Eye MG 3D Application - A comprehensive ocular anatomy and pathophysiology 3D atlas with real-time true color confocal images to enhance ophthalmology education and e-Counseling

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Concepts pertaining to ophthalmology have lots of theoretical frameworks. Neophyte residents and novice surgeons may have to mentally visualize these concepts during the initial days of training. Only a powerful cognitive tool such as a three-dimensional (3D) eyeball model, with real-time TrueColor confocal images (and not animated images or models), can fill in these intellecvt mental gaps. Giving the users (i.e., residents and students) the power to choose and visualize various parts of the eye, with multiple magnitudes of zoom, is mandatory for optimal e-learning. To make ophthalamic concept learning better, we have developed a 3D app Eye MG 3D (patent pending) comprising ocular anatomy and pathophysiological 3D models, built on an advanced interactive 3D touch interface, by using patient’s real-time confocal images to serve as a new-age pedagogical tool and e-counseling. According to our knowledge, there are no applications to date that incorporate real-time high-resolution multimodal confocal fundus images and photoreal visuals for interactive and immersive 3D learning.

Key words: 3D Ophthalmology, e-Counseling, e-Ophthalmology, Multimodal Imaging, Pedagogy, TrueColor Confocal Images

Throughout the last decade, several innovative and interactive smartphone applications became useful learning resources for ophthalmologists. They teach anatomy, clinical ophthalmology, mnemonics, grading systems, and surgical skills. However, in most of the anatomy teaching apps, the images used are 2D animated images or 3D animated models, which are quite different from the real-time images that one encounters in clinical practice. Moreover, there are very few zoom sections of complex, important landmark structures such as the angle of the anterior chamber in those teaching applications. Thus, we have developed a 3D application named “Eye MG 3D” (patent pending) to simplify ophthalamic concept learning [Fig. 1] for studying ocular anatomy and pathophysiology, built on an advanced interactive 3D touch interface, by using patient’s real-time confocal fundus images along with their multimodal images in multiple sections. We have also constructed the application with varying levels of zoom, ranging from a gonioscopic view to electron microscopic view, for complex structures such as the angle of the eye [Fig. 2]. This novel app aims to serve as a new-age 3D pedagogical tool for reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

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and e-counseling tool for ophthalmic learning and counseling, respectively.

Innovation

Usage of truecolor confocal real-time images to construct 3D models

The real-time gonioscopic images and the 110-degree mosaic real-time TrueColor confocal fundus images of various normal and pathological eyes were used for coding to build an advanced interactive 3D touch interface model. The highlight feature of this Eye MG 3D app is as follows: for every normal and pathological fundus, with a simple click of a button, various multimodal real-time images such as autofluorescence and infrared imaging can be visualized three-dimensionally. The various parts of each eyeball model with multimodal imaging were coded in the Unreal Engine software for customized sectional viewing and zoom of choice of the viewer in 360-degree angles [Fig. 3].

Features of the Eye MG 3D app

With the following steps, one can access this application for infinite e-learning or e-counseling:

1. Install the Eye MG 3D app on your android phone from the Google Play Store.
2. Click and launch the app.
3. To visualize various anatomical parts of the eye, click the “Anatomy” button from the main menu and then click the parts of the eye to be viewed accordingly [Figs. 4 and 5, Video Clips 1 and 2].
4. To visualize the various ocular pathologies [Fig. 6], click the “Pathology” button and then click the desired pathology from the drop-down list provided accordingly [Video Clip 3].
5. To access various 3D multimodal imaging of the fundus,
Figure 4: Image showing (a) Main menu of the “Eye MG 3D” app. Click the “Anatomy” button (red arrow) to view the eye anatomy. (b) Eye anatomy in the “Eye MG 3D” app. Click the “Anterior Segment” button (red arrow) to view the anterior segment of the eyeball. (c) Anterior Segment in the “Eye MG 3D” app. Click the “Angle” button (red arrow) to view the gonioscopic section of the angle. (d) Angle in the “Eye MG 3D” app. Click the “Trabecular Meshwork” button (red arrow) to view the electron microscopic structure of the angle. (e) Trabecular meshwork in the “Eye MG 3D” app.

Figure 5: Image showing (a) Main menu of the “Eye MG 3D” app. Click the “Anatomy” button (red arrow) to view the eye anatomy. (b) Eye anatomy in the “Eye MG 3D” app. Click the “Posterior Segment” button (red arrow) to view the posterior segment of the eyeball. (c) Posterior segment in the “Eye MG 3D” app. Click the “Fovea” button (red arrow)/the “Optic Disc” button (green arrow) to view the detailed structure of the fovea and the optic disc, respectively. (d) Fovea in the “Eye MG 3D” app. (e) Optic disc in the “Eye MG 3D” app.
click the button provided to change between the normal TrueColor fundus image and other multimodal fundus images [Figs. 7 and 8].

6. For visualization of 3D videos with real-time confocal images of various ocular pathologies, click on the “Video” button from the main menu to access it [Video Clips 4–9].

