# Design and Realization of AR-based Eye Disease Experience App

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## Abstract

China has the largest number of blind in the world. If we may understand the cause of eye disease, prevent it ahead of time, and treat it in time, the number of blind will be reduced significantly. Thus, it is of great necessity to put more efforts and money against the prevention and control of eye diseases. Design and development of the eye disease experience app may facilitate people's understanding and experience of eye diseases, featuring in the eye disease prevention field. Multiple symptoms are simulated with the unity shader in this paper, the eye disease App Different World with immersive headband equipment has been designed to create a better sensual experience.

Key words: eye disease experience; app; Unity shader; VR

# Introduction

China has the largest number of blind in the world. According to the ophthalmologists, a majority of blind may avoid blindness in the beginning, and even a part of the blind can regain their sight if they pay attention to understanding the cause of eye diseases, prevent it ahead of time, and treat it in time. Thus, it is of great necessity to put more efforts and money against the prevention and control of eye diseases.

Relating to quite a good deal of fields, however, multimedia technology brings little effect in prevention and control of eye diseases. Man-machine interaction may be realized based on AR, short for Augmented Reality, by which, people can experience the inconvenience and pain of the patient with eye disease, and beware of the necessity to prevent any eye disease. Application of AR technology drives the progress of multimedia experience platform, and with it, people can experience a different world in an immersive mode.

At present, the progress of ophthalmology linked with client development at home and abroad mainly focuses on examining eye diseases or experiencing an eye surgery [1]. A professional ophthalmologic examination can be completed by a smart phone with traditional eye examination equipment and specially-made camera for retina examination, and the cataract, glaucoma and other eye diseases can be examined. If an immediate treatment or doctor consultation is not available, the fundus retina image shot by the equipment may be sent to the doctor directly, by which, the doctor can understand the patient's state and take corresponding actions. In a similar case, VR technology is used in a simulated operation scene in the medical field, by which, the doctor may simulate the risks that may occur in the operation to lower the operational risk; It may also apply to the medical education to facilitate the student's learning as well [2].

According to the current development of multimedia technology in ophthalmology field, the multimedia technology is mostly used for patients or doctors, but not specially for prevention of diseases, even with a little function in prevention. Disease prevention and health attention overweight the treatment after falling ill much, and the optimal solution is to "nip in the bud" [3]. As smart mobile devices become more powerful, people spend more and more time on their mobiles, unwittingly leading to a huge pressure on the proper and healthy use of the eyes, and a larger number of patients with eye diseases. For this purpose, the research topic to design eye disease experience app based on AR technology is put forward in this paper, by which, the eye disease experience mode is wider, and people may experience the inconvenience and pain of the patient with eye disease, and beware of the necessity to prevent any eye disease, and AR application is also extended, and symptoms of eye diseases can be embodied more specifically through AR technology [4].

This research topic is to promote the prevention and control of eye diseases using multimedia technology, and enable people to beware of the necessity to prevent and control eye diseases based on the features combining AR technology and reliability. The AR-based eye disease experience mobile app that combines technology and equipment enables the experiencer to switch effect by 2D image identification other than clicking box, by which, the normal people may share the worlds with the patients suffering from different eye diseases [5].

# Design of eye disease experience app

# A. Design idea

Eyes are the most important access to the world. In case of any eye disease, the patient will see a world different from that in the eyes of normal people, and cannot enjoy the colorful world, bringing large inconvenience for the work and life. Normal people cannot share their world or understand their pain. As common disease, eye diseases occupy quite a large proportion in diseases. People at different ages may suffer from different eye diseases, and those have material prejudice to the physical and mental health of primary and middle school students mainly include myopia and strabismus; while the eye diseases of middle-aged and elderly people are more dangerous, because such eye diseases may cause blindness.

Common eye diseases are roughly embodied as "refractive error, visual field change, distorted vision, blurred vision, and dyschromatopsia", which are the main symptoms of myopia, glaucoma, central serous chorioretinopathy, cataract and color blindness respectively. Patients with glaucoma can only see the center position of the vision field and lose their surround vision field. Patients with cataract have a blurred vision, and in their vision field, all objects are like covered by a film and the colors lose their definitions. Patients with central serous chorioretinopathy see deformed and diminished objects with a reduced contrast. Patients with achromatopsia can only see a dull world without any color, and their vision field is like a black-and-white photo only with gray difference, but not color difference. With a high occurrence, such 4 eye diseases may lead into serious consequence and significantly change the vision effect, providing a more impressive sensual experience. For this purpose, they are adopted as the design content, and app is named as *Different World*.

