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Novel Method and Device for Direct Ophthalmoscopy Education

Ali Kheradmand[1], Roya Derakhshan[2], Mahbod Shahshahani[3*], Mahrad Shahshahani[3], Ali Foroughi[3], Kambiz Novin[4]

1. *Departmentof Medical Education, Medical Education and Learning Technologies School, Shahid Beheshti University of Medical Sciences, Tehran, Iran*
2. *Endometriosis Research Center, Iran University of Medical Sciences, Tehran, Iran*
3. *Department of Research and Development, Arina Medical Simulation Research Institution, Tehran, Iran*
4. *Departmentof Radiotherapy and Oncology, Iran University of Medical Sciences, Tehran, Iran*

ABSTARCT

Direct ophthalmoscopy is a medical examination used in emergency departments and clinics to diagnose important systematic diseases and screen chronic diseases. Despite the importance of this examination, studies have shown that medical staff is not enough enabled perform it. In this article, we will discuss the novel medical simulation that helps to learn how to examine patients' eyes with a direct ophthalmoscope. This cutting-edge technology is designed to mimic details of the human eye in various pathological conditions with providing realistic and immersive experiences for users. Helps medical students and medical staff to practice repeatably direct ophthalmoscopy in different diseases.

Keywords: Virtual Reality, Ophthalmoscopy, Retinal Examination, Education, Simulation, Technology, Interactive

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Corresponding Information: **Mahbod Shahshahani**, *Department of Research and Development, Arina Medical Simulation Research Institution, Tehran, Iran* & Email: mahbodshahshahani@gmail.com

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Highlights:

This study introduces a virtual reality–based ophthalmoscopy simulator designed to replicate pathological eye conditions. The device enables repetitive, hands-on practice for medical trainees, aiming to improve diagnostic skills. Integration into curricula may reduce diagnostic errors, enhance patient care, and strengthen clinical competency in retinal examination and ophthalmologic assessment.

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1. Introduction

Ophthalmoscopy is an essential and low-cost examination that plays a critical role in the diagnosis of many important diseases. This examination is fundamental in identifying emergency illnesses such as retinal hemorrhage hypertensive retinopathy and intracranial hemorrhage. Additionally, this exam serves as a crucial screening tool for the detection of organ damage in diabetic and hypertension patients. early treatment requires early diagnosis which is always performed by accessible and low-cost diagnosis tools and methods like direct ophthalmoscopy.

Despite the importance of this examination, many recent studies indicate that examination is going to be forgotten among medical staff. More than half of primary care Physicians Lack proficiency in performing this essential skill. these studies show the urgent need for an effective training solution to teach this ability to medical staff. Performing accurate direct ophthalmoscopy is vital for ensuring high-quality patient care and early diagnosis of emergency situations **(1)**.

Medical simulation is an emerging and Powerful tool in Healthcare education in recent years. offering realistic and controlled environments and virtual patients helps medical professionals to Leverage their skills without the risk of harming patients and also opportunity to teach uncommon diseases and illnesses to medical staff **(2)**.

In response to this need our team has developed an innovative medical simulation device for direct ophthalmoscopy. This cutting-edge technology is designed to mimic details of the human eye in various pathological conditions with providing realistic and immersive experiences for users. Helps medical students and medical staff to practice repeatably direct ophthalmoscopy in different diseases **(3)**.

2. Protocol

2.1 Evaluation of Retinal and ophthalmologic Features in Ophthalmoscopy examination

a. Step 1: Evaluation of Normal ophthalmologic Functions

The initial step is evaluating the normal functions of the eye and retina. This includes assessing the pattern of the iris and the pupil's reflex to light **(4)**. Another important item, is the visible area of the retina during direct ophthalmoscopy examination.

Variables considered in this evaluation are:

1- **Distance from the eye:** The ophthalmoscope's distance from the eye affects the visibility and clarity of patient retin.

2- **Light level of the examination room:** The room light level can influence the observation of retinal details.

3- **Ophthalmoscope settings:** The light intensity and focus settings of the ophthalmoscope are another variable to consider for simulating this examination.

b. Step 2: Evaluation of Pathologic Ophthalmologic findings

Skilled 3D In this step, we evaluate approximately 50 most important retinal diseases that our medical simulation aims to teach and assess. To consider variations among patients, we include more than 10 cases for each specific pathological condition. This approach results in a comprehensive database of real patient data, which is essential for accurately simulating retinal functions and pathologies **(5)**.

c. Step 3: Mathematical and 3D Modeling

After identifying the main features and principles of light behavior in the human eye, our engineering team begins the mathematical calculation and 3D modeling. This involves Anatomical and Physiological Modeling which forms the foundation of our simulation **(6)**. This step relies heavily on the physics and mathematics of light interaction with various parts of the eye **(7)**. This involves simulating how light behaves in eyes with specific conditions, allowing for realistic representations of diseases.

By following these steps, we ensure that our ophthalmoscopy simulation is, providing users with a realistic experience of examining normal and pathological retinal features (Figure 1-3).

Figure 1. Realistic simulation of direct ophthalmoscopy examination **(Design by Authors, 2024)**.

Figure 2. The software simulate different ophthalmologic diseases and clinical scenarios **(Design by Authors, 2024)**.

Figure 3. The centralized software offers a highly realistic simulation of direct ophthalmoscopy **(Design by Authors, 2024)**.

