Indonesian Journal of Electrical Engineering and Computer Science
Vol. 31, No. 3, September 2023, pp. 1286~1294
ISSN: 2502-4752, DOI: 10.11591/ijeecs.v31.i3.pp1286-1294

Optimize single line to ground fault detection in distribution grid power system using artificial bee colony

Feryal Ibrahim Jabbar[1], Dur Muhammad Soomro[2], Mohd Noor Abdullah[2], Nur Hanis Mohammad Radzi[2], Mazhar Hussain Baloch[3], Asif Ahmed Rahmoon[2], Hassan Falah Fakhruldeen[4,5]

[1]Department of Air Conditioning and Refrigeration Techniques Engineering, Al-Mustaqbal University College, Hillah, Iraq
[2]Department of Electrical Power Engineering, Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia, Batu Pahat, Malaysia
[3] Department of Electrical Engineering, Mehran University Engineering Sindh, Jamshoro, Pakistan
[4]Department of Computer Techniques Engineering, Faculty of Information Technology, Imam Ja'afar Al-sadiq University, Baghdad, Iraq
[5]Department of Computer Technical Engineering, College of Technical Engineering, The Islamic University, Najaf, Iraq

Article Info

Article history:

Received Jan 19, 2023
Revised May 1, 2023
Accepted May 6, 2023

Keywords:

Artificial bee colony
Chip of (eZdsp F28335-RS232)
Distribution network
Neural network
Petersen coil
Texas instrument in MATLAB

ABSTRACT

The most common power system (PS) distribution network fault, single line-to-ground fault (SLGF), causes residual current (I res) to start an electrical arc and high voltage (HV) three times the rated voltage in other healthy phases. HV from capacitive currents (IC) damages cable insulation and PS appliances. Peterson The neutral point coil (PC) reduces (I res) and extinguishes the electric arc, but the fault current (I fault) remains below the protection devices' threshold. Operations and equipment are riskier. PC adaptive eliminates electrical arcs, making the network safer. This paper detects I faults online using Texas instrument validation in MATLAB and adaptive by artificial bee colony (ABC). This paper discusses Texas instrument fault current detection and MATLAB validation. It improves system reliability, device protection, and copper savings by thousands of tons. ABC intelligently optimizes many mathematical problems. ABC with network neural artificial intelligence (AI) improves algorithm performance (artificial bee colony network neural (ABCNN)). This new method may improve distribution network SLGF detection. This first work can work online in electrical power stations by building the (eZdsp F28335-RS232) into the program to send fault signals to the control when SLGF occurs without damaging devices, equipment, cables, or power outages.

Corresponding Author:

Feryal Ibrahim Jabbar
Department of Air Conditioning and Refrigeration Techniques Engineering
Al-Mustaqbal University College
Hillah, Iraq
Email: feryal.ibrahim@uomus.edu.iq

1. INTRODUCTION

Fault detection is a crucial issue to be considered in the power system to ensure safety, reliability and to avoid accidents, damages to equipment and undesired blackouts. So, processing of the different faults in a distribution network requires different algorithms to detect a fault and extinguish the electric arc. This research work uses in novelty the methods. In the artificial bee colony (ABC) algorithm [1]–[5] has proved its importance in solving a number of the problems including in power system (PS) optimization. ABC algorithm is one of the most methods and novel of based heuristics intelligence. In this paper, the major mission of the

PS protection is to limit the damages to the distribution network in fault or abnormal cases. Besides, a difficulty for relays is to extract information from the voltage and current instruments that indicate that equipment is operating improperly. In this paper focus to the detection single line-to-ground fault (SLGF) and self-extinguishing electric arc using artificial bee colony network neural (ABCNN) control SLGF in distribution network, also working online by used the chip (eZdsp F28335-RS232) in PS by building this in the system. When a fault occurs, this chip sending signal (1) in the fault occur or (0) at no fault, to a control panel. This research focuses for processing of SLG fault in the power distribution system (i.e., 33⁄11 kV) [6]–[11]. This paper mainly focuses on the protection from the effect of the SLGF in the distribution grid in PS, also preventing equipment and devices from damage. By extinguishing the electric arc in a short period using a PC and the detecting of fault through the ABCNN. Figure 1 a block diagram of the basic configuration of eZdsp F28335 is shown. The main interfaces for eZdsp are the interface and the expansion interface. In these parameters, it converts analog data into digital data.

