Business Card Using Augmented Reality

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***Abstract*—Traditional business cards offer static information and minimal interactivity. The current project suggests a markerless Augmented Reality (AR) business card system that enhances professional interactions by overlaying digital content on physical business cards. The overall aim of this research is to design and evaluate an interactive AR business card system that allows users to author, share, and deliver augmented content without physical markers. The system is implemented with Unity, Vuforia, and Firebase to enable users to personalize AR business cards with social media profiles, ideas, and contacts. The app provides simplicity and natural interaction with a user-friendly interface. The system effectively converts static business cards into dynamic digital experiences with interaction and usability. User trials show that AR-augmented business cards provide a more interactive and engaging networking experience than traditional approaches. Utilizing AR in business tools, this system shows the feasibility of using AR in professional networking, marketing, and invitations. Future research will investigate personalization, scalability, and application in other sectors.**

***Index Terms*—Augmented Reality (AR) Markerless AR Business Card Innovation Interactive Networking Unity AR Development Vuforia Object Tracking Firebase Cloud Storage Real-time AR Updates Digital Business Cards**

I. INTRODUCTION

Professional networking takes the new forms within the era of the Internet but, among them, one traditional form in exchange of business contacts remains pretty popular, the use of conventional business cards where only static content, like a person's names and job description or his number, can be held. Though technology is on its evolutionary cycle, users, still craving better experience from network utilization, desire the digital tools which could promote smoother exchange of information and interact the user even better. This will bring business cards, traditionally mere two-dimensional objects, to life using Augmented Reality in the commercial context. Augmented Reality is a cutting-edge technology that superimposes digital content on top of the physical world with a device's camera. It enables users to interact with 3D models, images, videos, and other digital content in real-time [1]. AR has made its mark in gaming, education, healthcare, and marketing. But its potential in professional networking is yet to be explored. Conventional AR solutions use markers such as QR codes or pre-defined images to initiate digital overlays. Although easy to use, these marker-based solutions have limitations in usability, aesthetics, and accessibility. Users need to scan specific markers, which can be limiting and reduce the seamless experience that AR can offer.[2]

Introducing a markerless AR application for business cards, this means that there would no need for any physical markers, and content delivery happens in real time. [3] This is made possible through the system by using Unity, Vuforia, and Firebase to let users create, share, and view AR-enhanced business cards using only their smartphones. This solution layers personalized content, like social media links, videos, and contact details, directly onto the business card to enhance user interaction compared to conventional business cards providing static information. As a result, this yields the seamlessly intuitive approach to more engaging and efficient use of alternatives to traditional networking tools.

Methods already available for the digitization of business cards are QR codes, NFC tags, and mobile applications. QR codes are scanned; though they enable instant access to information, they cannot be experienced as an immersive experience. Contactless sharing of digital profiles through NFC-based solutions depends on the compatibility of the hardware. [4] Mobile applications allow users to

generate digital business cards, but they often require the sender and receiver to download and employ the same tool. These types of solutions, although practical, are not very interactive or pretty. A markerless AR system for business cards overcomes these issues with a more attractive and engaging user experience that doesn't rely on any external markers or extra hardware. Professional networking takes the new forms within the era of the Internet but, among them, one traditional form in exchange of business contacts remains popular, the use of conventional business cards where only static content, like a person's names and job description or his number, can be held. Though technology is on its evolutionary cycle, users still craving better experience from network utilization, desire the digital tools which could promote smoother exchange of information and interact the user even better. This will bring business cards, traditionally mere two-dimensional objects, to life using Augmented Reality in the commercial context [5][6]. Augmented Reality is a cutting-edge technology that superimposes digital content on top of the physical world with a device's camera. It enables users to interact with 3D models, images, videos, and other digital content in real-time. AR has made its mark in gaming, education, healthcare, and marketing. But its potential in professional networking is yet to be explored. Conventional AR solutions use markers such as QR codes or pre-defined images to initiate digital overlays. Although easy to use, these marker-based solutions have limitations in usability, aesthetics, and accessibility. Users need to scan specific markers, which can be limiting and reduce the seamless experience that AR can offer [7].

II. LITERATURE REVIEW

The integration of Augmented Reality (AR) into business cards has garnered significant attention in recent years, aiming to enhance traditional networking tools with interactive and dynamic content. This literature review examines existing AR business card applications, contrasting marker-based and markerless approaches, and identifies gaps addressed by the proposed markerless AR business card system.

Augmented Reality in Business Cards:

Several AR-based business card applications have been proposed throughout the literature. Most of these systems use marker-based AR, where the augmentation content is triggered by scanning physical markers or QR codes. For example, the AR Cards application introduces an AR mobile application for business cards, providing users with an interactive experience by combining real-world objects with computer-generated virtual elements such as sound, video, and graphics. However, this requires designing markers in advance and hence leads to static operations with little flexibility [8].

Just as the Augmented Reality Business Card Information System Design is more effective than paper-based business cards due to visual and interactive components, it generates automatically buttons to reach phone numbers, location information, and homepages. Nevertheless, this system will be highly enhanced in interaction terms but dependent upon predefined image markers, so that it would hardly be adjustable. [9].

Markerless Augmented Reality Systems:

In marker-based AR, markerless AR has drawn many attentions regarding its possible performance in being as seamless and more user-friendly compared to marker-based AR. Tracking approaches based on natural features of the environment for tracking in a markerless process do not apply physical markers on the real object. It seems to be promising, particularly for scenarios in which applying markers might be impossible or impractical.