2.2 Evaluation of ophthalmoscopy features and abilities

To create a realistic simulation, our team meticulously evaluated the various features and functions of the ophthalmoscope device. This involved a detailed examination of components such as lenses, lights, and other essential parts. Our engineering team embarked on the task of modeling a simulated ophthalmoscope. This endeavor encompassed both hardware production and software development, ensuring a holistic approach to replicating the device's capabilities. Our approach involved sophisticated mathematical and physical modeling techniques to achieve a realistic simulation of direct ophthalmoscopy examination. By employing mathematical algorithms and physics principles, we simulated the intricate features in the ophthalmoscope.

2.3 Choosing right technology to simulate

Our team proceeded to develop mathematical models based on physics formulas for this simulation. The final crucial step in this process is selecting the appropriate technology to produce the device.

Considerations for Technology Selection: The chosen technology must align with the technical and medical requirements of the simulation. This includes considerations such as accuracy, precision, and compatibility with existing medical training platforms. A key factor in technology selection in medical simulation is accessibility and costeffectiveness **(8)**. The chosen technology should be readily available and affordable, ensuring widespread adoption and accessibility to medical professionals and educational institutions. Another critical aspect is the ability to provide ongoing support and maintenance for the technology. This includes timely updates, troubleshooting assistance, and repair services.

Cost-effectiveness plays an important role in the selection of technology for producing medical simulation devices. It not only impacts the initial manufacturing cost but also influences the overall affordability of the final product for institutions. By choosing cost-effective technology, we can minimize production expenses and ultimately offer the ophthalmoscopy simulation device at a competitive price point **(9)**.

3. Results and Discussion

After more than a year of dedicated effort, our team has successfully developed an ophthalmoscopy simulation device that offers a range of capabilities to enhance medical training and education.

System Components

3.1 The system comprises three main physical components and one software

a. Simulated Ophthalmoscope: This essential part of the device replicates the functionality of a real ophthalmoscope. Users can adjust parameters such as lens diopter, light intensity, color, and shape like a real ophthalmoscope. These features directly impact the user's visual experience, requiring them to make informed decisions based on the simulated examination scenario and the condition of the virtual patient.

b. Electronic Color Eye: While working with the ophthalmoscope, the electronic color eye component plays a crucial role in providing realistic visual feedback. It accurately simulates the -appearance of various ophthalmologic features and abnormalities, allowing users to practice identifying and diagnosing various diseases in a controlled environment.

c. Connected Computer: Serving as the central control unit, the connected computer facilitates the operation of the simulated ophthalmoscope and electronic color eye components. It runs the simulation software, enabling users to interact with the virtual patient and simulate different ophthalmologic diseases and clinical scenarios.

3.2 Key Features and Functionality

The simulation provides highly realistic visual feedback, replicating the appearance of actual retinal structures and abnormalities. This immersive experience enables users to develop and refine their diagnostic skills in a risk-free environment **(10)**.

The centralized software controls the direct ophthalmoscopy simulation parameters based on the selected eye disease. By using this ophthalmoscopy simulation device, medical staff, and students can refine their ophthalmoscopic skills without the need to practice on real patients.

The device is suitable for users of varying skill levels of direct ophthalmoscopy, from medical students to experienced ophthalmologists, providing a versatile platform for continuous learning and skill development.

4. Declarations

Acknowledgment

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Ethical Considerations

Not applicable.

Conflict of Interest

The authors declared no conflict of interest.

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References

1. Mackay DD, Garza PS, Bruce BB, Newman NJ, Biousse V. The demise of direct ophthalmoscopy: a modern clinical challenge. Neurol Clin Pract. 2015;5(2):150-7. [PMID] [PMCID] [DOI:10.1212/CPJ.0000000000000115]
2. Hartley MJ, Bartley GB. Ophthalmology and Direct Ophthalmoscopy in Contemporary Medical Education. Am J Ophthalmol. 2022;238: PXV-XVI. [DOI:10.1016/j.ajo.2022.02.004][PMID]
3. Howell GL, Chávez G, McCannel CA, Quiros PA, Al-Hashimi S, Yu F, et al. Prospective, randomized trial comparing simulator-based versus traditional teaching of direct ophthalmoscopy for medical students. Am J Ophthalmol. 2022; 238:187-96. [DOI:10.1016/j.ajo.2021.11.016] [PMID]
4. Belliveau AP, Somani AN, Dossani RH. Pupillary Light Reflex. [Updated 2023 Jul 25]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: [https://www.ncbi.nlm.nih.gov/books/NBK537180/]
5. Yorston D. Retinal Diseases and VISION 2020. Community Eye Health. 2003;16(46):19-20.
6. González G, Fitt AD. The mathematical modelling of human eyes-a PhD study. Mathematics Today. 2003;39:20-5.
7. Kling S, Hafezi F. Corneal biomechanics - a review. Ophthalmic Physiol Opt. 2017;37(3):240-52. [DOI:10.1111/opo.12345] [PMID]
8. Hippe DS, Umoren RA, McGee A, Bucher SL, Bresnahan BW. A targeted systematic review of cost analyses for implementation of simulationbased education in healthcare. SAGE Open Med. 2020;8:2050312120913451. [PMID] [DOI:10.1177/2050312120913451] [PMCID]
9. Wouterse B, van Baal P, Versteegh M, Brouwer W. The value of health in a cost-effectiveness analysis: theory versus practice. PharmacoEconomics. 2023;41(6):607-17. [PMID] [DOI:10.1007/s40273-023-01265-8] [PMCID]
10. Ricci LH, Ferraz CA. Ophthalmoscopy simulation: advances in training and practice for medical students and young ophthalmologists. Adv Med Educ Pract. 2017;8:435-9. [DOI:10.2147/AMEP.S108041] [PMID] [PMCID]