Fractal Dual Band Antenna for WLAN Applications

Nidhi Lal
Dept. of Wireless Communication and Computing
Indian Institute of Information Technology
Allahabad, India
nidhi.2592@gmail.com

Shishupal Kumar
Dept. of Wireless Communication and Computing
Indian Institute of Information Technology
Allahabad, India
iwc2013016@iiita.ac.in

Abstract— **Fractal antenna, as name concerns, uses fractal i.e. structure does not change and repeat it when large focus has created upon it. This repetition feature of this antenna provides a great flexibility that it can be designed and can used in different frequencies. These antennas gives a finite area of coverage but the diameter of perimeter becomes infinite. Fractal antenna is used in most of the traditional and innovative applications today. In antenna engineering fractal geometry is very useful for performance improvement, in terms of gain and other things. Fractal antenna gives high performance with high variation in the size of its structure. This paper demonstrates an optimized and compact printed dual band fractal antenna suitable for WLAN applications. The proposed antenna works on 2.4GHz and 5.2 GHz. Simulation results show that the proposed design gives improved performance in terms of return loss and gain.**

***Index Terms*— Microstrip patch antenna; fractal geometry; WLAN;**

I. INTRODUCTION

Wireless communication becoming popular day by day and also developing rapidly. In a professional field and also in the home applications the use of wireless network is increasing for its easy to use properties. To satisfy increasing demands of users, IEEE has introduced various frequency bands for WLAN applications. IEEE 802.11 WLAN standards specify two operating frequencies, i.e. 2.4 (2400-2484 MHz) and 5.2 GHz (5150-5350 MHz). So in order to satisfy these standards, dual band antennas are required, which can be easily printed on a circuit board and size of which will be small to be fitted on a circuit board. Because of simplicity in design and fabrication many researches are exploring this field. furthermore fractal geometry has been introduced to propose microstrip patch antennas. The proposed antenna is suitable for wireless local area network (WLAN) with operating frequency ranges from 2.12 to 2.62GHz with a return loss of -16.62dB at 2.4 GHz and4.75 to 5.67 GHz with a return loss of -44.14dB at5.2 GHz. The antenna has also shown an acceptable gain and directivity. Fractal antenna inherits the feature of Euclidean antenna. The use of fractal in Fractal antenna by two ways. In the first way, antenna elements are becoming discrete to end Application's users and in the second way, a blueprint antenna is proposed which uses self-structure geometry so that resultant antenna can work on different frequencies. The fractal design has been introduced to increase the return loss of the antenna. The proposed antenna is suitable for use in laptop like devices.

II. RELATED WORK

Various modified works have been done in the antenna design field using fractal geometry. One of these types of work is by using a dual-Koch loop structure, a wideband vertical patch antenna (VPA) was designed [3]. In [4] techniques to reduce the size of microstrip patch antennas is proposed. Paper [5] shows the reduction of the size of the antenna by 50% for using fractal geometry approach. In [6] authors demonstrated details of fractal geometries developed to get multiband behaviour of the patch resonator antenna. In [7] novel type of miniature microstrip patch antenna has been demonstrated based on fractal geometry. In [8] new cell of UC- PBG structures for microstrip antennas is adopted to reduce the surface waves and improve the radiation patterns. Koch curve fractal geometry is also a popular choice for the miniaturization of antenna [13]. [9-18] have shown improved performance for antennas. [19] The topology used for making microstrip patch antenna is U-shaped, which is a single narrowband patch antenna. [20] The E-shaped microstrip patch antenna is used for WLAN applications. [21]While, Dual wideband stacked patch antenna is used for both WLAN and WIMAX applications [22]. Due to these properties [23], the microstrip patch antenna has become very popular in many applications such as in WiMAX communication system and mobile applications.

III. PROPOSED WORK

In this paper, we are implementing Fractal Dual band Antenna, which is used efficiently for wireless local area network. The antenna which is used in Wi-Fi/WLAN should contain high gain with directional or omnidirectional features. Directional antenna radiates signal with beam width consideration of few range, but omnidirectional antenna radiates or transmitted signal in all directions with having center radiator node property. The designer of antenna can use directional or Omnidirectional according to their requirement set up. Fractal antenna has unique features that it can contain many geometries with properties of fractal as well as the reason for considering fractal antenna in WLAN applications is, Fractal contains so many advantages when applied to antenna and used for wireless communication. If the fractal antenna is used in WLAN then the size of the antenna will reduce with great performance and antenna can perform in various resonance frequencies. For achieving Wideband performance, infinite Complexity combined with self-similarity i.e. repetition. Compact size of Fractal antenna provides higher gain with great efficiency and this feature make them more suitable to use them in wireless communication applications. Our implemented fractal used 2.4GHz and 5.2 GHz.

