



THE NOVEL ELECTRONIC DEVICE FOR EARLY DETECTION OF AGE-RELATED MACULAR DEGENERATION

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SUMMARY

The article provides a description of a developed method for early diagnosis of dry age-related macular degeneration in the form of a device for assessing contrast sensitivity and conducting the Amsler test. The device is designed as portable VR glasses and a joystick. The article presents the technical parameters of the device and the principle of its operation. The panel displayed during patient examinations is shown. The presented device is intended for use both in outpatient healthcare settings and for self-assessment of contrast sensitivity by patients, serving as an effective means for the early diagnosis of dry age-related macular degeneration.

KEYWORDS: age-related macular degeneration; early diagnosis; contrast sensitivity.

INTRODUCTION

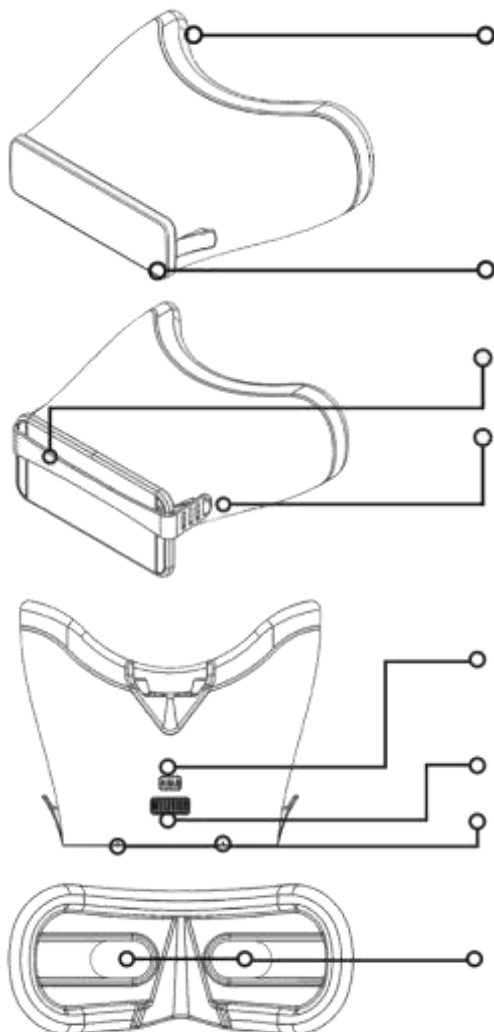
Currently, age-related macular degeneration (AMD) is one of the most common eye disorders, the progression of which leads to irreversible loss of central vision [1,2]. To detect changes in the macular area, doctors primarily rely on traditional ophthalmic examinations, which are not always capable of verifying early stages of the disease. The examination for AMD includes targeted medical history collection, Amsler grid testing, determination of visual acuity with the best correction for distance and near vision, perimetry, and examination of the fundus under pharmacological mydriasis using direct/indirect ophthalmoscopy [3,4,5]. Presently, ophthalmologists have a range of highly precise and reliable objective research methods

at their disposal: optical coherence tomography (OCT), digital fundus photography, and fluorescein angiography (FA). These methods allow real-time visualization of the retina's structure, and OCT additionally enables quantitative assessment of retinal layer thickness. In foreign publications, there is active discussion on AMD prevention and screening [6,7,8]. Various diagnostic maneuvers have been proposed to predict and identify early stages of the disease.

The development of a VR-integrated electronic device, that has been designed to early detect and predict the risk of age macular degeneration. The VR device and software developed by us consists of several parts. The first part is the VR-glasses device part, which consists of the following construction (fig.1-2) and has the following indicators (table 1):



Figure 1. The composition of device for measurement the contrast sensitivity through computerized software support and the VR-glasses.



Soft contoured pillow for a comfortable fit on the face.

Protective coating to prevent dust; removed before use.

Silicone elastic strap to protect smartphone during testing

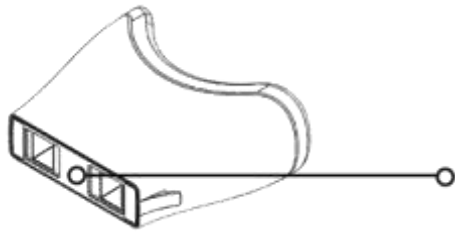
Handles for attaching an elastic band

The Pupillary Distance screen indicates that this is the "bottom" of the VR-glasses

Adjustable "PD" wheel

Additional characters

Optical part showing the mobile application



The micro-absorbent surface secures the smartphone screen to the VR-glasses device without damaging or leaving residue

Figure 2. Technical characteristics of the device.

