Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 5, 2021, Pages. 1809 - 1815
Received 15 April 2021; Accepted 05 May 2021.

Study and Implementation of 19-Level Multilevel Inverter and its Onfigurations

S.SathishKumar[1], M.Sivachitra[2], R.Meenakumari[3],G.Gowsiha[4], S.Kokila[3], R.Santhiya[6]

[1]Associate Professor, Department of Electrical and Electronics Engineering,M.Kumarasamy College of Engineering, Karur, Tamilnadu.
[2]Professor,Department of Electrical and Electronics Engineering, Kongu Engineering College,Perundurai, Tamilnadu.
[3]Professor, Department of Electrical and Electronics Engineering, Kongu Engineering College,Perundurai, Tamilnadu.
[4]UG Scholar, Department of Electrical and Electronics Engineering,M.Kumarasamy College of Engineering, Karur, Tamilnadu.
[5]UG Scholar, Department of Electrical and Electronics Engineering,M.Kumarasamy College of Engineering, Karur, Tamilnadu.
[6]UG Scholar, Department of Electrical and Electronics Engineering,M.Kumarasamy College of Engineering, Karur, Tamilnadu.

ABSTRACT

We can't envision a day in the twenty-first century without electrical appliances, and the most important thing is to have an uninterrupted power supply. In the construction of a continuous running power supply system, the inverter is an essential part. This project proposes a novel pulse-width-modulated (PWM) control scheme and a nineteen-level single-phase multilevel inverter with reduced switch count. The output voltage level of the proposed multilevel inverter is increased by using eight switches driven by multi-carrier modulation techniques. The inverter can generate 19 levels of output voltage from the dc supply voltage using an asymmetrical configuration. The proposed system was tested using MATLAB simulation, and the DSPIC30F2010 controller was used to implement the hardware.

Keywords : multi-level inverter (MLI),pulse width modulation(PWM),total harmonic distortion(THD).

1. INTRODUCTION

Large inverters had been used to meet the growing need of high-power industrial applications, which might range from tens to hundreds of megawatts. The medium voltage range (2,3-13,8 kilovolt) of AC engines is some examples of this fact. Because of the high voltage range, connecting only one semiconductor switch to the grid directly is difficult. To put it another way, a new type of power converter has been implemented in high-power applications as a way to address this difficulty. Multilevel converters use high-speed switching modules that prevent the problem of connecting them to the grid directly by connecting individual devices to

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 5, 2021, Pages. 1809 - 1815
Received 15 April 2021; Accepted 05 May 2021.

multiple DC stages[1-4]. Many implementations include multi-level converters; automotive engine drives, renewable energy systems interfaces (photo-voltaic, wind, and fuel cell systems)[5], high-voltage, direct current transmission systems (HVDC), and traction systems. In different applications, multi-level converters are also available.

Such benefits of using this type of converter are:

- They work at a lower switching frequency than the traditional converter.
- A very low harmonic distortion can be drawn input current.
- They reduce the machine tension so that it generates a lower voltage mode.
- A staircase waveform can be produced as an output with less harmonic .

Several multilevel topologies have been developed in recent years. The number of switching alternatives available makes it more difficult to modulate than the two-level conventional converter[6-7]. Besides, several modulation techniques for these converters have been developed. [28][29][30]Two modulation techniques are Sinusoidal Pulse Width Modulation and Selective Harmonic Removal[8-11]. The modular multi-level converter is the newest and best available topology for high-performance applications (M2C). For this topology, different methods of control and modulation were proposed. This master thesis aims to study and test one of them, based on a Pulse Width (PWM) technique, which is phase-shifted, with the carrier[12-15].

2. MATERIALS AND METHODS:

This system is made up of a single-phase conventional H-bridge inverter, 4 switches, and 4 voltage sources. MOSFETs are the switching devices used in this application[16-17]. As compared to other transistors such as BJT and IGBT, its operating frequency is higher and it produces lower switching losses. It's also compact and cost-effective. As compared to inverters with the same number of levels, the H-bridge topology has major benefits over other topologies, such as fewer voltage switches, power diodes, and ideally no capacitors, as compared to inverters with the same number of levels[18-27].

2.1 OBJECTIVE

The main purpose of this research is to learn,

- The generation of 19-level AC output is based on DC sources such as batteries and solar panels.
- The switch count is to be condensed in this proposed system.
- Total Harmonics distortions (THD) are to be reduced in the output.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 5, 2021, Pages. 1809 - 1815
Received 15 April 2021; Accepted 05 May 2021.