## B. Function design

The App has the following main functions:

1. Simulation of eye disease symptoms. Image processing methods were adopted to simulate the visual effects of glaucoma, eucommia, cataract and color blindness.

2. AR function. Provided with VR headsets, the experiencer will have an immersive sensation, but it is not convenient to switch the simulation effect of eye disease symptoms, and the AR identification technology will facilitate such switching.

3. Switching among different eye disease symptoms with identification card. 2D image identification cards representing different eye disease characteristics are designed.

4. Voice prompts. The experiencer does not have any true feeling about whether the identification is successfully after the experiencer uses the identification card. Thus, the voice prompts are added to the App to explain the corresponding symptoms after the card is successfully identified.

## Realization of eye disease experience app

## A. Realization of AR function

AR, a new technology interactive with the actuality in real time that is developed based on virtual reality technology, is widely used in medical field. As information combination technology between the real world and virtual world, VR technology will, according to the real-time actual scene, simulate the information that is hard to be solidified in the actual world via computer and other equipment, and enable such simulated result to co-exist with material object at the same space through display equipment and to be sensed by people, thus realizing a sensual experience beyond both actuality and stimulation, which intensifies the interaction and realizes the "seamless" joint between actuality and stimulation to the maximum extent [6].

In AR technology, the lens will align the identification card to identify and track the 2D image in real time after launching AR Camera, and the pre-set virtual role will be displayed at the designated area on screen [7]. AR mainly provides functions of identification and tracking, and the latter is mainly used in this paper.

## B. Vision effect realization of a patient with eye disease

The emphasis of this paper lies in the real simulation of symptoms of different eye diseases. Through comparative

research, shader attached to the Unity is adopted for this paper. Shader is a program outputting a specified color, chartlet, etc. in correspondence with a pixel and a color that the renderer can understand. It is mainly used for image rendering and screen effects, for example, to render images as required by the programmer based on the image processor [8].

According to the symptoms of glaucoma, a diminish vision field should be simulated. Therefore, the invisible position is darkened, a circle is drawn from the center point, and the area outside the circle is black, and the circle is the normal view field. With the circle as the boundary, the circle is rendered based on the real-time image captured by the camera, and the area outside the circle is rendered into black, shown as Fig. 1.





Patients with cataract have a blurred vision, and multiple methods are available for shader to render a blurred image. UV rendered based on image is adopted in this paper, in which, the displacement of image rendering takes place when moving UV point and overlays on the normal image to simulate a blurred vision.

Patients with central serous chorioretinopathy have a distorted vision, and the object in center of vision field is distorted, especially, a shaped object will have a more obvious symptom. For this effect, UV center of the rendered image is the center of vision, and the area within a certain radius is distorted, the effect is shown as Fig. 2.



Fig. 2 The simulation of symptoms of central serous chorioretinopathy

Patients with achromatopsia can only see a dull world only with black, white and grey. The RGB color value of each pixel is picked up and processed into grayscale values when rendering the image.

The object to be rendered in this research is a scene captured

by the camera in real time, other than a static image. Separate shader files are mainly used for texture rendering, the shader should be adopted for rendering real-time scenes, and the shader's code should be connected to the camera. For that purpose, a shader should be clearly stated in the c# file, and the shader file is dragged to C# to simply render the scene captured by the AR Camera. A new Camera will be created in this paper to connect these files and will synchronize with the rotation angle through AR Camera. Certain offset will take place at x direction to simulate the distance between the two eyes and form the double-screen effect, by which, the real-time scenes shot by AR Camera can be rendered, and management is facilitated to avoid errors as well.

#### C. Post-debugging and release

Post-debugging is the most important step before releasing the app. It is necessary for developers to take corresponding measures based on different reactions of the experiencers, which is also a preliminary investigation on whether the App is popular. Developers should also consider the targeted App users to pick the experiencer, because no app can satisfy every user.

The completed app will be released on Android. Fig. 3 is a user experience scenario.



Fig. 3 The simulation of symptoms of central serous chorioretinopathy

#### Conclusion

Unity3D has a wide application. Its cross-platform features are the main basis to be selected for the development of this topic, and its shader and screen effects are the main technologies of App design. Shader attached to the Unity is adopted to realize the real-time shooting of the camera, of which, the effect is quite good.

The outstanding feature of AR system is the information fusion between the real world and virtual world, featuring a real-time interaction. For that purpose, AR technology is widely used in various fields, such as medical, construction, and education, which is very suitable for this eye disease experience app.

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