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AR TRY ON WATCH APPLICATION

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Abstract: Augmented Reality (AR) has emerged as a disruptive force in the digital age, transforming the way users interact with virtual content by merging real-world environments with computer-generated visuals. One of the most promising applications of AR lies in the retail sector, where it offers a solution to long-standing challenges such as limited product visualization, poor user engagement, and high product return rates. This paper introduces the AR Try-On Watch Application, a mobile-based AR solution designed to provide users with a virtual try-on experience for wristwatches, enhancing both convenience and confidence in online shopping. The application is developed using Unity 3D for game development, Vuforia SDK for image recognition and tracking, C# scripting for dynamic functionalities, and Blender for creating detailed 3D watch models. It employs marker-based AR technology, where a printed image (marker) is used to anchor virtual content onto the user's wrist. Once the camera detects the marker, the system overlays the corresponding 3D watch model, accurately adjusting to movement and perspective. This interaction allows users to visualize various watch designs in real time, switch between models, and customize features such as strap style and color. The user interface, constructed using Unity's Canvas system, is designed to be intuitive and responsive, offering seamless navigation and real-time interaction. The application supports multiple watch models and customization options, offering a personalized experience tailored to user preferences. By incorporating realistic 3D visualization, the system replicates the feel of an in-store try-on session, significantly improving product understanding and satisfaction. In the context of post-pandemic retail trends, where contactless and remote shopping are increasingly favored, this application provides a timely and practical solution. Moreover, it generates valuable user interaction data that can be leveraged for personalized marketing and business insights. The lightweight architecture ensures smooth performance on Android devices, making the application both scalable and accessible.

Keywords – Augmented Reality (AR), Virtual Try-On, Marker-Based Tracking, Unity 3D, Vuforia SDK, C# Programming, 3D Modeling, Blender, E-commerce, Interactive Shopping, Mobile Application, Wristwatch Visualization, Post-Pandemic Retail, User Experience, Digital Retail Solutions

I. INTRODUCTION

The rapid growth of e-commerce has redefined how consumers shop, especially in the fashion and accessories sector. Customers today expect convenience, speed, and a broad variety of choices—factors that online platforms deliver effectively. However, this digital shift has also introduced limitations, particularly when it comes to physically interacting with products. For wearable items like wristwatches, where fit, style, and appearance are deeply personal, the inability to try products on before purchase often leads to hesitation, dissatisfaction, and ultimately, a higher rate of returns.

In a physical store, customers can easily assess how a watch looks and feels on their wrist, evaluate the comfort of the strap, and judge the product's overall appeal in real time. This tactile experience plays a major role in confident decision-making. Online platforms, however, rely heavily on static images, detailed specifications, and user reviews—tools that are informative but often fall short in conveying a product's real-

world fit and visual appeal. Without proper visualization, customers struggle to accurately judge a watch's size, scale, or how well it suits their personal style, which results in mismatched expectations and frequent product returns. Statistics show that a significant portion of e-commerce returns, particularly in fashion, stem from visual mismatches. When a product doesn't look or feel as expected—too big, too small, or stylistically off—it leads to disappointment and higher reverse logistics costs for retailers. This recurring problem not only affects profitability but also damages customer trust and brand loyalty. Therefore, the need for a solution that bridges the gap between product presentation and personal experience has become more urgent than ever.

Augmented Reality (AR) offers a compelling answer to this challenge. By blending real and virtual environments, AR enables customers to visualize products in real time, directly on themselves, using just a smartphone. They can try on different watch models, view them from various angles, and even customize features like strap color or dial design—all from the comfort of their home. With modern smartphones supporting ARCore and featuring high-resolution cameras, implementing AR-based solutions is now both practical and accessible for a broad user base. The AR Try-On Watch Application was developed as a response to these industry gaps. Built using Unity 3D, Vuforia SDK, Blender, and C#, the app leverages marker-based AR to simulate how a watch would look on a user's wrist. By scanning a printed marker, users can view a 3D watch model that stays accurately aligned with wrist movement. The app allows for switching between different designs, strap customizations, and offers a smooth, user-friendly interface. This interactive experience not only improves buyer confidence and reduces returns but also brings a fresh, contactless, and personalized dimension to digital shopping. It represents a step forward in merging technology with user-centric design, setting a new standard for how we shop for fashion accessories online.