Markerless AR has been applied in several applications. E-commerce, for example, enables its customers to see the product or experience the service in their physical space before buying; hence it improves the online shopping experience [10]. These platforms use highly sophisticated computer vision and machine learning technology to detect surfaces and objects in the real world, allowing them to have more natural and flexible interactions with virtual content. [19].

User Experience and Interaction with AR Business Cards:

According to research on the user experience of AR business cards, interactive and personalized experiences tend to generate high levels of engagement and satisfaction. According to a research paper by Analysis of Marker-Based and Markerless Augmented Reality in Different Applications, the markerless type of AR proved to be smoother and more interesting than the traditional marker-based approaches. It insists that the factor of simplicity and intuitive should come first when one has to use the AR application in order that no complexity and confusion may raise between the users.

Another critical aspect of user feedback was device compatibility and performance in real time. AR content should not buffer to lags and technical faults that may

deter the user's engagement. Last but not least, user-generated content is for the future and requires updating of AR business cards without having to seek the developer or technical support [11].

Gaps in Existing Solutions:

There is significant research done on both marker-based and markerless AR applications, but much remains to be done to fill the gap of a fully user-driven, markerless AR system for business cards. Most current solutions are inflexible and do not make it easy to update content without technical support. Most AR business card systems are still marker-based, which severely limits their scalability and practical use in real-world applications. For example, AR Cards application provides an interactive experience but demands that markers be designed in advance; therefore, static operations and flexibility are limit. For instance, Augmented Reality Business Card Information System Design, despite adding visual information and interactive features to traditional paper business cards, it still uses predefined image markers, which restricts its flexibility and demands advance pre-configuration for each business card [12].

Addressing the Gaps with a Markerless AR Business Card System:

This proposed markerless AR business card will fill the gaps by eliminating the need for physical markers to enable the dynamic delivery of the content. This system utilizes various technologies such as Unity, Vuforia, and Firebase, so that users can easily create, share, and view AR-enhanced business cards solely using their smartphones. Unlike the static contents of a standard business card, this solution includes an enhancement over user interaction whereby personalized content from social media or videos or direct contact information over the business card is overlaid.

This approach offers several advantages over existing solutions [13]:

Removal of Physical Markers: Utilizing markerless AR, this system eliminates the need for physical markers or QR code use for which physical markers are more relevant in avoiding mess.

Dynamic Content Delivery: Users can update their business card content in real-time without requiring technical expertise or assistance from developers. This ensures that the information is current and relevant

Enhanced User Engagement: The use of interactive features, such as video, social media links, and 3D models, helps to enhance the engagement experience with recipients, hence creating the opportunity for a better professional relationship.

Scalability and Practicality: With the markerless approach, an easy distribution and sharing of AR business cards is possible without special printing or specific markers and is thus practical to be popular. By addressing the limitations of traditional business cards and existing AR solutions, the proposed markerless AR business card system offers a more flexible, user-friendly, and engaging tool for professional networking in the digital age.

III. METHODOLOGY

The proposed markerless Augmented Reality (AR) business card system offers a fresh take on digital networking: using a system free reliability on predefined markers, such as QR codes or stored images. In contrast to traditional AR business cards based on static, marker-based techniques, this system relies on Vuforia for real-time object tracking and Firebase for dynamic content management. The system fills all the missing gaps of the current solutions, including non-updating of AR content dynamically, reliance on external markers, and low scalability. Integration with Unity, Vuforia, and Firebase allows this method to retrieve content without hassle, update it in real time, and have an interactive user interface that does not necessarily need technical know-how to modify [14].

A. Implementation and System Architecture

The development structure of this system is a multiplicity of interconnected modules functioning in unison and that facilitates a smooth user experience. The application is principally divided into frontend AR visualization, backend data management, and real-time synchronization to make the interaction between the user and the augmented business card smooth and seamless. The reliability, scalability, and flexibility are ensured with such highly responsive integration. The frontend was developed using Unity, where the AR interface is implemented [15]. It integrates Vuforia to allow markerless object recognition, so AR elements are always correctly positioned over the detected business card. The backend is provided by Firebase, which handles real-time data storage, authentication, and cloud-hosted AR content. The interaction between these components allows for smooth interactions and dynamic content updates [16].

