Implementation of Augmented Reality Technology in the Design of the Kaswari Elok 87 Ship as a Tourism Vessel in the Sea Area of West Papua

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Abstract – The lack of interactive visualization media in presenting tourism transportation information in West Papua has become an obstacle in attracting interest and understanding among potential users. This study implements augmented reality (AR) technology to present the interior and exterior design of the MV Kaswari Elok 87 ship in an interactive and realistic manner. AR technology enables detailed visualization of the ship without the need for a physical model, thereby facilitating the design presentation process. The application was developed using Unity 3D and tested on two Android devices. The results show that the system can display the ship model stably with optimal performance at a distance of 20–190 cm and a 360° viewing angle, achieving an average frame rate of 33 FPS.

Keywords: augmented reality, image processing, marker detection, rendering

I. INTRODUCTION

The tourism sector is one of the strategic sectors that contributes significantly to Indonesia's economy, both at the national and regional levels. As a country renowned for its cultural diversity and natural wealth, Indonesia holds great potential in tourism, particularly through the utilization of its natural resources (SDA) and human resources (SDM). This potential not only boosts foreign exchange earnings but also contributes to job creation, infrastructure development, and the improvement of community welfare across various regions [1].

Indonesia is the largest archipelagic country in the world, with a total of 17,504 islands spread across 32 provinces prior to the formation of North Kalimantan and West Sulawesi [2]. The diversity of tourist destinations in various regions positions the tourism sector as one of the main pillars of national development. Therefore, optimal management and development of tourism are essential to enhance Indonesia's tourism competitiveness on the global stage and to promote inclusive and sustainable economic growth.

Papua is one of the provinces with immense tourism potential, both in terms of natural beauty and cultural richness. However, this potential remains underutilized. Several challenges hinder its development, including limited and expensive transportation access, unattractive tourism packaging, inadequate supporting facilities (amenities), suboptimal use of information technology, and lack of synergy between the government and tourism stakeholders [2]. In addition, the lack of information about tourist destinations in Papua also contributes to the low number of tourist visits [1]. These conditions result in a lower influx of visitors and limit the tourism sector's contribution to the regional economy.

One innovative effort to address these challenges is the integration of augmented reality (AR) technology into the development of tourism transportation access. AR enables the presentation of information in a more interactive and engaging manner, thereby increasing tourist appeal. The design of the MV Kaswari Elok 87 ship was developed using AR technology as a form of information technology utilization to support the tourism sector in Papua. AR allows prospective passengers and tourists to view and interact with virtual visualizations of the ship's interior and exterior design prior to the trip. Moreover, this technology can serve as an effective digital promotional tool to introduce the ship's facilities to potential tourists [3].

Based on this background, this study aims to implement augmented reality (AR) technology in the innovative design of the MV Kaswari Elok 87 ship as part of an *effort* to improve transportation access and tourism appeal in West Papua. The implementation of this technology is expected to offer a viable solution for tourism development through the integration of innovative ship design and the use of information technology.

II. METHODS

The design and development of the Augmented Reality application for the MV Kaswari Elok 87 ship was carried out through several stages. The stages of this research process are illustrated in Figure 1.

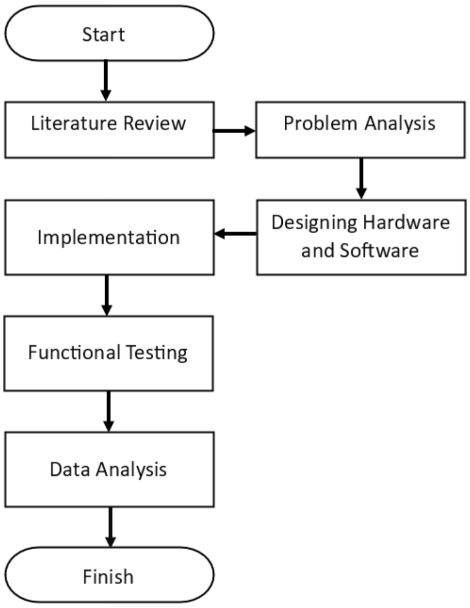

Figure 1. Research Stages

A. Hardware Design

The system design is illustrated in the following figure:

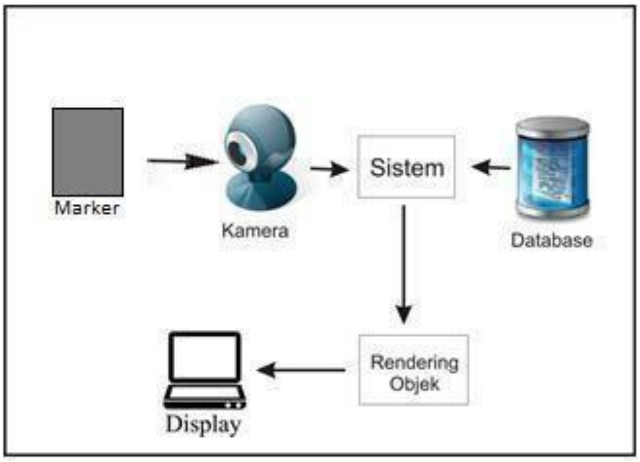

Figure 2. Hardware Design

In this study, the hardware used consists of a laptop, a POCO F3 Android smartphone, a Vivo V20 Android smartphone, and an augmented reality marker. The laptop serves as the primary tool for designing the system, which includes the development process of an augmented reality (AR)-based application using Unity3D. Once the application has been developed, the system is tested using the POCO F3 Android smartphone as the first testing device and the Vivo V20 Android smartphone as the second testing device to evaluate the system's performance under real usage conditions.

Table 1. Specifications of the First Testing Device (left) and the Second Device (right)

DISPLAY	Type	AMOLED 120 Hz
	Size	6,67 inch (~16,93 cm)
	Resolution	2400 × 1080 piksel (FHD+)
PLATFORM	OS	Android 11 dengan MIUI 12 for POCO
	Chipset	Qualcomm Snapdragon 870 (7 nm)
	CPU	Octa Core
MEMORY	Memory	Tidak ada slot microSD (penyimpanan internal 128 GB/256 GB
	RAM	RAM : 6 GB
CAMERA	Primary	48 MP (wide f/1.8, PDAF) + 8 MP ultra-wide f/2.2 (119°) + 5 MP macro f/2.4 dengan AF
	Secondary (front camera)	20 MP, f/2.5, HDR

DISPLAY	Type	AMOLED
	Size	6,44 inch
	Resolution	2400 x 1080 piksel (HD)
PLATFORM	OS	Android 11
	Chipset	Qualcomm Snapdragon 720G
	CPU	Octa Core
MEMORY	Memory	Eksternal :128 GB
	RAM	RAM : 8 GB
CAMERA	Primary	64 MP, f/1.9, (wide), PDAF
	Secondary (front camera)	44 MP, f/2.0, (wide), AF

Based on Figure 2. Hardware Design, data from the laptop is transferred to the testing devices in the form of a developed augmented reality (AR) application. The application is then installed on the smartphones and is designed to display a menu that activates the camera scanner. When the camera detects an augmented reality marker, the system processes the captured data through the programming embedded in the application, allowing a 3D ship model to be displayed interactively on the screen of the testing devices [4].

The use of this hardware aims to ensure that the system functions effectively in real-world environments and provides an optimal user experience in visualizing 3D objects using augmented reality technology [5].

B. Hardware Design

The software design in this system is illustrated in the following figure:

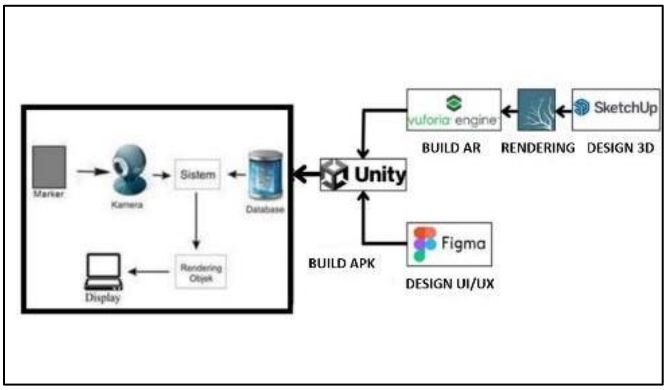

Figure 3. Software Design

In the development process of the Augmented Reality (AR) application in this study, several supporting software tools were used to facilitate each stage of development—from planning to implementation. The software utilized includes Unity 3D, Lumion 3D version 11, SketchUp, Vuforia, Figma, and Canva. The 3D ship model was created using SketchUp to design both the exterior and interior of the ship in detail. This 3D model was then visualized and rendered using Lumion to produce a more realistic appearance [6].