2.2 WORKING PRINCIPLE

For this nineteen-step inverter, a MOSFET-based complete bridge inverter circuit is cascaded are shown in figure.1. This H bridge inverter circuit already has three switches attached to it. To shield the switching devices from dv/dt and di/dt ratings, a snubber circuit (RC) is wired over both switches. The three switches are connected in series by three diodes. When the switch is opened, it completes the circuit.The simulink model are shown in figure.2

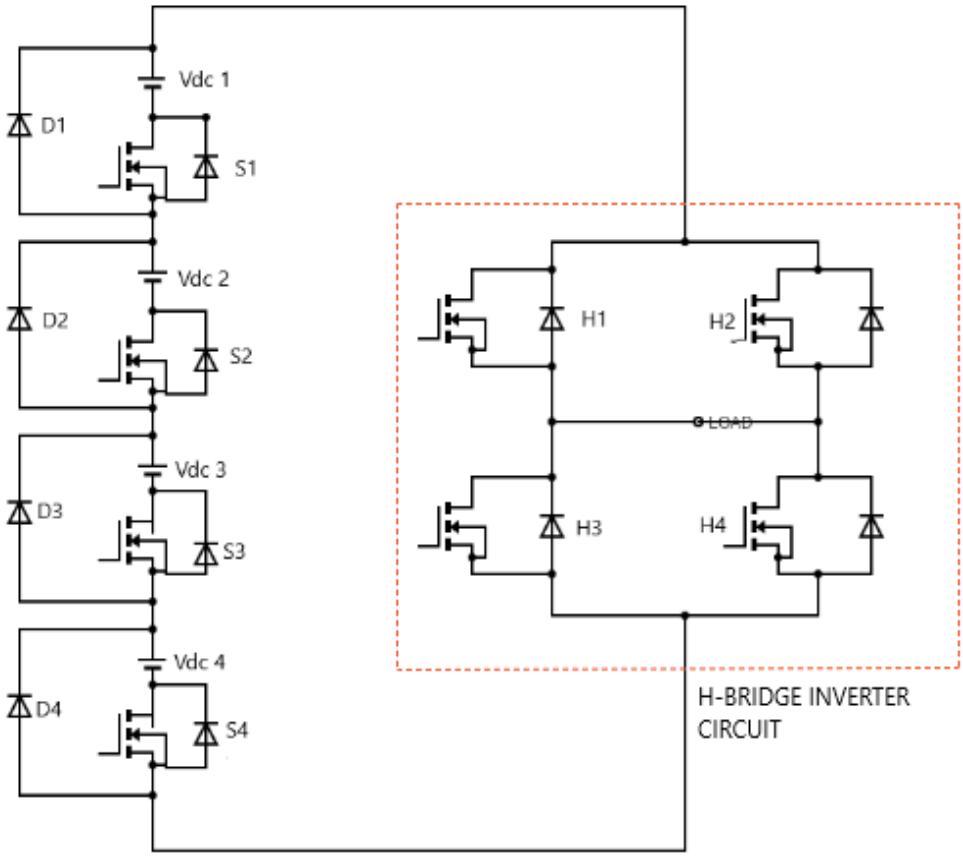

Figure.1 Circuit diagram for 19-level MLI

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 5, 2021, Pages. 1809 - 1815
Received 15 April 2021; Accepted 05 May 2021.