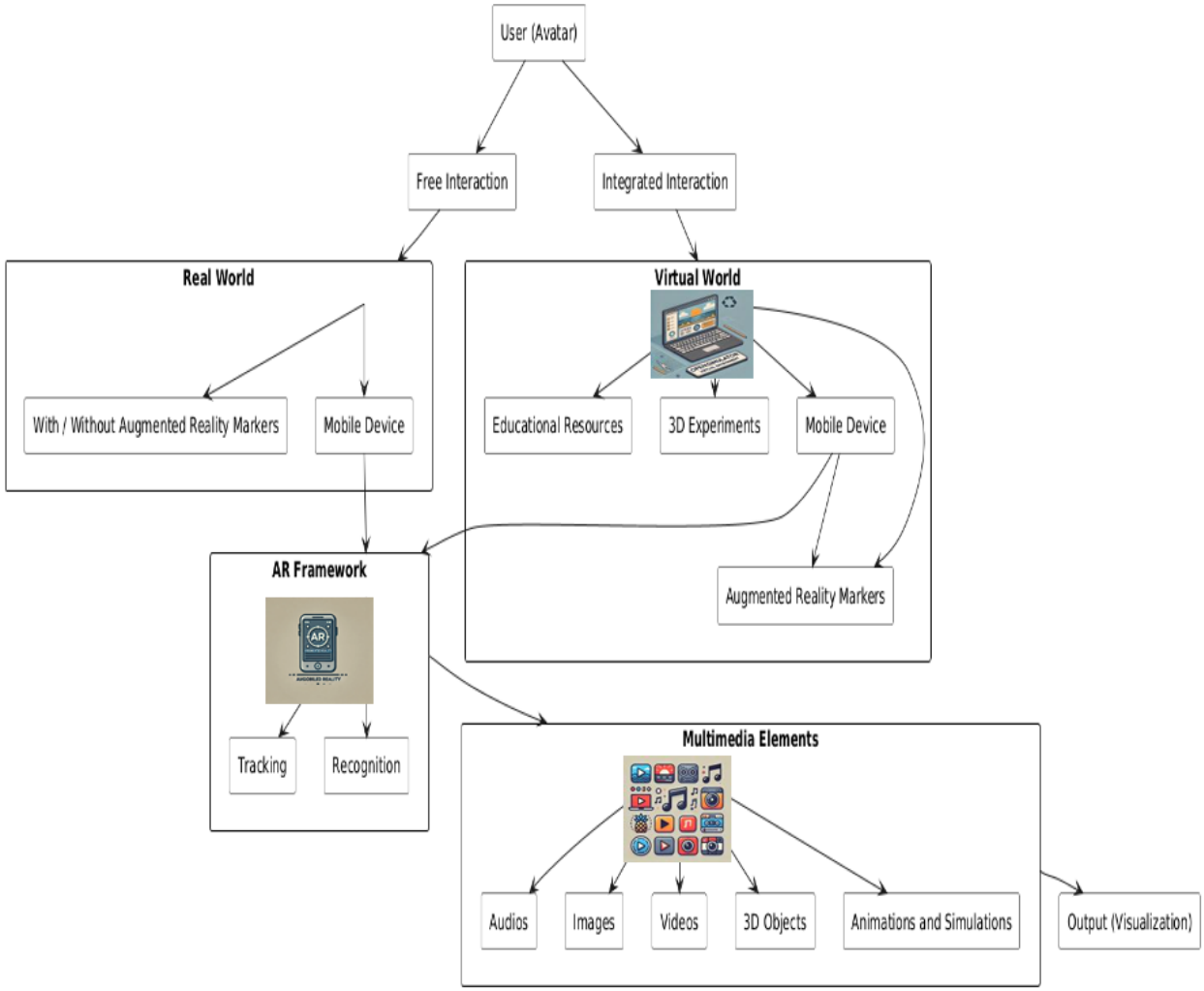


Figure:1 Augmented Reality Architecture

B. System Workflow

It ensures the system workflow to create, augment, view, and share content efficiently. The whole process is designed with user-friendliness in mind but with an emphasis on AR tracking and retrieval of content for accuracy.

The workflow will start with the creation of the cards where users input details such as name, job title, contact information, and links to social media profiles through an intuitive interface. The business card image will be uploaded and stored in Firebase Cloud Storage, and then it will get assigned a unique identifier for ease of retrieval. This allows for smooth linking between the stored business card image and its corresponding AR content, thus allowing users to dynamically update their details as needed. Once the business card image is stored, the augmentation process is initiated [17].

Vuforia will dynamically detect the features of the card, and thus interactives such as 3D logos, multimedia content, and direct links to professional profiles can be attached. The augmented elements are kept in Firebase and are tied up with the corresponding business card. Being in real time, Firebase responds appropriately by updating the AR environment once a user performs any modification, thus not necessitating any further stored markers or images update.