Unity 3D served as the primary platform for AR software development, integrated with Vuforia for object tracking and image recognition, enabling interaction between virtual objects and the real-world environment [7]. Canva and Figma were used in the design of the user interface and other graphical elements that support the application [8].

The entire process began with a requirements analysis to determine the desired technical specifications and features, followed by concept design, development, testing, and debugging. Each stage required the careful selection of appropriate software and effective coordination to produce a functional and high-quality AR application.

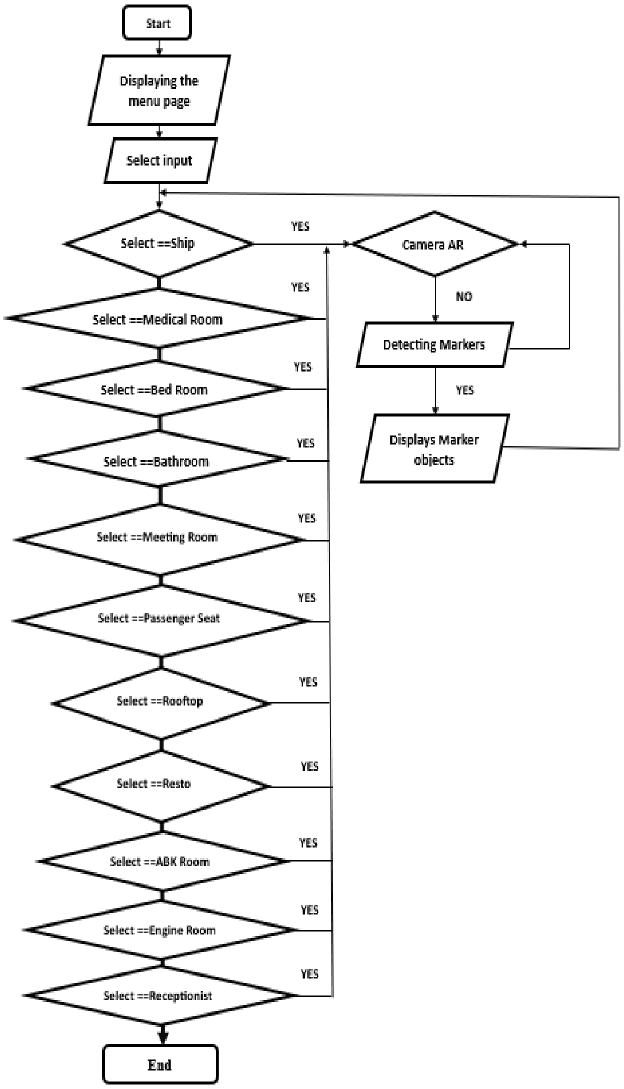

Figure 4. System Design

C. System Design

The system design stage was carried out to integrate all software components involved in the development of the Android-based Augmented Reality (AR) application. This application presents a 3D visualization of the exterior and interior design of the MV. *Kaswari Elok 87* ship.

The system was developed using Unity as the primary software, with C# as the programming language. The 3D ship model was created using SketchUp and rendered using Lumion. The AR component was developed using the Vuforia SDK, which is integrated into Unity to support marker tracking and the placement of virtual objects [9].

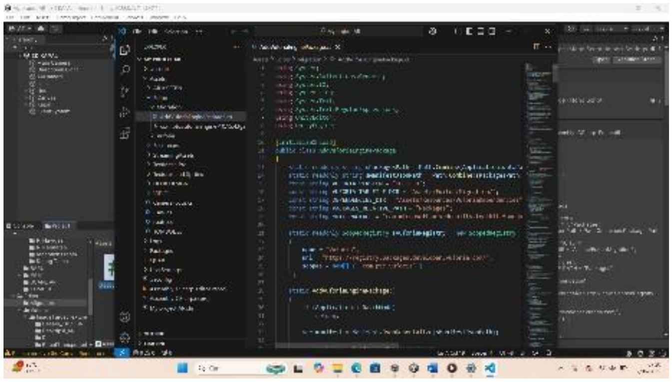

Figure 5. Programming

The application structure consists of several main user interfaces, including:

1. Splash Screen

   The initial screen displayed when the augmented reality application is launched shows the Unity logo. This is followed by the main menu screen.