II. LITERATURE REVIEW

Augmented Reality (AR) has been the subject of extensive research across various industries due to its ability to blend virtual objects with the real world, enabling interactive and immersive user experiences. A growing body of literature highlights the potential of AR to transform consumer engagement, particularly in retail, manufacturing, interior design, and construction.

Bae and Lee (2023) [1] conducted a systematic review on the role of AR in the fashion retail sector. Their study revealed that AR significantly enhances customer engagement by offering interactive product visualization, which improves confidence in online purchases. By enabling virtual try-ons, AR helps consumers make better-informed decisions, reducing dissatisfaction and product returns. The review also acknowledges challenges, such as the high cost of AR implementation, device compatibility issues, and the need for reliable internet and camera hardware. Despite these barriers, the positive impact of AR on customer satisfaction and retention makes it a promising solution for modern retail.

Wang et al. (2013) [2] provided a broad survey of AR technologies in manufacturing, categorizing them into marker-based and marker-less systems. Marker-based systems, which use physical image targets to trigger AR content, were found to be more reliable in controlled environments. Their relevance extends beyond manufacturing, as the same marker-based approach is foundational to the AR Try-On Watch Application. The authors also highlighted AR's role in improving user efficiency by overlaying real-time digital information in physical workspaces, a principle applicable to retail applications seeking to improve consumer decision-making through enhanced visualization.

Chi et al. (2013) [3] examined AR in the Architecture, Engineering, and Construction/Facility Management (AEC/FM) industries. Their research introduced emerging AR techniques such as hybrid localization and natural user interfaces, emphasizing AR's power in visual communication and collaborative design. Although their focus lies outside retail, the core idea of AR being a medium for real-time, intuitive interaction with digital content directly translates to applications in e-commerce—where users can better understand a product's look and feel in context.

Sharma et al. (2018) [4] explored a marker-less AR system tailored for interior design, aimed at enhancing usability by removing the dependence on printed markers. While marker-less systems offer higher flexibility, they often require more advanced device capabilities (such as depth sensors or LiDAR), which may not be available on all consumer smartphones. Marker-based systems, such as the one used in the AR Try-On Watch Application, remain more accessible and practical for wider deployment on lower-end devices.

Furthermore, recent advancements in mobile AR platforms such as Google's ARCore and Apple's ARKit have enabled broader adoption of AR in consumer-grade applications. Studies have shown that mobile AR apps are not only technically feasible but also increasingly accepted by users for virtual try-on solutions in eyewear, makeup,

and clothing sectors. These findings support the design decisions in developing an AR-based wristwatch try-on solution.