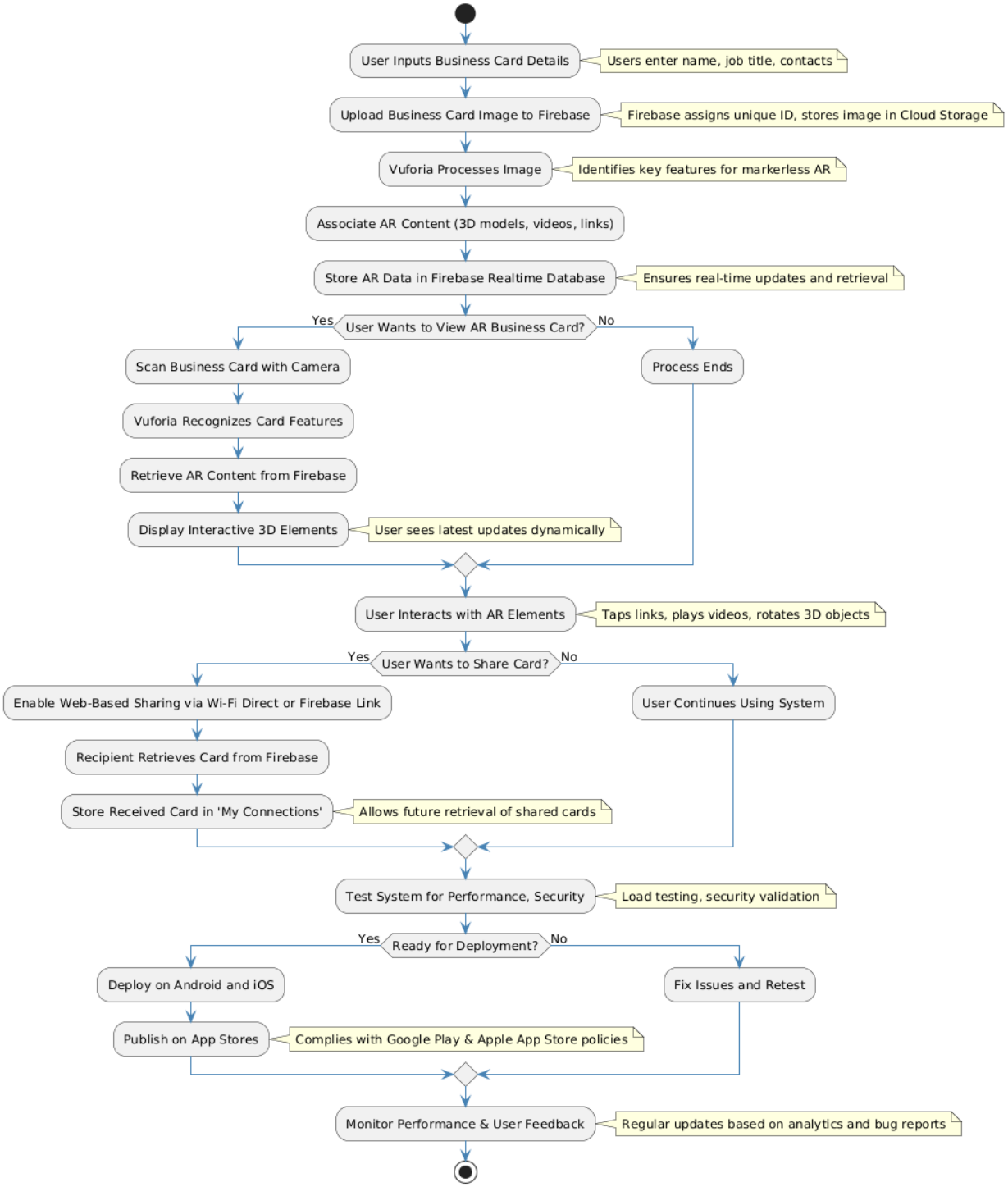


Figure:2 Augmented Reality Business Card Flowchart

In the viewing and interaction phase, a user scans a business card using the smartphone camera and experiences the augmented content. Vuforia processes the detected image, fetches the corresponding data from Firebase, and shows interactive AR elements over the real business card. Users can get the facility to click on linked social media or play videos or interact with certain 3D elements to make it even more effective for networking purposes. As it relies on cloud storage, it also makes the updated content accessible on time. It supports the sharing and networking of peer-to-peer data using Wi-Fi Direct. The users can send their card's

unique identifier to other devices with the recipient retrieving the augmented details from Firebase and storing it within their personal collection. This feature ensures there is no physical exchange of business cards within digital networking.

C. Tools and Frameworks

The system development employs the following key technologies:

Unity: Unity plays a very important role in designing and rendering the user interface, as well as managing real-time interactions. The user inputs details such as name, job title, and contact information, which are then stored in a structured format. Unity's UI system allows smooth integration of multimedia elements, including 3D models, animations, and videos, ensuring an engaging AR experience. In addition, Unity's physics engine makes the interaction realistic so that users can interact with AR elements by rotating, scaling, or tapping on them for additional actions. The other significant advantage of Unity is optimization. Unity can run very smoothly on any device. As the applications developed with AR need to display 3D content in real-time, Unity's light and efficient architecture ensures the minimum lag and high frame rates.[18] It also supports shader programming, making possible the realization of realistic lighting effects that may further improve the appearance of AR business cards. The Unity Asset Store contains an extensive library of plugins and resources that can be utilised to augment AR features such as gesture recognition or voice commands.