3. SIMULATION RESULTS:

3.1 PROPOSED SYSTEM SIMULINK:

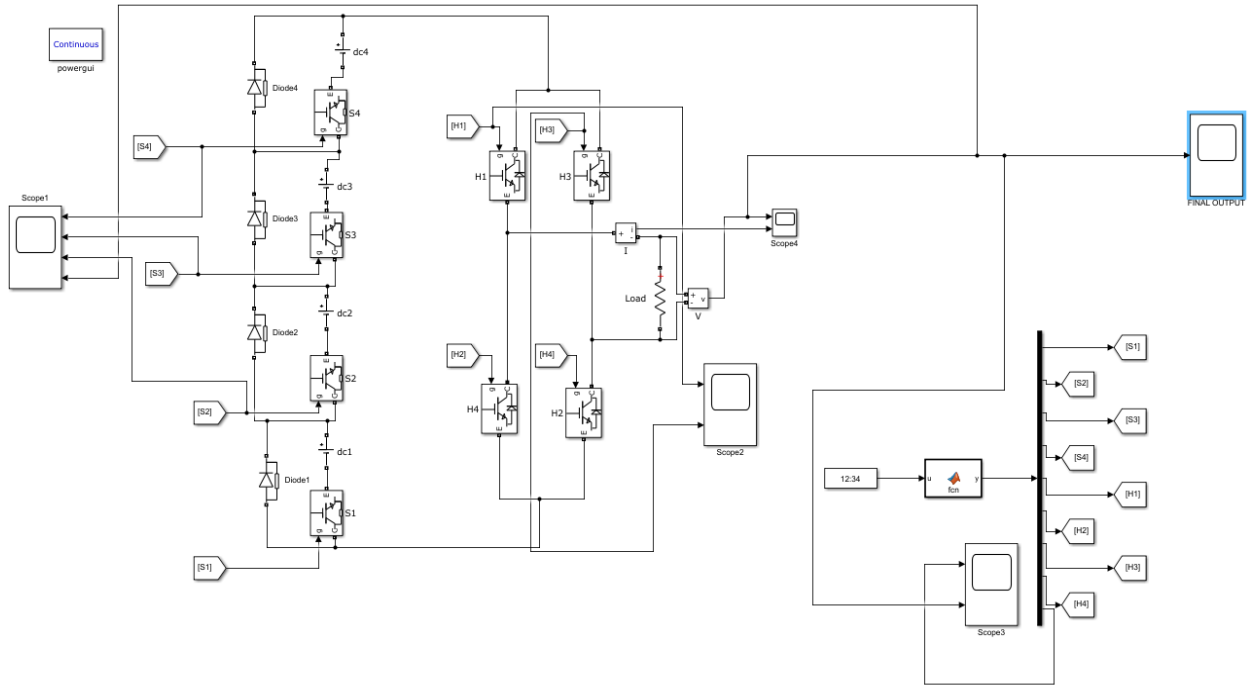

Figure.2 Simulation Model

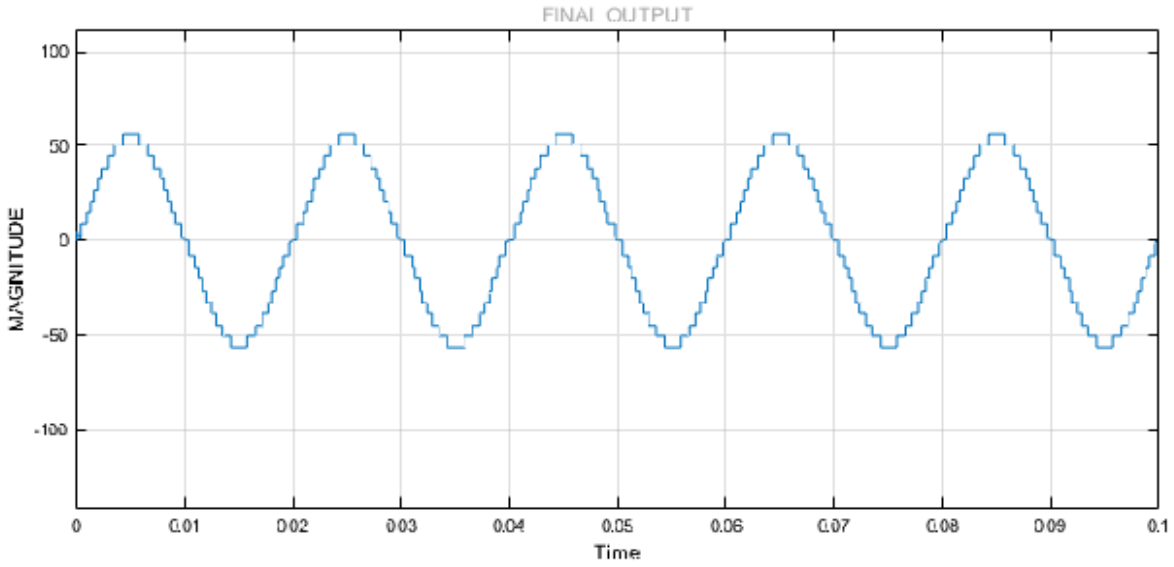

Figure.3 Proposed 19-level inverter output

The voltage waveforms of a nineteen-level inverter is seen in the fig.3. The waveform of the

