Influence analysis of director's elements on the circular Yagi disc antenna performance at 1.8 GHz

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ABSTRACT

This paper aims to investigate and design a Yagi disc antenna with a variable number of director elements for Band 3 in fourth-generation long term evolution (4G LTE) mobile applications. The array technique was introduced by increasing the number of director elements to achieve superior results and better performance, such as higher gain and lower return loss. Initially, the simulated results of return loss and gain with one director element were -19.02 dB and 8.51 dBi, respectively. Then, by increasing the number of directors to three and five elements, the antenna's performance improved significantly from -32.44 to -42.68 dB for return loss and from 8.51 to 11.17 dBi for gain, respectively. The simulated circular Yagi disc antenna provided a response in the range of 1.78 to 1.82 GHz. Therefore, a model was fabricated and tested to validate the antenna design. The measured results matched well with the simulated ones. By increasing the number of director elements, the measurement results of gain and return loss at a frequency of 1.8 GHz also showed improvement from 7.70 to 11.09 dBi and from -27.31 to -32.91 dB, respectively. Meanwhile, the measured antenna provided a wider bandwidth in the range of 1.72-1.82 GHz.

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1. INTRODUCTION

The circular Yagi disc antenna design was introduced and integrated as an external antenna to boost the quality and connectivity for the fourth-generation long term evolution (4G LTE) mobile communication system. 4G LTE allows us to use and experience the internet more quickly and richly [1]. Additionally, the LTE standard offers a solution to address issues in cellular networks by enabling faster data rates, increased capacity, and reduced latency, as supported by various studies [2]–[5]. The wireless broadband industry has shown significant interest in LTE 1,800 technology due to its compatibility with the existing global system for mobile communications (GSM) 1,800 band. The efficient repurposing of the spectrum from GSM 1,800 to LTE 1,800 has proven to be highly advantageous [6], [7]. Consequently, the advancement and fine-tuning of LTE 1,800 antennas play a crucial role in meeting the evolving requirements of contemporary wireless technologies [8]. A Yagi antenna is a type of antenna that has a high gain of the receiving signal and a low return loss value [9]. This kind of antenna is very suitable for 4G LTE mobile communication systems. Based on some research, there are several things that need to be taken care of during the designing of a directional antenna for a 4G LTE mobile communication system. In this study, a directional antenna will radiate and receive more significant power in specific directions (base transceiver station), allowing increased performance and reducing interferences from unwanted sources [10]. A directional antenna performs better than omnidirectional antennas in terms of gain and directivity [11].

Recently, several works with different methods have been designed to obtain high gain of the antenna. In [12], the developing of a circular patch antenna with a 2×2 array technique for a 1.8 GHz long term evolution (LTE) application with 6.36 dBi of realized gain is proposed. The array technique will affect the antenna gain. The higher the number of arrays, the higher the antenna gain value. The authors in [13] designed a microstrip Yagi antenna appropriate for wireless fidelity (Wi-Fi) applications. The authors focus on developing the antenna by enhancing the gain using the array method with two branch elements. As a result, the gain has increased from one branch element and two branch elements which is 6.36 to 9.58 dB respectively. The proposed antenna was designed by using the 1x2 array method with two branch elements increased the antenna gain by 2.61 from 6.89 dB of one branch of the antenna. In addition, adding parasitic patch elements is one of the best ways to enhance the gain. In [14], substantial gains of 5 and 1.5 dBi were obtained in the 4G and 2G frequency bands, respectively, by inserting a three-element folded slot-loop patch element. In this case, increasing the parasitic patch also broadened the frequency bandwidth from 0.78 up to 2.7 GHz. However, the gain variations induced by the triangle structure are slightly larger.

In this paper, the influence of the number of director elements on antenna performance at a frequency of 1.8 GHz will be analyzed. The results will then be compared between simulation and measurement for discussion purposes. Finally, a conclusion will be drawn from this investigation to explain the findings and provide suggestions for future study.

2. ANTENNA DESIGN

To simplify the process of designing antenna, the systematic metrics should be specified in the form of a flowchart, as shown in Figure 1. The circular Yagi disc antenna with aluminum material was proposed in order to design an external antenna for the band 3 LTE mobile application. They selected aluminum material because it is much cheaper compared to copper. This protective aluminum oxide coating protects the metal's surface against corrosion and conducts heat and electricity excellently [15].

