Augmented Reality Try On 3D (ARTON3D)

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***Abstract*— An AR smart mirror integrates traditional mirror functionalities with augmented reality technology, offering users a host of interactive capabilities. By employing sensors and advanced computer vision algorithms, these mirrors can detect users and overlay virtual content onto their reflections. This content may encompass various features like weather updates, news snippets, social media feeds, and tailored product/service recommendations. With an AR smart mirror, individuals can virtually try on clothing, access medical information or reminders, and manage smart home devices without physical interaction . The advent of AR smart mirrors heralds a potential revolution in how we interact with technology and information daily, seamlessly blending the physical and digital realms. These mirrors have versatile applications across diverse settings, from homes and workplaces to retail establishments and public areas, enriching our interactions with surroundings and facilitating informed decision-making. While still in nascent stages of development, AR smart mirrors represent an enticing frontier in the rapidly evolving domain of augmented reality technology**

Keywords*— AR smart mirrors, sensors, computer vision, overlay, reflections, try on, potential revolution, versatile applications, informed decision making, rapidly evolving domain, augmented reality technology

I. Introduction

While the concept of virtual trial rooms has been present for some time, recent strides in Augmented Reality (AR) and Machine Learning (ML)[1] have notably enhanced their functionality and realism. Initially, early efforts centered on projecting static 2D images of clothing items. However, with the fusion of AR and ML technologies, prototypes now boast the capability to generate 3D cloth models on the user's body in real-time, thereby enriching the virtual try-on experience. Traditionally, mirrors have served as instruments for self-reflection and interaction. Smart mirrors represent an evolution in this realm, striving to augment mirrors by integrating pertinent information to offer advanced features. These enhancements include personalized data such as the current date, news updates, local time adjusted to the user's location, and weather forecasts[2]. Studies indicate that individuals typically allocate approximately 30 minutes to tasks like washing, applying makeup, and dressing upon waking up, often utilizing the mirror during this time. Introducing a smart mirror can optimize this period by providing relevant daily information, effectively utilizing this observation time without causing distractions.

Furthermore, this project not only aims to enhance home environments with smart mirrors but also proposes the development of a smart try-on system tailored for commercial and retail sectors, specifically targeting new trial room experiences. This system seeks to leverage cutting-edge advancements in AR and ML to revolutionize customer engagement with products in retail settings[4]. Through seamless integration of virtual try-on capabilities into trial rooms, retailers can offer customers a more immersive and personalized shopping experience[4]. This innovative solution will enable customers to visualize how clothing items will appear and fit in real-time, facilitating confident purchase decisions while reducing reliance on physical inventory[5]..

II. Literature Review

Augmented Reality (AR) try-on technology, exemplified by ARTON3D, has garnered considerable attention in the retail sector for its potential to transform the online shopping experience, particularly in fashion retail. Research in this area has explored the various applications and benefits of AR try-on tools like ARTON3D, highlighting their capacity to enable consumers to virtually try on clothing and accessories in real-time. Studies indicate that such technology positively influences consumer behavior by enhancing perceived usefulness, ease of use, and visual realism, thereby contributing to higher conversion rates and customer satisfaction. Advancements in computer vision, 3D modeling, and user interface design have played a significant role in improving the effectiveness and usability of AR try-on systems, making tools like ARTON3D more immersive and lifelike for users. Design principles focusing on interactive virtual mirrors, personalized recommendations, and seamless integration with e-commerce platforms have also been emphasized to enhance the user experience. Looking ahead, the future of AR in fashion retail presents promising opportunities, with emerging trends such as virtual fashion shows and AR-powered fitting rooms. ARTON3D is positioned to capitalize on these trends and continue innovating in the AR try-on space, further revolutionizing the way consumers shop for fashion items online.