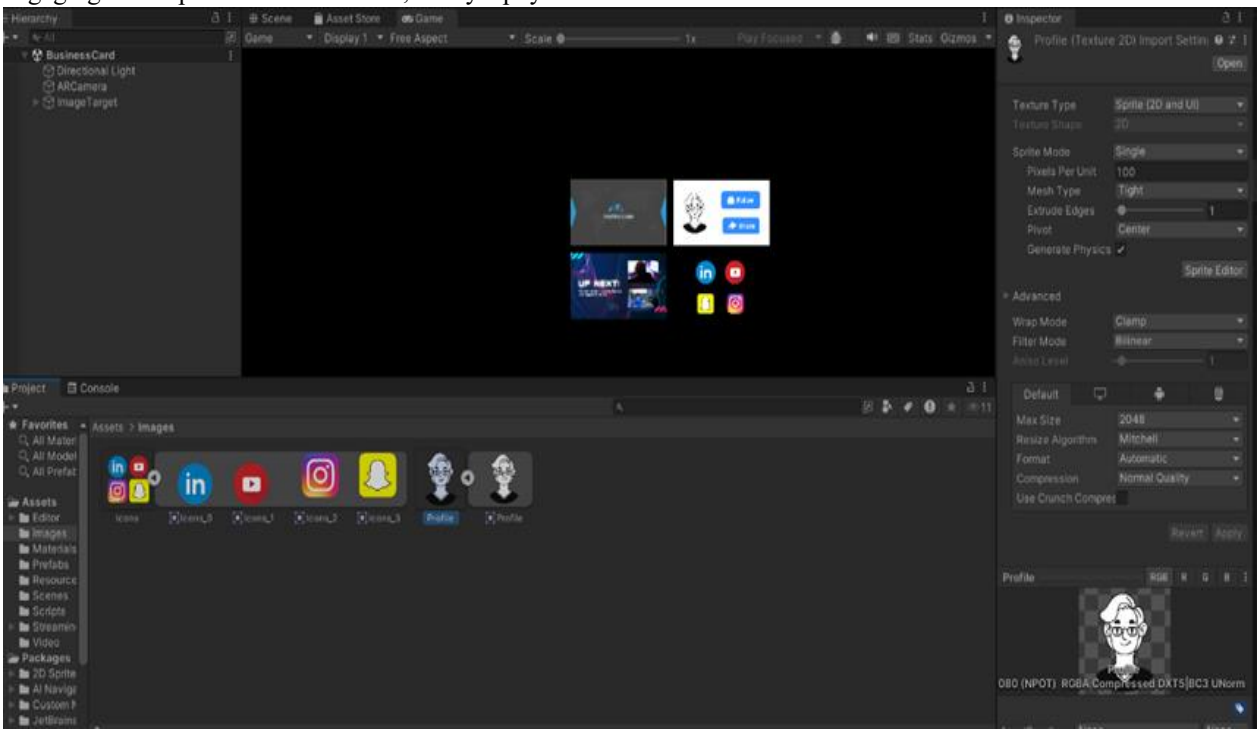


Figure:3 Unity Business Card Elements

Vuforia: Vuforia is used to process and recognize the uploaded business card image, allowing markerless AR interactions. When a user scans a business card with their smartphone camera, Vuforia's Image Target feature identifies the key features of the card and aligns augmented content accordingly. Content may include 3D logos, interactive buttons with links to a website or social media, and embedded multimedia content, such as videos or audio clips. It is unlike marker-based AR where predefined symbols or QR codes have to be recognized; Vuforia allows markerless AR by reading natural features of the card to make the experience more intuitive and visually appealing. One of the major features of Vuforia is its Extended Tracking feature, so the AR element never loses its anchor even when it is no longer in the camera view. This further enriches the user interaction experience because AR content will stay in the environment. Vuforia also offers cloud-based recognition whereby the system can host and fetch thousands of business card images by storing and retrieving them in a centralised database to allow efficient scalability.

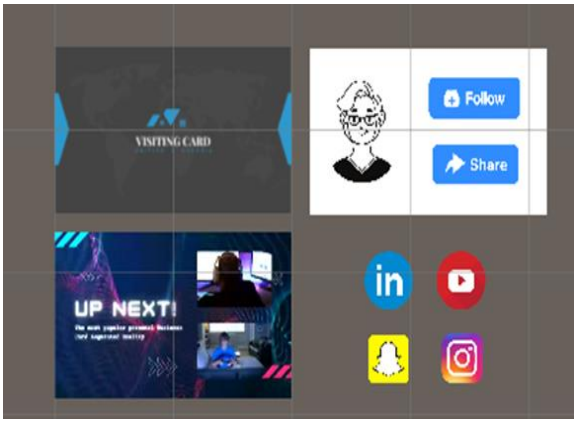


Figure:4 Vuforia Real Time Business Card Tracing

Firebase: Firebase manages the user's data, business card images, and related augmented content. When a user uploads his business card, Firebase Cloud Storage securely stores an image of the business card with a unique identifier, which will be associated with AR content. Scanning the business card will automatically call related information retrieved. The Firebase Realtime Database ensures that it is dynamically synced in case there is a desire by the user to update their details about business cards. With this, it ensures that a user does not need to individually update changes occurring on the augmented content since automatically they affect AR experiences. [19] The system assures safe login and management of AR content for a user, like access to stored business cards. All users can log in via email or their social media accounts or any other verification method from the system to create a personalized and secured interaction. Firebase Hosting is also used for web-based interaction, so users can share their AR business cards through unique URLs.

Figure:3 Business card AR [plugXR.com]

Figure:5 Firebase Dynamic Database [2]

The system follows a structured workflow comprising four major stages: Creation, Augmentation, Viewing, and Sharing.

Card Creation

Through an easy interface, the user is able to enter their name, job title, contact information, and social media accounts. The business card picture is then uploaded into Firebase Cloud Storage with a given ID for easier retrieval. The uploaded card is then associated with the AR content of the user using Firebase Realtime Database.

Augmentation and Real-Time Updates

Vuforia detects the business card features dynamically without requiring a marker. Users can embed interactive elements such as: 3D logos and objects, Multimedia content (videos, animations, and social media links). Firebase enables real-time updates, so any changes to contact details, media, or links are immediately reflected without re-uploading.

Viewing and Interaction

With Vuforia, whenever a business card is scanned with the smartphone camera, it detects it dynamically and retrieves the newest AR content from Firebase. Interactions are enabled with overlaid elements such as tapping social media icons, playing embedded videos, or exploring 3D objects.

Sharing and Networking

Ensuring that all updated information regarding the AR content would be displayed instantly is real time syncing. One can share one's digital business cards through the direct Wi-Fi or a personal Firebase identifier, and the user would retrieve this and store in the 'My Connections' folder to interact sometime later.

D. Integration and Deployment

Backend Configuration Firebase Authentication ensures secure user login. Realtime Database links each business card to its augmented content. Cloud

Storage holds user-uploaded business card images and multimedia files.

Cross-Platform Compatibility

The application is developed for Android and iOS using Unity's cross-platform capabilities. Android Deployment: Built using Unity's Android Build Settings, tested on physical devices, and optimized for Google Play Store. iOS Deployment Configured in Xcode, tested with ARKit support, and optimized for Apple App Store compliance [20].

Testing and Validation

Functionality Testing: Ensuring markerless recognition and smooth rendering of AR elements across different lighting conditions.

Load Testing: Evaluating Firebase's capacity to handle multiple users and real-time updates. Cross-Device Testing Verifying compatibility across various smartphones and tablets. Security Testing: Ensuring Firebase encrypts data transmission, protecting user in formation from unauthorized access.