An antenna based on Yagi is a directional antenna consisting of two elements: a driven element and a parasitic element that comprises a reflector and directors. The Yagi antenna typically has one reflector because additional reflectors have little impact. The reflector is located behind the main driving element. The driven element is the parasitic element to which power is applied. It is generally a half-wave dipole or commonly, a folded dipole. A folded dipole element is typically used because the proximity of the other parasitic elements causes the feed impedance of the dipole to decrease. Using a folded dipole brings the feed impedance back to a value that provides a better match to the feeder-employed field [16], [17]. The director or directors are located in front of the driven component that produces the necessary current required to radiate electromagnetic radiation into the space field [18]–[21].

Generally, the driven element's length is slightly shorter than $\lambda/2$, ranging from 0.45λ to 0.49λ. The length of the reflector element is usually 5% larger compared to the driven element, and the directors are generally shorter by 5% than the driven element. The spacing of the reflector from the driven element is about 0.1λ to 0.25λ. The spacing also depends on bandwidth, gain, F/B ratio and sidelobe pattern specifications [22], [23]. The Yagi Disc antenna is fed by an RG58 50 Ω coaxial cable. The simulations utilized by computer simulation technology (CST) for this proposed design correspond to the detailed antenna dimensions listed in Tables 1 and 2. The proposed design with the dimension of the circular Yagi disc antenna, consisting of a dipole and several parasitic elements are shown in Figure 2.

Figure 3 illustrates the proposed antenna design process by varying the number of director's elements. The first iteration with a single director element is shown in Figure 3(a), Figure 3(b) presents the second iteration with three arrays of director's elements, and the suggested antenna with five arrays of director's elements which provides a high gain and efficiency of the antenna is in Figure 3(c).

Figure 4 depicts a parametric study of the proposed antenna, mainly created inside a single director element of the design process. The proposed antenna's resonant frequency was determined by the structure's parameter, which corresponded to λo at the center frequency of 1.796 GHz, as shown in Figure 4(a). Two director elements were added and attached to the next existing element after the existing antenna director elements for the purpose of studying the effect on antenna performance. Increasing the number of arrays helped to improve the gain [24]–[28]. In our case, increasing the number of director elements will enhance the gain and return loss of the antenna for the frequency of 1.8 GHz, as shown in Figure 4(b), so that the antenna with three elements of director gets a low return loss value which is -32.44 dB at frequency of

1.8 GHz compared than an antenna with single director element, -19.02 dB. In conclusion, a configuration consisting of five director elements of equal dimensions was combined in the antenna design. The simulated outcomes clearly demonstrated that the proposed antenna effectively exhibited stopband characteristics across the frequency range of 1.8 GHz, with the minimum return loss value recorded at -42.68 dB. Additionally, the antenna's bandwidth extended from 1.78 to 1.82 GHz, maintaining a return loss lower than -10 dB as shown in Figure 4(c). Furthermore, increasing the number of director elements enhances the antenna's performance in terms of return loss specifically at 1.8 GHz.