Summary of Literature Review

Sr.No.	Title	Publication Year	Approach	Advantage	Disadvantage
1.	Virtual Fitting Rooms	April 2022	The architectural design of virtual fitting rooms and analyze several advanced AI techniques	briefly compared and analyzed the biometric privacy law landscape in the US, EU, and India.	Ethical issues that can arise from the usage of underlying AI technologies
2.	Customization of User Experience in Fashion Technology	February 2023	Customize purchasing the clothes by using 3D body scanners to get the exact measurements so that the user can wear readymade clothes according to his exact body dimensions.	Philips aimed to create an informative mirror with health monitoring capabilities.	They need for on-body electronics to collect and analyze health data, which could make the system more complex
3.	The Influence of Virtual Wardrobe Apps on Sustainable Fashion Practices	Announced in 2011	The study approach involved descriptive analysis, content analysis and theoretical analysis in the first section. The later sections focus on sustainability practices across the apparel supply chain that can foster acceptance of sustainable fashion.	A systematic review and future research agenda for sustainable fashion in the apparel industry	sustainability challenges in textile and apparel manufacturing firms
4.	Augmented Reality: An Upcoming Digital Marketing Tool	2021	The authors examine the potential of AR technology to transform marketing strategies, enhance customer engagement, and create unique experiences for consumers.	AR can address the challenges of online shopping by offering virtual try-on experiences, enabling consumers to visualize products in their own environment	Need for technological infrastructure, cost considerations, and ensuring seamless user experiences
5.	Implementation of Artificial Intelligence in Fashion	2022	The implementation of artificial intelligence (AI) in the fashion industry	Improved product discovery and enhanced shopping experiences. AI algorithms can analyze vast amounts of data to offer personalized recommendations based on individual preferences, style, and previous purchase behavior.	Concerns related to the ethical use of AI, potential biases in algorithmic decision-making, and the need for transparency and explainability.
6.	Artificial Intelligence for Fashion	2023	The author discusses how AI can be employed in areas such as trend forecasting, product	This technology allows customers to make more confident and informed decisions when shopping online,	The need for transparency, accountability, and responsible data usage to address concerns

			design, supply chain optimization, personalized recommendations, virtual try-on experiences, and customer service.	reducing the likelihood of returns and exchanges.	related to privacy, bias, and algorithmic decision-making
7.	Augmented Reality Fashion	2019	AR technology can create virtual fitting rooms, allowing customers to try on clothes virtually and see how they look on their own bodies. By analyzing body measurements and proportions, the AR system can recommend personalized clothing options that fit the customer's preferences and body type.	AR technology can provide information about the sustainability aspects of clothing items, such as materials, production processes, and certifications. By offering transparency and educating consumers about sustainable fashion choices, AR technology empowers them to make more informed and responsible purchasing decisions	As the need for high-quality graphics and seamless user experiences, acknowledge potential barriers related to user acceptance and the integration of AR technology within existing retail environments.
8.	Augmented Reality Applications in Sustainable Fashion	2023	The increasing importance of sustainability in the fashion industry and the potential of AR technology to contribute to sustainable practices.	By leveraging AR for virtual try-on, sustainable fashion brands can offer a more efficient and eco-friendly shopping experience	The need for accurate garment recognition and realistic virtual representations

III. Proposed Workflow

1) Initialization:

Power on the AR mirror system.
Ensure the mirror display is clear and ready for interaction.
Start the AR application/software.

2) User Interaction:
The user approaches the mirror.
The AR application detects the user's presence and activates the interface.

3) Selection of Products:
The user selects the category of products they want to try on (e.g., clothing, accessories, glasses).
They can browse through available options either through touch, gesture, or voice commands.

4) Virtual Try-On:
Once the user selects a product, the AR system superimposes a virtual representation of the product onto the user's reflection in real-time.
The user can adjust the size, color, or style of the product as needed.
The AR system uses computer vision algorithms to ensure accurate placement and fit of the virtual product on the user's body or face.

5) Interaction with Virtual Products:
Users can interact with the virtual products, such as rotating, zooming, or flipping them to view from different angles.
They can also experiment with layering different products together to see how they complement each other.

6) Saving or Sharing:
Users have the option to save their favorite combinations or share them with friends through social media or email directly from the AR interface.

7) Feedback and Adjustment:
Collect feedback from users about their experience and any issues encountered during the try-on process.
Use this feedback to improve the AR system's accuracy, performance, and user interface in future iterations.