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 5, 2021, Pages. 1809 - 1815
Received 15 April 2021; Accepted 05 May 2021.

output voltage is almost sinusoidal. With just eight switches, the proposed topology was able to achieve the nineteen-level output voltage. Its THD value also complies with the IEEE harmonics normal are shown in figure.4

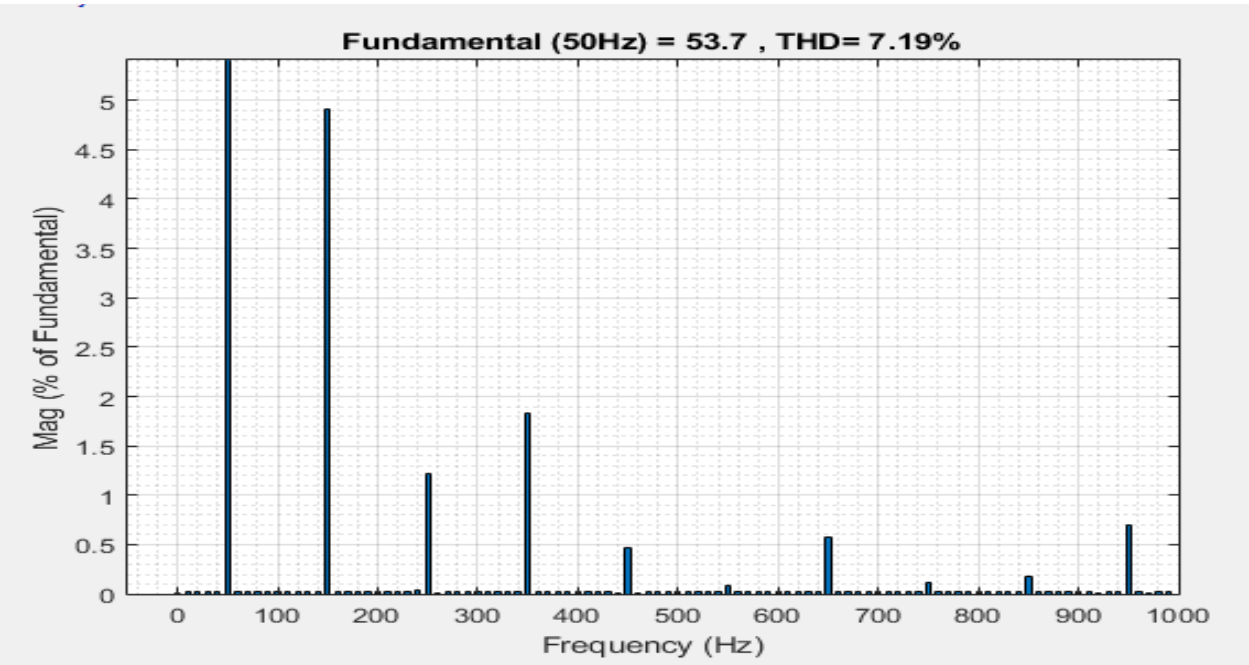

Figure.4 THD value of the nineteen-level output voltage

4. CONCLUSION

Multilevel inverters produce better output waveforms with less THD. This article has presented a new PWM system for the multi-level inverter proposed.Only one reference signal is used in this project, and it is compared to a triangular wave signal to generate PWM signals. In these multi-level inverters, three different levels of DC voltage are used. As a result, this configuration is known as an asymmetrical cascaded inverter. The nineteen levels of the output voltage are achieved by controlling the modulation index and different levels of DC voltage. By feeding the nineteen-level output voltage into a matrix converter, we can obtain variable AC output voltage. The nineteen-level inverter can power any industrial AC load. The output of the nineteen levels can be increased even more. When renewable energy sources are used effectively, overall system efficiency can be improved.

REFERENCES

[1] P. Omer, J. Kumar, and B. S. Surjan, ‘‘A review on reduced switch count multilevel inverter topologies,’’ IEEE Access, vol. 8, pp. 22281–22302, 2020.
[2] M. D. Siddique, S. Mekhilef, M. Rawa, A. Wahyudie, B. Chokaev, and I. Salamov, ‘‘Extended multilevel inverter topology with reduced switch count and voltage stress,’’ IEEE Access, vol. 8, pp. 201835–201846, 2020.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 5, 2021, Pages. 1809 - 1815
Received 15 April 2021; Accepted 05 May 2021.