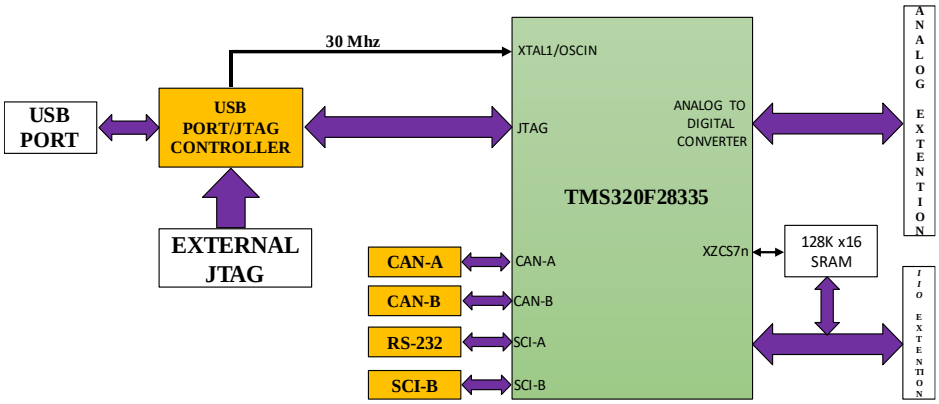

Figure 1. Block diagram of the basic configuration for the eZdsp F28335

The eZdsp F28335 processing to helps of introduce model-based development and virtual test processes to validate result and test processes optimizing customized development. General improvements it is a query mechanism for searching items in the entire database efficiently and effortlessly. Also, it can explore and help to identify referenced items as well as to use one item in multiple projects and workspaces. This mechanism and automatically connecting service interfaces of the simulation between application and basic software components for the use in practical. This makes the processing easier and faster for achievement [12]–[15].

The eZdsp F28335 is allowing developers to evaluate the TMS320F28335 digital signal controller (DSC) to limited, if it meets their application requirements. Furthermore, the module is an perfect of platform to enhancement and run the software for the TMS320F28335 processor by using the eZdsp F28335 DSC. In Texas instrument at illustrated in Figure 2, mechanical of works between (eZdsp F28335) and MATLAB.

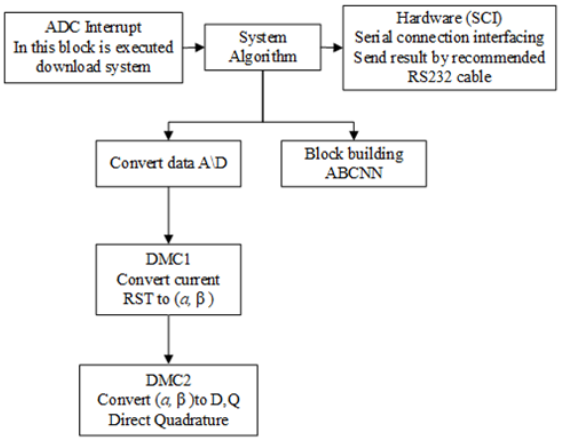

Figure 2. Mechanical of works between eZdsp F28335 and MATLAB

The comprehensive 1/O configuration block is used for specifying the hardware setup configuration of DSPACE I/O. This is done by simply connecting the relevant blocks to the Simulink blocks that contain the I/O parameter specification. This can be done anywhere in your model and at a variety of sample rates. Compound I/O boards can have separate blocks for each of their individual purposes [16].

2. METHOD

2.1. DSP2 board with the MATLAB/Simulink

The DSP2 these boards based on the digital signal processor. These blocks enable easy graphical programming of the different control algorithms under the MATLAB/Simulink. The real-time of the practical and the code of the digital signal processors, and it is executed in real-time. The DSP2 library for Simulink in combination with the DSP terminal, which was also developed, and enables easy online monitoring of the DSP2 variables in the text or graphical mode and the parameter tuning, meanwhile the generated code is executed on the DSP2 board. With the DSP2 library for Simulink, the development time of the different control algorithms that are executed on the DSP2 board is reduced. Figure 3, shows a block diagram [17]–[20].

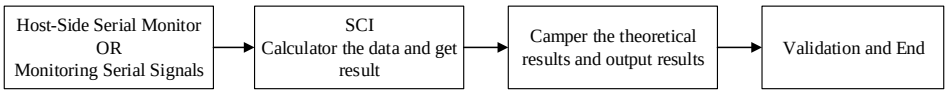

Figure 3. Host side serial monitor (HSSM) used to check the output on the oscilloscopes as well as to transmit the data from the Simulink to the eZdsp F28335l

2.2. Experimental results and discussion at (ABCNN Online by using eZdsp F28335)

In this section, we will go through the findings of the experiment. It is the Mechanism eZdsp F28335 for automatically connecting the service interfaces of the simulation between the application and the relevant software components with the intention of making use of them in virtual environments. Because of this, the procedure is made simpler and takes up less time, both of which ultimately contribute to the achievement [21].

2.2.1. ABC method

Artificial bee colony is an artificial technical used for optimization and validation to enhance the system performance. The artificial bee colony optimization algorithm is one of the nature-inspired algorithms. Derived from the behavior of bees and Simulates foods that search for bee habits. This method to be a major contribution to the processing of this problem is that the optimize values based on hybrid ABCNN algorithm. We have dealt with the finding of the optimal methods of Peterson coil values, which specify the value of earth fault current as low as possible. Moreover, we have used two methods to control Peterson coils, such as using the artificial neural fuzzy inference system, and compare to used artificial bee colony to determine the earth's fault current and identify faulty feeder in the distribution network. The contribution of novelty (ABC). That algorithm as to detection single line to ground fault and self- extinguishing at a short time. This method is considered more novelty and no researchers have this used have a good property such as, easy to use interfacing, best solution, fast response as compare with anther algorithm, no needs modeling working with nonlinear system, simple of alteration time, and high quality [22].