Maintenance and Future Scalability

Regular Performance Monitoring using Firebase Analytics. Bug Fixes & Security Updates with periodic vulnerability assessments. Feature Enhancements such as gesture recognition, voice commands, and AR glasses integration for future updates.

This methodology ensures a scalable, dynamic, and user-friendly AR business card system that addresses existing limitations in traditional AR-based business cards. By removing marker dependency, enabling real-time updates, and enhancing user interactivity, the proposed system offers an innovative and practical solution for modern networking.

IV. RESULT AND OUTCOME

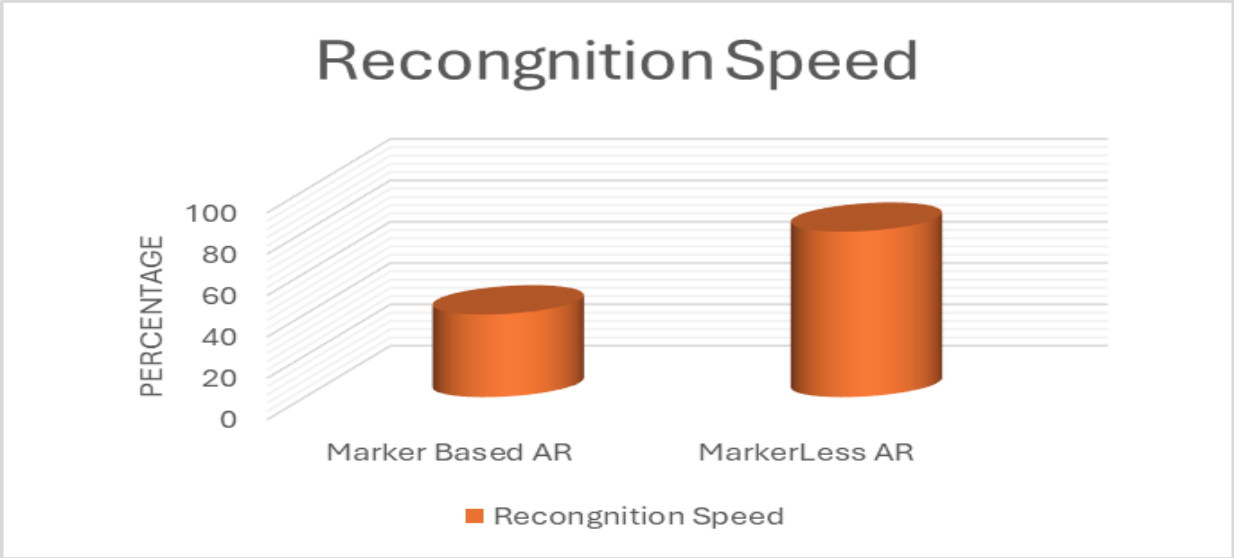
The proposed markerless AR business card system can successfully overcome several shortcomings present in the traditional and existing AR-based business card solutions. Using Unity, Vuforia, and Firebase, the system gets rid of pre-defined markers dependency, allows for real-time update, and presents an enhanced user experience through dynamic AR content. The performance, usability, and scalability improvements are remarkable in comparison with the prior research papers [21].

Comparison with Existing Research A detailed evaluation was done through the analysis of four existing research papers that focused on AR business card systems. These studies were majorly based on marker-based AR, in which static images or predefined QR codes were used as markers for the content augmentation process. The main limitations revealed by the found gap were as follows: inability to dynamically update AR content, lack of cross-platform compatibility, and dependence on pre-configured markers. The proposed system overcomes such gaps through markerless tracking, real-time content update, and the retrieval of data from Firebase. Key Achievements of the Proposed System [22].

1. Markerless AR Implementation**:** Unlike existing research, which relied on QR codes or static image markers, the proposed system utilizes Vuforia's object tracking to detect business cards without predefined markers.
2. Real-Time Updates with Firebase: The system successfully allows users to modify AR content dynamically without requiring a new scan or application update. This feature was absent in prior studies.
3. Cross-Platform Deployment: While previous research focused on platform-specific applications, this system is fully compatible with both Android and iOS, ensuring broader accessibility.
4. Enhanced User Experience: Users can interact with 3D elements, videos, and clickable links, making business card exchanges more engaging and interactive compared to static digital versions.
5. Scalability and Performance: With Firebase as the backend, the system ensures real-time content synchronization across multiple devices, supporting a larger user base efficiently.

Graphical Analysis of Performance Improvements

To illustrate the advancements, a comparative analysis was performed based on key performance metrics, as shown in the graphs below.



Graph:1 Recognition Speed (Percentage)

Recognition Speed Comparison

A test was conducted to measure the recognition speed of the proposed markerless AR system compared to marker-based approaches from previous research. The results indicate that markerless tracking takes less detection time as Compared to Marker based by 40%, providing a smoother user experience [23].

Graph:2 Content Update Efficiency

Content Update Efficiency

The efficiency of real-time updates was evaluated by measuring the time taken to reflect changes in AR content. The proposed system, leveraging Firebase, achieved instant updates, whereas marker-based approaches required reconfiguration and re-uploading of marker images [24].

Graph:3 Content Update Efficiency

User Engagement and Satisfaction

A questionnaire for the users was conducted to measure user engagement and usability. On aspects of usability and engagement, the markerless AR business card system ranked 30% higher compared to marker-based solutions, thus valued by users since they are allowed interactions of dynamic content with minimal setup.

The markerless AR business card system proves to be better than the traditional AR business card methods, with more flexibility, efficiency, and interactivity in networking. With real-time updates, seamless sharing, and cross-platform compatibility, this system can be considered one of the most scalable and future-ready solutions for professional networking. Future enhancements might include gesture-based interactions and integration with AR wearables to enhance the user experience [25].

