ARCam: A User-Defined Camera for AR Photographic Art Creation

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ABSTRACT

Photography in augmented reality can be challenging due to the restrictions of pre-defined settings. However, adjustable photography settings and real-time previews are significant for AR photographic creation as creators must adjust multiple camera properties to present unique visual effects. In this work, we designed an AR camera (ARCam) with various adjustable properties to give users a high degree of freedom for photographic art creation in real-time preview.

Index Terms: Human-centered computing—Visualization—Visualization systems and tools—Visualization toolkits; Human-centered computing—HCI—Interaction paradigms—Mixed/ augmented reality

1 INTRODUCTION

Photography is often regarded as the art of using light. Photographers create artwork by manually optimizing photographic properties such as aperture, shutter speed and ISO [6]. In recent years, AR has become a new artistic paradigm thanks to the low production cost and rapid reproduction regardless of the spatial limitation [2]. In many AR applications, the virtual 3D model requires more attention and focus compared to the physical environment which is mostly considered as the background. When users want to focus on a single object and blur the background to prevent the distraction of cluttered items or to protect their privacy, it is difficult to do so due to the non-adjustable default settings. Although some social media platform (e.g., Snapchat) has included many background filters [3], AR content creators have little flexibility editing their photographic works with unique styles.

This work aims to achieve a highly adjustable system by developing a user-defined AR camera. Hence, the user can customize multiple properties such as color tones, light intensity, focus distance, and exposure time while previewing the stylized photo in real time over the process of photographic creation. The primary functions of ARCam include camera properties simulation, real-time preview of processed images, and lighting estimation.

2 ARCAM FRAMEWORK

2.1 Implementation

The AR application was developed in Unity3D 2021.3.12 with the EasyAR toolkit [1] which allows plane detection and surface tracking. The exported application was run on an Android 13 mobile phone. The user interface contains five buttons from the top to bottom: *reset*, *setting*, *shot*, *post-processing switch* and *surface detection switch*.

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[1]https://www.easyar.com

The *setting* button allows the user to adapt multiple properties include lighting conditions, depth of field, shutter angle and filter color, given in Fig. 1. These properties each have several parameters for edition, demonstrated in Fig. 2.

Figure 1: ARCam user interface with settings panel expanded to adjust properties in real-time preview

2.2 Functions and Scenarios

2.2.1 Depth of field and motion blur

Physical camera and film properties used in AR like depth of field can greatly improve the photographic quality [4]. We provide the users with adjustment of depth of field, motion blur and chromatic aberration to create the effects of real camera properties. Changing the value of focus distance and focal length to set the distance to the point of focus and the distance between the lens and the film can change the depth of field. The larger the focal length value is, the shallower the depth of field is. This gives a visual cue about an object's distance and a clear composition of objects in the photo, as presented Fig. 3. To simulate the blur effect a physical camera creates when it moves with the lens aperture open, or when it captures an object moving faster than the camera's exposure time, increase the value of the shutter angle gives longer exposure and a stronger blur effect, as given in Fig. 3.

2.2.2 AR stylization and real-time preview

In image processing, content creators can design different photo styles by adjusting brightness, contrast ratio and filter colors etc. Similar intention is also applicable to unifying the style of virtual objects and the physical environment. To change the tint of the render, we provide red, green and blue channels for the users to edit the color of the filter. And parameters like hue shift, saturation and contrast can alter the hue and intensity of all colors adjust overall range of the tonal values. To add some special visual effects to the photo like glitch art [1] which is one of the core elements of the cyberpunk art style that takes the broken and distorted images caused by the hardware and software failures of digital devices and manipulates them artistically, users can increase the value of chromatic aberration. The chromatic aberration effect splits color along boundaries of objects into red, green, and blue channels to mimic RGB split glitch or color shift glitch, as in Fig. 4.