8) Shutdown:
Once the user is done, they can exit the AR application.
Power off or put the AR mirror system into standby mode to conserve energy when not in use.

9) Maintenance and Updates:
Regularly maintain the AR hardware and software to ensure optimal performance.
Install updates or patches to improve functionality and security.

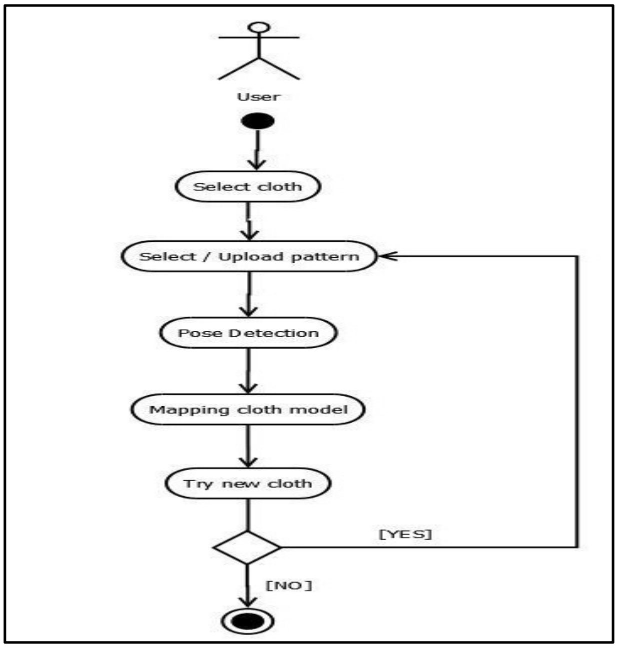

FIG.1:PROPOSED WORKFLOW

IV. METHODOLOGY

THE CREATION AND EXECUTION OF "ARTON3D" ADHERE TO A STRUCTURED METHODOLOGY, WHICH INVOLVES MULTIPLE CRUCIAL PHASES TO GUARANTEE A METHODICAL AND EFFICIENT APPROACH TOWARDS ACCOMPLISHING THE PROJECT'S GOALS.

A. Requirement analysis:

1. Functional Needs:

   a) Facial Identification: The smart mirror must employ facial recognition technology to identify and authenticate registered users[6].

   b) Virtual Trial: Users should be able to virtually experiment with clothing and accessories presented on the mirror's interface.

   c) Weather Updates: The mirror needs to provide up-to-date weather forecasts tailored to the user's location.

   d) Calendar Integration: Users should access and manage their schedules through the mirror, displaying appointments and events.

2. Non-Functional Needs:

   a) Performance: The smart mirror must respond promptly to user interactions, ensuring a smooth user experience[7].

   b) Security: User data, especially facial recognition data, should be securely stored and inaccessible to unauthorized individuals.[1]

   c) User-Friendliness: The mirror's interface should be intuitive and easy to navigate, catering to users with varying levels of technological proficiency[2].

   d) Scalability: The system should be designed to accommodate future upgrades in hardware and software.

   e) Reliability: The smart mirror should operate consistently and without interruptions, ensuring users can depend on its functionality.Maintaining the Integrity of the Specifications[14]

B. Design And Implementation:

1.1. Hardware Design

a) The hardware design of ARTON 3D plays a pivotal role in the project, encompassing the selection of appropriate components and the establishment of the physical infrastructure necessary for the mirror's functionality. Below are the key components utilized in the hardware design:

b) Mirror Panel: The mirror panel, featuring a semi-reflective surface, serves as a two-way mirror. This design allows the display to be visible through the mirror while reflecting the user's image. The size and quality of the mirror panel significantly impact the overall user experience.

c) Display Screen: Positioned behind the mirror panel, a high-resolution display screen showcases information, graphics, and animations. We have opted for an LCD screen with a resolution of 1920x1080 pixels to ensure clear and vivid visuals.

d) Raspberry Pi: Serving as the central processing unit, a Raspberry Pi microcomputer drives the functionality of the smart mirror. It is responsible for executing the software, processing user interactions, and managing other peripherals.[18]

e) Frame and Enclosure: A custom-designed frame and enclosure securely house the mirror panel, display screen, and Raspberry Pi. The frame's design should be visually appealing and seamlessly blend with the surrounding environment.

f) Two-Way Mirror Film: In instances where a pre-made two-way mirror panel is unavailable, a two-way mirror film can be applied to a standard glass panel to create the desired reflective surface.