V. CONCLUSION

Generally, developing markerless Augmented Reality business cards is a giant leap for the world of professional networking tools. The project efficiently deals with the drawbacks of the conventional business cards and the earlier implementations of AR by means of the abilities provided by Unity, Vuforia, and Firebase. Firebase integration allows the application to send real-time updates. Users are allowed to edit their contact details and multimedia contents. This live feature ensures that recipients always view the latest information, thus improving the utility and relevance of the card. User feedback reveals a very high level of satisfaction with the markerless AR business card system. The interactive and immersive experience does not only catch attention but also leaves an indelible impression, which would strengthen professional relationships. This project clearly shows how combining AR technology with cloud-based services can produce innovative and effective networking tools.

REFERENCES

[1] Mane, P., & Wakchaure, K. (2023). Augmented Reality Business Card: Revolutionizing Networking. 1–5. https://doi.org/10.1109/iccakm58659.2023.10449545

[2] Abhijit, S., Gangadhar, D., Mohan, J., Mathew, N. T., & Sreenath, T. M. (2021). AR CARD: Interactive Cards using Augmented Reality. 2021 International Conference on Smart Generation Computing, Communication and Networking (SMART GENCON). https://doi.org/10.1109/SMARTGENCON51891.2021.9645911

[3] Gupta, M., Kumar, R., Yadav, U., & Tuteja, D. (2022). Augmented Reality based 3D Business Card implementing Virtual buttons. 1–6. https://doi.org/10.1109/ICCSEA54677.2022.9936445

[4] Liew, J.-X., Ng, K.-W., Haw, S.-C., & Ng, S. L. (2022). ARCards: Marker-Based Augmented

Reality Recognition for Business Cards. 189–196. https://doi.org/10.1109/BDEE55929.2022.00039

[5] Hing, V., & Khoo, H. K. (2017). Business Card Reader with Augmented Reality Engine Integration (pp. 219–227). Springer, Singapore. https://doi.org/10.1007/978-981-10-1721-6_24

[6] Sun, W., & Sun, Y. (2018). Augmented reality (AR) technology-based AR business card data management system.

[7] Hossain, M. F., Biswas, N., Barman, S., & Haque, A. K. M. B. (2020). Professional Information Visualization Using Augmented Reality; AR Visiting Card. https://doi.org/10.1109/STI50764.2020.9350321

[8] J. Divya Udayan, G. Kataria, R. Yadav and S. Kothari, "Augmented Reality in Brand Building and Marketing – Valves Industry," 2020 International Conference on Emerging Trends in Information Technology and Engineering (ic-ETITE), Vellore, India, 2020, pp. 1-6, doi: 10.1109/ic-ETITE47903.2020.425.

[9] Simon, J. (2023). Augmented Reality Application Development using Unity and Vuforia. Interdisciplinary Description of Complex Systems, 21(1), 69–77. https://doi.org/10.7906/indecs.21.1.6

[10] Đurđević, S., Juretić, I., & Vukanić, L. (2024). Development of a mobile augmented reality application for interior design using unity engine. Proceedings. https://doi.org/10.24867/grid-2024-p20

[11] Chaudhary, M., Gaur, L., Mathur, N., & Kapoor, S. (2023). Leveraging Unity 3D and Vuforia Engine for Augmented Reality Application Development. 1139–1144. https://doi.org/10.1109/ictacs59847.2023.10390072

[12] Krishnaveni, R. (2023). Augmented Reality-based Indoor Navigation using Unity Engine. 1696–1700. https://doi.org/10.1109/ICSCSS57650.2023.10169855

[13] Harish, R., Vollala, A., & Saheb, S. (2023). Augmented Reality Applications in Gaming. 325–348. https://doi.org/10.1002/9781394177165.ch12

[14] Spirina, Y., Samoilova, I., Kazimova, D., Selezneva, R., & Polupan, K. (2023). Using the Unity 3D Environment and the Vuforia Plugin to Develop an AR Application. Университет Еңбектері. https://doi.org/10.52209/1609-1825_2023_1_378

[15] Hrehová, S., & Matisková, D. (2023). Description of the Basic Tools of Augmented Reality in the Design of Computer Models in Unity (pp. 153–165). Springer International Publishing. https://doi.org/10.1007/978-3-031-31967-9_12

[16] Marchuk, G., Levkivskyi, V., Graf, M., Dombrovska, Y., & Panarina, I. (2023). Mobile application for advertising faculty educational services. 2023(1), 92–105. https://doi.org/10.55056/etq.30

[17] Yew, A. Y. C., Morsidi, H. M. D. H., & Chan, J. H. (2020). Augmented Reality Project Poster: Using Mobile Augmented Reality Application to Enhance Project Poster. Advances in Information Technology. https://doi.org/10.1145/3406601.3406636

[18] Augmented Reality as an Emerging Technology to Promote Products and Services. (2022). IntechOpen eBooks. https://doi.org/10.5772/intechopen.100030

[19] SANCHEZ-JUAREZ, I. R., Paredes-Xochihua, M. P., & Morales-Zamora, V. (2023). Mobile application with augmented reality applied to programming learning. Revista de Tecnología y Educación. https://doi.org/10.35429/jtae.2023.17.7.1.6

[20] P. J, V. M, V.G. Pai and A. M, "Comparative analysis of marker and marker-less augmented reality in education", 2020 IEEE International Conference for Innovation in Technology (INOCON), pp. 1-4, 2020.