Figure 6. Initial Application Display

2. Main Menu

   The main menu screen serves as navigation to the core features of the application. It includes the "Scan Now" option, an exit button (represented by a cross icon), and a team profile section.

Figure 7. Application Menu Display

3. AR Camera
   The main feature for displaying 3D ship objects through the camera and markers.

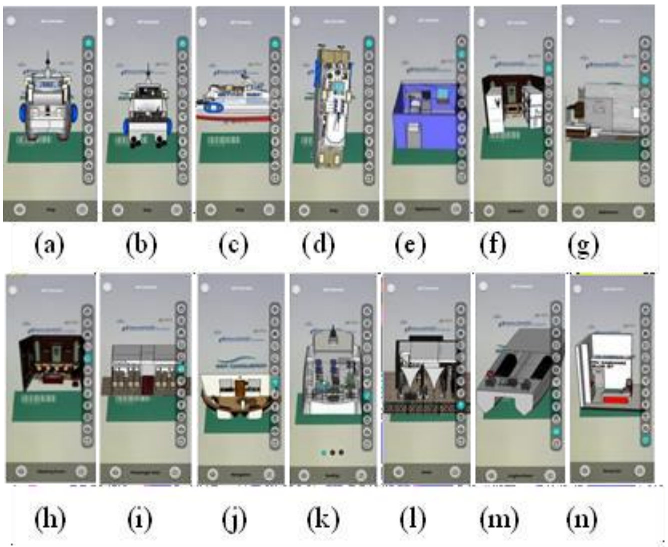

Figure 8. AR Camera Views of Each Ship Room

(a) Front view of the ship (b) Rear view of the ship (c) Side view of the ship (d) Top view of the ship (e) Medical room (f) Bedroom (g) Bathroom (h) Meeting room (i) Passenger seat (j) Navigation room (k) Rooftop (l) Restaurant (m) Engine room (n) Reception

4. Ship Information

The ship information page in the augmented reality application presents a complete description and data about the MV Kaswari Elok 87.

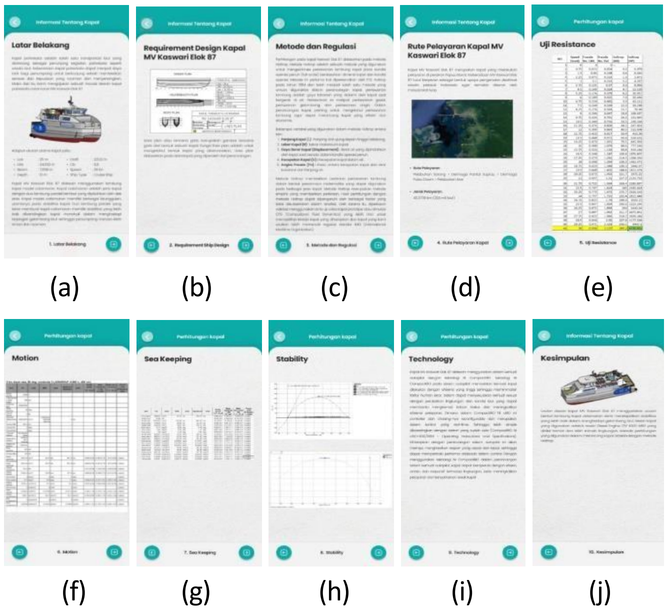

Figure 9. Ship Information Page Display

(a) Ship background (b) Ship design requirements (c) Ship methods and regulations (d) Sailing route (e) Resistance test data (f) Ship motion data (g) Ship seakeeping data (h) Ship stability graph (i) Ship technology (j) Conclusion

5. Team Profile

Displays brief information about the development team. Each element is designed to support intuitive user interaction and ensure the application runs smoothly on Android devices.