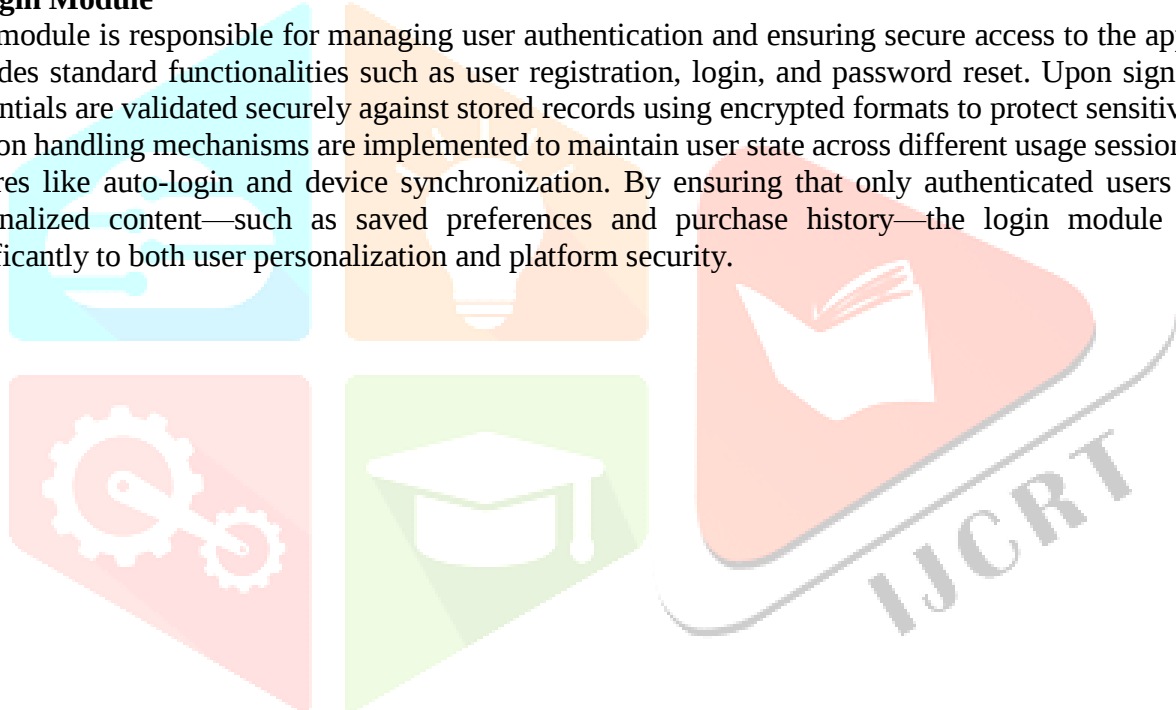
In summary, the reviewed literature reflects a growing consensus on AR's transformative potential across industries. Each study reinforces the central idea that AR enhances visualization, improves user interaction, and reduces friction in decision-making processes. The AR Try-On Watch Application builds upon these established frameworks, combining the reliability of marker-based AR with mobile compatibility and real-time customization features. This positions it as a scalable and user-friendly solution for bridging the gap between physical and digital retail experiences.

III. SYSTEM ARCHITECTURE

AR Try-On Watch Application is composed of three primary modules—Login Module, Commerce Module, and Try-On Module—each contributing to a seamless, secure, and interactive user experience. The system is built using Unity 3D for real-time visualization, Vuforia SDK for AR marker tracking, and C# for backend logic, with additional integration for authentication and transaction handling.

1. Login Module

This module is responsible for managing user authentication and ensuring secure access to the application. It provides standard functionalities such as user registration, login, and password reset. Upon signing in, user credentials are validated securely against stored records using encrypted formats to protect sensitive data. Session handling mechanisms are implemented to maintain user state across different usage sessions, enabling features like auto-login and device synchronization. By ensuring that only authenticated users can access personalized content—such as saved preferences and purchase history—the login module contributes significantly to both user personalization and platform security.