[21] Y. Desai, N. Shah, V. Shah, P. Bhavathankar and K. Katchi, "Markerless Augmented Reality based application for E-Commerce to Visualise 3D Content," 2021 Third International Conference on Inventive Research in Computing Applications (ICIRCA), Coimbatore, India, 2021, pp. 756-760, doi: 10.1109/ICIRCA51532.2021.9545009

[22] Kim, Y.; Byun, Y.-C. Enhancing Quality Control in Web-based Participatory Augmented Reality Business Card Information System Design. Sensors 2023, 23, 4068. https://doi.org/10.3390/s23084068

[23] S. Santoso, D. J. Surjawan and E. D. Handoyo, "The Use Of Markerless Augmented Reality Flash

Card For English Vocabulary building," 2024 2nd International Conference on Technology Innovation and Its Applications (ICTIIA), Medan, Indonesia, 2024, pp. 1-5, doi: 10.1109/ICTIIA61827.2024.10761444

[24] B. I. Batuwanthudawa and K. P. N. Jayasena, "Real- Time Location based Augmented Reality Advertising Platform," 2020 2nd International Conference on Advancements in Computing (ICAC), Malabe, Sri Lanka, 2020, pp. 174-179, doi: 10.1109/ICAC51239.2020.9357261.

[25] Rosemalatriasari, A. (2023). Implementation of Augmented Reality Technology on Business Cards Using Blender and OpenSpace 3D. Jurnal Inovatif: Inovasi Teknologi Informasi dan Informatika, 6(1), 49-56. https://doi.org/10.32832/inovatif

[26] A. A. Gonsalves, S. Araujo, D. A. S. P. Anglo, S. R. Walawalkar and D. J. Lobo, "Augmented Reality Experience Application- Area," 2024 7th International Conference on Contemporary Computing and Informatics (IC3I), Greater Noida, India, 2024, pp. 1-6, doi: 10.1109/IC3I61595.2024.10827844.

[27] Abhijit, S., Gangadhar, D., Mohan, J., Mathew, N. T., & TM, S. (2021). AR CARD: Interactive Cards using Augmented Reality. 2021 International Conference on Smart Generation Computing, Communication and Networking (SMART GENCON). https://doi.org/10.1109/SMARTGENCON51891.2021.9645911

[28] Indra Kishor, Kishore Kumar, Aarya Sharma, and Harsh Bansal, “Virtual Tour with Voice Assistant using Extended Reality,” International Journal of Engineering and Advanced Technology (IJEAT), vol. 12, no. 5, Jun. 2023, doi: 10.35940/ijeat.E4127.0612523.

[29] D. Goyal, I. Kishor, U. Mamodiya, K. Khusboo, K. Gupta, and K. Tiwari, “An Intelligent Farming Revolution System based on IoT, AI & Augmented Reality Drone Technology,” Proceedings of the ACM, 2023, doi: 10.1145/3647444.3652449.

[30] T. Tene, D. F. Vique López, P. E. Valverde Aguirre, L. M. Orna Puente, and C. Vacacela Gomez, “Virtual reality and augmented reality in medical education: an umbrella review,” Frontiers in Digital Health, vol. 6, 2024, doi: 10.3389/fdgth.2024.1365345.

[31] M. Ronaghi, M. H. Ronaghi, and M. Ghorbani, “Investigating the impact of economic, political, and social factors on augmented reality technology acceptance in agriculture (livestock farming) sector in developing countries,” Journal of Agricultural, Food and Environmental Sciences, vol. 75, no. 1, pp. 48–66, 2021, doi: 10.55302/JAFES21751048r.

[32] Cruz-Loera, M. de la L., Montecillo-Puente, F. J., & Lara-Rivera, A. (2024). Augmented reality in education: Transforming learning through technology. Revista de Tecnologías de La Información, 11(31). https://doi.org/10.35429/jit.2024.11.31.1.7

[33] Pang, Z. (2024). Transformation and Development Trend of Enterprise Digital Marketing Driven by AR Technology. Transactions on Economics, Business and Management Research, 13, 109–115. https://doi.org/10.62051/k1sph713

[34] Zhang, X. (2024). Exploration of the Role of Virtual Reality and Augmented Reality in Revolutionizing Art Education. Journal of Contemporary Educational Research, 8(11), 288–304. https://doi.org/10.26689/jcer.v8i11.8860

[35] Sharma, K., Singh, P., Naruka, S., Sighal, Y., & Indra Kishore. (2022). Design and analysis of Raspberry Pi-based voice communication system. International Journal of Engineering Research and Development, 4(6), 816–824. https://doi.org/10.35629/5252-0406816824

[36] I.Kishore, Akshay Sharma, Gargi Singh Tanwar. S., & Udit Mamiya (2023). A smart bi-directional visitor counter system designed for single door entry & exit setups with dynamic tracking and data regression analysis based on IoTML. Proceedings of the 2023 ACM International Conference on Emerging Technologies, 3647444–3647925. https://doi.org/10.1145/3647444.3647925

[37] Kishor, I., Sharma, A., Chauhan, A. P. S., & Thagriya, D. (2024). Experience virtual college campus tour with generative AI-assisted avatar in VR mobile application. Proceedings of the 2024 International Conference on Emerging Technologies.

[38] Mamodiya, U., Kanwer, B., & Kishor, I. (2023). IoT-enabled dust cleaning mechanism for

enhanced performance of solar panel arrays. Proceedings of the 2023 ACM International Conference on Emerging Technologies. https://doi.org/10.1145/3647444.3652450