Figure 4, represent Simulation at SLGF at the method which is using ABCNN. Also, this method is a hybrid between interface and design then that to be contribution between artificial bee colony and design block in Simulation with neural network.

2.3. ADC interrupt block (IRQ1 ($\boldsymbol{C28}0\times \boldsymbol{IC28}\times \mathbf{3}\times$)

This block called ADC, which is executing a download system. The system algorithm is used to convert analog to digital converter and inside block. Build an ABCNN, also inside it. Three blocks make and give the system to convert the data from Dspace. The system calculator block and the system calculator is used to execute feedback between the desired and actual system finally. This block (feedback) is essential in this Simulink for more robustness and more aquart and with fast response. Al so besides, the data type conversion is also used to calculate the actual values. Monitoring signals using CAN or serial connections: This block is also called serial connection interface (SCI) transmits the data from the Simulink to the SCI. It received by using RS232 cable recommended Serial connection. Also, the system control is used to compare on a line between the desired actual and value. eZdsp F28335: We can use this chap for detection fault online by building this chap in the system to detect fault and process using in the power station at future work. Main contribution Artificial bee colony with fault detection based on artificial intelligence. Stages of processing problem [23].

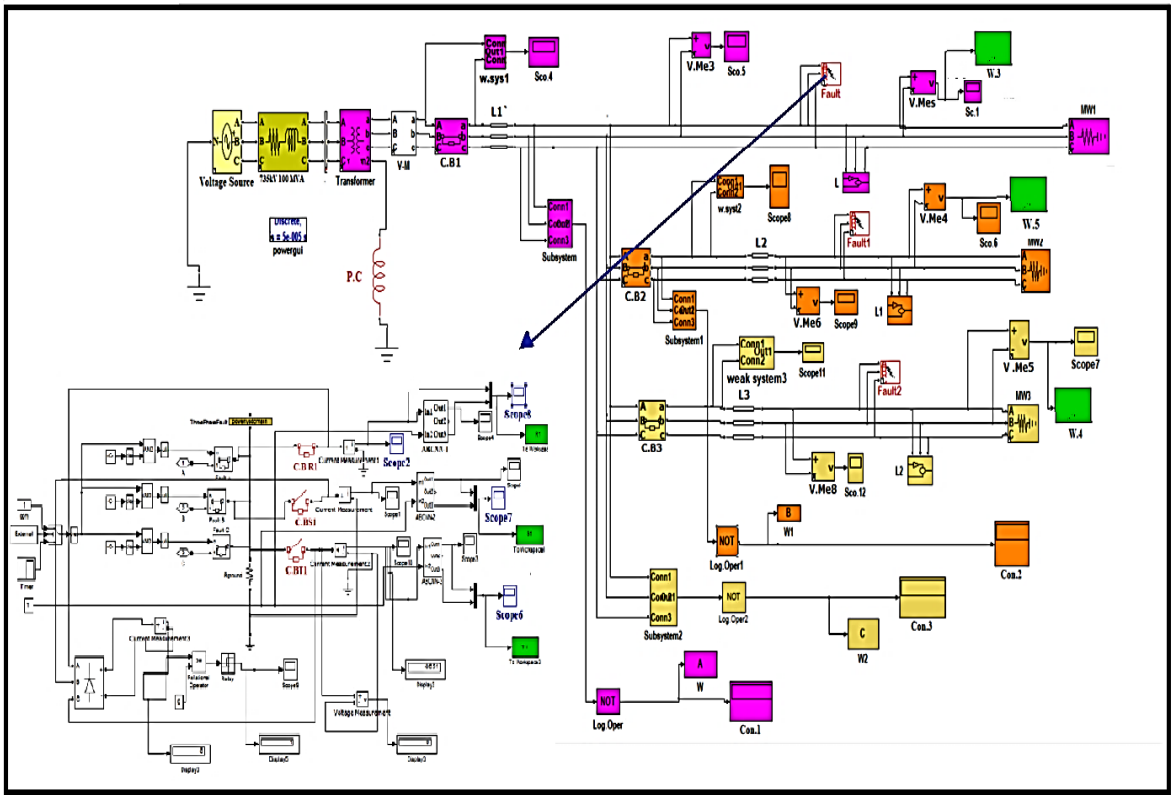

Figure 4. Simulation at SLGF at adaptive by ABCNN

2.4. eZdsp F28335 description

In the configuration, these block for determine, when the setup configuration of eZdsp F28335 I/O by merely connecting the relevant blocks to the Simulink blocks. Configuration inclusive the block for specifying the hardware setup.in Configuration the eZdsp F28335 will be I/O simply by connecting the relevant blocks to the Simulink blocks in Texas instrument in MATLAB also the parameter specification of the eZdsp F28335 such as voltage level, resolutions, digital I/O, serial interface parameters and validation. Also, can either replace an entire controller with a eZdsp F28335 prototyping system or test new functions by bypassing an existing production controller and all this without manual programming. then the Simulink block diagram design is automatically executing on the system and calculated in real-time therefor eZdsp F28335 offers a wide range of hardware and software components [24], [25]. Figure 5 shows the stages of operation in the laboratory by using MATLAB and eZdsp F28335.