The VR-glasses device is integrated with a Bluetooth remote control, which allows the controller to remotely check itself. The "VR-glasses macula vision test" device can conduct three types of tests in order to express the visual effect of the central retina.

1. Examination of uncorrected distance vision acuity
2. Examination of contrast sensitivity related to central visual acuity
3. Examination of visual pathological changes in central vision using Amsler's grid represented by colors.

Table 1

Technical indicators of the device.

No	Parameters	Indicators
	Size (length, width, height)	177 x 144 x 77 mm
1	Weight	213±7,5 gr
2	Power supply	Non
3	Brewing temperature	From 0° to 35°
4	Storage temperature	From 20° to 45°
5	Relative humidity	From 5% to 95%
6	Integrated phone requirement	iOS 9.3, Android 6.0 and other modern platforms
7	The screen size of the mobile device	Beyond 300 px
8	Visual acuity range	From 0 to 1.0

The complete design of the remote control is shown in figure 3.



- 1 Back and forward buttons
- 2 Bluetooth indicator
- 3 Direction keys
- 4 Confirm/Select
- 5 Battery indicator
- 6 On/off button
- 7 Charging cable

Figure 3. Complete technical description of the remote control.

The results of the "VR-glasses macula vision test" device are stored securely in the memory of the mobile application. Test results are dynamically compared over time. The results will be discussed with the ophthalmologist.

The second part is the passport part, where the person who wants to be examined by the program fills his information (surname, first name, patronymic, gender, etc.) according to his wishes. (fig. 4).



Figure 4. View of the passport part of the mobile electronic application.

After filling out the passport section, the program will automatically provide an interactive animation that will help

you pass the "Study Guide" test. The distance between the two pupils is entered as shown in Figure 5.

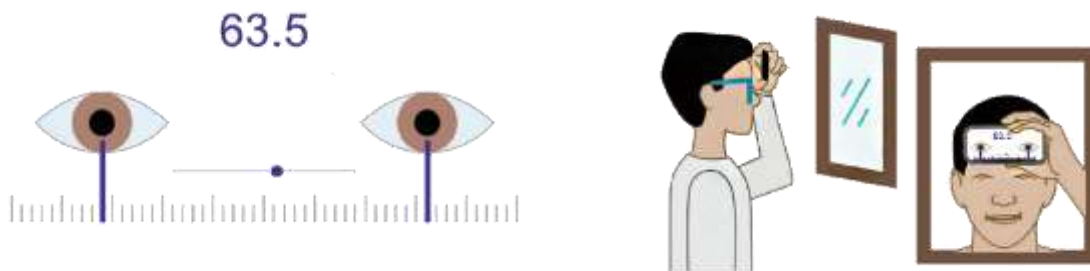


Figure 5. Interactive animation to help you pass the test.

The program then moves on to the second part, which tests uncorrected central visual acuity. The test comes with brief

instructions for performing the test and is illustrated as a separate window for each eye (fig. 6).