A. ANTENNA GEOMETRY

This antenna consists of a 50Ω microstrip feed line with waveguide feeding mechanism. The antenna has been printed on FR – 4 (lossy) substrate material with permittivity 4.3 and thickness of 1.5 mm. Ground plane of length 7.5 mm and the same width as the substrate has been used in the opposite side of the patch in the same end of the feed line. Copper has been used as antenna material. The total volume of the antenna is 45x35x1.5 mm^3.

The antenna has given away agreeable end result by simulation. Following Fig 1 shows the geometry of proposed Fractal antenna.

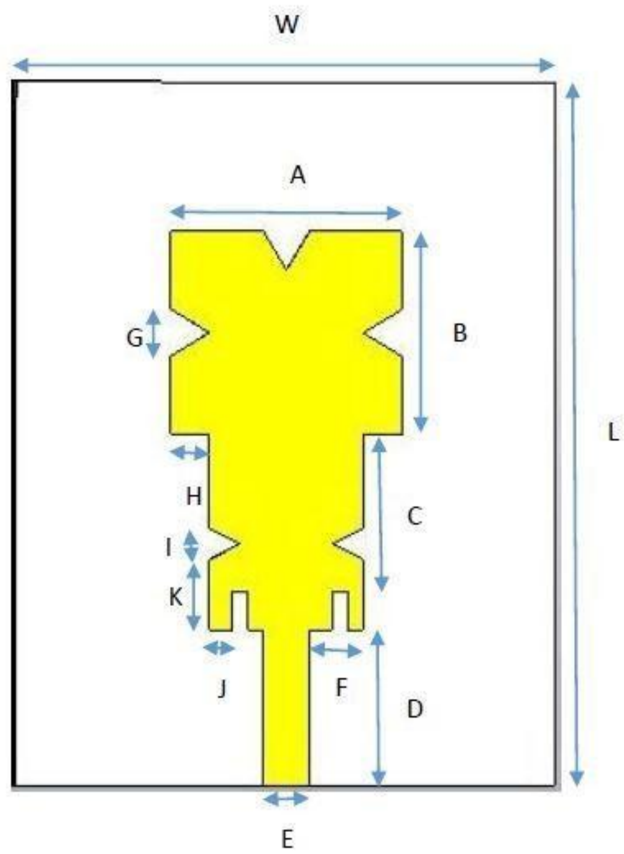

Fig1. Structure of the proposed antenna

B. DESIGN SPECIFICATIONS

The proposed antenna has been simulated on transient solver in CST Microwave Studio simulation tool. This Antenna design simulator CST is installed on windows 7 very easily. listing of parameters used in the intend of Fractal antenna is specified below within table 1.

Parameter	Value(mm)
A	13
B	13
C	10
D	10
E	3

F	3.5
G	3
H	2.5
I	2
J	1.5
K	4.5
L	45
W	35

TABLE 1. Parameters of proposed Antenna

IV. RESULTS AND DISCUSSION

Simulation of the proposed antenna has been done intransient solver in the CST Microwave Studio. The performance of the WLAN applications depends on convinced parameters such as gain, radiation pattern, and return loss. These parameters depend on the simulation recital and design methodology of the fractal antenna. These results proved by simulation and the corresponding results have been shown below.

A. RETURN LOSS

The antenna has shown a return loss better than -10 dB and are -16.62dB at 2.4 GHz and 4.75 to 5.67 GHz and -44.14dB at 5.2 GHz. Fig.2 shows the return loss of the proposed antenna in both the frequency.