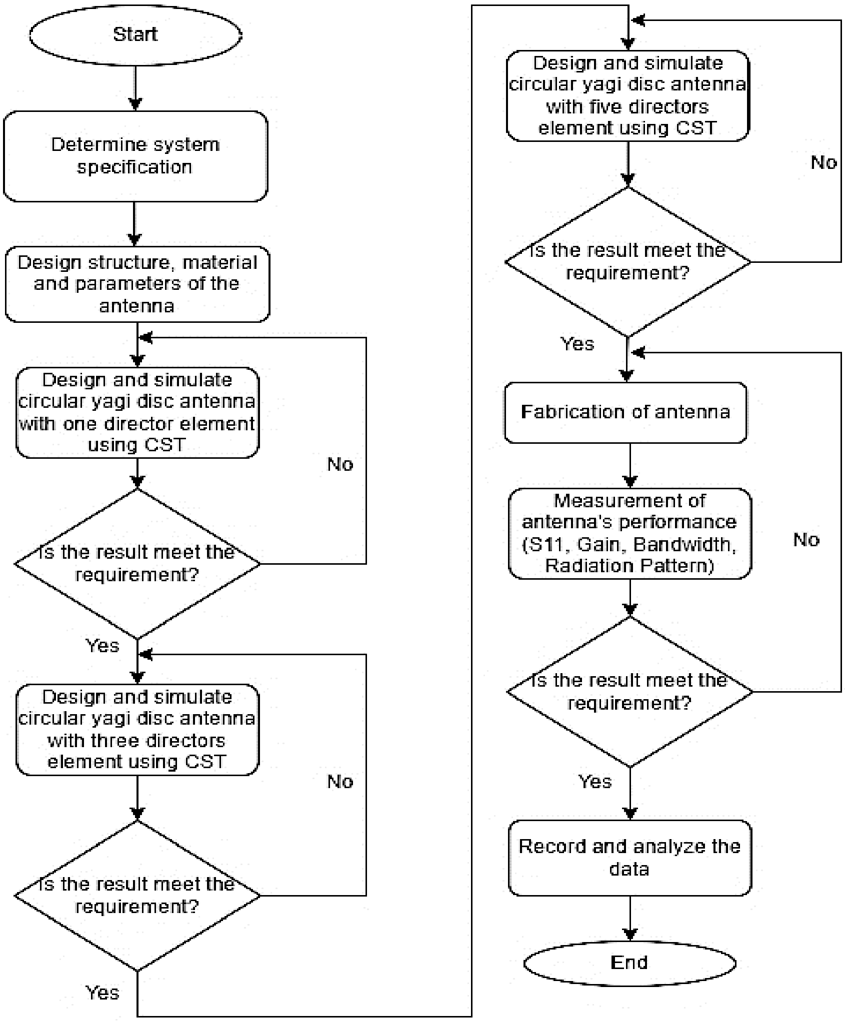


Figure 1. Methodology flowchart of the antenna design

Table 1. Disc diameter dimensions

Parameter	Value (mm)	Parameter	Value (mm)	Parameter	Value (mm)
D_{ref}	140	D_{dir2}	57	D_{dir5}	57
D_{dri}	93.4	D_{dir3}	57		
D_{dir1}	80	D_{dir4}	57		

Table 2. Distance between each element dimensions

Parameter	Value (mm)	Parameter	Value (mm)	Parameter	Value (mm)
$S_{ref-dri}$	14.9	$S_{dir2-dir3}$	38	$S_{feedpoint-diskedge}$	13.5
$S_{dri-dir1}$	16.3	$S_{dir3-dir4}$	38		
$S_{dir1-dir2}$	43.5	$S_{dir4-dir5}$	38		

The gain of the antenna is referred to as how much power is transmitted from an isotropic source in the direction of peak radiation. Figure 4 shows the gain that radiates from the proposed antenna. At the first proposed antenna, the gain of the antenna with a single director element is 8.51 dBi at 1.8 GHz, as shown in Figure 5(a). Then, Figure 5(b) displays the gain of the antenna increases to 9.79 dBi after the elements of directors are added to two more director elements which makes three director elements in total. To provide good antenna performance that functions as an external antenna of a 4G LTE router, the antenna gain must be enhanced further to improve the signal between the transmitter and receiver. Therefore, the number of directors needs to increase to five directors in order to have a good effect on the antenna gain. The maximum gain of the antenna with five element directors is 11.17 dBi at 1.8 GHz, as shown in Figure 5(c).