[3] M. Jayabalan, B. Jeevarathinam and T. Sandirasegarane, "Reduced switch count pulse width modulated multilevel inverter," IET Power Electr., vol. 10, no. 1, pp. 10-17, 2017.
[4] V. Thiyagarajan and P. Somasundaram, "Modified Seven Level Symmetric Inverter with Reduced Switch Count", Advances in Natural and Applied Sciences, Vol. 11, No. 7, pp. 264-271, 2017.
[5] C. Dhanamjayulu, S. R. Khasim, S. Padmanaban, G. Arunkumar, J. B. Holm-Nielsen, and F. Blaabjerg, ‘‘Design and implementation of multilevel inverters for fuel cell energy conversion system,’’ IEEE Access, vol. 8, pp. 183690–183707, 2020, doi: 10.1109/ACCESS.2020.3029153.
[6] J. S. M. Ali, R. S. Alishah, N. Sandeep, S. H. Hosseini, E. Babaei, K. Vijayakumar, and U. R. Yaragatti, ‘‘A new generalized multilevel converter topology based on cascaded connection of basic units,’’ IEEE J. Emerg. Sel. Topics Power Electron., vol. 7, no. 4, pp. 2498–2512, Dec. 2019.
[7] R. S. Alishah, S. H. Hosseini, E. Babaei, M. Sabahi, and G. B. Gharehpetian, ‘‘New high step-up multilevel converter topology with self-voltage balancing ability and its optimization analysis,’’ IEEE Trans. Ind. Electron., vol. 64, no. 9, pp. 7060–7070, Sep. 2017.
[8] E. Samadaei, A. Sheikholeslami, S. A. Gholamian, and J. Adabi, ‘‘A square T-type (ST-Type) module for asymmetrical multilevel inverters,’’ IEEE Trans. Power Electron., vol. 33, no. 2, pp. 987–996, Feb. 2018.
[9] M. N. Hamidi, D. Ishak, M. A. A. M. Zainuri, and C. A. Ooi, ‘‘Multilevel inverter with improved basic unit structure for symmetric and asymmetric source configuration,’’ IET Power Electron., vol. 13, no. 7, pp. 1445–1455, May 2020.
[10] V. Thiyagarajan and P. Somasundaram, "New single phase asymmetric multilevel inverter with reduced number of power switches," International Conference on Power and Embedded Drive Control (ICPEDC), Chennai, India, pp. 219-222, 2017.
[11] C. Dhanamjayulu and S. Meikandasivam, ‘‘Implementation and comparison of symmetric and asymmetric multilevel inverters for dynamic loads,’’ IEEE Access, vol. 6, pp. 738–746, 2018.
[12] C. Dhanamjayulu and S. Meikandasivam, ‘‘Performance verification of symmetric hybridized cascaded multilevel inverter with reduced number of switches,’’ in Proc. Innov. Power Adv. Comput. Technol. (i-PACT), Vellore, India, Apr. 2017, pp. 1–5.
[13] S. S. Lee, ‘‘Single-stage switched-capacitor module (S3CM) topology for cascaded multilevel inverter,’’ IEEE Trans. Power Electron., vol. 33, no. 10, pp. 8204–8207, Oct. 2018.
[14] P. Bhatnagar, R. Agrawal, and K. K. Gupta, ‘‘Reduced device count version of single-stage switched-capacitor module for cascaded multilevel inverters,’’ IET Power Electron., vol. 12, no. 5, pp. 1079–1086, May 2019.
[15] M. D. Siddique, S. Mekhilef, N. M. Shah, A. Sarwar, A. Iqbal, and M. A. Memon, ‘‘A new multilevel inverter topology with reduce switch count,’’ IEEE Access, vol. 7, pp. 58584–58594, 2019.
[16] A. Tirupathi, K. Annamalai, and V. Tirumala, ‘‘A new hybrid flying capacitor–based single-phase nine-level inverter,’’ Int. Trans. Elect. Energy Syst., vol. 29, no. 12, 2019, Art. no. e12139.
[17] J. S. M. Ali and V. Krishnasamy, ‘‘Compact switched capacitor multilevel inverter (CSCMLI) with self-voltage balancing and boosting ability,’’ IEEE Trans. Power Electron., vol. 34, no. 5, pp. 4009–4013, May 2019.
[18] J. S. M. Ali, D. J. Almakhles, S. A. A. Ibrahim, S. Alyami, S. Selvam, and M. S. Bhaskar, ‘‘A generalized multilevel inverter topology with reduction of total standing voltage,’’ IEEE Access, vol. 8, pp. 168941–168950, 2020.
[19] A. Taheri and H. Samsami, ‘‘New topology of a switched-capacitor-based multilevel inverter

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 5, 2021, Pages. 1809 - 1815
Received 15 April 2021; Accepted 05 May 2021.

with a single DC power supply,'' IET Power Electron., vol. 12, no. 6, pp. 1571–1584, May 2019.