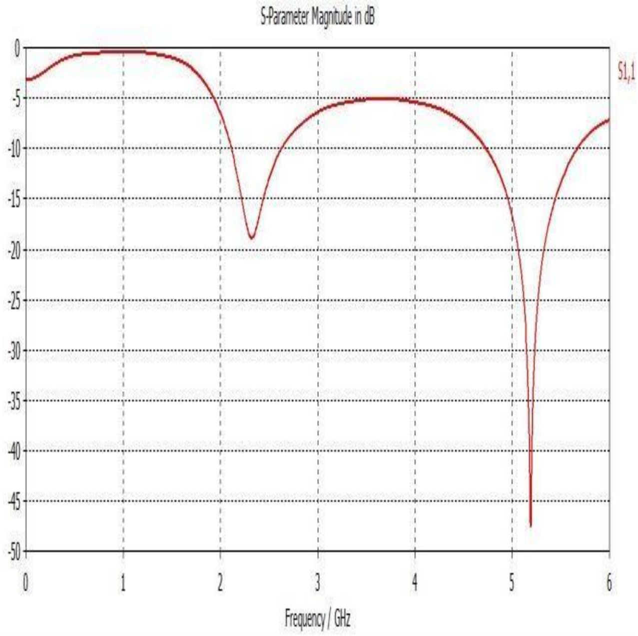

Fig2. Return loss plot of the proposed fractal antenna

Since the value of S parameter is less than -10 dB as indicated in fig 2 which henceforth results in very less.

B. VOLTAGE STANDING WAVE RATIO (VSWR)

Voltage Standing Wave Ratio (VSWR) of the anticipated antenna is not as much of 2 and is 1.35 with consideration of frequency 2.4 GHz and 1.01 with consideration of frequency 5.2 GHz, which is satisfactory and acceptable. Plot of VSWR of proposed antenna is publicized in Figure 3.

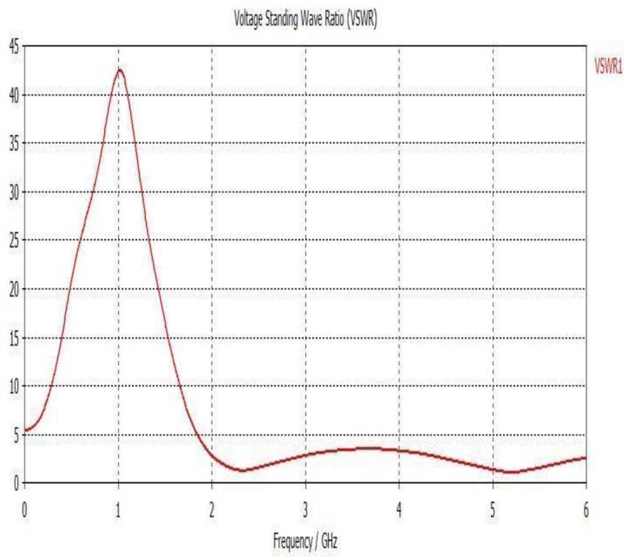

Fig3. VSWR plot of the anticipated antenna

In figure 3, The VSWR is for eternity a real and positive number for antenna which is simulated and developed. According to the work reported in [15] the less significant the

VSWR is, the superior the antenna is coordinated to the transmission line and the supplementary power is delivered to the antenna.

C. RADIATION PATTERNS

"A radiation pattern defines the variation of the power radiated by an antenna as a function of the direction away from the antenna. This power variation as a function of the arrival angle is observed in the antenna's far field."[16, 24].The gain of an antenna is described as the intensity of radiation of the antenna in a particular direction, which relates the concept of directivity and electrical efficiency of the antenna. The [25-28]Radiation pattern is the representation of obtaining gain, including direction as a function. The radiation patterns have been simulated and shown in Fig.4 and Fig.5.

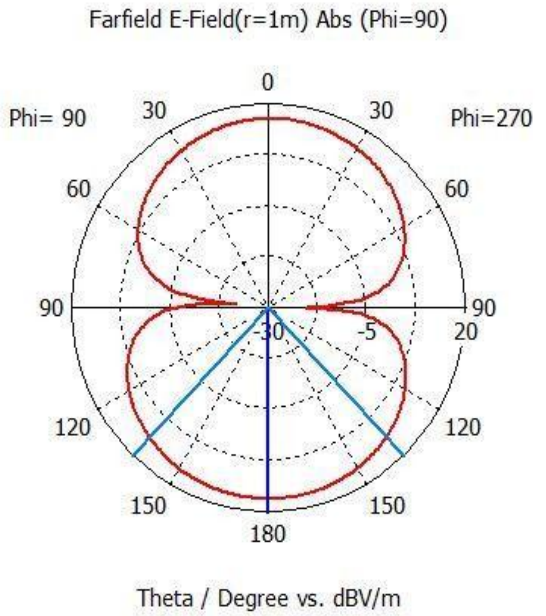

Fig. 3. Radiation pattern for E Plane with consideration of frequency 2.4 GHz

Figure 3 depicts the radiation pattern which refers to the directional (angular) dependence of the strength of the radio waves from the antenna proposed for E Plane 2.4 GHz.