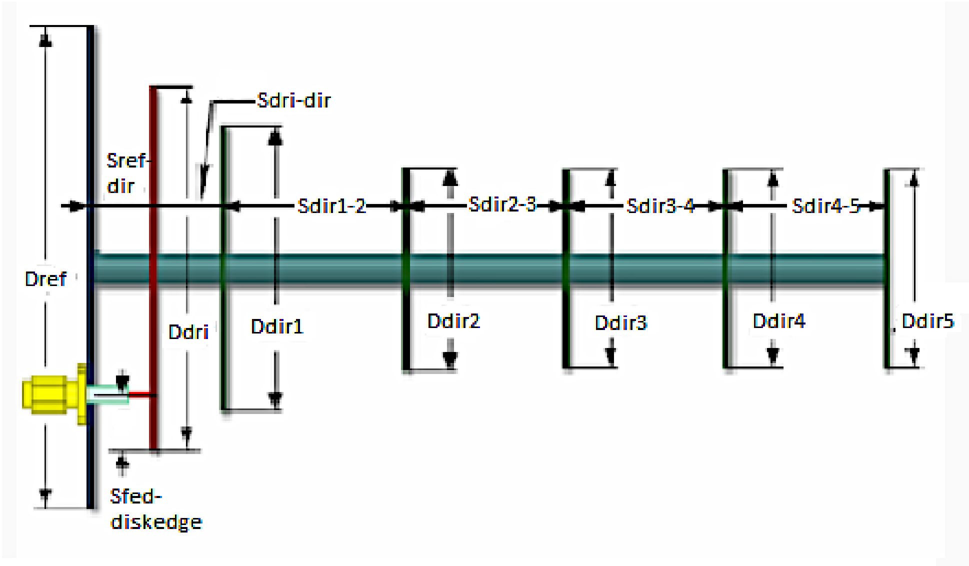
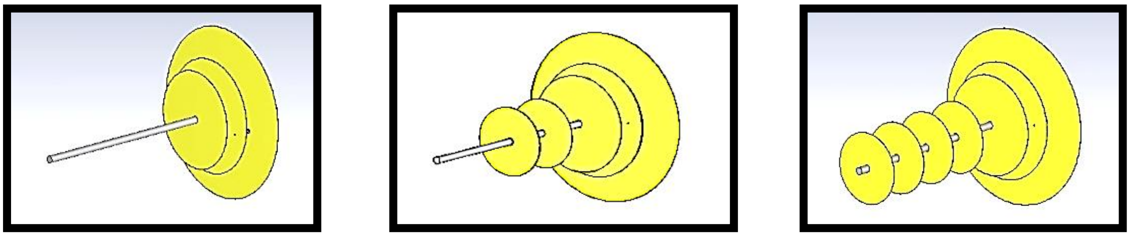
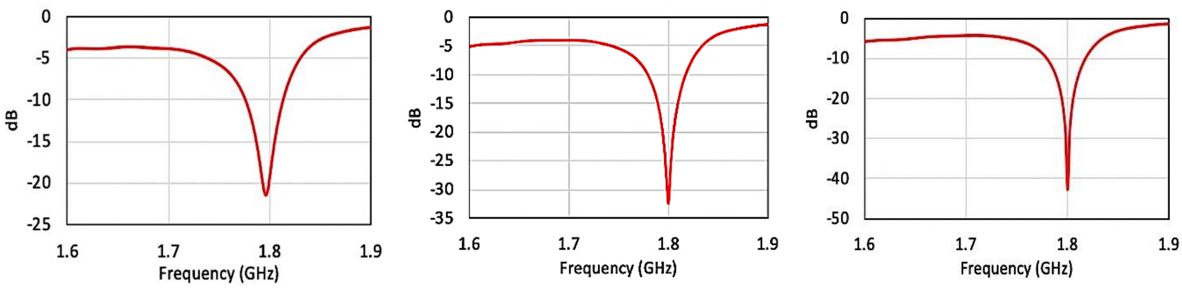


Figure 2. The dimensions of the proposed antenna



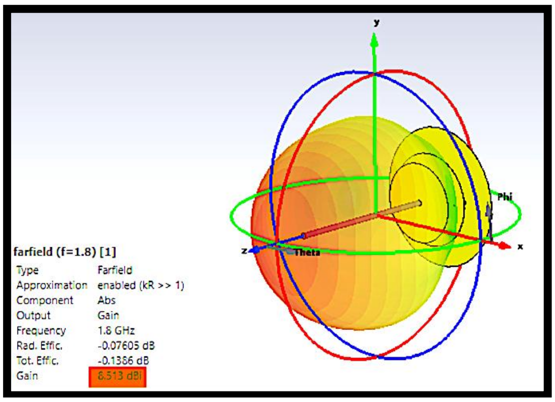
(a) (b) (c)

Figure 3. The proposed antenna design (a) first iteration, (b) second iteration, and (c) third iteration

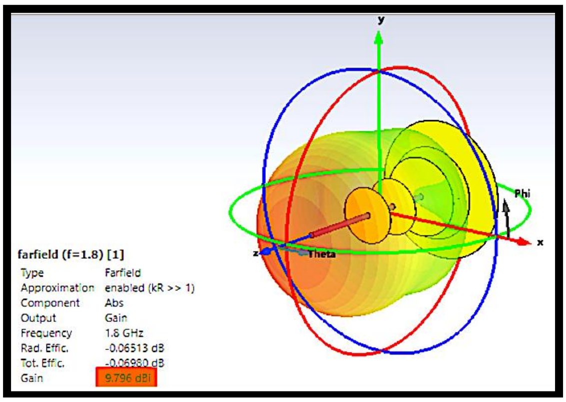


(a) (b) (c)

Figure 4. Simulated S11 (a) one director element, (b) three director elements, and (c) five director elements



(a)



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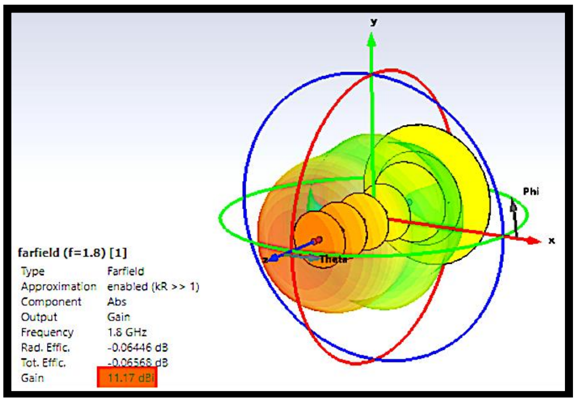