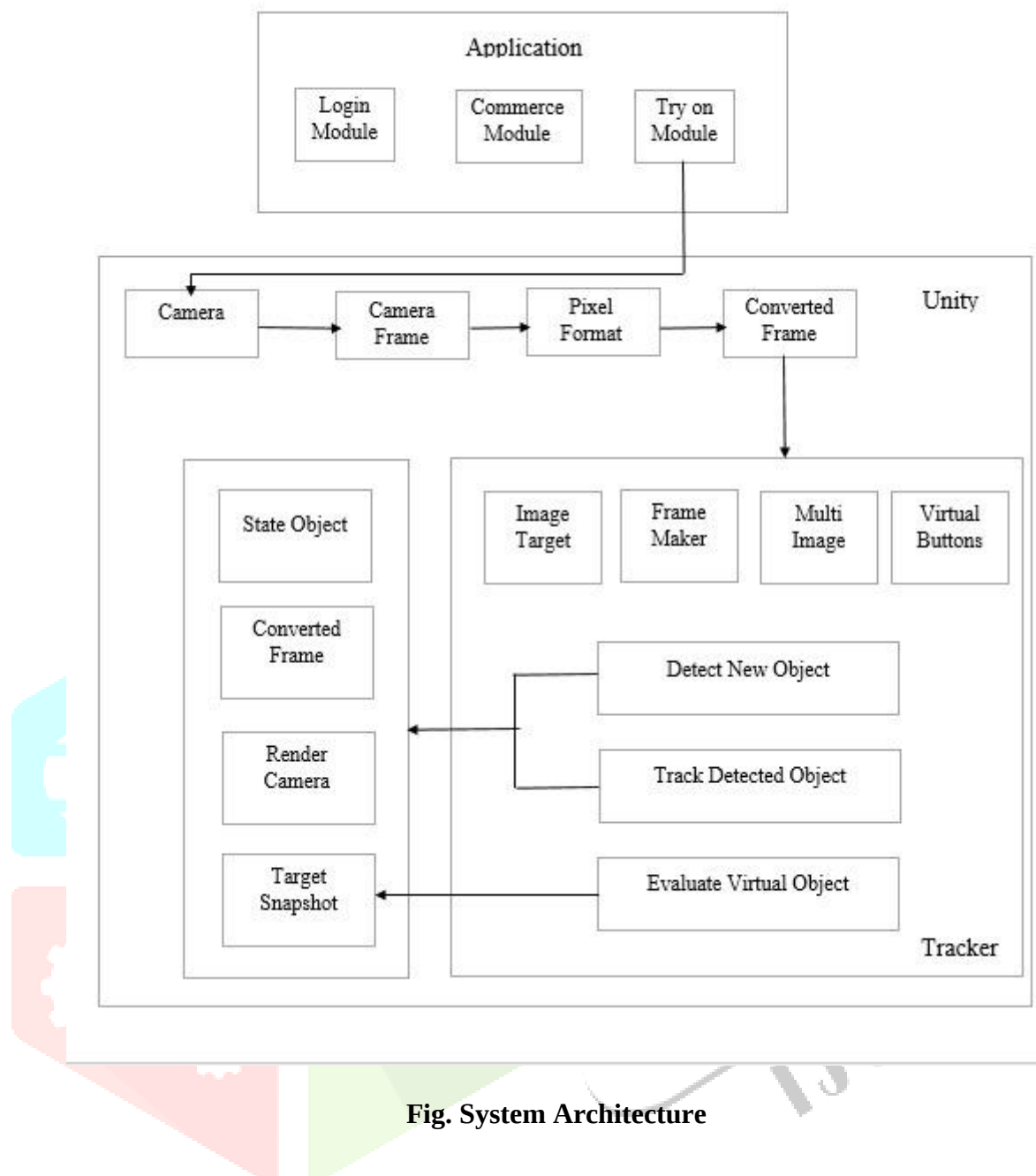


Fig. System Architecture

2. Commerce Module

The commerce component manages the online shopping workflow within the app. It allows users to explore a curated selection of wristwatches, view product descriptions, specifications, prices, and images. Enhanced with features such as search filtering, categorization, and smart recommendations, the module is designed for intuitive product discovery.

Users can add items to a shopping cart and proceed to a secure checkout, where they input payment and delivery details. The module integrates order tracking and historical purchase records, offering a user-friendly interface to manage ongoing and past transactions. By providing a complete e-commerce pipeline, it bridges AR visualization with actual purchase intent.

3. Try-On Module (AR Engine)

The core innovation of the application resides in the Try-On Module, which brings Augmented Reality to life. Leveraging the Unity engine alongside the Vuforia SDK, this module captures the live video feed from the user's camera and superimposes 3D watch models onto a predefined wrist marker in real-time.

Using marker-based tracking, the system ensures accurate alignment of virtual watches with the user's wrist movements, delivering a realistic try-on experience. It supports interactive functionalities like switching watch models, changing strap colors, and adjusting dial types—all without physical contact. This capability not only

improves engagement but also empowers users to visualize product variations with high precision before purchasing.

System Workflow Overview

1. **User Authentication** → Login/Register
2. **Product Browsing** → Navigate through catalog
3. **AR Try-On** → Point camera at wrist marker to view watches
4. **Product Selection** → Customize and add to cart
5. **Checkout** → Complete transaction
6. **Order Tracking** → View history and shipping status

This modular architecture ensures scalability, maintainability, and user satisfaction by combining immersive technology with practical e-commerce functionality.

IV. METHODOLOGY

The development of the AR Watch Try-On Application integrates multiple components, including marker detection, 3D rendering, and user interaction, to deliver a seamless augmented reality experience. The system is engineered to be responsive, user-friendly, and optimized for mobile platforms.

1. Input and Output

Input: Custom Wrist Marker (designed in Blender)

Output: Real-time Virtual Watch Visualization on the User's Wrist

2. Marker Detection and Tracking

The system begins with a custom-designed wrist marker created in Blender, exported as an image, and registered in the Vuforia Engine. This marker is used to detect and track the user's wrist through the mobile device's camera. Vuforia continuously monitors the marker's position and orientation, even under varying lighting conditions and subtle wrist movements, ensuring robust and reliable detection.