1.2. Software Design

a) The software architecture of the ARTON 3D Smart Mirror is a crucial aspect of its functionality, encompassing the operating system, user interface, and applications. Below are the principal components utilized in the software design:

b) Operating System: Raspbian OS, a Linux-based operating system optimized for the Raspberry Pi, was selected as the foundational platform for our smart mirror.[18]

c) User Interface (UI): The user interface was meticulously crafted to ensure intuitiveness and user-friendliness, presenting information modules, widgets, and interactive elements on the mirror's surface. A custom graphical user interface (GUI) was developed specifically for this purpose.[2]

d) 3D Rendering Engine: To generate the 3D holographic effects, we implemented a dedicated 3D rendering engine. This engine processes 3D models and animations, projecting them onto the mirror's surface in real-time.[11]

e) Voice Recognition and Control: Incorporating voice recognition software enables users to interact with the mirror using voice commands, employing microphones and speech-to-text technology for seamless interaction.[5]

f) Internet Connectivity: The smart mirror relies on internet connectivity to access real-time data, including weather updates, news headlines, and social media feeds. This connectivity ensures that users have access to up-to-date information at all times.[4]

1.3. Implementation

a) Mirror Assembly: The initial phase of implementation involves assembling the mirror hardware. This includes attaching the two-way mirror panel to the frame, mounting the display screen behind it, and securely placing the Raspberry Pi and other components within the enclosure.[15]

b) Software Installation: Subsequent to hardware setup, the Raspberry Pi is loaded with Raspbian OS, followed by the installation of the custom smart mirror software. This software encompasses modules for the user interface, 3D rendering engine, voice recognition, and internet connectivity.[18]

c) Scaling the 3D Cloth Model: Adjusting the scale of the 3D cloth model involves specific steps. Firstly, in Blender, the clothes' dimensions are altered to correspond to real-world measurements, such as shoulder length, elbow length, and full torso length. Following this, the scale of the 3D cloth model is set to 1.00 in Blender.[11]

d) User Training and Documentation: Comprehensive user training materials and documentation are crafted to offer guidance on utilizing and optimizing the functionality of the ARTON 3D Smart Mirror.[16]

e) Final Assembly and Deployment: After thorough testing and confirmation of all components' proper functionality, the mirror undergoes final assembly and is prepared for deployment. This may entail wall mounting or positioning it in the desired location.

C. Testing And Deployment:

1) Testing

I. Unit Testing: Unit testing involved evaluating individual components or modules of the system independently to ensure their proper functioning. In the context of the ARTON 3D Smart Mirror, unit testing will primarily focus on the following components:

a) Hardware Testing:

i. Display: Validating the mirror's display functionality to ensure clear and accurate reflections.

ii. Camera: Assessing the camera's performance for facial recognition and gesture detection.

iii. Computer: Ensuring the mini-computer operates seamlessly.[18]

b) Software Testing:

i. Operating System: Evaluating the compatibility and performance of the chosen operating system.

ii. User Interface: Confirming that the user interface (UI) is responsive, user-friendly, and devoid of errors.[14]

iii. 3D Rendering: Verifying the 3D rendering engine's ability to accurately display virtual objects.

iv. Connectivity: Testing Wi-Fi connectivity for smooth communication with external devices.

v. Data Management: Validating functions related to data storage and retrieval, such as saving user preferences and accessing external data sources.[1]

II. Integration Testing: Integration testing centers on assessing the interactions between different components. For the ARTON 3D Smart Mirror, integration testing will include:[17]

a. Software and Hardware Integration: Evaluating communication between software and hardware components, such as adjusting the display based on user commands.

b. Gesture Control Integration: Validating the integration of gesture control with other functionalities, such as controlling 3D objects based on gestures and navigating the system.

2) Deployment

I. Pre-Deployment Preparation:

Before deploying the ARTON 3D Smart Mirror to its intended location, several preparatory steps were essential:

(1) Final Testing: Performing thorough final testing to ensure all identified issues and bugs are resolved.