(c)

Figure 5. Simulated S11 (a) one director element, (b) three director elements, and (c) five director elements

3. MEASURED RESULTS AND DISCUSSION

The antenna was fabricated using aluminum material for each element, as shown in Figure 6. The chosen aluminum thickness is 0.3 mm, making this antenna lighter and easier to install. Besides, the antenna boom uses steel metal such as bold and hex nuts to join the elements correctly and tightly.

Taking into account the physical attributes, meticulous efforts have been made to ensure that the manufactured antenna possesses identical characteristics to the proposed design. Subsequently, the fabricated Yagi disc antenna was subjected to measurements within an anechoic chamber to evaluate its transmission properties, as depicted in Figure 7. The measurement process involved placing a horn antenna in front of the antenna under test, configuring them as a transmitter and receiver, respectively, to facilitate signal exchange.

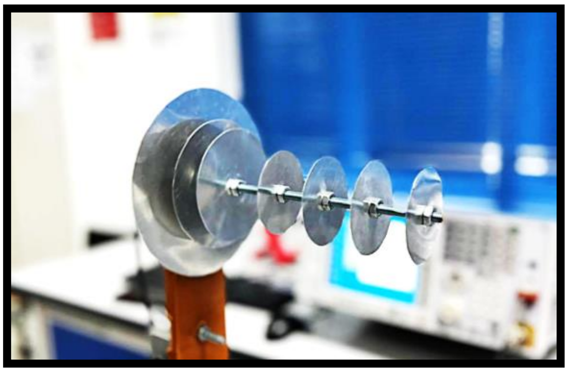


Figure 6. Fabricated of circular Yagi disc antenna

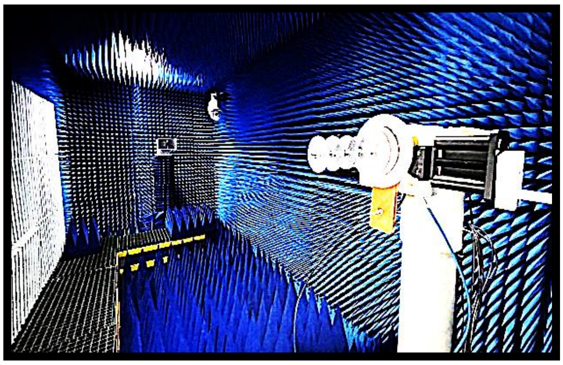


Figure 7. Measurement setup of circular Yagi disc antenna

The simulated and measured return loss (S11) results are displayed in Figure 8. It is clear that the proposed antenna exhibited a stopband response from 1.78-1.82 GHz for the simulation and 1.62-1.68 GHz, 1.72-1.82 GHz for the measurement, with almost below -10 dB of return loss performance. Based on the measurement, it can also conclude that the increment number of directors' elements will improve the antenna's efficiency.

The performance of the fabricated antenna looks better when it has covered a vast amount of bandwidth, almost 100 MHz, compared to the simulation result, which is only 40 MHz. For example, the measurement results of an antenna with five-element directors have covered the frequency range from 1.72 to 1.82 GHz. This fabricated antenna can also operate at a frequency of 1.65 GHz in addition to 1.8 GHz. Meanwhile, the simulated gain and measured gain appear nearly identical, indicating that the antenna's gain performance has not changed significantly since it was fabricated.