[20]Adel Nazemi Babadi, Omid Salari, Mohammad Jafar Mojibian, Mohammad Tavakoli Bina , "Modified Multilevel Inverters With Reduced Structures Based on Packed U-Cell", IEEE Journal of Emerging and Selected Topics in Power Electronics(Volume: 6, Issue: 2, June 2018).

[21] Sathish Kumar Shanmugam , Karthikeyan Muthusamy , Vijayachitra Chennippan , Suresh Balasubramaniam , Sampathkumar Ramasamy , Saravanan Subramanian Modelling Of Solar Photovoltaic Array Fed Brushless Dc Motor Drive Using Enhanced Dc-Dc Converter Proceedings Of The Romanian Academy, Series a Volume 20, Number 2/2019, Pp. 169–178.

[22] Shanmugam Sathish Kumar, Arumugam Senthilkumar, Palanirajan Gowtham, Ramachandran Meenakumari, Kanagaraj Krishna Kumar Implementation of solar photovoltaic array and battery powered enhanced DC-DC converter using B4-inverter fed brushless DC motor drive system for agricultural water pumping applications. Journal of Vibroengineering, Vol. 20, Issue 2, 2018, p.1214-1233. https://doi.org/10.21595/jve.2018.19449

[23] Shanmugam Sathish Kumar, Senthilkumar Arumugam Design and implementation of DC source fed improved dual-output buck-boost converter for agricultural and industrial applications.
Journal of Vibroengineering, Vol. 19, Issue 8, 2017, p. 6433-6454. https://doi.org/10.21595/jve.2017.19228.

[24] Shanmugam, S.K., Ramachandran, M., Kanagaraj, K.K. and Loganathan, A. (2016) Sensorless Control of Four-Switch Inverter for Brushless DC Motor Drive and Its Simulation.Circuits and Systems, 7, 726-734. http://dx.doi.org/10.4236/cs.2016.76062

[25] V. Krishnaveni, K. Kiruthika and S. S. Kumar, "Design and implementation of low cost four switch inverter for BLDC motor drive with active power factor correction," 2014 International Conference on Green Computing Communication and Electrical Engineering (ICGCCEE), Coimbatore, India, 2014, pp. 1-7, doi: 10.1109/ICGCCEE.2014.6922424.

[26] Sathishkumar S., Meenakumari R., Jobanarubi E., Anitta P.J.S., Ravikumar P. (2015) Microcontroller Based BLDC Motor Drive for Commercial Applications. In: Kamalakannan C., Suresh L., Dash S., Panigrahi B. (eds) Power Electronics and Renewable Energy Systems. Lecture Notes in Electrical Engineering, vol 326. Springer, New Delhi. https://doi.org/10.1007/978-81-322-2119-7_81

[27] Meenakumari Ramachandran Sathishkumar Shanmugam Design and Implementation of Embedded Processor Based Brushless Motor Drive using Lead Acid Battery as Source with Lithium Ion Capacitor, Indonesian Journal of Electrical Engineering and Computer Science,Volume 14 Issue 3 Pages 455-469.

[28]Sujatha, K., and D. Shalini Punithavathani. "Optimized ensemble decision-based multi-focus imagefusion using binary genetic Grey-Wolf optimizer in camera sensor networks." *Multimedia Tools and Applications* 77.2 (2018): 1735-1759.

[29]Chang, Jinping, Seifedine Nimer Kadry, and Sujatha Krishnamoorthy. "Review and synthesis of Big Data analytics and computing for smart sustainable cities." *IET Intelligent Transport Systems* (2020).

[30]Song, Hesheng, and Carlos Enrique Montenegro-Marin. "Secure prediction and assessment of sports injuries using deep learning based convolutional neural network." *Journal of Ambient Intelligence and Humanized Computing* 12.3 (2021): 3399-3410.