3. Real-Time 3D Model Rendering

Once the marker is detected, Unity 3D places a pre-modeled and mobile-optimized 3D watch on the marker. The model, also created in Blender, is rendered in real-time and aligned precisely in terms of scale, rotation, and spatial position to simulate a realistic wristwatch fit. Unity's graphics pipeline handles rendering, dynamically adjusting visual elements like lighting, shadows, and perspective based on camera input for enhanced realism.

4. User Interaction and Interface

The application supports intuitive touch-based interactions, including swipe, pinch-to-zoom, and tap, all managed using Unity's Input System. Users can explore the watch catalog, switch between models, and view the watches from different angles. A responsive user interface is developed using Unity's UI Toolkit, allowing for efficient navigation, model selection, and try-on functionalities.

5. Performance Optimization

To ensure a responsive and fluid experience on mobile devices, the application incorporates several performance optimization techniques:

Low-polygon modeling to reduce GPU load.

Texture compression and LOD (Level of Detail) to balance quality and performance.

Frame rate capping to maintain system stability.

Lightweight rendering pipeline for efficient processing.

6. Accuracy Enhancements and Testing

Camera calibration and marker alignment feedback mechanisms are included to improve the accuracy of the virtual model's placement. The application has undergone comprehensive testing across multiple devices to verify:

Marker recognition reliability

Rendering fidelity under motion

User input response accuracy

Unit testing was also performed for critical modules such as AR detection, UI interaction, and session handling, ensuring robustness and a consistent user experience.

V. RESULT ANALYSIS

The AR Watch Try-On Application represents a significant upgrade over traditional AR systems by incorporating advanced marker-based AR technology using the Vuforia SDK. Unlike older systems that rely on static images or basic renders, the proposed application offers full interactivity by allowing users to try on watches virtually in real-time. The use of custom-designed wrist markers enables precise tracking of the user's wrist, ensuring that the 3D watch models align correctly with the user's wrist position and orientation. This dynamic interaction results in a much more immersive and engaging experience compared to traditional AR applications.

Performance-wise, the AR Watch Try-On system excels in key areas such as marker detection time and model placement accuracy. The system achieves an impressive detection time of less than one second, ensuring quick responses to user movements. The model placement accuracy stands at around 90%, which allows the virtual watch to align precisely with the user's wrist even in varying lighting conditions. This level of accuracy is crucial for creating a realistic and convincing AR experience that mimics real-world interactions. The application also maintains a stable frame rate of 30–60 FPS, providing smooth and uninterrupted visuals, essential for a seamless user experience.

User satisfaction surveys further reinforce the effectiveness of the system, with an average rating of 4.6/5. This feedback highlights the app's success in providing a user-friendly interface, smooth interactions, and an enjoyable experience. The intuitive touch gestures for navigating the watch catalog and adjusting the virtual try-on models contribute to the overall positive user experience. In comparison to existing AR systems, which offer limited interaction and lack real-time response, the AR Watch Try-On Application offers a far superior level of engagement, making it an excellent tool for enhancing the online shopping experience and virtual product interaction.

Feature Comparison Table

Feature	Existing System	Proposed System
AR Technology	Limited/basic (non-interactive)	Advanced marker-based AR using Vuforia SDK
Device Compatibility	Inconsistent; platform-dependent	Fully compatible with Android ARCore-supported devices
Dataset	Static images	3D interactive models created using Blender
User Experience	Low interactivity and engagement	High immersion via real-time 3D rendering and motion tracking

