored for individual pages or sections. This dynamic nature of CSS enables consistent branding and design choices throughout a web project while accommodating unique requirements on a per-page basis.

With its extensive selection of selectors and properties, CSS permits granular targeting and manipulation of HTML elements. Selectors serve to identify specific elements, such as headings, paragraphs, images, or navigation menus, while properties determine their appearance. By skillfully combining selectors and properties, designers can create visually stunning layouts, intuitive navigation systems, and engaging interactive elements.

Moreover, CSS facilitates responsive web design, a crucial approach in today's multi-device landscape. Through media queries, CSS enables the adaptation of page layouts and styles to different screen sizes, ensuring optimal readability and usability across various devices, including desktops, tablets, and smartphones. This responsive capability ensures that web pages retain their intended visual integrity and functionality, regardless of the device used to access them.[7]

1. *Blender*

Blender is a powerful and versatile open-source 3D modeling and animation software. It offers a wide range of features and tools that allow users to create stunning visualizations, animations, and interactive 3D experiences.

Blender offers a comprehensive set of modeling tools that enable users to create 3D objects from scratch or modify existing ones. It supports both polygonal modeling and sculpting techniques, providing flexibility and precision in shaping complex geometries. Blender's modeling tools include extrusion, beveling, boolean operations, and subdivision surfaces, among others.

Blender also provides a robust system for applying textures and materials to 3D models, enhancing their visual appearance and realism. Users can create or import textures and assign them to different parts of the model using UV mapping techniques. Blender also offers a wide range of material options, including shaders, reflections, transparency, and particle effects, enabling users to achieve various surface properties and visual effects.[8]

1. *Assemblr World*

Assemblr World is an augmented reality platform that allows users to create and share interactive 3D scenes and experiences. It provides an intuitive and user-friendly interface for designing virtual spaces, placing objects and characters, and adding interactive elements. With Assemblr World, users can bring their imagination to life by blending the real world with virtual objects and animations. [9]

Some of the key features include.

* Scene creation where users can choose from a library of pre-made objects, characters, and environments, or import their own custom assets.
* Object placement and manipulation where users can easily place and position objects within their scenes using intuitive drag-and-drop controls. They can adjust the size, rotation, and scale of objects to fit their desired design.
* Sharing and Collaboration where users can share their created scenes with others. Users can publish their scenes to the Assemblr World community, where other users can explore, interact with, and provide feedback on their creations.

# Method

The implementation of our website utilizes marker-based Augmented Reality (AR) technology which combines the real-world environment with virtual objects generated by a computer in real-time. This technology is applied, using images as markers that are attached to each wall of a room. The marker is then scanned by the camera on a smartphone. User will then be connected to a prepared website called Assemblr, which then displays augmented reality images or objects.

We utilize the agile methodology to develop an augmented reality project with a team of 4 developers over a period of 4 months. In developing an application within such a timeframe, it is crucial to have the product tested and improved as quickly as possible during the implementation phase. This agile approach is expected to accommodate future needs and developments. The agile methodology is based on an iterative work process where agreed-upon solutions and structured collaboration among team members are highly important. This method is short-term in nature and requires rapid adaptation to address any changes

The detailed structure of the methodology is as follows:

1. The process begins with conducting a literature review related to the research object and learning the design of the classroom as well as measuring the size of the classroom, including the objects inside of it.
2. After gaining a comprehensive understanding, the required system for the application is determined.
3. Next, an initial planning phase is carried out to outline the intended outcome of the website.
4. Assets are designed and developed using blender.
5. The assets are imported into assemblr and a 3D environment is designed with the imported assets to create a 3D room
6. An image is later set as a marker for the user to scan.
7. Testing is conducted, and if the augmented reality functions as expected, it is released. If not, further improvements will be made.
8. A website is then developed with the help of HTML and CSS
9. Another testing is conducted, and if the website functions as expected, it is released. If not, further improvement will be made accordingly.

A picture containing diagram, text, plan, technical drawing

Description automatically generated

Figure 1. Flowchart for the Stages of AR-based Website Development (Part 1)

# Result and discussion

## Concept

The primary purpose of this website, along with its augmented reality (AR) implementation, is to enhance the understanding of the classroom layout and functionalities within the Bina Nusantara Malang campus. Users can easily access the website and choose between two options: Smart Class or Creative Class. Upon selecting an option, users will be prompted to scan a marker, which will then generate a 3D environment.

By utilizing this website, users gain the opportunity to explore and interact with virtual representations of the campus rooms. The AR technology provides a realistic and immersive experience, allowing users to visualize the physical space and its various elements. This aids in familiarizing students with the layout, features, and functionalities of the Smart Class and Creative Class environments.

