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Art Rich: Place Your AR Artwork

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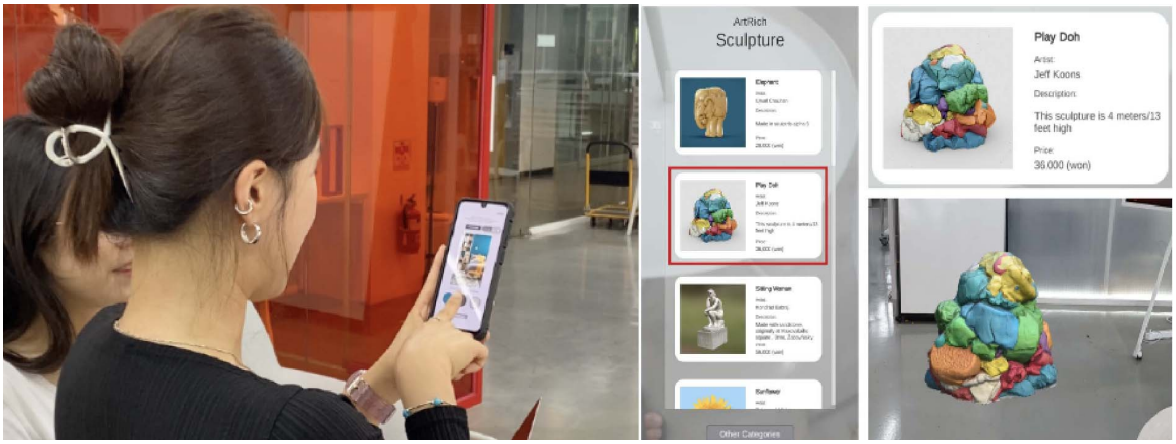

Figure 1: The user uploaded a picture of her room and got the three main colors extracted. When the user clicks one from the list of artworks in the category, it's augmented in the user's space shown in the bottom right image.

ABSTRACT

We propose Art Rich, an artwork augmentation service that helps users choose artworks to decorate their personal space without visiting the art fairs or galleries. We recommend artworks that match the color scheme of their rooms. By developing it in a Unity environment, augmented services could be implemented, and using the k-means algorithm, the primary color in the user's room is extracted. The extracted color is compared to artworks' colors, and artworks with similar or complementary colors are recommended. In addition, by measuring the length of the area to place the artwork, users can determine the size of the artwork. This service allows users to place artworks in their space and even purchase them. This could meet the art tech needs of the MZ generation, who want to quickly select artworks within their budget without visiting places in person. From an artist's point of view, it functions as a platform by inserting a link to information about their artwork and exhibition history.

Keywords: Artwork Recommendation, RGB Color Detection, AR Measurement, Dominant Color Extraction

1 MOTIVATION AND BACKGROUND

While art was sometimes considered a luxury long ago, its universal value has increased remarkably to the point that placing it in a living space is now seen as a refined interior. In addition, due to the development of technology, the size of the art market is rapidly growing, and the global art market is expected to grow from 275.58 billion dollars in 2021 to 455.37 billion dollars in 2022 in 2022 at a compound annual growth rate (CAGR) of 65.2 [1]. However, there is a lack of AR artwork visualization solutions from the perspective of producers of artworks, that are, artists and consumers, respectively, to revitalize this art market stably. As an artist, as the number of offline exhibition halls has decreased due to COVID-19, it has become difficult to expose and promote their works and the artists themselves to people. Also, even if they want to purchase an artwork, it is difficult for consumers to know whether it fits their office or home, so it is often difficult to buy it. Therefore, the market for art combining digital art and AR, which is easy for consumers to access artworks and promote artists and artworks themselves, is growing [2].

'IKEA Place' [3] visualizes how furniture would look and be suitable in people's homes. We saw some positive possibilities that AR could have in the art market. Furthermore, inspired by its concept of connecting AR with the furniture, we thought that if consumers could virtually place artwork in their space before purchasing it, not only artists could effectively promote themselves and their works, but also consumers could experience artworks in their area that has AR's virtual space combined. In the case of augmenting the actual artwork, when people ran the Acute Art app [4] in a designated place for each city, they could see the companion figure 'KAWS' floating in the air. It is a way to keep 25 kinds of ubiquitous KAWS figures by combining AR and VR for life. The figure can be purchased through the Acute Art website, placed anywhere, and photographed at any time. The AR Kit of the company 'PINZLE' [5] is launched to help people purchase by first hanging the artwork on the wall in AR. After finding artworks that suit their taste, they can determine in advance where this work will fit their space or what the actual size of the artwork will be. The application ARTPEDIA's AR [6] view function is for the virtual placement of artworks. When the reference point recognizes the floor and turns blue, fix the reference point where the floor meets the wall. The location and size can be adjusted. INHAABIT [7], a startup that proposes augmented reality

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art, can augment and show paintings but does not have a system to view artist profiles or recommend artworks.