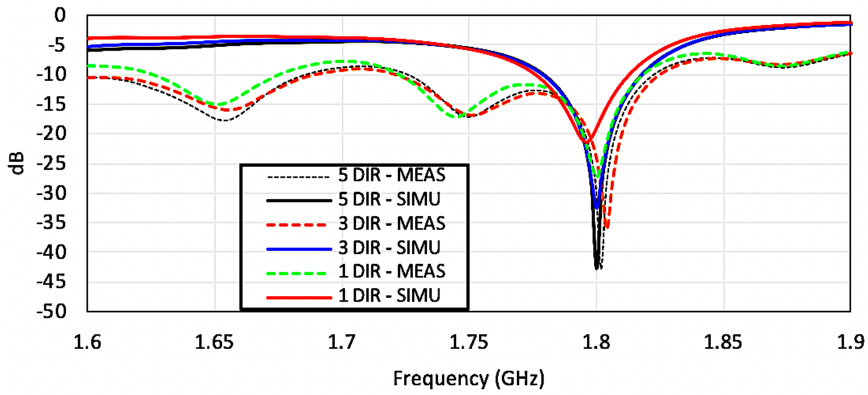
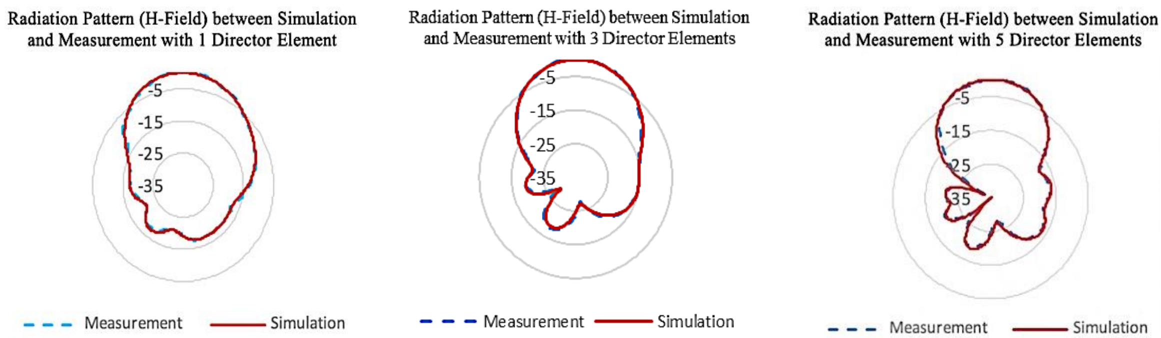


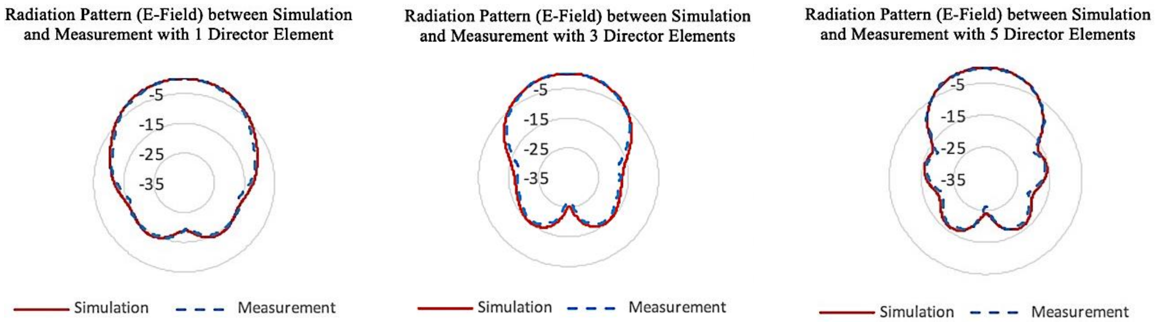
Figure 8. S11 comparison of simulation and measurement results

The following parameter measured the antenna radiation pattern, as shown in Figures 8 and 9. Radiation patterns for all antenna types were measured at *phi*=0 degrees (H-Field) and *phi*=90 degrees (E-Field). As a result, it is evident that the radiation pattern retains its features and shape, nearly identical to the simulated one, as suggested in [25]. Therefore, little change between measured and simulated antenna radiation. Parameters such as the main lobe and back lobe are likewise in the simulated position. From the radiation pattern illustrated in Figures 9(a)-(c) and Figures 10(a)-(c), it can be seen that as the number of director elements increases, the half power beam width (HPBW) angle becomes smaller, and the antenna becomes more directive. The observed antenna's HPBW at *phi*=0 (H-Field) and *phi*=90 (E-Field) is nearly identical to the simulated one, at 57.5 and 73.3 degrees for one director element, 54.2 and 62.3 degrees for three director elements, and 48.0 and 52.7 degrees for five director elements respectively. The measured gain of the antenna for one, three and five directors are 7.08, 10.08, and 11.09 dBi, correspondingly. Tables 3 and 4 show the summary results of the simulation and measurement of antenna performance at the resonant frequency of 1.8 GHz, respectively, with a different number of antenna's director elements.