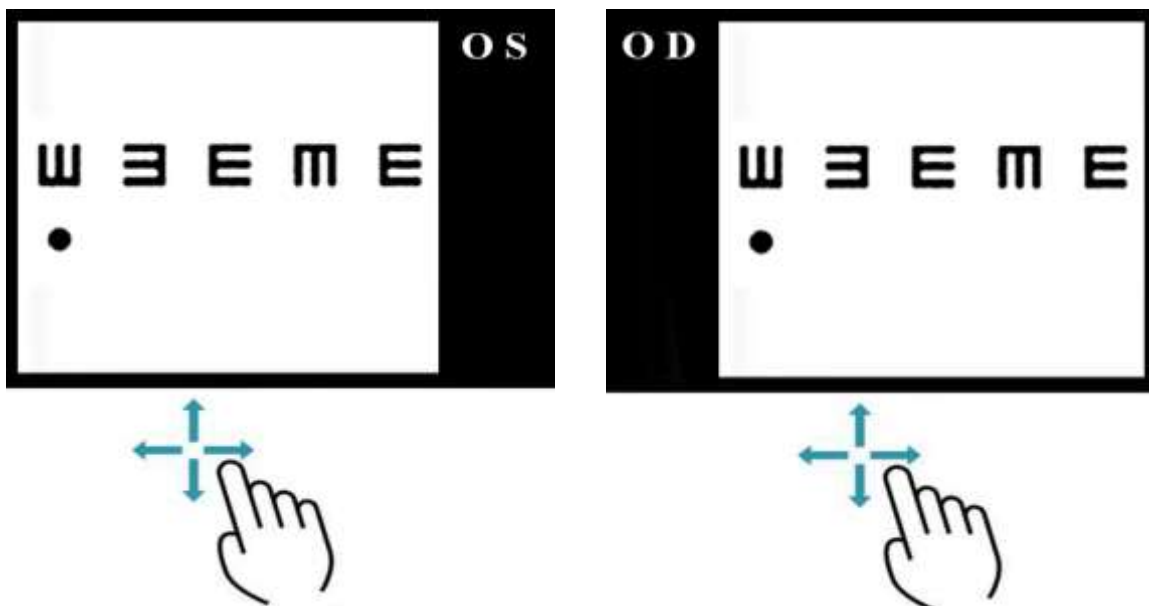


Figure 6. Slide in the "E" direction. Double click to go back.

The end of the direction is pressed from the remote control in the direction of the closed end to the open end of the letter "E" displayed on the open part of the smartphone screen (fig.7).



Figure 7. The order of pressing the remote-control arrows towards the open end of the letter's "E".

Central uncorrected distance visual acuity test results are expressed as 0 to 1.0 for each eye and binocularly based on the Snellin and LogMAR scale at the end of the test.

The program then moves on to the test key, a contrast sensitivity test related to central visual acuity. There are also optotypes for each eye expressed in contrast from 0% to 100% (fig. 8).

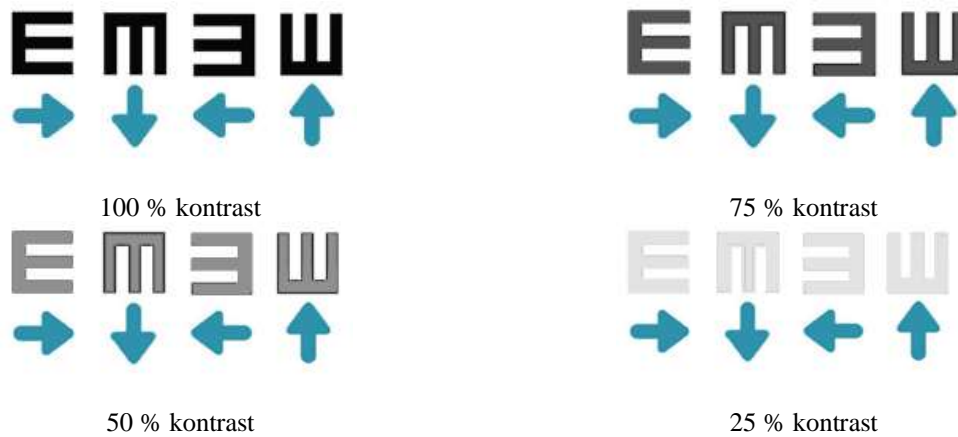


Figure 8. Contrast sensitivity test related to central visual acuity.

As a result of the test, the level of contrast sensitivity for each eye is evaluated and recorded. Finally, the program automatically switches to the test of visual pathological changes in the central vision using the Amsler grid, which is represented by colored lines. Here, the 3D Amsler grid representing black, red, green, blue colors and their contrasts is depicted separately for each eye. If the subject does not have subclinical changes in the retina, no changes are observed on the Amsler grid.

If there are any subclinical changes in the macula of the retina, the patient will have changes related to the photoreceptors located in this area. As a result, different forms of metamorphosis are observed in Amsler's grid. Each test is

significant in characterizing the occurrence of AMD and the subclinical changes occurring in the retinal macula. The program automatically calculates the results according to the specified answers from the respondent, then AMD calculates the progression of the disease based on the visual changes: divided into low risk, medium risk, high risk levels, and then self-checks the results. presents to the person who transferred. According to a certain risk group, the program provides recommendations for further actions to the examined person.