The aim of the Art Rich application is to create a system that allows the user to select the artworks from the catalog and examine their artworks closely via AR, and know each artwork's information such as its name, its artist, and a brief description of it that the user selected before buying. In addition to providing these, we also aim to develop an artwork recommendation system. For example, it establishes a suggestion system according to the color harmony of the place and the artwork and measuring the area.

There are two main aspects of what our service wants to help. The first is to handle the artwork customer's concern about whether the work will fit his house before purchasing the piece. The second is to solve the artist's difficulties in promoting the work due to the non-face-to-face era. The detailed workflow proposed by our service are as follows:

- Detecting the floor and walls through 'Plane Detection' to augment the artworks in space similar to the real world
- Enabling the users to move smoothly, rotate, and resize artworks augmented in the user's space with a single touch
- Accessing information about the augmented artworks and connecting the users to their purchase website
- Extracting the 3 dominant colors of the user's space and recommending an artwork in a similar or complementary color relationship to the color extracted so that it matches the space
- Proposing a proportion of the artwork size appropriate to the size of the user's room by measuring the width and height of a specific area

2 Related Works

2.1 Artwork Recommendation

In the area of Computational Vision, one of the oldest approaches to extracting information from an image is to use Explicit Visual Features such as brightness, color, and texture. This analysis relies on measures obtained from image representation defined as a set for EVF for attractiveness: brightness, saturation, sharpness, entropy, RGB-contrast, colorfulness, and naturalness [8]. Dominguez et al. study and compare the performance of DNN and Explicit Visual Features (EVF) for physical artwork recommendation using transactional data from an online store of physical paintings. They obtain a vector of explicit visual features of attractiveness using the OpenCV software library based on brightness, saturation, sharpness, entropy, colorfulness, and naturalness. The brightness measured the level of luminance in RGB color space. In the case of saturation, it defines the vividness of a picture; colorfulness estimates how distant the colors are from gray; and naturalness determines how realistic the image is, grouping pixels in Sky, Grass, and Skin [9].

Visual recommendation systems are not sufficient in the research yet. They do not constitute a good work of art recommendation system. Although there are artwork suggestion systems for color detection, there is no color-oriented system over AR. Studies focus on the algorithmic approach and metadata. There is neither a museum platform nor a personalized strategy that offers an art recommendation system using the AR camera feature. In this sense, our research includes a new approach in its field.

2.2 AR Measurement

There are commercial measurement applications. One of them is the AiRDose smartphone app [10]. The app that uses augmented reality to provide length-based weight estimates and equipment sizing recommendations, AiRDose, was programmed to transform to obtain these estimates. The primary aim was to compare the length estimated by AiRDose with the actual size obtained with the standard tape measure. For this, the measurement tape method has been applied. Second, the IKEA Place application allows users to arrange a room or apartment of a specific size in real-time with real-size elements. This will enable them to lay out, for example, a two meter by three-meter room in such a way that includes a bed, table, television, and wardrobe.

Third, MeasureKit: AR Ruler Tape is also useful and offers many options. For example, the mode in Ruler Tool allows users to quickly link multiple rulers together in one measuring session and measure the floor area enclosed by a chain. This allows the app to offer an accurate measuring experience, including on walls and other vertical planes. While most similar AR ruler apps are limited to measuring accurately only on a desk and floor, MeasureKit enables users to calculate a painting on a wall efficiently [11] We have integrated the applied AR measurement function into our recommendation system to improve artwork placement.

3 Our Approach

3.1 Plane Detection, Zoom In/Out, Rotation, Smoothing

We designed a user interface to ensure our target users can use it comfortably and find what they want. Through plane detection, the floor, table, ceiling, and wall displayed on the camera screen can be recognized, and virtual objects can be naturally placed in real space using the anchor function. In addition, we wanted to provide a UI that allows easy manipulation without additional buttons so that you can zoom in and out of artworks with a finger touch. In addition to the code, Leantouch was used to overlap the actual space so that the artwork could be moved, placed, and rotated.

3.2 Linking to Artists' Websites and Information

We considered how we would provide some information about the AR artwork. Therefore, we included the function that the users can tap and see the simple statement of the artwork like the name, price, and artist's name. And if the user clicks the button above, implemented with the 'Onclick' function, it links to the artists' website. Therefore, users can quickly get detailed information about the artist and artwork. In addition, users can show or hide information by turning the button on and off.

3.3 Recommendation System – Color Detection

To suggest artworks that match the color scheme of the place, we let users upload an image of their site. By clicking the 'Upload your space' button implemented with the function 'GetImageFromGallery' from the asset NativeGallery, the application accesses the gallery or file explorer on the user's phone. Since it is implemented with the 'save' function, it remembers the image once uploaded for the user's convenience. After loading the picture, the top three dominant colors of the uploaded image are detected and presented below the image.

