HANDHELD THERMAL VISION DEVICES WITH VARIABLE CHARACTERISTICS

Tatyana N. Khatsevich
Siberian State University of Geosystems and Technologies, 10, Plakhotnogo St., Novosibirsk, 630108, Russia, Professor, Department of Photonics and Device Engineering, phone: (383)343-29-29, e-mail: khatsevich@rambler.ru

Evgeniy V. Druzhkin
LUGGAR Co Ltd., 11, Shevchenko St., Novosibirsk, 630074, Russia, General Manager, phone: (962)829-63-39, e-mail: druzhkinev@luggar.biz

Ksenia D. Volkova
Optical Design Office Co Ltd, 11, Shevchenko St., Novosibirsk, 630074, Russia, Design Engineer, phone: (923)240-77-94; e-mail: volkovakd@ luggar.biz

The intensive development of thermal imaging device is accompanied by the expansion of its functional possibilities. One of them is the realization of changing magnifications and fields. The aim of the work is to justify the method of changing focal lengths and fields, ensuring the constancy of the relative aperture and axial length of the lenses when changing the field in thermal imaging devices using uncooled microbolometer infrared sensor arrays. A method of structural synthesis of a lens of three components is proposed. The method is characterized by the following: the optical power of the first component is equal to the optical power of the lens, the sum of the optical powers of the second and third components is zero. The aperture diaphragm is located on the third component. The internal component has two discrete positions. Relations between the parameters of components that are found provide the invariability of the back focal length and the relative aperture of the lens when changing the focal length. The capabilities of the method are confirmed by the development of four infrared lenses with two- and three-fold differences in focal lengths. Decreasing the length along the axis and the stability of the relative aperture of the lens with diffractive image qual-ity when changing the focal length in an optical scheme with a bi-aspheric design is achieved.

Keywords: infrared lenses, thermal imaging device, uncooled infrared microbolometer, discrete field, variable focal length, bi-aspheric design, relative aperture

REFERENCE

1. Tarasov, V. V., & Yakushenkov, Y. G. (2004). *Infrakrasnye sistemy «smotryashchego» tipa [Infrared systems of "looking" type]*. Moscow: Logos Publ., 444 p. [in Russian].

2. Mann Allen, Arthur, R., & Weeks, Jr. (2009). *Infrared Optics and Zoom Lenses: Vol. TT83*. SPIE PRESS BOOK, 182 p.

3. Allie M. Baker. (2010). US 7848015. Compact two-element infrared objective lens and IR or thermal sight for weapon having viewing optics. Retrieved from "Google Patent": https://patents.google.com/patent/US7848015B2/en.

4. Allie M. Baker. (2011). CA 2696775. Compact two-element infrared objective lens and ir or thermal sight for weapon having viewing optics. Retrieved from "Google Patent": https://patents.google.com/patent/CA2696775C/en.

5. Robert Chipper. (2004). US 20040036982. Fixed focus, optically athermalized, diffractive infrared zoom objective lens. Retrieved from "Google Patent": https://patents.google.com/patent/US20040036982.

6. Chihiro Hiraiwa, & Tatsuya Izumi. (2007). JP 3982554. Infrared zoom lens and infrared camera. Retrieved from "Google Patent": https://patents.google.com/patent/JP3982554B2/en.

7. Hyun Kyu Kim, & Ok Chang Min. (2013). KR 101265436. The dual field of view lens module for uncooled the thermal imaging camera. Retrieved from "Google Patent": https://patents.google.com/patent/KR101265436B1/en.

8. Xu Yuhui, Liu Tao, Zhao Ying, Sun Jianjun, & Ma Tao. (2014). CN 203385929. Infrared zoom lens with large zoom ratio. Retrieved from "Google Patent": https://patents.google.com/patent/CN203385929U/en.

9. Abraham Reichert. (2007). US 7564617. Short infrared zoom lens system. Retrieved from "Google Patent": https://patents.google.com/patent/US7564617B2/en.

10. Olejnik S. V. (2008). *Patent RF No. 2316797.* Lens objective with changeable focal length for operation within ir spectrum area. IP Russian Federation [in Russian].
11. Olejnik S. V., & Khatsevich, T. N. (2008). *Patent RF No. 2339983.* Lens objective with variable focal length for operation in infrared spectrum (versions). IP Russian Federation [in Russian].
12. Khatsevich, T. N., & Druzhkin, E. V. (2015). *Patent RF No. 2538067.* Objective with a variable field of view for infrared device (variants). IP Russian Federation [in Russian].
13. Hubert Caron. (2015). CA 2750354. Dual field-of-view optical imaging system with dual focus lens. Retrieved from "Google Patent": https://patents.google.com/patent/CA2750354C/en.
14. Druzhkin, E. V., & Khatsevich, T. N. (2018). Implementation of general technical and special requirements in the development of small-sized thermal imaging observation devices and sights. *Pribory [Instruments]*, *1*(211), 43–50 [in Russian].
15. Khatsevich, T. N., & Druzhkin, E. V. (2018). Analysis of objective lens for compact infrared devices using a two-component objective model. *Vestnik SGUGiT [Vestnik SSUGT]*, *23*(2), 245–261 [in Russian].

Received 21.04.2020