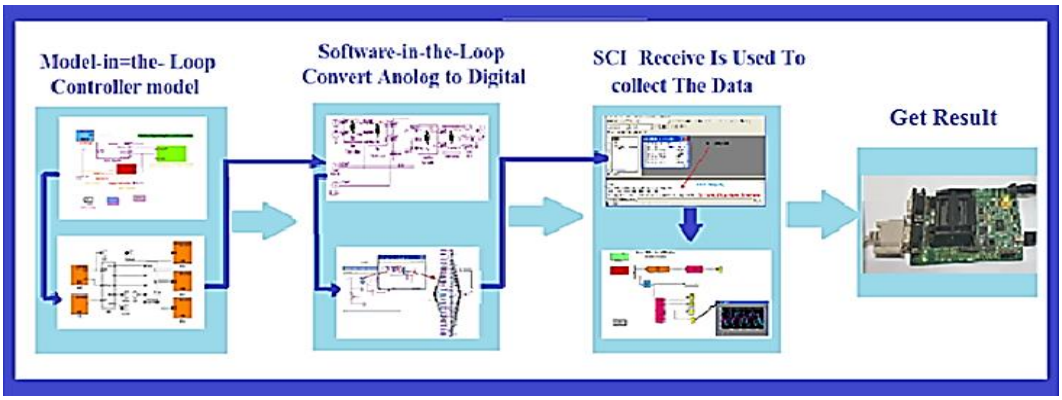

Figure 5. Stages of operation in the laboratory by using MATLAB and eZdsp F28335

3. RESULTS AND DISCUSSION

This section handles, the experimental result is proposed to execute the system performance artificial bee colony with a neural network. Experimental Simulink need to working, working in discrete and no work continuous and must be covert the data analog to digital. In comparison to the classical methods, found in Figures 6 and 7, in the case of ABCNN, we found the fault current approached the rated current. Also, there is no overshoot, no disturbance, no undershoot, and high system study state. Besides, the duration of the fault is minimal. In comparison to the classical methods found, the results in the case of ABCNN, we found the fault current approached the rated current. Lastly, there was no overshoot, no disturbance, no undershoot, and a high study state. Figure 7 represent best fault and also the duration of the fault is very small as shown in this Figure.