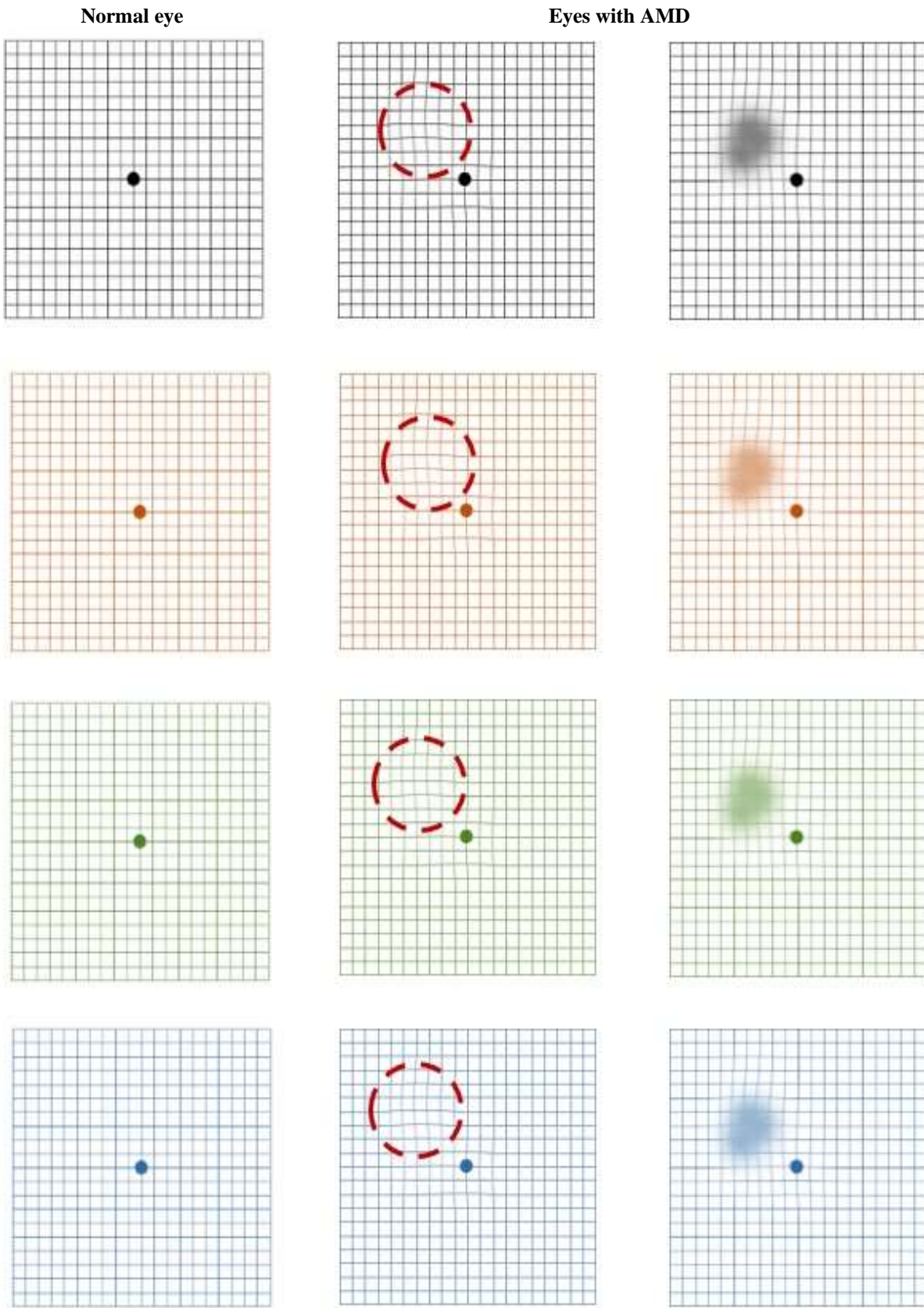


Figure 9. Display of Amsler test results in the program with normal and pathological options.



In addition, to increase awareness among the population, there is an informational component of the program, which contains information about the disease, presented in the local language.

Thus, the “VR-glasses macula vision test” device and electronic software developed by us are intended for public use and are easy to use. Examination of patients is carried out in a short time. At the same time, developed device allows to determine the risk group and the dynamics of its development process. Most importantly, in the ambulatory setting, this electronic application is convenient and facilitates the work of primary general practitioners. All these features of the program help to increase the prevention of visual impairment and blindness caused by AMD.

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