Figure 10. Team Profile Display

D. Data Collection

The data collection in this study focused on testing the augmented reality (AR) system for visualizing ship structures interactively. The initial stage involved creating a 3D model of the ship using design software such as Blender or AutoCAD [10], which was then converted into a format compatible with AR platforms like Unity or Vuforia. Next, AR markers (such as specific images or QR codes) were printed and placed on various parts of the ship model to serve as reference points for object recognition by the camera.

The data collection process included testing marker detection under various lighting conditions, observation distances, and viewing angles, as well as evaluating the accuracy of the 3D model overlay on the markers. Additionally, the system's response to user movement around the ship model was measured to assess display latency and model stability as the user changed positions [9]. Data were collected through software logs and video documentation, then analyzed to evaluate tracking accuracy, object rendering quality, and user interaction comfort with the AR application.

E. Data Analysis

The collected data were analyzed to assess the performance of the augmented reality (AR) system within the ship visualization application. Key parameters observed included marker detection accuracy, 3D model rendering speed, system latency, and display stability in response to camera position changes.

Each testing scenario—such as variations in distance, angle, and lighting—was analyzed to determine detection consistency and model resilience against environmental disturbances. The success and failure rates of marker detection were calculated to evaluate the system's reliability. The results of this analysis are expected to confirm that the developed AR application meets standards for visualization accuracy, user comfort, and optimal performance under various operational conditions.

III. RESULT AND DISCUSSION

A. System Implementation

This study implements a marker-based Augmented Reality (AR) system designed to display 3D visual information of ship.

components in real-time through a mobile application. The system was developed using Unity as the main platform and Vuforia Engine as the marker detection library. The 3D models of the ship components were created in FBX format and imported into Unity for interactive display upon marker recognition by the device's camera.

The markers were printed in a size of 24 cm x 16 cm and functioned as reference points for virtual object detection. Development was carried out using the C# programming language to control model invocation logic, user interface display, and object scaling and positioning in the 3D space. The application is designed to run on Android devices with a minimum operating system requirement of Android 9 and was tested using a mid-range smartphone. All models and data were stored locally within the application package to ensure fast rendering performance.

Figure 11. Marker Display

B. Device Performance Analysis

The system architecture consists of AR software developed using C# programming in Unity, along with a simple database to store 3D models and ship technical information. The 3D models, visualized as individual ship rooms complete with interior elements, appear when the camera detects the corresponding marker.

This system is designed by taking into account important factors such as the distance between the camera and the marker, as well as the user's viewing angle. Testing shows that the system can successfully recognize the marker and display the model with a high success rate at the distances listed in the table below:

Table 2. Effect of Camera Distance on Marker Detection (First Device)

Jarak kamera terhadap marker (cm)	Rata-Rata Lacency (s)	Keberhasilan Deteksi Marker (%)	lacency 1 (s)	lacency 2 (s)	lacency 3 (s)	lacency 4 (s)	lacency 5 (s)
20	1,64	100	1,61	1,66	1,58	1,69	1,66
30	1,77	100	1,8	1,73	1,84	1,72	1,76
40	2,1	100	2,09	2,14	2,04	2,17	2,07
50	1,65	100	1,6	1,69	1,66	1,57	1,67
60	2,03	100	1,98	2,09	2,01	2,07	2
70	1,96	100	1,9	1,99	2,04	1,87	2
80	1,7	100	1,65	1,76	1,68	1,72	1,69
90	3,14	100	3,06	3,22	3,18	3,05	3,19
100	2,18	100	2,15	2,12	2,25	2,17	2,21
110	1,38	100	1,32	1,44	1,39	1,35	1,4
120	2,29	100	2,33	2,21	2,38	2,26	2,27
130	2,36	100	2,31	2,42	2,4	2,29	2,37
140	2,79	100	2,84	2,76	2,89	2,74	2,72
150	2,95	100	3,02	2,9	2,99	2,87	2,97
160	2,54	100	2,51	2,63	2,45	2,58	2,53
170	2,38	100	2,41	2,32	2,46	2,35	2,36
180	2,53	100	1,97	2,35	2,32	2,48	2,53
190	2,75	80	2,16	2,68	3,12	tidak	3,04
200	4,72	20	4,72	tidak	tidak	tidak	tidak
210	4,38	20	4,38	tidak	tidak	tidak	tidak