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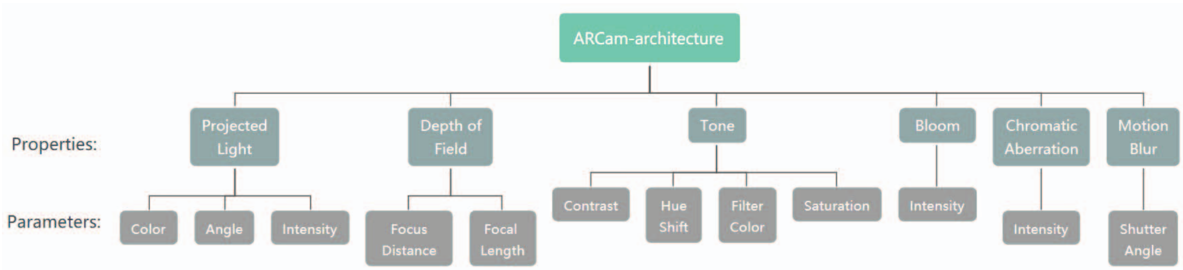

Figure 2: Hierarchy of the parameters and the corresponding properties.

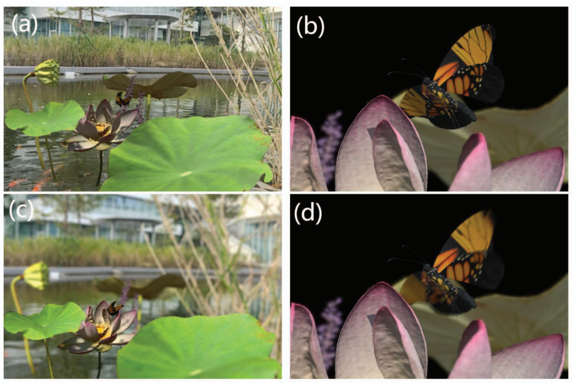

Figure 3: Demonstration of depth of field and motion blur, the lotus flowers and leaves are virtual objects. (a) is the original image, (b) uses the depth-of-field effect, (c) is the original image, and (d) uses the motion blur effect.

Figure 4: Demonstration of AR stylization and adaptive lighting. The whale in the air is the virtual object. (a) shows the original image, while (c) shows the cyberpunk art style image with hue shift and chromatic aberration. (b) and (d): The light projected onto the virtual object automatically adapts to the light of the real environment.

2.2.3 Auto-estimation and user-adjusted lighting

Existing AR toolkits such as ARCore and ARKit can approximate the lighting status of the physical environment and apply the the same light cues to the virtual object, which allows the AR system to provide more realistic experience [5]. However, this can lead the virtual objects to be overexposed or underexposed due to the lighting condition of the physical environment and leaves little chance for people to adjust the light to present the virtual objects. Therefore, in addition to automatically sensing the ambient light and calculating the light intensity projected onto the virtual object in real time by calling the optical sensor of the mobile phone, ARCam allows the user to adjust the intensity, angle and the color of the light projected onto the virtual objects, presented in Fig. 4

3 Conclusion

The physical environment in AR is often considered as the background when demonstrating the 3D model, and the photographic properties of such background is unable to be modified . In this work, we employed the traditional photography process to AR scenario and proposed the ARCam to enable customized parameters. Creators can adjust the depth of field, color and other basic parameters such as brightness and saturation in the scene and inspect the effect in real time. We showed scenarios using functions like depth of field, stylization and auto-adaptive light to demonstrate how ARCam can provide greater freedom for users to create AR photographic art.

4 Limitations and Future Work

The work still suffers some defects. One limitation of our study is that the developed ARCam functions may not satisfy the user preference due to diversified user habits and the lack of user study. Future work includes implementing user studies for optimizing the operating interfaces to improve user experience. Another limitation is that although we try to simulate the ambient light intensity artificially and apply such light intensity on virtual objects to make consistent light between the virtual and physical world, ARCam needs to involve more light cues such as shadows and reflections to deliver a realistic AR experience. Also, more camera simulations like lens distortion and special visual effects can be provided to the user for them to better produce the photographic art works.

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