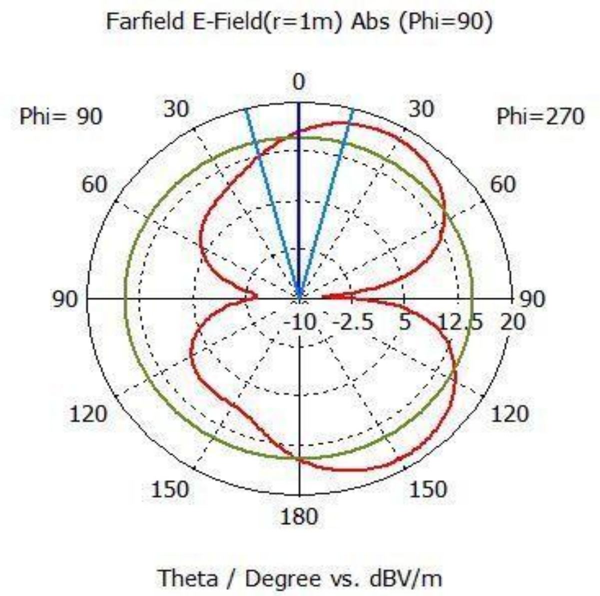

Fig 4. Radiation pattern for E Plane with consideration of frequency 5.2 GHz

Figure 4 depicts the radiation pattern which refers to the directional (angular) dependence of the strength of the radio waves from the antenna proposed for E Plane 5.2 GHz.

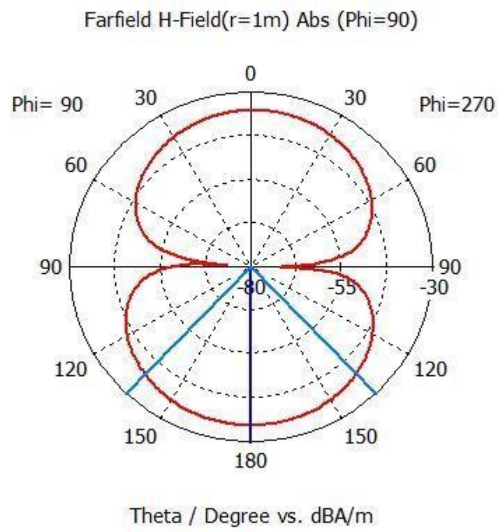

Fig. 5. Radiation pattern for E Plane with consideration of frequency 5.2 GHz

Figure 5 depicts the radiation pattern which refers to the directional (angular) dependence of the strength of the radio waves from the antenna proposed for E Plane 5.2 GHz.

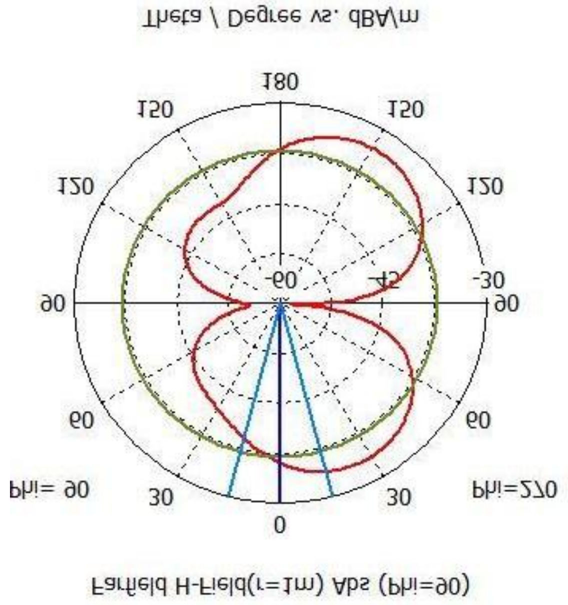

Fig. 6. Radiation pattern for E Plane with consideration of frequency 5.2 GHz

Figure 6 depicts the radiation pattern which refers to the directional (angular) dependence of the strength of the radio waves from the antenna proposed for E Plane 5.2 GHz.