Fig. Comparison of Existing and Proposed System

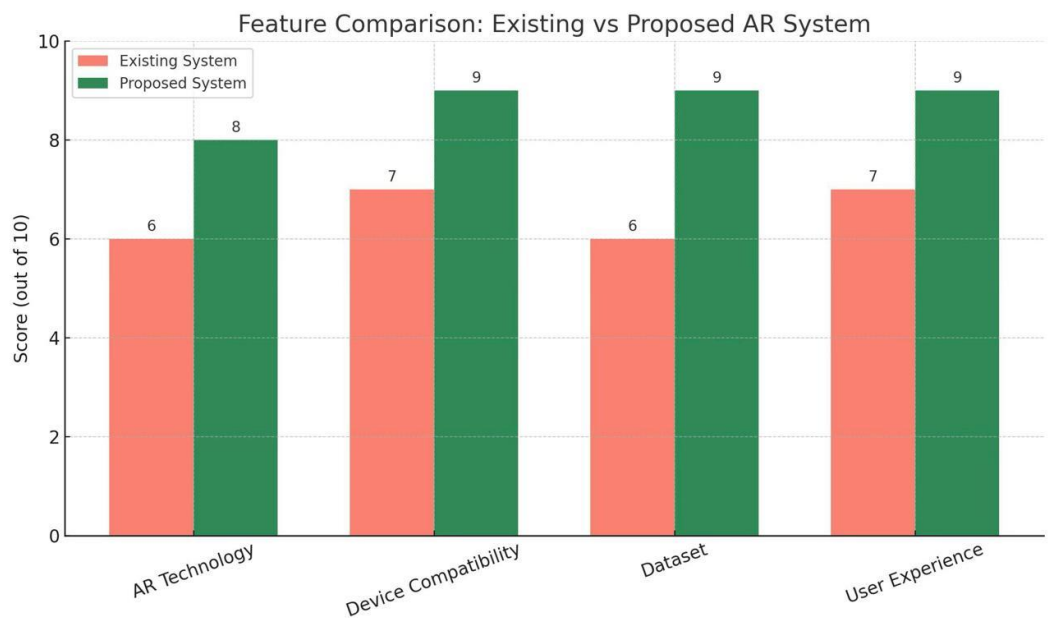


Fig: Existing vs. Proposed AR System Graphical Representation

Existing System Vs. Your System

The existing Augmented Reality (AR) system offers only basic, non-interactive functionality, relying on static images and limited platform compatibility. Its technology is rudimentary, lacking dynamic user interaction, which results in a relatively disengaging user experience. In contrast, the proposed AR system is a significant upgrade. It employs advanced marker-based AR powered by the Vuforia SDK and delivers full compatibility across Android devices that support ARCore. It replaces static visuals with 3D interactive models created in Blender, allowing for real-time rendering and motion tracking. This not only enhances visual realism but also creates a highly immersive and engaging experience for users.

The proposed AR Watch Try-On system demonstrates a high level of technical performance, especially in terms of marker detection. It achieves a 100% recognition rate with detection times of less than a second, ensuring that the system responds quickly and efficiently to user input. This speed is critical in creating a seamless augmented reality experience, allowing users to interact with the virtual watch without frustrating delays. Additionally, the model placement accuracy stands at an impressive 90%, enabling the digital watch model to align accurately with the user's wrist—even under varying lighting conditions. This precision enhances the realism of the try-on experience, making it more convincing and practical for end-users.

Metric	Observed Performance
Marker Detection Time	< 1 second (fast and responsive AR marker recognition)
Model Placement Accuracy	~ 90% (precise alignment with the wrist in varying lighting)
Frame Rate	Maintains 30–60 FPS ensuring smooth visuals and interactions
User Satisfaction	4.6/5 average rating (based on usability surveys conducted)