The user-friendly interface and straightforward process enable seamless navigation and engagement. With a simple scan of the marker, users can effortlessly access the 3D environment and explore the virtual representation of their chosen class. This interactive experience provides an effective means of conveying information and promoting a deeper understanding of the campus facilities.

## Design

1. Navigation Structure

A diagram of a flowchart

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Figure 3. Navigation Flowchart

Based on the navigation flowchart in Figure. 3, the user will open a website that will display two options: "Smart Class" and "Creative Class." When the user selects one of the options, they will be directed to assemblr. In assemblr, the user will be prompted to scan the provided marker in front of the selected class location. After scanning, the user can interact with the 3D environment generated inside Assemblr.

A diagram of a flowchart

Description automatically generated with low confidence

Figure 4. Navigation Flowchart for Creative Class’s Interaction

Based on the navigation in Figure 4, user can interact with the table and screen object inside the 3D environment. When users tap/click a table behind a mascot, an overview image of Creative Class will be shown. On the other hand, when users tap/click a screen, a video will be played.

A diagram of a flowchart

Description automatically generated with low confidence

Figure 5. Navigation Flowchart for Smart Class’s Interaction

Based on the navigation in Figure 5, user can interact with the table and screen object inside the 3D environment. When users tap/click a table behind a mascot, an overview image of Smart Class will be shown. On the other hand, when users tap/click a screen, a video will be played.

1. User Interface

This is the user interface that will be displayed on the homepage of the website.

*A screen shot of a sign

Description automatically generated with low confidence*

*Figure 5. Website’s Homepage*

Users can choose between Creative Class and Smart Class. Both lead to their own 3D environment. Clicking Creative Class shows 3D environment that resembles Creative Class while Clicking Smart Class shows 3D environment that resembles Smart Class

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*Figure 6. 3D Environment for Creative Class*

There are two interactions presented in both Creative Class and Smart Class 3D environment such as Clicking a table behind a mascot to display an image and clicking a screen to play a video.

1. *Marker*

This marker will be displayed in front of Smart Class and will be used whenever a user wants to generate a 3D environment of Smart Class

*A room with tables and chairs

Description automatically generated with low confidence*

*Figure 8. Marker for Smart Class*

This marker will be displayed in front of Creative Class and will be used whenever a user wants to generate a 3D environment of Creative Class



*Figure 9. Marker for Creative Class*

1. *Range of Marker*

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*Table 1. Range of 15,8 cm x 15,8 cm Marker (0 = unable show AR, 1 = able to Show AR)*

During the measurement process, the marker was positioned on a vertical wall. The horizontal distance was measured between the marker and the camera, while the vertical distance was measured between the middle part of the marker and the camera. The results, as shown in Table 1, indicate the maximum functional range of the marker.

According to the findings, the marker can function effectively within a maximum horizontal distance of 50 cm. Similarly, the marker's maximum vertical distance or height for proper functionality is 38 cm. However, it should be noted that when the marker is placed only 15 cm horizontally from the camera, the maximum height between markers is limited to 8 cm. This limitation arises from the fact that a shorter horizontal distance causes the markers to be out of the camera's view when the camera's height is increased. On the other hand, longer horizontal distances allow for higher heights, but there is a threshold beyond which marker functionality is disabled. The measurements provided in Table 1 serve as a reference for optimal marker usage, ensuring an optimal distance for users.

##### Conclusions

The website, named Binus@Malang Augmented Reality Class Tour, was created with the aim of helping students become more familiar with the layout and features of the classrooms in Bina Nusantara Malang campus.

The implementation of the website utilizes marker-based AR technology, where specific images called markers are used to trigger the display of virtual objects in a real-time 3D environment. The markers are scanned using a smartphone camera, and the users are then connected to a website called Assemblr, which displays augmented reality images or objects.

The development process followed an agile methodology, which allowed for iterative work and quick adaptation to changes. The process involved conducting a literature review, understanding the classroom designs and measurements, designing assets using Blender, importing them into Assemblr, setting markers, testing the AR functionality, and developing the website using HTML and CSS.

The website offers two options: "Smart Class" and "Creative Class." Users can choose between the two and scan the corresponding markers to generate the 3D environments. Inside the 3D environments, users can interact with objects such as tables and screens. Clicking on a table behind a mascot displays an overview image of the class, while clicking on a screen plays a video.

The marker range was measured to determine the maximum horizontal and vertical distances for optimal marker functionality. It was found that the marker functions well within a maximum horizontal distance of 50 cm and a maximum vertical distance of 38 cm. Higher distances can be achieved with longer horizontal distances, but there is a limit to the height when the marker is placed closer to the camera. Further improvements and enhancements can be made based on user feedback and evolving AR technologies.

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