Journal of Biosensors & Bioelectronics
ISSN: 2155-6210

Thammawongsa et al., J Biosens Bioelectron 2013, 4:5
DOI: 10.4172/2155-6210.1000e125

Editorial Open Access

Artificial Vision Model by Small Scale Conjugate Mirrors

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Artificial eyes are among the most important organs which have been the popular researches and investigations, where basically can give the blind person sight ability. Normally, bionic eyes have become the basic artificial eyes for the blind that depends on the circumstances surrounding the loss of sight. For retinal prostheses, which are the most prevalent visual prosthetic under developments, in which the candidates for visual prosthetic implants find the procedure most successful if the optic nerve was developed prior to the onset of blindness. Persons born with blindness may lack a fully developed optical nerve, which typically develops prior to birth. Visual prosthetics are being developed as a potentially valuable aid for individuals with visual degradation, where all other efforts remain investigational, and most have not yet made it to any clinical use in patients. Artificial vision device has become the important instruments for various applications, for instance, surveillance, blind people, robot, eyesight problem, especially, for the humanoid robotic applications. Results in both design and practical works have been reported [1-3], in which the potential applications have been reported [4-6], where one aspect of results has shown the feasibility of using artificial eyes (vision) for human eye replacement [7,8], in which the possibility of vision image connection between optic nerve and brain cells can be realized [9], which is useful for realistic artificial eye use. The use of THz technology can be adopted to employ with human tissue penetration and investigation, where there are some works reported the use of THz for imaging and investigations [10,11], where an interesting result is the use of Whispering Gallery Mode (WGM) of light within a tiny optical device, where the 3D image basic device known as a conjugate mirror can be easily constructed by using the WGMs of light within a PANDA ring circuit [12,13]. The THz WGMs can also be generated and use to form the 3D image and linked to the optic nerve and brain [14]. By using this method, the artificial vision (bionic eyes) can be constructed and realized, which has currently become the current challenge researches and investigations.

In this article, it is a design and simulation work, in which the small scale device is designed to function as an artificial eye, where firstly, only one pixel 3D image is formed. The used simulation software is a Finite Different Time Domain (FDTD) program. However, in this work the device parameters and material can be fabricated and formed a system for 3D artificial vision. In principle, a basic device known as a conjugate mirror can be formed by using the artificial eye model as shown in Figure 1a, where the partially reflected light intensities are interfered and the 3D whispering gallery modes occurred within the ring centers and linked to the optic nerves, the scanning image for large area is also available, therefore, finally, the 3D images can be constructed and linked to the human brain cells for perceptions. In practice, the reflected light beams (each pixel) can be interfered and formed the 3D image, where the images can be linked to the optical nerves (optic chiasm) by the THz WGMs via R2 ring (blue WGM), where the 3D images can be constructed by the human image processing unit in the brain as shown in Figure 1b [15].

To form the artificial eye concept using the proposed device system, a commercial semiconductor laser is chosen as an input light source, which is input into an artificial eye model device via the input port as shown in Figure 1. The partial portions of lights are then reflected from the through and drop port ends back to the system, which is manipulated to be the reflected optical power form the target object, which can be processed similar to the reflected lights by the WGMs from the center two side rings. The used parameters are obtained by using the realistic material parameters of *InGaAsP/InP*. Here, the waveguide core n=3.14 is bordered on each side by air n=1, where in this case the two side ring radii are larger than the center one. The parameters for add-drop optical multiplexer and both rings on the left and right hand sides of the PANDA ring are set at R_l=R_r=2.5 μm and radius of the center ring is R_{ad}=1.5 μm. The coupling coefficient ratios are κ_1=κ_4=0.5, κ_2=κ_3=0.5, effective core area of the waveguides is A_{eff}=0.30 μm^2, and waveguide loss coefficient is α=0.1 dBmm^{-1}. Results as shown in Figure 2, the

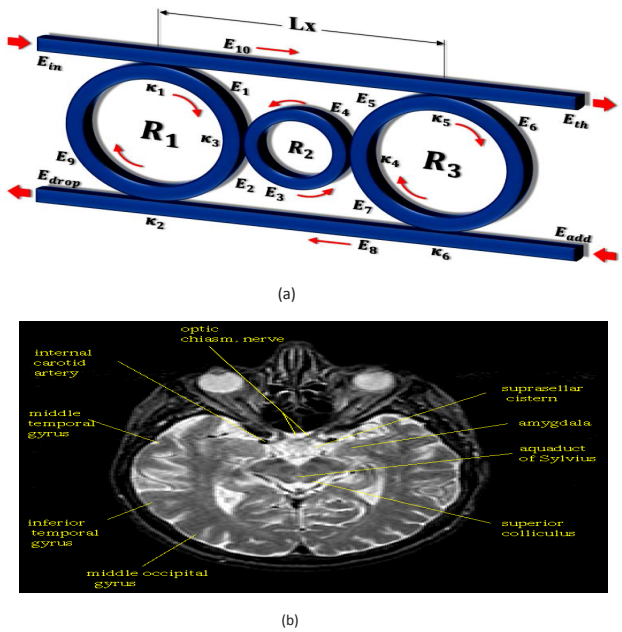

Figure 1: Artificial vision system model using ring conjugate mirrors, where (a) the artificial vision pixel, (b) the eye nerve link and image processing, where E_i: optical fields, Lx: 50 μm, R_s: ring radii, K_s: coupling constants, E_{in}: input port, E_{th}: through port output, E_{drop}: drop port output, E_{add}: add port input.