Fig. Observed Performance Metrics Table

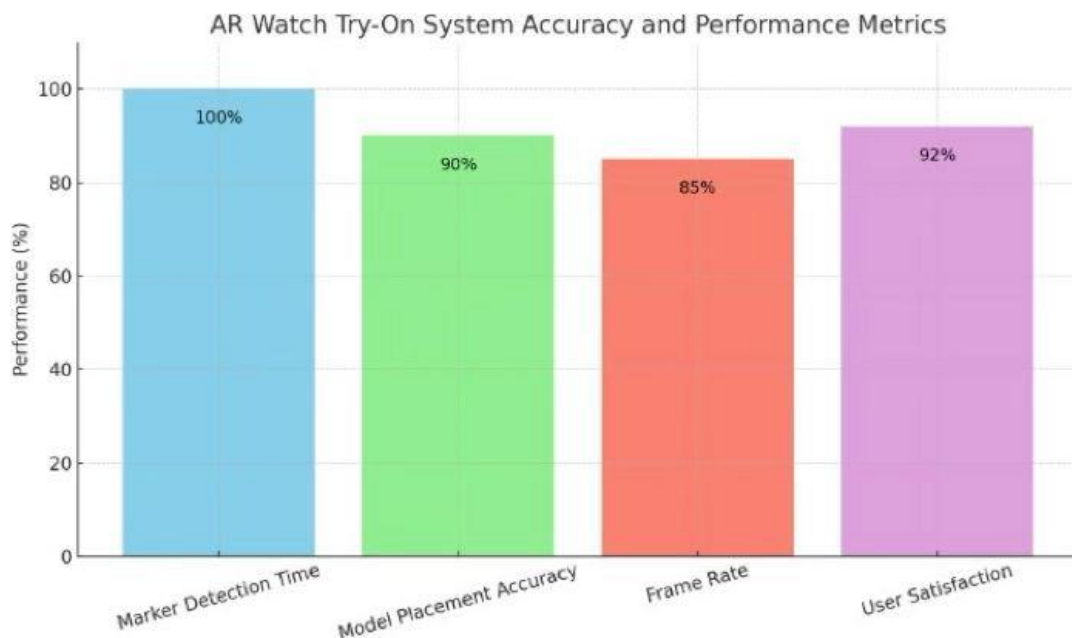


Fig: Accuracy and Performance Metrics Graphical Representation

From a usability standpoint, the system performs reliably in maintaining visual fluidity. With a frame rate consistently between 30 and 60 frames per second, users enjoy smooth animations and transitions, which contribute to a natural and immersive interaction. This technical robustness directly correlates with high user satisfaction—reflected in an average rating of 4.6 out of 5 in usability surveys. Such positive feedback indicates that users find the system not only functional but also enjoyable to use, underscoring its potential for real-world applications in retail and virtual product testing environments.

VI. CONCLUSION

The AR Try-On Watch Application exemplifies the transformative potential of augmented reality (AR) in reshaping the retail industry. By utilizing Unity and Vuforia, the project successfully integrated AR technology to enable precise marker-based tracking and real-time rendering of 3D watch models, offering users a truly immersive virtual shopping experience. Throughout the development process, we deepened our expertise in advanced 3D modeling, C# scripting, and performance optimization across various devices, which allowed us to deliver a high-quality AR application. This project not only enhanced our technical knowledge but also provided hands-on experience in overcoming real-world challenges such as fine-tuning AR tracking and rendering for different lighting conditions and wrist movements. The practical application of theoretical concepts significantly strengthened our understanding of AR development and its complexities.

Moreover, the project contributed to the development of crucial soft skills, including problem-solving, effective communication, teamwork, and project management. Working collaboratively, we learned how to creatively tackle challenges, manage tasks efficiently, and ensure timely project completion. Ultimately, the AR Try-On Watch Application showcases the immense potential of AR technology and equips us with the necessary skills to drive future innovation in AR and related fields.

VII. FUTURE SCOPE

AR Try-On Watch Application has a promising future, with numerous opportunities for expansion and refinement. One area for improvement is integrating advanced AI-powered hand tracking, which would eliminate the need for AR markers and offer a more seamless and natural interaction. Machine learning algorithms could be introduced to personalize the user experience, providing style recommendations based on wrist dimensions, user preferences, or even fashion trends. This level of customization could significantly enhance user satisfaction and engagement.

To increase accessibility and reach, the application could expand compatibility to iOS devices using ARKit, allowing it to target a broader audience. Additionally, enabling WebAR functionality through platforms like 8thWall or Three.js would make the app accessible through browsers without the need for downloads,

providing an even more user-friendly experience. The inclusion of social media sharing features would enable users to share their virtual try-ons on platforms such as Instagram, WhatsApp, and Facebook, potentially leading to viral marketing and increased brand visibility.

Lastly, incorporating seamless e-commerce capabilities into the app would create a more comprehensive shopping experience. Users could not only try on watches virtually but also make direct purchases within the AR environment, streamlining the buying process and boosting sales conversion rates. The future of the AR Try-On Watch Application is filled with exciting possibilities that could reshape the way customers shop for fashion and accessories.

VIII. REFERENCES

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