By detecting multiple colors in the room, the system can suggest artworks to the user according to color preference. We used similar and complementary color references in standard interior designs for color selection. For example, if the wall color to be placed has a cold color, the system may suggest an artwork similar to the room's color or recommend warm colors, which are complementary colors of the room. When a user uploads his interior image to get color based artwork recommendation, our application converts the image into Unity's texture 2D type to read the pixels of the picture. After the image is read using the function 'GetPixel,' it gets the three primary colors using the K-means algorithm. The cluster value is set to three for extracting the three primary colors.

These colors will be demonstrated in the form of a round button, and when users click on them, they will get a list of recommended artworks based on that particular color. To name the RGB values into the 'color names' we are familiar with, we converted the RGB values

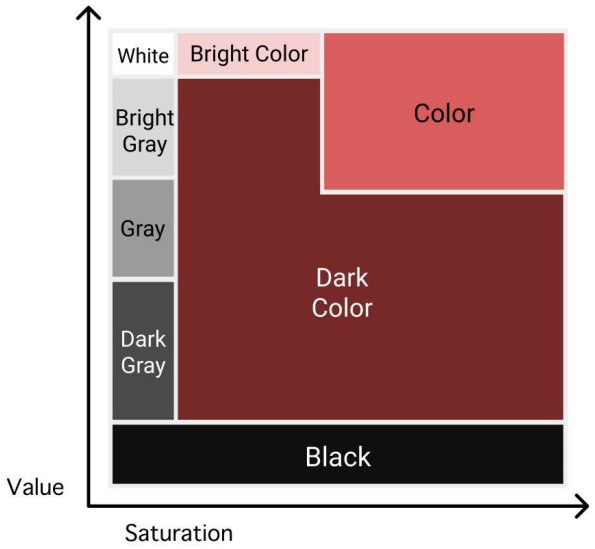

Figure 2: The color chart is divided into nine areas based on the saturation and value. The color, bright color, and dark color are further divided according to the hue values.

into HSV values using the RGB to HSV function, and the HSV value is named as a color corresponding to the range of preset color values. The pre-set color range was calculated as follows: After dividing the color chart into eight areas based on the saturation and the value, the overall color was split into a total of thirty-five colors by further dividing it based on the hue value. Finally, the chosen color is compared with the pre-designated primary color of each artwork. The artworks in a similar or complementary color relationship to the color the user picked are shown on the recommended artwork list.

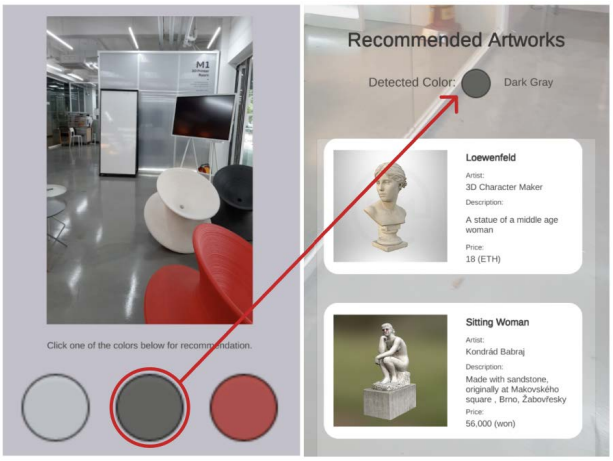

Figure 3: A screen that shows the extraction of three primary colors. When the user clicks one of the colors, it shows the recommended artworks based on similar or complementary colors.

Additionally, users may touch the space in real-time and detect the color of the touched point. To get the RGB value of a touched point, we converted the scene being filmed with a camera to a texture type using 'Unity. texture = RTImage (cam)' so that the scene visible to the camera is recognized as an image. Then we implemented a function 'Test get pixel' to extract the color in augmented reality, not the screen color in Unity. When the mobile phone is illuminated in space, you can know the location and RGB values when you touch the color value you want to see on the screen with your finger.

3.4 Recommendation System – Measurement

The second recommendation system is an AR measurement tape making a more accurate artwork placement in practice. We have reached the sources for measurement on AR sample GitHub sources [12]. After completing the measurement coding, we added the code file in the prefab we use for the measurement tape application, which we call measurement balls. As a result, the system shows the length of two balls so that one ball is fixed and the other goes to the desired distance. This measurement factor can go from in centimeters, so this measurement has an element that calculates wherever measurement users want to use, such as walls. The application is intended to create the Measuring Tape mode, which allows the users to measure by dragging their fingers between any two points on the plane to make a measurement. The Art Rich app prototype was developed in Unity Game Engine version 2019.4.36. We installed our application on a Samsung A70 Smartphone, which runs on Android OS.