(2) Data Backup: Backing up all user data, preferences, and settings to prevent potential loss during deployment.

(3) User Training: If necessary, conducting training sessions for end-users to acquaint them with the smart mirror's operation.

II. Deployment Process:

The deployment process involves physically installing the smart mirror, configuring it, and making it ready for end-users.

(1) Hardware Installation:

(a) Mounting: Securely mount the smart mirror in the desired location, ensuring stability and proper positioning.

(b) Connectivity: Ensure the mirror is connected to a stable Wi-Fi network and any necessary external devices.

(2) Software Configuration:

(a) Initial Setup: Configure the smart mirror's software, including the operating system, user preferences, and network settings.

(b) Security: Implement essential security measures to safeguard user data and the smart mirror system.[1]

(3) User Onboarding:

(a) User Guidance: Provide user guides or on-screen instructions to assist users in getting started with the smart mirror.[2]

(b) Support: Establish support channels for users to seek assistance or troubleshooting.[17]

III. Post-Deployment Monitoring and Maintenance:

Deployment marks the beginning of the operational phase, requiring continuous monitoring and maintenance to ensure long-term functionality and user satisfaction.

(1) Performance Monitoring: Regularly monitor the smart mirror's performance, covering both hardware and software components.

(2) Software Updates: Periodically release updates to enhance functionality, address bugs, and improve security.

(3) User Feedback: Collect user feedback continuously to inform ongoing improvements.[2]

(4) Technical Support: Offer ongoing technical support to address user inquiries and resolve any issues promptly.

V. REQUIREMENTS

ARTON3D mirror are typically composed of the following elements[18]:

1. Reflective Surface: Utilized as the mirror's reflective component, enabling the display to be visible through it when activated and functioning as a regular mirror when inactive.

2. Screen: A slim, high-resolution monitor or screen positioned behind the reflective surface, responsible for presenting various information and visuals.

3. Microcomputer (e.g., Raspberry Pi): Functions as the central processing unit of the smart mirror, executing essential software and managing diverse functionalities. The Raspberry Pi is a popular choice due to its compact size and adaptability.[18]

4. Frame: Provides structural support and enhances the aesthetic appeal, framing the reflective surface and screen.

5. Software: Customized applications drive features such as weather updates, calendar integration, and news feeds. Tailored to individual preferences, the software may include additional capabilities like voice commands or touch interaction.

6. Sensors: Motion sensors can be integrated to activate the display upon detecting movement, while ambient light sensors adjust brightness according to surrounding light levels.

7.Connectivity: Integration with Wi-Fi or other communication protocols enables the smart mirror to retrieve real-time data and updates.

8. Power Source: A dependable and efficient power supply ensures continuous operation of the smart mirror.

By amalgamating these components, ARTON3D smart mirrors deliver a personalized and interactive user experience, seamlessly merging technology with a traditional household item.

VI. RESULT

Before delving into the findings and analysis, let's briefly review the project objectives outlined :

1) Objective 1: Develop a fully operational ARTON 3D Smart Mirror prototype.

2) Objective 2: Implement advanced facial recognition and gesture control functionalities.

3) Objective 3: Evaluate user satisfaction and usability through user testing.

Prototype Development:

This section provides an outline of the technical development of the ARTON 3D Smart Mirror, encompassing both hardware and software components. Challenges encountered during development are discussed along with their resolutions[7]:

a) Achievement of 2D cloth try-on and gesture control.

b) Cloth rendering and human face recognition.

c) Pose detection.