V. CONCLUSION

The proposed simple dual band fractal printed antenna which has operating frequencies of 2.4 GHz and 5.2 GHz has shown an acceptable return loss and gain. The antenna has a gain of 2.109 dB with consideration of frequency at 2.4 GHz and 3.44 dB with consideration of frequency 5.2 GHz. So, it can be concluded that the proposed antenna is appropriate for applications concerning to WLAN.

REFERENCES

[1] Rathore, A.; Nilavalan, R.; AbuTarboush, H.F.; Peter, T., "Compact dual-band (2.4/5.2GHz) monopole antenna for WLAN applications," Antenna Technology (iWAT), 2010 International Workshop on , vol., no., pp.1,4, 1-3 March 2010.

[2] Chen, W. -L; Wang, G. -M; Zhang, C. -X, "Fractal-shaped switched-beam antenna with reduced size and broadside beam," Electronics Letters , vol.44, no.19, pp.1110,1111, September 11 2008.

[3] Wong, T.P.; Lau, C.K.L.; Luk, Kwai-Man; Lee, K.-F., "Wideband Fractal Vertical Patch Antenna," Antennas and Wireless Propagation Letters, IEEE , vol.6, no., pp.5,6, 2007.

[4] Wen-Ling Chen; Guang-Ming Wang; Chen-xin Zhang, "Small-Size Microstrip Patch Antennas Combining Koch and Sierpinski Fractal-Shapes," Antennas and Wireless Propagation Letters, IEEE , vol.7, no., pp.738,741, 2008.

[5] Thakare, Y.B.; Rajkumar, "Design of fractal patch antenna for size and radar cross-section reduction," Microwaves, Antennas & Propagation, IET , vol.4, no.2, pp.175,181, Feb. 2010.

[6] Dalsania, P.; Shah, B.; Upadhyaya, T.; Dwivedi, V.V., "Analysis of Multiband Behaviour on Square Patch Fractal Antenna," Communication Systems and Network Technologies (CSNT), 2012 International Conference on , vol., no., pp.76,78, 11-13 May 2012.

[7] Hazdra, P.; Mazanek, M., "Miniature microstrip fractal patch antenna working with crossed-diagonal mode," Antennas and Propagation, 2006. EuCAP 2006. First European Conference on , vol., no., pp.1,4, 6-10 Nov. 2006.

[8] Gao Wei; Deng Hui, "Improved Microstrip Fractal Patch Antenna Using Uni-planar Compact Photonic Bandgap Structure (UC-PBG)," Communications and Mobile Computing, 2009. CMC '09. WRI International Conference on , vol.1, no., pp.33,37, 6-8 Jan. 2009.

[9] Ali, Z.; Singh, V.K.; Singh, A.K.; Ayub, S., "Bandwidth Enhancement of W Slot Microstrip Antenna Using Stacked Configuration," Communication Systems and Network Technologies (CSNT), 2012 International Conference on , vol., no., pp.31,34, 11-13 May 2012.

[10] Singh, V.K.; Ali, Z.; Singh, A.K., "Dual Wideband Stacked Patch Antenna for WiMax and WLAN Applications," Computational Intelligence and Communication Networks (CICN), 2011 International Conference on , vol., no., pp.315,318, 7-9 Oct. 2011.

[11] Singh, V.K.; Ali, Z.; Singh, A.K.; Ayub, S., "Dual Band Microstrip Antenna for UMTS/WLAN/WIMAX Applications," Communication Systems and Network Technologies (CSNT), 2013 International Conference on , vol., no., pp.47,50, 6-8 April 2013.

[12] Ali, Z.; Singh, V.K.; Singh, A.K.; Ayub, S., "Wide Band Inset Feed Microstrip Patch Antenna for Mobile Communication," Communication Systems and Network Technologies (CSNT), 2013 International Conference on , vol., no., pp.51,54, 6-8 April 2013 doi: 10.1109/CSNT.2013.20

[13] Ashutosh Kumar Singh,R.A.Kabeer,M.Shukla, Z. Ali, V. K. Singh, Shahanaz Ayub "Performance analysis of first iteration koch curve fractal log periodic antenna of varying flare angles" Central European Journal of Engineering (CEJE), Springer ISSN: 1896 1541Volume 3, Issue 1, pp 51-57,March, 2013.