Discussion

Pedagogical transformation

This pedagogical transformation in e-ophthalmology aims to reinvent the approach to ophthalmic teaching through virtual platforms. This 3D app is constructed with pioneering ways...
Figure 7: Image showing (a) Main menu of the "Eye MG 3D" app. Click the “Pathology” button (red arrow) to view various ocular pathologies. (b) Eye pathology level in the "Eye MG 3D" app. Click the “Flecked retina” button (red arrow) from the drop-down list to view the pathology. (c) Click the “Color” button (red arrow) to view the colored model of the Fleck retina. (d) Click the “IR” button (red arrow) to view the infrared image of the flecked retina. (e) Click the “AF” button (red arrow) to view the autofluorescence image of the flecked retina.

of cult teaching, which can be extended out to any video output device [Fig. 1], along with photoreal cinematic 3D learning in ophthalmology. Multimodal confocal real-time imaging and ultra-zoom features in an e-learning app with deep visualization experiences have never been reported in the literature and can pave the way for a new age in ophthalmic pedagogy.

e-Counseling stations
Eye MG 3D will not only benefit the residents and ophthalmologists but will also help in customized patient counseling. This application is also constructed in a patient-friendly format. Thus, the nature of the disease and procedures ranging from a simple YAG laser peripheral iridotomy or anti-VEGF injection to a complex trabeculectomy/retinal surgery can be counseled with this app [Fig. 9]. The complex structures such as the angle of the anterior chamber, ciliary body, and posterior segment of the eye are constructed with 3D photoreal visuals of real-time images for simple and effective patient counseling experiences.[6,7]

Prerequisites of the Eye MG 3D App and its availability in various platforms
This app is currently available free of cost from Google Play Store for Android phones that run Android 7.0 or above.
Figure 8: Image showing (a) Eyeball with vitreous inside the “Pathology” section of the app. Click the “Vitreous On” button (red arrow) to disable vitreous for a clear view of the posterior segment. (b) Eyeball inside the “Pathology” section of the app with no vitreous.

Figure 9: Image showing the “Eye MG 3D” app being used for e-counseling.

Figure 10: Image showing the “Eye MG 3D” app available in Google Play Store and the QR code for downloading the app for Android users.

Figure 11: Image showing the screenshot of the website (meh.org.in) where the Windows version of the app (red arrow) can be accessed and downloaded free of cost.

Users can either download the app from Google Play Store or directly scan the QR code [Fig. 10]. Detailed ocular structures and pathologies related to ophthalmology are being added periodically (once every 4 weeks) as updates for comprehensive ophthalmic pedagogy and counseling. We are also working on more add-on features (such as real-time clinical 3D videos) for the Eye MG 3D app, which will be made available to the users.

According to our knowledge, we tested the Eye MG 3D app on various Android phones, and there seems to be no issue regarding the processing power, touch screen, or sensor. It is also very user-friendly. For iOS, this app is available from the App Store as "Eye MG Max", which is an upgraded version with technical variations. It is also possible to run this on a Windows computer instead of a smartphone. You can access the Windows version of the app from the website (meh.org.in). On the website, hover over the “RESEARCH & DEVELOPMENT” tab and choose the “Eye MG App” option. Then, click the icon [Fig. 11] to download the zip file and install the application on your PC/laptop that supports Windows. The Windows version of the app is also provided free of cost.
Conclusion

Carving a mobile application for neophytes for pedagogy and patients for counseling with 3D real-time confocal images will allow them not to have any dark side regarding the anatomy and pathology of oculus uterque (OU). According to our knowledge, there is no application to date that incorporates real-time high-resolution confocal multimodal images for interactive 3D learning. Thus, we developed the 3D application named “Eye MG 3D” for immersive pedagogy and e-patient counseling.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Akkara JD. Commentary: Dawn of smartphones in frugal ophthalmic innovation. Indian J Ophthalmol 2018;66:1619.
2. Akkara J, Kuriakose A. Innovative smartphone apps for ophthalmologists. Kerala J Ophthalmol 2018;30:138‑44.
3. Ramesh PV, Aji K, Joshua T, Ramesh SV, Ray P, Raj PM, et al. Immersive photoreal new-age innovative gameful pedagogy for e-ophthalmology with 3D augmented reality. Indian Journal of Ophthalmology 2022;70:275‑80.
4. Akkara JD, Kuriakose A, Raju B. e-Learning resources for ophthalmologists. Kerala J Ophthalmol 2020;32:191‑8.
5. Ramesh PV, Ramesh SV, Ray P, Aji K, Raj PM, Akkara JD, et al. New-Age innovative pedagogy for virtual ophthalmic webinars with Green Mat technology - A unique communication tool for continuing medical education in e-ophthalmology during the COVID-19 pandemic. Indian J Ophthalmol 2021;69:3768‑71.
6. Ramesh PV, Balasubramaniam P, Devadas AK, Ray P, Ramesh SV, Ramesh MK, et al. Venturing into the third dimension of cataract surgery/observations with digital heads-up display – A personal take on NGENUITY for anterior segment surgeries. Indian J Ophthalmol 2022;70:694‑5.
7. Ramesh PV, Ray P, Ramesh SV, Devadas AK, Joshua T, Balamurugan A, et al. Cerebral Arterial Circulation: 3D Augmented Reality Models and 3D Printed Puzzle Models [Internet]. IntechOpen; 2022 [cited 2022 Feb 22]. Available from: https://www.intechopen.com/online-first/80306
8. Eye MG 3D-Apps on Google Play [Internet]. Available from: https://play.google.com/store/apps/details?id=com.EyeMG_3D&hl=en&gl=IN. [Last accessed on 2021 Aug 31].