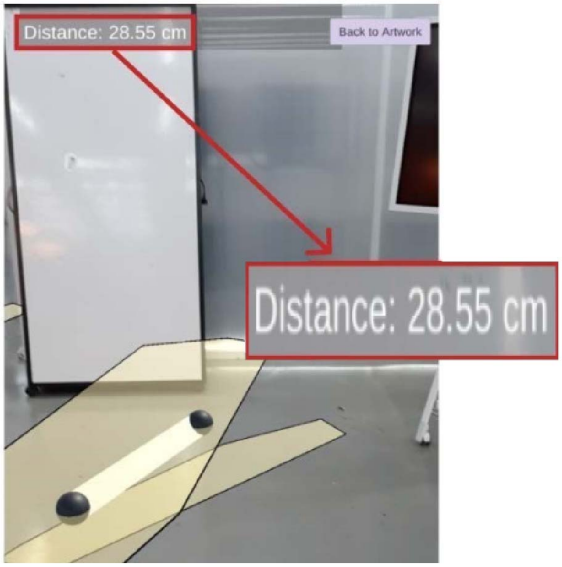

Figure 4: A screen that indicates that the user is measuring the length of a specific area to help determine the size of the artwork.

4 Exemplary Scenario

Art Rich, our proposed application, targets the MZ generation, people in their 20s and 30s who are interested in artwork and interior design and are skilled at using smartphones. Nowadays, they are more interested in artwork for investment purposes as there is even a new term 'art-tech (art + investment technique).' Furthermore, with COVID-19, people have been spending more time at home and began to take an interest in home interior, which led their attention to artwork, a great way to show off their taste intensively [13]. The environment in which they will use this application applies to any space where they want to put the artwork, and the detailed usage scenarios are as follows.

First, when users open the Art Rich application, two options are available to choose an AR artwork. The first option is choosing from Artwork categories. This is a method of selecting one of the various

categories of artwork, reading the descriptions of the artworks in that category, and selecting an artwork among them. For instance, if users are interested in sculpture, they choose the 'Sculpture' category and look through the artwork list. Suppose users have difficulty selecting the right one for their space from the list. Then, they can go back to the application's main screen and select the second option, 'Scan your place.' To use this function, users must upload a picture of the room, and ArtRich provides three primary colors representing the space. For example, suppose red, green, and dark grey colors are extracted, and the user picks dark gray.In that case, ArtRich recommends several artworks whose colors are consistent with a similar or complementary color of the 'dark grey.' Users can choose among them and then freely manipulate the artwork's position, size, and rotation in her AR space. Suppose users want guidelines when selecting a size. In that case, they can click the 'Measuring' button and measure the area's width that people are curious about, or a figure of 1/3 or 1/5 of the width of a specific part of the space that the user scanned could be provided. Before users' final decision on the artwork, they can visit the artist's website and go directly to the purchase website by clicking the 'Purchase' button.

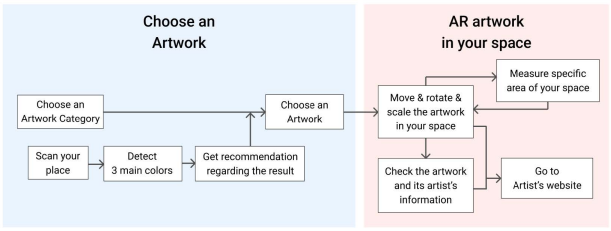

Figure 5: Potential User Scenario

5 Discussion & Conclusion

The universal value of art has increased remarkably to the point where placing it in a living space is now seen as a refined interior design. In addition, the size of the art market has increased noticeably due to the development of technology. However, for art producers, especially artists and consumers, there is a lack of AR artwork visualization solutions to steadily revive this art market. It has become more difficult to introduce the works of art and the artists themselves to people. Lastly, even if they want to buy a piece of art, it is difficult for consumers to know whether it is suitable for their office or home, so it is often difficult to purchase. These are reasons that we developed the AR application to create a platform that combines digital art and AR, which is easy for consumers to access and promote artists and artworks. We suggested the color detection and AR measurement as recommendation system.

There are several points that Art Rich has to be developed. First, if the user wants to buy the artworks on Art Rich application, she has to go to the external website that sells artworks and purchase them. Therefore, purchasing the artworks through an In-app transaction will make it easier for users to buy. Second, the user scenario of our app is implemented from a consumer perspective, and it is also necessary to implement a scenario from the artist's perspective, which includes the artwork uploading process. Third, the artworks according to the dominant three colors are being recommended. However, if the artworks are also suggested according to the picked RGB value of the user's choice, it will provide more suitable works for consumers.

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