(a) (b) (c)

Figure 9. Radiation pattern H-field (a) one director element, (b) three director elements, and (c) five director elements



(a) (b) (c)

Figure 10. Radiation pattern E-Field (a) one director element, (b) three director elements, and (c) five director elements

Table 3. Simulation of antenna performance at 1.8 GHz

No. of Director's element	Bandwidth (MHz)	Return loss (dB)	Gain (dBi)
1	40	-19.02	8.51
3	40	-32.44	9.79
5	40	-42.68	11.17

Table 4. Measurement of antenna performance at 1.8 GHz

No. of Director's element	Bandwidth (MHz)	Return loss (dB)	Gain (dBi)
1	100	-27.31	7.70
3	100	-29.40	10.08
5	100	-32.91	11.09

4. CONCLUSION

In this paper, a circular Yagi disc antenna is designed and simulated for Band 3 4G LTE mobile communication systems. The effect of changing the number of element directors on the antenna's performance is investigated through simulations and measurements. The measurement results show that the suggested circular Yagi disc antenna has high gain and good reflection coefficient in the range of the LTE 1,800 system. Furthermore, the simulation results are highly consistent with the measurement results. As a result, the final design of a circular Yagi disc antenna with five director elements has the potential to be used as an external antenna for 4G LTE routers to improve antenna gain and directivity.

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REFERENCES

[1] Verizon, "What is 4G LTE and why it matters," *Verizon News Archives*, 2018. https://www.verizon.com/about/news/what-4g-lte-and-why-it-matters (accessed Dec. 01, 2022).

[2] H. Elsherbiny, H. M. Abbas, H. Abou-zeid, H. S. Hassanein, and A. Noureldin, "4G LTE network throughput modelling and prediction," in *IEEE Global Communications Conference*, Dec. 2020, pp. 1–6, doi: 10.1109/GLOBECOM42002.2020.9322410.

[3] Y. Hao, "Investigation and technological comparison of 4G and 5G networks," *Journal of Computer and Communications*, vol. 9, no. 1, pp. 36–43, 2021, doi: 10.4236/jcc.2021.91004.

[4] E. T. Tchao, J. D. Gadze, and J. Obeng, "Performance evaluation of a deployed 4G LTE network," *International Journal of Advanced Computer Science and Applications*, vol. 9, no. 3, pp. 165–178, 2018, doi: 10.14569/IJACSA.2018.090325.

[5] R. Kamaruddin, "Return looss improvement of radial line slot array antennas on closed ring resonator structure at 28 GHz," *Przegląd Elektrotechniczny*, vol. 1, no. 5, pp. 67–71, May 2021, doi: 10.15199/48.2021.05.10.

[6] H. S. Wong, M. T. Islam, and S. Kibria, "Design and optimization of LTE 1,800 MIMO antenna," *The Scientific World Journal*, vol. 2014, pp. 1–10, 2014, doi: 10.1155/2014/725806.

[7] A. J. A. Al-Gburi, I. B. M. Ibrahim, Z. Zakaria, and N. F. B. M. Nazli, "Wideband microstrip patch antenna for sub 6 GHz and 5G applications," *Przeglad Elektrotechniczny*, vol. 97, no. 11, pp. 26–29, Nov. 2021, doi: 10.15199/48.2021.11.04.

[8] Ding *et al.*, "Integration of LTE 230 and LTE 1,800 in power wireless private networks," *Future Internet*, vol. 11, no. 11, Oct. 2019, doi: 10.3390/fi11110221.

[9] S.-W. Kim, S.-K. Noh, H.-G. Yu, and D.-Y. Choi, "Design and analysis of a quasi-Yagi antenna for an indoor location tracking system," *Sensors*, vol. 18, no. 12, Dec. 2018, doi: 10.3390/s18124246.