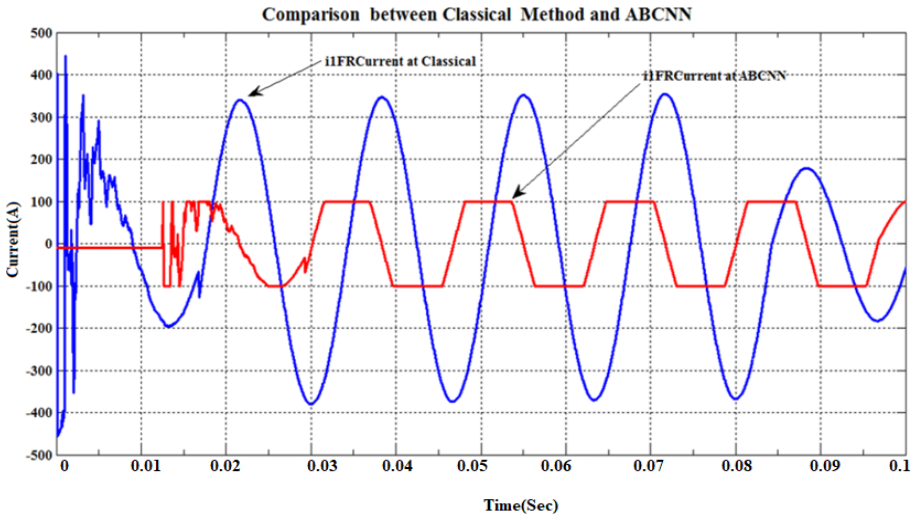

Figure 6. The classical method versus ABCNN

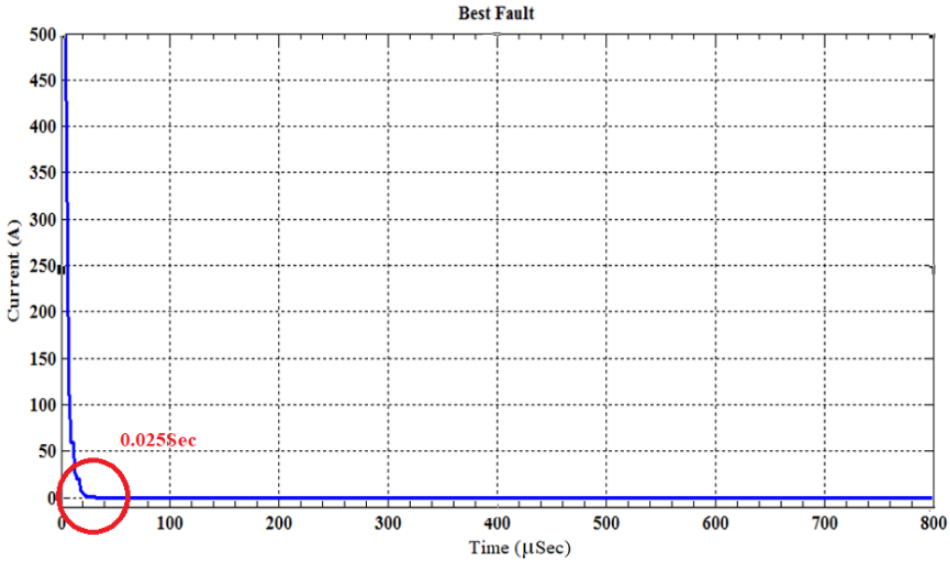

Figure 7. Best result

3.1. Experimental results

This method depended on training+testing+validation, and no used previously in this field. The characterized of these method hybrid ABC+NN can be used online using Texas instrument in MATLAB by building this chip (eZdsp F28335) in power station operation in practical experiences. In review the results of these methods and the comparison between classic methods and novelty method in experimental Simulink need

to working: i) working in discrete and no work continuous and ii) must be covert the data analog to digital. Figure 8 represent compare between the faults current, which are adaptive by classical method PC and ABCNN, in online operation using chip (eZdsp F28335) method in an experimental result (workspace), we can see that have similar values.

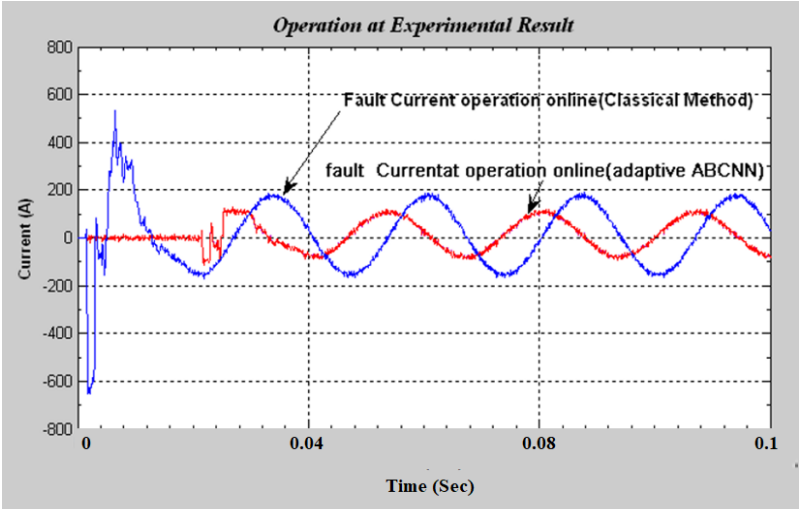

Figure 8. Classical and ABCNN experimental result

3.2. Comparison the results between the simulations and (eZdsp F28335-RS232) in taxes instrument MATLAB

In the following Figure 9, we see the difference between the value of the fault current when using classical methods and the value of the fault current when using novel methods ABCNN, which have become compatible with future developments and to become more effective and applied in power station we used eZdsp F28335- RS 232, and when you use it the results were idealistic as we obtained matching results for simulation results and this indicates the possibility of using this method in training in distribution power stations. This work contributes to the detection of SLGF in the shortest period ranging (0.025 sec) in addition to interfacing between mf (simulation) and design (Simulink) by neural network. This work first used ABCNN, and no one has used these methods previously. Figure 9 represent compare between the faults current, which are adaptive by classical method point coil (PC) and ABCNN, in online operation using chip (eZdsp F28335) method in an experimental result (workspace), we can see that have similar values.