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Received October 13, 2013; **Accepted** October 14, 2013; **Published** October 21, 2013

Citation: Thammawongsa N, Ali J, Yupapin PP (2013) Artificial Vision Model by Small Scale Conjugate Mirrors. J Biosens Bioelectron 4: e125. doi:10.4172/2155-6210.1000e125

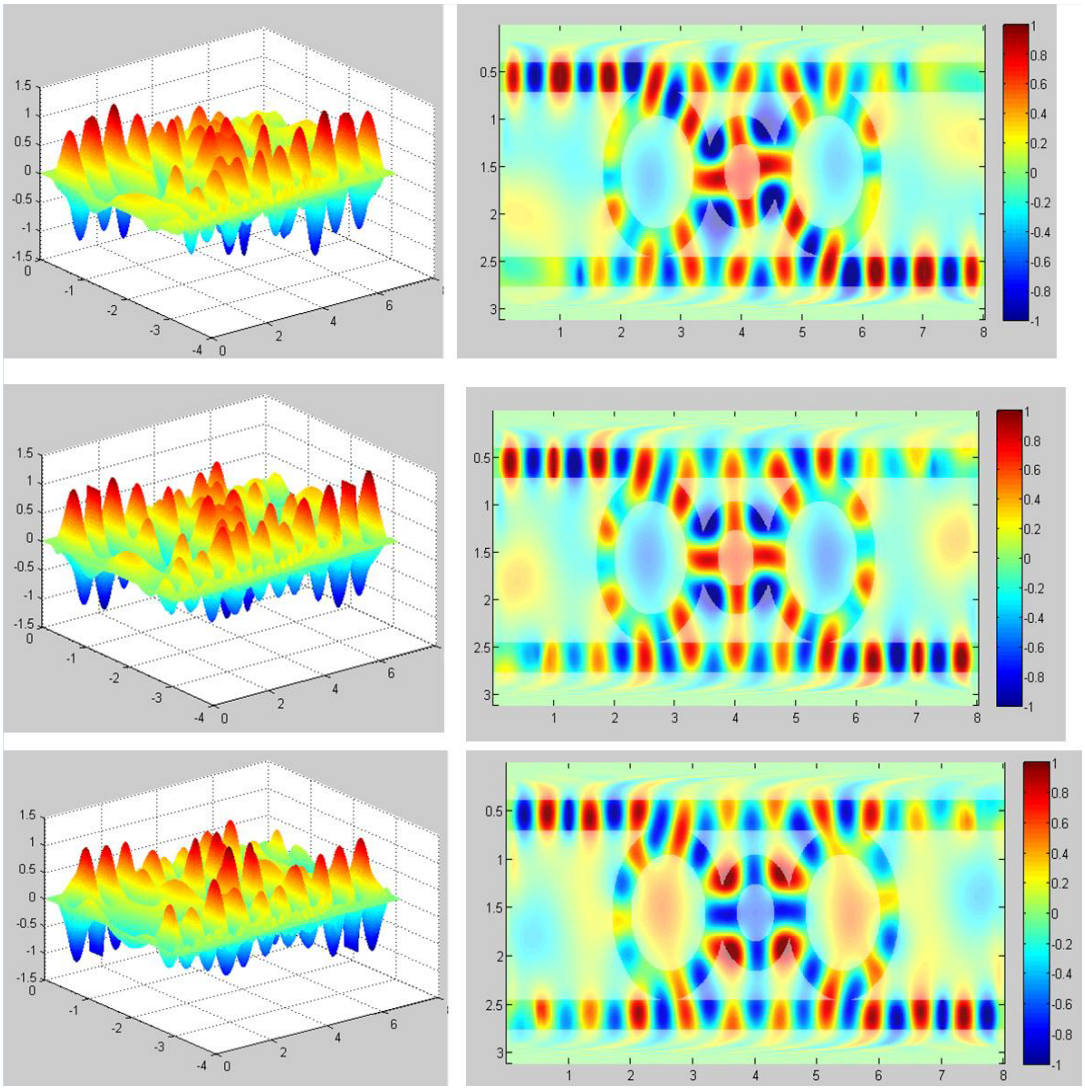

Figure 2: 3D image from cascaded ring conjugate mirrors, where the bottom is the required result lights, lights are input from both left and right eyes, where red WGM: going out beam, blue WGM: coming in beam.