Table 3. Effect of Camera Distance on Marker Detection (Second Device)

Jarak kamera terhadap marker (cm)	Rata-Rata Lacency (s)	Keberhasilan Deteksi Marker (%)	lacency 1 (s)	lacency 2 (s)	lacency 3 (s)	lacency 4 (s)	lacency 5 (s)
20	1,47	100	1,55	1,32	1,46	1,43	1,59
30	1,44	100	1,45	1,41	1,46	1,4	1,48
40	1,42	100	1,44	1,39	1,43	1,38	1,46
50	1,63	100	1,65	1,62	1,6	1,68	1,59
60	1,49	100	1,55	1,32	1,5	1,6	1,48
70	1,45	100	1,43	1,33	1,47	1,38	1,64
80	1,3	100	1,32	1,65	1,19	1,25	1,1
90	1,8	100	1,8	1,66	1,95	1,72	1,87
100	1,22	100	1,26	1,26	1,14	1,3	1,14
110	1,19	100	1,13	1,19	1,26	1,22	1,15
120	1,31	100	1,69	1,43	1,11	1,35	0,97
130	1,39	100	1,36	1,46	1,4	1,33	1,41
140	1,39	100	1,37	1,29	1,45	1,38	1,46
150	1,44	100	1,47	1,4	1,77	1,32	1,24
160	1,53	100	1,56	1,74	1,56	1,49	1,3
170	1,43	100	1,71	1,36	1,33	1,4	1,36
180	1,24	100	1,36	1,16	1,07	1,3	1,21
190	1,4	100	1,53	1,38	1,29	1,48	1,32
200	1,85	100	1,94	1,46	1,52	2,96	1,36
210	2	20	tidak	2,28	tidak	tidak	tidak

The test results above show the average latency relative to the distance between the camera and the marker using the first Android device. At distances ranging from 20 cm to 180 cm, the system demonstrated optimal marker detection performance with a 100% success rate and relatively stable latency, ranging from 1.38 to 3.14 seconds. However, at distances beyond 180 cm—specifically from 190 cm to 210 cm—there was a noticeable decline in detection accuracy and a significant increase in latency. In some cases, the system even failed to detect the marker.

In comparison, the test results of the second Android device show better overall average latency performance. At the same distances, the second Android device recorded lower and more consistent latency; for instance, at distances from 90 cm to 180 cm, latency ranged from 1.2 to 1.8 seconds, compared to 2.18 to 3.14 seconds on the first device. Moreover, the marker detection success rate on the second Android device remained at 100% up to a distance of 200 cm, indicating improved performance in long-distance detection. This suggests that the second Android device offers better efficiency and stability in marker processing for augmented reality-based applications.

Table 4. Effect of Camera Angle on Marker (First Device)

Sudut kamera terhadap marker (°)	Rata-Rata Lacency (s)	Keberhasilan Deteksi Marker (%)	lacency 1 (s)	lacency 2 (s)	lacency 3 (s)	lacency 4 (s)	lacency 5 (s)
0	1,56	100	1,54	1,57	1,56	1,55	1,58
30	1,69	100	1,67	1,72	1,7	1,68	1,68
60	1,72	100	1,7	1,73	1,74	1,71	1,72
90	1,78	100	1,8	1,77	1,76	1,79	1,78
120	1,8	100	1,81	1,82	1,78	1,8	1,79
150	1,86	100	1,85	1,87	1,88	1,86	1,84
180	1,67	100	1,65	1,69	1,66	1,67	1,68
210	1,69	100	1,7	1,68	1,69	1,71	1,67
240	1,63	100	1,62	1,64	1,61	1,65	1,63
270	1,76	100	1,77	1,75	1,76	1,78	1,74
300	1,89	100	1,9	1,88	1,87	1,91	1,89
330	1,67	100	1,65	1,68	1,66	1,69	1,67
360	1,73	100	1,74	1,71	1,75	1,72	1,73

Table 5. Effect of Camera Angle on Marker (Second Device)

