Calculation of the optical scheme of an augmented reality video module

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1. Introduction

At present the optical properties of coatings applied to the waveguide displays of AR glasses are not clearly investigated, and there are also difficulties in designing an optical scheme of a video module of AR glasses [1].

2. Optical module

2.1 Module scheme and its composite elements

Figure 1 illustrates the optical module scheme. Where: 1 – emitting diode; 2 – lenses responsible for transmitting radiation to the beamsplitter; 3 – beamsplitter; 4 – microdisplay; 5 – lens; 6 – waveguide. Figure 2 illustrates the augmented reality display waveguide with areas for coating [2].

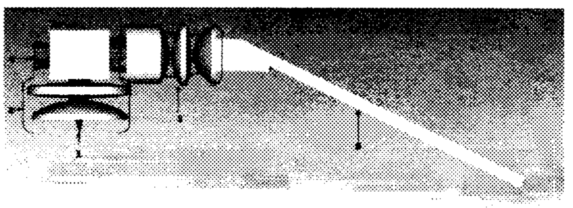

Figure 1: Optical module scheme

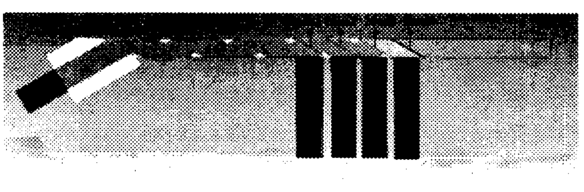

Figure 2: The waveguide scheme with areas for coating

3. Optical properties of augmented reality display waveguide

3.1 The required coating parameters

Four versions of coating parameters for semireflective mirrors were studied [3]. Reflection coefficients for each version are:

Version 1: Zone1: 40%, Zone2: 55%, Zone3: 63%, Zone4:80%.

Version 2: Zone1: 30%, Zone2: 45%, Zone3: 53%, Zone4:70%.

Version 3: Zone1: 15%, Zone2: 35%, Zone3 :43%, Zone4:60%.

Version: Zone1: 20%, Zone2: 25%, Zone3: 34%, Zone 4: 50%.

Figure 3 shows the values of the radiation power reflected from each zone for all versions of coating parameters.

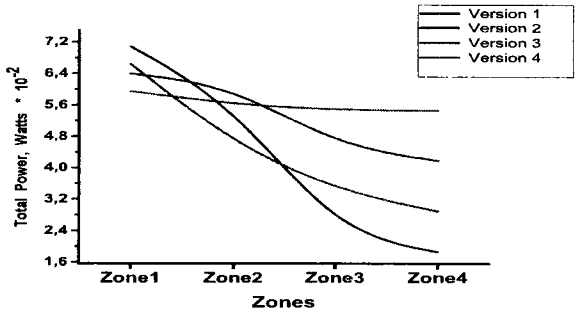

Figure 3. Radiation power dependence for each zone

3.2 Modeling optical properties of coatings of waveguide AR displays

Based on the calculation of optical coating properties of three materials (Ta_2O_5/SiO_2, TiO_2/SiO_2, Nb_2O_5/SiO_2) and at different angles of incidence, optimal thickness and number of layers of applied coatings were calculated, and also optimal materials for each semireflective surface were selected. They are: Zone1: TiO_2/SiO_2, d=2.693 µm, N=30; Zone2: Nb_2O_5/SiO_2, d=2.285 µm, N=27; Zone3: Ta_2O_5/SiO_2, d=2.767 µm, N=29, Zone4: TiO_2/SiO_2, d=2.707 µm, N=27. It is shown that the optimal angle of incidence is the angle $\theta = 30^0$. Figure 4 shows the dependence of reflection coefficients on wavelength of the incident radiation of optimal materials for each zone.

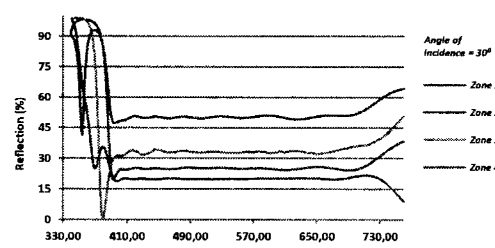

Figure 4. Dependence of reflection coefficients on wavelength for each zone

4. References

[1] L. Tommaso De Paolis, P. Bourdot, "Augmented Reality, Virtual Reality, and Computer Graphics", 5th International Confer ence, AVR 2018 Otranto, Italy, June 24- 27, 2018 Proceedings, Part II, 719 p.

[2] D. Schmalstieg and G. Reitmayr, The world as a user interface: Augmented reality forubiquitous computing, Central European Multimedia and Virtual Reality Conference, 2005.

[3] P.P. Yakovlev, B.B. Meshkov. Design of Interference Coatings – Mashinostroenie, Moscow, 1997, 185 p.