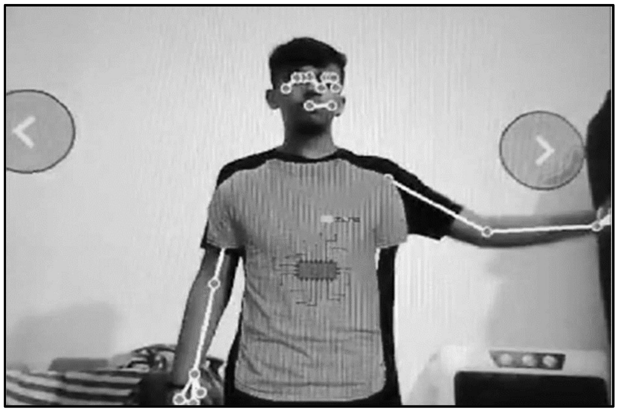

Fig.2: 2D cloth try on with gesture control

Fig.3: Denim jacket 3D try on (Front)

Fig.4: Denim jacket 3D try on (Back)

Fig.5: Puffer jacket 3D try on (Front)

Fig.6: Puffer jacket 3D try on (Back)

Advanced Features Implementation:

Further exploration is made into implementing advanced features like facial recognition[6] and gesture control, drawing from libraries such as Openpose and Cvzone. Algorithms utilized include VTON for virtual try-on via Computer Vision and Magic Mirror for standby operations[13].

❖ User Testing:

a) Test Methodology:

During user testing, participants bring garments in front of the mirror for scanning. Subsequently, the mirror adapts and superimposes the scanned image with the individual's reflection, providing a virtual representation with the selected clothing[10]. The system allows garments to follow body movements[11], offering a realistic simulation. Additionally, lighting adjustments in the fitting room enhance the user's experience, enabling them to view outfits under different lighting conditions[10].

b) Analysis:

An analysis of the 2D pose estimation model (Openpose) reveals an accuracy range of 90-95%[14], as indicated by prior research. Testing conducted on real-world videos confirms the model's acceptable accuracy.

c) Discussion:

The integration of established concepts and methodologies in existing smart mirror systems has resulted in a reliable and user-friendly interactive system. The ARTON 3D Smart Mirror represents a novel application of smart technology, offering seamless interaction and ease of use.

VII. Conclusion

The ARTON 3D Smart Mirror project has been an endeavour to develop an innovative and interactive mirror that seamlessly integrates physical and digital aspects, providing users with a unique and personalized experience. Throughout the project's progression, significant achievements have been reached, culminating in the fulfilment of various objectives and milestones. We completed 2D cloth try on as an milestone and have been working with 3D rendering to accomplish 3D overlaying.

In summary, the ARTON 3D Smart Mirror project represents a significant advancement in the realm of interactive smart devices, offering users a seamless integration of functionality, personalization, and privacy. With its innovative features and user-centric design, the ARTON 3D Smart Mirror is poised to redefine user engagement with their reflections and digital content in the contemporary era.

VIII. Future Enhancements

The aim of this study is to develop an effective and budget-friendly solution for creating a Smart Mirror, aiming to streamline the user's daily routine by providing essential information without the need to check other devices like PCs, tablets, or smartphones. The mirror seeks to offer this information seamlessly, integrating into the user's existing bathroom routine effortlessly.

While the ARTON 3D Smart Mirror project has made significant strides, there are numerous opportunities for future improvements and advancements to enhance its functionality and market appeal:

• Hardware Enhancements: Continuously improving hardware components, such as enhancing display resolution, to deliver more realistic and immersive experiences.[3]

• Software Upgrades: Regular software updates and expanding the software ecosystem to introduce new features, applications, and compatibility with emerging technologies.[17]

• AI Integration: Incorporating artificial intelligence and machine learning algorithms to provide personalized recommendations and enrich user experiences.[5]

• Expansion of App Selection: Collaborating with third-party developers to diversify the range of apps and widgets available, catering to various user interests and requirements.[4]

• IoT Integration: Strengthening integration with Internet of Things (IoT) devices to establish the mirror as a central control hub for smart home devices.[17]

• Advanced 3D Image Rendering: Implementing sophisticated 3D clothing models to enhance realism and immersion.[11]

• User Analytics Implementation: Deploying advanced analytics tools to gain insights into user behavior and preferences, facilitating better customization and targeted advertising.[6]

• Cost Efficiency Optimization: Exploring avenues to reduce manufacturing costs, thereby making the ARTON 3D Smart Mirror more accessible to a broader consumer base.[15]

• Global Market Expansion: Strategizing for international expansion and localization efforts to tap into global markets and adapt to regional preferences.[4]

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