[14] Ali, Z.; Singh, V.K.; Singh, A.K.; Ayub, S., "E-Shaped Microstrip Antenna on Rogers Substrate for WLAN Applications," Computational Intelligence and Communication Networks (CICN), 2011 International Conference on , vol., no., pp.342,345, 7-9 Oct. 2011

[15] Vinod Kumar Singh, Zakir Ali, A. K. Singh, Shahanaz Ayub "Dual band triangular slotted stacked microstrip antenna for wireless applications" Central European Journal of Engineering (CEJE), Springer ISSN: 1896 1541Volume 3, Issue 2, pp 221-225 June, 2013.

[16] Singh, A.K.; Kabeer, R.A.; Ali, Z.; Gurjar, D., "Performance analysis of compact Koch fractal antennas at varying iterations," Engineering and Systems (SCES), 2013 Students Conference on , vol., no., pp.1,5, 12-14 April 2013.

[17] Zakir Ali,Vinod Singh,Ashutosh Kumar Singh etal., "Compact Dual Band Microstrip Patch Antenna for WiMAX lower band Application" In the proceedings of IEEE International

Conference on Control, Computing, Communication and Materials-2013(In Press)

[18] Siddhartha Mishra,Akash Kumar,Ashutosh Kumar Singh, “Dual Band Textile Antennas for ISM Bands” In the proceedings of IEEE International Conference on Control, Computing, Communication and Materials-2013(In Press)

[19] Kai Fang Lee, Shing Lung Steven Yang, AhmedA. Kishk, and Kwai Man luk, “The versatile uslot patch antenna,” IEEE Antennas andPropagation Magazine, vol. 52, no. 1, February 2010

[20] Ali, Z.; Singh, V.K.; Singh, A.K.; Ayub, S., "E-Shaped Microstrip Antenna on Rogers Substrate for WLAN Applications," Computational Intelligence and Communication Networks (CICN), 2011 International Conference on , vol., no., pp.342,345, 7-9 Oct. 2011

[21] Singh, V.K.; Ali, Z.; Singh, A.K., "Dual Wideband Stacked Patch Antenna for WiMAX and WLAN Applications," Computational Intelligence and Communication Networks (CICN), 2011 International Conference on , vol., no., pp.315,318, 7-9 Oct. 2011.

[22] Sanjeev Dwivedi,Abhishek Rawat and R.N Yadav, “Design of U-shaped Microstrip patch antenna For WIMAX Applications at 2.5GHz” IEEE WiMAX sys. applications and comm.,2013. Proceeding of the 2014 IEEE Students' Technology Symposium TS14P02 299 978-1-4799-2608-4/14/$31.00 ©2014 IEEE 388

[23] W. Chen, K. F. Lee, and and R. Q. Lee, “Spectral-domain momentmetho analysis of coplanar microstrip parasitic subarrays,” Microw.Opt. Technol. Lett., vol. 6, no. 3, pp. 157–163, 1993.

[24] Lal, Kumari Nidhi, and Ashutosh Kumar Singh. "Modified design of microstrip patch antenna for WiMAX communication system." Students' Technology Symposium (TechSym), 2014 IEEE. IEEE, 2014.

[25] Lal, Nidhi, et al. "A Heuristic EDF Uplink Scheduler for Real Time Application in WiMAX Communication." arXiv preprint arXiv:1501.04553 (2015).

[26] Lal, N.; Singh, A.P.; Kumar, S., "Modified trial division algorithm using KNJ-factorization method to factorize RSA public key encryption," Contemporary Computing and Informatics (IC3I), 2014 International Conference on , vol., no., pp.992,995, 27-29 Nov. 2014

[27] Bhaskar-Semwal, V., et al. "Accurate location estimation of moving object In Wireless Sensor network." International Journal of Interactive Multimedia and Artificial Intelligence 1.4 (2011).

[28] Lal, Nidhi. "An Effective Approach for Mobile ad hoc Network via I-Watchdog Protocol." arXiv preprint arXiv:1412.8013 (2014).