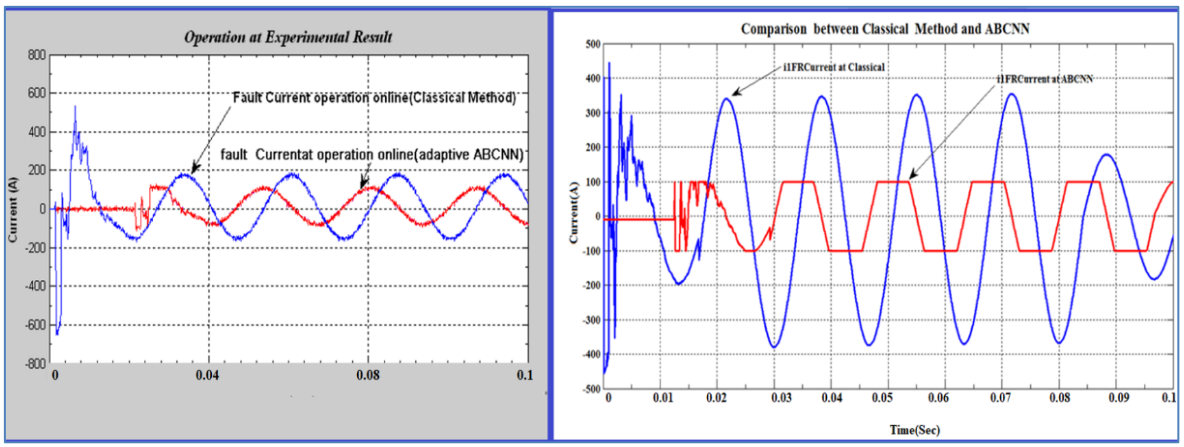

Figure 9. ABCNN and classical methods current

4. CONCLUSION

In this project, the significant contribution converts the Simulink working online because most simulations work only theoretically and also validation by using Texas instrument (eZdsp F28335). This method can use in power stations to detect a fault and to process it by building in the system. This chip sending a signal to the control panel when the fault to be an occurrence in (1) which fault and (0) no-fault. Get a good result for fault current became matching rated current for undesired blackout, saving many thousand tons of copper of cable which is bearing when SLGF occurrence in a distribution network and stability voltage in fault and un fault also more accurate, quality and more stable. Fault current was equal to the rated current and at a very ideal time with a value of (0.025 sec). We compare the results of classical methods and modern methods/ and also have no overshoot, no undershoot, and no wave distortions, which produces a steady-state in the power system and high efficiency. The ground this ABC validity in practical use in power plants by connecting and also validation to using taxes instrument (eZdsp F28335).

REFERENCES

[1] T. M. Lai, W. C. Lo, W. M. To, and K. H. Lam, "RMS percent of wavelet transform for the detection of stochastic high impedance faults," in *2012 IEEE 15th International Conference on Harmonics and Quality of Power*, Jun. 2012, pp. 823–828, doi: 10.1109/ICHQP.2012.6381245.

[2] A. Al-Khaykan, I. H. Al-Kharsan, M. O. Ali, A. J. Alrubaie, H. F. Fakhruldeen, and J. M. Counsell, "Impact of multi-year analysis on the optimal sizing and control strategy of hybrid energy systems," *Energies*, vol. 16, no. 1, p. 110, Dec. 2023, doi: 10.3390/en16010110.

[3] A. Mohammadiounotikandi, H. F. Fakhruldeen, M. N. Meqdad, B. F. Ibrahim, N. Jafari Navimipour, and M. Unal, "A fire evacuation and control system in smart buildings based on the internet of things and a hybrid intelligent algorithm," *Fire*, vol. 6, no. 4, p. 171, Apr. 2023, doi: 10.3390/fire6040171.

[4] H. H. Chang and R. Zhang, "Machine learning techniques for single-line-to-ground fault classification in nonintrusive fault detection of extra high-voltage transmission network systems," in *Advances in Intelligent Systems and Computing*, vol. 891, 2019, pp. 109–116.

[5] J. Huang, X. Lin, and H. Liu, "An adaptive technique of earth fault detection and self-extinguishing by controllable Petersen-coil," in *Asia-Pacific Power and Energy Engineering Conference, APPEEC*, Mar. 2011, pp. 1–4, doi: 10.1109/APPEEC.2011.5748647.

[6] Y. Wang *et al*., "Faulty feeder detection of single phase-earth fault using grey relation degree in resonant grounding system," *IEEE Transactions on Power Delivery*, vol. 32, no. 1, pp. 55–61, Feb. 2017, doi: 10.1109/TPWRD.2016.2601075.

[7] X. Yan, Z. He, and W. Chen, "An Investigation into arc self-extinguishing characteristics on Peterson coil compensated system," in *2008 International Conference on High Voltage Engineering and Application, ICHVE 2008*, Nov. 2008, pp. 249–252, doi: 10.1109/ICHVE.2008.4773920.

[8] N. I. Elkalashy, M. Lehtonen, H. A. Darwish, M. A. Izzularab, and A. M. I. Taalab, "Modeling and experimental verification of high impedance arcing fault in medium voltage networks," *IEEE Transactions on Dielectrics and Electrical Insulation*, vol. 14, no. 2, pp. 375–383, Apr. 2007, doi: 10.1109/TDEI.2007.344617.

[9] Y. W. Wang, F. Long, and Z. X. Zuo, "Support vector machine for classification and its application to the small current grounding fault line detection in Peterson-coil-grounding system," in *Proceedings - 4th International Conference on Intelligent Computation Technology and Automation, ICICTA 2011*, Mar. 2011, vol. 1, pp. 727–730, doi: 10.1109/ICICTA.2011.189.

[10] X. Lin, S. Ke, Y. Gao, B. Wang, and P. Liu, "A selective single-phase-to-ground fault protection for neutral un-effectively grounded systems," *International Journal of Electrical Power and Energy Systems*, vol. 33, no. 4, pp. 1012–1017, May 2011, doi: 10.1016/j.ijepes.2011.01.017.