[10] A. J. A. Al-Gburi, I. Ibrahim, M. Y. Zeain, and Z. Zakaria, "Compact size and high gain of CPW-fed UWB strawberry artistic shaped printed monopole antennas using FSS single layer reflector," *IEEE Access*, vol. 8, pp. 1–1, 2020, doi: 10.1109/ACCESS.2020.2995069.
[11] J. A. Azevedo and F. E. Santos, "Performance evaluation of directional antennas in ZigBee networks under NLOS propagation conditions," *Electronics*, vol. 11, no. 13, Jun. 2022, doi: 10.3390/electronics11132032.
[12] O. S. Baskoro, I. P. Ardana, P. K. Sudiarta, and A. Munir, "A 2×2 inset feed circular patch antenna array for 1.8GHz LTE application," in *2018 4th International Conference on Wireless and Telematics (ICWT)*, Jul. 2018, pp. 1–4, doi: 10.1109/ICWT.2018.8527823.
[13] N. bt. Ismail, M. T. Ali, N. N. S. N. Dzulkefli, R. Abdullah, and S. Omar, "Design and analysis of microstrip Yagi antenna for Wi-Fi application," in *2012 IEEE Asia-Pacific Conference on Applied Electromagnetics (APACE)*, Dec. 2012, pp. 283–286, doi: 10.1109/APACE.2012.6457677.
[14] H. Wen, Y. Qi, Z. Weng, F. Li, and J. Fan, "A multiband dual-polarized omnidirectional antenna for 2G/3G/LTE applications," *IEEE Antennas and Wireless Propagation Letters*, vol. 17, no. 2, pp. 180–183, Feb. 2018, doi: 10.1109/LAWP.2017.2778761.
[15] T. Maeda, H. Miyazaki, R. Iwasaki, and R. Kobayashi, "Heatproof aluminum with excellent electric conductivity and thermal conductivity," *Sumitomo Electric Technical Review*, no. 92, pp. 68–72, 2021.
[16] A. Jamal Abdullah Al-Gburi, I. Ibrahim, Z. Zakaria, and A. Dheyaa Khaleel, "Bandwidth and gain enhancement of ultra-wideband monopole antenna using MEBG structure," *Journal of Engineering and Applied Sciences*, vol. 14, no. 10, pp. 3390–3393, Nov. 2019, doi: 10.36478/jeasci.2019.3390.3393.
[17] M. Elhefnawy, "Design and simulation of an analog beamforming phased array antenna," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 10, no. 2, pp. 1398–1405, Apr. 2020, doi: 10.11591/ijece.v10i2.pp1398-1405.
[18] E. N. Umayah and V. M. Srivastava, "Comparative analysis of feeding techniques for cylindrical surrounding patch antenna," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 10, no. 5, pp. 5377–5384, Oct. 2020, doi: 10.11591/ijece.v10i5.pp5377-5384.
[19] V. Bankey and N. A. Kumar, "Design of a Yagi-Uda antenna with gain and bandwidth enhancement for Wi-Fi and Wi-Max applications," *International Journal of Antennas*, vol. 2, no. 1, pp. 1–14, Jan. 2016, doi: 10.5121/jant.2016.2101.
[20] M. Zeain, "Design of helical antenna for next generation wireless communication," *Przegląd Elektrotechniczny*, vol. 1, no. 11, pp. 98–101, Nov. 2020, doi: 10.15199/48.2020.11.19.
[21] M. Shamsudin, I. Ibrahim, and K. Ulaganathen, "4G LTE directional antenna design," in *4th International on Telecommunications, Electronic and Computer Engineering*, 2022.
[22] A. J. A. Al-Gburi, Z. Zakaria, I. M. Ibrahim, and E. B. A. Halim, "Microstrip patch antenna arrays design for 5G wireless backhaul application at 3.5 GHz," in *Lecture Notes in Electrical Engineering*, vol. 865, Springer Singapore, 2022, pp. 77–88.
[23] H. Guo and G. Wen, "Design of Yagi-Uda antenna with multiple driven elements," *Progress In Electromagnetics Research C*, vol. 92, pp. 101–112, 2019, doi: 10.2528/PIERC19013002.
[24] B. Bonev, Z. Radkova, L. Dimcheva, and P. Petkov, "Minkowski fractal Yagi antenna," in *International Scientific Conference on Information (ICEST)*, 2018.
[25] A. Ullah, N. Ojaroudi Parchin, A. S. I. Amar, and R. A. Abd-Alhameed, "Eight-element antenna array with improved radiation performances for 5G hand-portable devices," *Electronics*, vol. 11, no. 18, Sep. 2022, doi: 10.3390/electronics11182962.
[26] R. Reddy and R. Swaminathan, "Directivity improvement of 9-element Yagi Uda antenna by increasing director elements in comparison with 7-element Yagi Uda antenna," in *2022 3rd International Conference on Intelligent Engineering and Management (ICIEM)*, Apr. 2022, pp. 561–564, doi: 10.1109/ICIEM54221.2022.9853131.
[27] A. H. Ilyasah, M. R. Hidayat, and S. U. Prini, "2×1 truncated corner microstrip array antenna to increase gain and bandwidth for LTE applications at 2.3 GHz frequency," *Jurnal Elektronika dan Telekomunikasi*, vol. 22, no. 1, Aug. 2022, doi: 10.55981/jet.436.
[28] G. Haridoss, S. Ravimaran, J. William, M. Wasim, and M. Abdullah, "High gain series fed two dipole array antenna with reduced size for LTE application," *IETE Journal of Research*, vol. 68, no. 2, pp. 1084–1090, 2022, doi: 10.1080/03772063.2019.1639555.

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