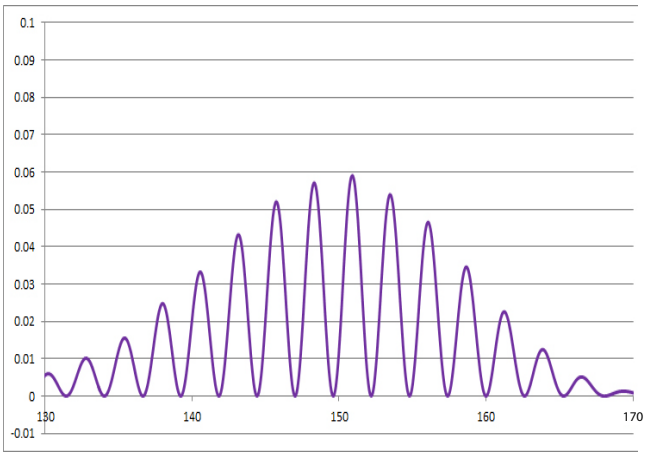

Figure 3: Four-wave mixing result of light in the cascaded conjugate mirror system.

reflected lights are interfered and formed the four-wave mixing within the system, where finally, the resonant whispering gallery mode output can be seen at the center if each ring, while the signals can also be detected by detector at the add port output as shown in Figure 3. The red and blue WGM outputs are the going out and coming in direction, respectively. For large scale applications, the micro-artificial eye array can be constructed and large pixel area (volume) can be formed and collected to link to the optic nerves and brain cells by the red and blue WGMs respectively. Finally, the 3D image perception is recognized and processed by the brain cells.

A cascaded microring resonator system has been designed and used as a small scale artificial vision device (pixel) for artificial eye applications. A single point 3D image of the target object, where in this case is presented by a reflected signals on the device end coupling power, which can be constructed for large scale images and linked to the optic nerve and brain cells and can be used for artificial vision. To confirm the 3D image output, such a required result of the 3D image is as shown by the output result of the WGM signals in terms of four-wave

mixing concept, which is confirmed. In application, the large area of devices can be formed and constructed by a thin film technology, which can be used for imaging devices, artificial eyes and humanoid robot eyes, in which the eye sight and blindness problems can be investigated and solved. Moreover, in case of THz pulse signals cannot penetrate and link to the access point, then the Chinese needle methods can also be used as the linked probes between 3D image data and optic nerves.

The authors would like to acknowledge the King Mongkut's Institute of Technology Ladkrabang (KMITL), Bangkok 10520, Thailand for giving the research facilities.

References

1. Weiland JD,Humayun MS (2006) Intraocular retinal prosthesis. IEEE Eng Med Biology Mag 25: 60-66.
2. Jeong KH, Kim J, Lee LP (2006) Biologically inspired artificial compound eyes. Science 312: 557 -561.
3. He Q, Liu J, Yang B, Dong Y, Yang C (2013) Fabrication and characterization of biologically inspired curved-surface artificial compound eyes. J Microelectronical System 22: 4-6.
4. Dobelle WH (2000) Artificial vision for the blind by connecting a television camera to the visual cortex. ASAIO J 46: 3–9.
5. Kaniusas E, Varoneckas G, Mahr B, Szeles JC (2011) Optic visualization of auricular nerves and blood: optimization and validation. Instrumentation and Measurement. IEEE Transaction on 60:3253-3258.
6. Tamee K, Chaiwong K, Yothapakdee K, Yupapin PP (2013) Brain signal monitoring and encoding for humanoid robots use. J. Biosensors & Bioelectronics 4:13e-124.
7. Zainol FD, Thammawongsa N, Mitatha S, Ali J, Yupapin PP (2013) Nerve communication model by bio-cells and optical dipole coupling effects. Artificial Cells. Nanomedicine and Biotechnology 2013: 1-8.
8. Tamee K, Chaiwong K, Yothapakdee K, Yupapin PP (2013) Psychiatric investigation using WGMs using a nonlinear microring circuit. J Innovative Optical Health Sciences: 6: 1-7.
9. Sarapat N, Frank TD, Yupapin PP (2013) Conjugate mirror design and simulation using a nonlinear coupling microring circuit. J Nonlinear Optical Physics & Materials 22: 1-11.
10. Uomwech U, Sarapat K, Yupapin PP (2010) Dynamic modulated Gaussian pulse propagation within the double PANDA ring resonator system. Microw Opt Technol Lett 52: 1818-1821.
11. Yupapin PP (2013) Nonlinear coupling effects of waves in a panda ring. Science Discovery 1: 1-5.
12. Jonas JB (1992) Human optic nerve fiber count and optic disc size. Investigative Opthalmology & Visual Science 33: 2012-2018.
13. Jonas JB (2004) Predictive factors of the optic nerve head for the development of progression of glaucomatous visual field loss. IOVS Invest Ophtalmol Vis Sci 45:2613-2618.
14. Cavallini GM, Forlini M, Gramajo AL, Brombin A, Torlai G, et al. (2013) Optic nerve aplasia and microphthalmos: a case report. J Genet Syndr Gene 4: 175.
15. Optic nerve, Wikipedia, October 2013.