Sudut kamera terhadap marker (°)	Rata-Rata Lacency (s)	Keberhasilan Deteksi Marker (%)	lacency 1 (s)	lacency 2 (s)	lacency 3 (s)	lacency 4 (s)	lacency 5 (s)
0	1,43	100	1,42	1,39	1,45	1,44	1,45
30	1,62	100	1,58	1,63	1,6	1,67	1,62
60	1,7	100	1,65	1,72	1,76	1,68	1,69
90	1,86	100	1,92	1,88	1,8	1,83	1,87
120	1,74	100	1,77	1,7	1,72	1,74	1,77
150	1,9	100	1,93	1,97	1,84	1,89	1,87
180	1,64	100	1,6	1,66	1,63	1,67	1,65
210	1,71	100	1,68	1,72	1,73	1,74	1,69
240	1,57	100	1,52	1,6	1,55	1,58	1,6
270	1,67	100	1,66	1,63	1,69	1,7	1,67
300	1,93	100	1,94	1,92	1,89	1,97	1,93
330	1,52	100	1,5	1,47	1,54	1,55	1,54
360	1,78	100	1,8	1,76	1,74	1,79	1,81

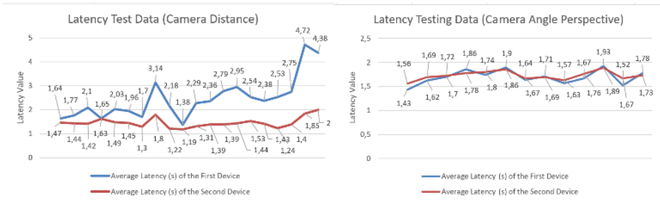

Figure 12. Latency Testing Graph

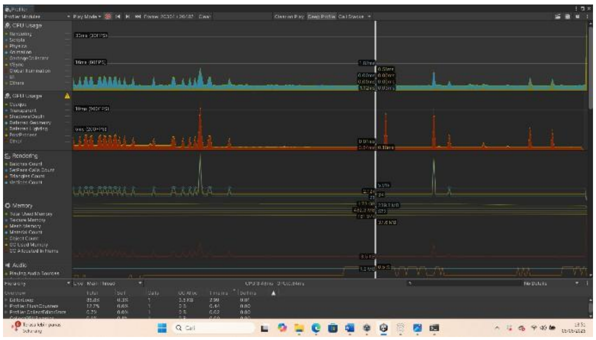

Figure 13. Device FPS Analysis in Unity 3D

Formula of FPS : [16]

$$FPS = \frac{1000}{\text{ms per frame}}$$

$$FPS = \frac{1000}{33\ ms} = 30,3$$

IV. CONCLUSION

Based on the research and testing that have been conducted, the following conclusions can be drawn:

a. The implementation of Augmented Reality (AR) technology for the visualization of the MV. Kaswari Elok 87 ship design has been successfully carried out using the Unity 3D platform. The AR application can display the ship model stably up to a distance of 1.9 meters while maintaining accuracy from various viewing angles. Performance testing using Android Profiler shows an average frame rate of 33 FPS, which indicates a fairly stable and responsive system performance.

b. Testing using two different Android devices revealed significant differences in performance. On the first Android device, marker detection performed optimally with a 100% success rate and stable latency (1.38–3.14 seconds) at a distance of 20–180 cm. However, there was a decline in accuracy and an increase in latency at distances above 180 cm. In contrast, the second Android device demonstrated superior performance, with lower latency (1.2–1.8 seconds) at the same distance and a 100% detection success rate up to 200 cm. This study indicates that the performance of AR applications is highly influenced by the specifications of the device used.

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REFERENCES

[1] H. Mebri, E. Suradinata, and K. Kusworo, “INTERNAL TOURISM DEVELOPMENT STRATEGY INCREASING REGIONAL ORIGINAL INCOME (PAD) IN JAYAPURA CITY PAPUA PROVINCE,” *Jurnal Ilmiah Wahana Bhakti Praja*, vol. 12, no. 1, pp. 102–114, Oct. 2022, doi: 10.33701/jiwbp.v12i1.2537.