[11] M. Michalik, M. Łsukowicz, W. Rebizant, S. J. Lee, and S. H. Kang, "New ANN-based algorithms for detecting HIFs in multigrounded MV networks," *IEEE Transactions on Power Delivery*, vol. 23, no. 1, pp. 58–66, Jan. 2008, doi: 10.1109/TPWRD.2007.911146.

[12] Y. Bi, J. Zhao, and D. Zhang, "Single-phase-to-ground fault feeder detection based on transient current and wavelet packet," in *2004 International Conference on Power System Technology, POWERCON 2004*, 2004, vol. 1, pp. 936–940, doi: 10.1109/icpst.2004.1460128.

[13] A. R. Sedighi, M. R. Haghifam, and O. P. Malik, "Soft computing applications in high impedance fault detection in distribution systems," *Electric Power Systems Research*, vol. 76, no. 1–3, pp. 136–144, Sep. 2005, doi: 10.1016/j.epsr.2005.05.004.

[14] C. C. Zhou, Q. Shu, and X. Y. Han, "A single-phase earth fault location scheme for distribution feeder on the basis of the difference of zero mode traveling waves," *International Transactions on Electrical Energy Systems*, vol. 27, no. 5, p. e2298, May 2017, doi: 10.1002/etep.2298.

[15] H. Wang, X. Cai, and L. Liu, "PSCAD simulation study on the distribution network voltage transformer failure," in *Proceedings of the 3rd International Conference on Mechatronics, Robotics and Automation*, 2015, vol. 15, doi: 10.2991/icmra-15.2015.271.

[16] H. F. Fakhruldeen, T. S. a. Mansour, F. I. Jabbar, and A. Alkhayyat, "Multiple inputs all-optical logic gates based on nanoring insulator-metal-insulator plasmonic waveguides," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 12, no. 6, pp. 6836–6846, Dec. 2022, doi: 10.11591/ijece.v12i6.pp6836-6846.

[17] M. A. Barik, A. Gargoom, M. A. Mahmud, M. E. Haque, H. Al-Khalidi, and A. M. Than Oo, "A decentralized fault detection technique for detecting single phase to ground faults in power distribution systems with resonant grounding," *IEEE Transactions on Power Delivery*, vol. 33, no. 5, pp. 2462–2473, Oct. 2018, doi: 10.1109/TPWRD.2018.2799181.

[18] Jun Liang, Zhihao Yun, Feifan Liu, and Yutian Liu, "A method of fault line detection in distribution systems based on wavelets," in *Proceedings. International Conference on Power System Technology*, 2002, vol. 4, pp. 2635–2639, doi: 10.1109/ICPST.2002.1047264.

[19] B. N. Alsunbuli, H. F. Fakhruldeen, W. Ismail, and N. M. Mahyuddin, "Hybrid beamforming with relay and dual-base stations blockage mitigation in millimetre-wave 5G communication applied in (VIOT)," *Computers and Electrical Engineering*, vol. 100, p. 107953, May 2022, doi: 10.1016/j.compeleceng.2022.107953.

[20] P. Liu and C. Huang, "Detecting single-phase-to-ground fault event and identifying faulty feeder in neutral ineffectively grounded distribution system," *IEEE Transactions on Power Delivery*, vol. 33, no. 5, pp. 2265–2273, Oct. 2018, doi: 10.1109/TPWRD.2017.2788047.
[21] M. Q. Alsudani, H. F. Fakhruldeen, H. A. J. Al-Asady, and F. I. Jabbar, "Storage and encryption file authentication for cloud-based data retrieval," *Bulletin of Electrical Engineering and Informatics (BEEI)*, vol. 11, no. 2, pp. 1110–1116, Apr. 2022, doi: 10.11591/eei.v11i2.3344.
[22] B. Gunes, G. Kayisoglu, and P. Bolat, "Cyber security risk assessment for seaports: A case study of a container port," *Computers and Security*, vol. 103, p. 102196, Apr. 2021, doi: 10.1016/j.cose.2021.102196.
[23] H. A. J. Al-Asady, H. F. Fakhruldeen, and M. Q. Alsudani, "Channel estimation of OFDM in C-band communication systems under different distribution conditions," *Indonesian Journal of Electrical Engineering and Computer Science (IJEECS)*, vol. 23, no. 3, pp. 1778–1782, Sep. 2021, doi: 10.11591/ijeecs.v23.i3.pp1778-1782.
[24] H. Kanamaru, "The extended risk assessment form for IT/OT convergence in IACS security," in *2021 60th Annual Conference of the Society of Instrument and Control Engineers of Japan, SICE 2021*, 2021, pp. 1365–1370.
[25] R. Jalil, A. Sabbar, H. F. Fakhruldeen, and F. I. Jabbar, "Design and implementation of PC to PC data transmission using wireless visible light communication system," *Indonesian Journal of Electrical Engineering and Computer Science (IJEECS)*, vol. 26, no. 3, pp. 1423-1428, Jun. 2022, doi: 10.11591/ijeecs.v26.i3.pp1423-1428.