[2] M. Ismail, “Strategi Pengembangan Pariwisata Provinsi Papua,” *Matra Pembaruan*, vol. 4, no. 1, pp. 59–69, 2020, doi: 10.21787/mp.4.1.2020.59-69.

[3] A. A. Rahma, “Potensi Sumber Daya Alam dalam Mengembangkan Sektor Pariwisata Di Indonesia,” *Jurnal Nasional Pariwisata*, vol. 12, no. 1, p. 1, 2020, doi: 10.22146/jnp.52178.

[4] R. Maulana and A. suryaperdana Agoes, “Rancang Bangun Aplikasi Pengenalan Kapal Perang Indonesia Menggunakan Augmented Reality,” *Journal of Information Technology*, vol. 4, no. 2, pp. 07–11, 2023, doi: 10.47292/joint.v4i2.88.

[5] T. Sundari. Wati Masrul, Hendri Silva, “Pelatihan Sketch Up Untuk Guru SMKN 5 Pekanbaru Pada,” vol. 3, no. 2, pp. 131–138, 2022, doi: 10.31849/fleksibel.v4i2.14258.

[6] Idham Syarifudin, Veronika Widi Prabawasari, and Agus Nugroho, “Studi Komparasi Penggunaan Tools Cahaya Omni Sebagai Pendukung Cahaya Spotlight Pada Render Exterior Dengan Software Rendering Lumion 11, Enscape 3.4 Dan Twinmotion Edu 2022,” *Jurnal Teknik dan Science*, vol. 2, no. 2, pp. 61–71, 2023, doi: 10.56127/jts.v2i2.792.

[7] D. Novianti, S. Supandi, and W. Wijonarko, “Pengembangan Media Pembelajaran Desain Grafis Berbasis Android Menggunakan Unity 3D Untuk Siswa Kelas X Semarang,” *JIPETIK:Jurnal Ilmiah Penelitian Teknologi Informasi & Komputer*, vol. 3, no. 1, pp. 21–26, 2022, doi: 10.26877/jipetik.v3i1.8933.

[8] C. Xiao and Z. Lifeng, “Implementation of mobile augmented reality based on Vuforia and Rawajali,” *Proceedings of the IEEE International Conference on Software Engineering and Service Sciences, ICSESS*, pp. 912–915, 2014, doi: 10.1109/ICSESS.2014.6933713.

[9] M. B. Thoyyib and D. Hafidh Zulfikar, “Desain UI/UX Website Referral untuk Program Gerakan Funding Culture Menggunakan Figma,” 2023.

[10] R. Maulana and A. S. Agoes, “Rancang Bangun Aplikasi Pengenalan Kapal Perang Indonesia Menggunakan Augmented Reality”.

[11] V. Eng and K. Kunci, “Rancang Bangun Game Edukasi untuk Membantu Proses Pembelajaran Matematika Kelas 3 SD dengan Menggunakan Unity,” 2021. [Online]. Available: https://journal.uib.ac.id/index.php/combines

[12] J. Kim, M. Lorenz, S. Knopp, and P. Klimant, “Industrial Augmented Reality: Concepts and User Interface Designs for Augmented Reality Maintenance Worker Support Systems,” in *Adjunct Proceedings of the 2020 IEEE International Symposium on Mixed and Augmented Reality, ISMAR-Adjunct 2020*, Institute of Electrical and Electronics Engineers Inc., Nov. 2020, pp. 67–69. doi: 10.1109/ISMAR-Adjunct51615.2020.00032.

[13] R. A. Saputro, P. Manik, and S. Hadi, “STUDI PERANCANGAN KAPAL LAYAR KATAMARAN SEBAGAI KAPAL PARIWISATA DI KEPULAUN SERIBU.”

[14] L. Rahmawati and R. Firmansyah, “Perancangan Game Edukasi Pengenalan Wisata Pegunungan Indonesia dengan Unity 3D Berbasis Android,” vol. 3, no. 1, 2022.

[15] "13900-55859-1-PB”.

[16] Institute of Electrical and Electronics Engineers. Turkey Section. and Institute of Electrical and Electronics Engineers, *3rd International Symposium on Multidisciplinary Studies and Innovative Technologies : proceedings : 11-13 October 2019, Ankara, Turkey.*