BIOGRAPHIES OF AUTHORS

Feryal Ibrahim Jabbar obtained B.E. in Electrical Power Engineering from the University of Mosul, in 2008 and a master's degree from the University of Babylon in 2015, respectively, and a Ph.D. from the University of Malaysia UTHM. She is currently working as an Assistant Lecturer (Department of Air Conditioning and Refrigeration Techniques Engineering) at Al-Mustaqbal University College. Her research interests are artificial intelligence, renewable energy, sustainable energy development, energy system control, energy development for sustainable development, and hybrid energy system. She has published more than 11 research publications in artificial intelligence and electric power systems. She can be contacted at email: feryal.ibrahim@mustaqbal-college.edu.iq.

Dr. Dur Muhammad Soomro is an energetic and dynamic Engineer and an Academician, having capability to work in a team as well as independent, possessing wide experience of field, teaching, and research in the field of Electrical Power Engineering. He received his baccalaureate in Electrical Engineering and master's in Electrical Power Engineering from Mehran University of Engineering and Technology (MUET) Jamshoro, Sindh, Pakistan in 1990 and 2001 respectively. Dr. Soomro has achieved his PhD degree in the field of Electrical Engineering from Universiti Teknologi Malaysia (UTM), Johor, Malaysia in 2011. Presently he is working as an Associate Professor in the Departments of Electrical Power Engineering, Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia, where he has been faculty member since September 05, 2011. His research interests include power system (reliability, stability and control, quality, protection), and renewable energy. He can be contacted at email: dursoomro@uthm.edu.my.

Mohd Noor Abdullah is received his B.Eng. (Hons) in Electrical Engineering and M. Eng. in Electrical Engineering (Power System) from Universiti Teknologi Malaysia (UTM) in 2008 and 2010 respectively. He also received a Ph.D. degree in Electrical Engineering from University of Malaya (UM) in 2014. Currently, he is an Associate Professor at the Department of Electrical Engineering and principal researcher of Green and Sustainable Energy (GSEnergy) Focus Group, Faculty of Electrical and Electronic Engineering (FKEE), Universiti Tun Hussein Onn Malaysia (UTHM). His research interests include energy management and efficiency, renewable energy, photovoltaic system, power dispatch, and meta-heuristic optimization techniques. He can be contacted at email: mnoor@uthm.edu.my.

Nur Hanis Mohammad Radzi received her B.Eng. and M.Eng in Electrical Engineering (Power) from Universiti Teknologi Malaysia (UTM) in 2005 and 2009 respectively. She also received Ph.D. from The University of Queensland, Brisbane, Australia in 2012. Currently, she is an associate professor with the Department of Electrical Engineering, Faculty of Electrical and Electronic Engineering at Universiti Tun Hussein Onn Malaysia (UTHM). She is also a Professional Engineer awarded by the Board of Engineers Malaysia (BEM) and registered Chartered Engineer under the Institution of Engineering and Technology (IET) UK. Her research interests include transmission pricing, power system economics, energy management, and renewable energy. She can be contacted at email: nurhanis@uthm.edu.my.

Dr. Mazhar Hussain Baloch received the B.E. and M.E. degrees in electrical engineering from Mehran UET, Jamshoro, in 2008 and 2013, respectively, and the Ph.D. degrees from Shanghai Jiao Tong University, China, and University Sains Malaysia, in 2017 and 2019, respectively. He is currently working as an Assistant Professor (Electrical Engineering), College of Engineering A Sharqiyah University Ibra Oman. He has more than 15 years' total experience as a researcher/teacher and as professional in industries. His research interests include renewable energy, sustainable energy development, power system control, stability and optimization of wind energy conversion systems, and research on DC and AC micro grid systems, and published more than 70 research publication in different reputable journals/conferences. He can be contacted at email: mazharhussain@muetkhp.edu.pk.

Asif Ahmed Rahmoon received the degree (Electronics Engineering), 2014 Jamshoro, Sindh, Pakistan. Master (Electrical Power Engineering), 2018 Jamshoro, Sindh, Pakistan. Ph.D. Scholar in Department of Electrical Power Engineering, FKEE, Universiti Tun Hussein Onn Malaysia, Malaysia in both papers, and published more than 70 research publication in different reputable journals/conferences. He can be contacted at email: asifahmedrahimoon1@gmail.com.

Hassan Falah Fakhruldeen received the B.Eng. degree in Communications Engineering from Al-Furat Al-Awsat Technical University, Iraq, in 2010 and the M.S. and Ph.D. degrees in electronics and communications engineering from Baghdad University, Iraq, in 2013 and 2020, respectively. Currently, he is an Associate Professor at the Department of Electrical Engineering, University of Kufa. His research interests include photonics, optics, optical fiber communications, nano-photonic devices, plasmonics devices, optical communications, optical fiber networks, plasmonic sensors, all-optical signal processing, 5G communications, communications transmission lines, signal transmission planning, wireless networks, wireless communications, and radio over fiber communications. He can be contacted at email: hassan.fakhruldeen@gmail.com.