Investigating and Optimizing the Operation of Microgrids with Intelligent Algorithms

Ahmed Kadhim Hado [1], Bashar S. Bashar [2], Musaddak Maher Abdul Zahra [3,4], Reza Alayi [5*], Yaser Ebazadeh [6], Iswanto Suwarno [7]
[1] Civil Engineering Department, University of Warith Al-Anbiyaa, Karbala, Iraq
[2] Department of engineering/Al-Nisour University College/Baghdad/Iraq
[3] Computer Techniques Engineering Department, Al-Mustaqbal University College, Hillah 51001, Iraq
[4] Electrical Engineering Department, College of Engineering, University of Babylon, Hilla, Babil, Iraq
[5] Department of Mechanics, Germi Branch, Islamic Azad University, Germi, Iran
[6] Department of Computer Engineering, Germi Branch, Islamic Azad University, Germi, Iran
[7] Department of Electrical Engineering, Universitas Muhammadiyah Yogyakarta, Indonesia
Email:[1] ahmed.k.hado94@gmail.com, [2] bashar.s.eng@nuc.edu.iq, [3,4] musaddaqmahir@mustaqbal-college.edu.iq, [5] reza_alayi@iaugermi.ac.ir, [6] yaser.ebazadh@iau.ac.ir, [7] iswanto_te@umy.ac.id
*Corresponding Author

***Abstract*—Microgrids need optimization to reduce economic problems and human losses. Scattered resources in power systems and microgrids have led to many environmental, economic and human, and animal losses. The most important part of these problems is related to voltage and frequency fluctuations when possible occurrences such as extreme load changes or errors in microgrids. These problems lead to microgrid collapse. Therefore, providing optimal solutions that can solve these challenges is essential. For this purpose, the present study has tried to provide a high-performance control structure in the time of internal and external disturbances based on short-term planning. The proposed approach is the use of an evolutionary neuro-fuzzy network. Perhaps the main reason for using this approach can be due to uncertainty in the distribution and distribution of loads in microgrids and power systems. Simulation has been performed in MATLAB and Simulink environments, and the results show that the optimal load distribution has been done evolution in microgrids**

Keywords—Microgrids; Short-term planning; Power systems; Optimal load distribution; Neuro-Fuzzy Network.

ABBREVIATIONS

APF	Active Power Filter
ANFIS	Adaptive Neuro-Fuzzy Inference
MG	Microgrid System
MGU	Microgrid System Utility
PQ	Power Quality
PCC	Point of Common Coupling
UPFC	Unified Power Quality Conditioner

I. INTRODUCTION

The microgrid is becoming an effective way to solve the power supply problem on off-grid islands. Investment economics is one of the main factors affecting its development and application, which is very challenging due to the various uncertain information involved in the investment decision-making process. The presence of scattered resources and microgrids in the power system, despite the many economic and environmental benefits, has added new problems to the power system. One of these problems is voltage and frequency fluctuations when possible occurrences such as severe load changes or errors in the power system. In island work mode, due to the lack of support power, the intensity and scope of these fluctuations and the probability of instability and collapse of the microgrid are much higher. Meanwhile, due to the low inertia of the scattered resources in the microgrid and the high switching speed of power electronic devices, the dynamics of an island microgrid are much faster than conventional power systems. Therefore, it is necessary to have an efficient control structure with the rapid operation when a disturbance occurs in the system [1-4].

In traditional distribution networks, frequency and voltage deviations are considered indicators for system security detection. While in an independent microgrid with a power electronic interface, frequency and voltage deviations in the microgrid due to power and load disturbances are well controlled by a real power-frequency controller and reactive voltage-power controller. Hence, contrary to what occurs in traditional distribution networks, frequency and voltage deviations are important to detect the security of independent microgrids with electronic power interface resources. It's not counted.

However, in an independent microgrid, the balance between production and power consumption is considered an indicator for evaluating its security, especially in the event of power and load disorders. Therefore, if this equilibrium is not established in the microgrid, it is considered unsafe. In this case, preventive measures, including load loss and production adjustment, should be taken in the shortest time in the microgrid. In this research, a new strategy is proposed to investigate the dynamic security of microgrids to investigate this issue as a short-term planning decision-making model, and the occurrence of power and load disorders as well as the use of the adaptive fuzzy neural network are investigated evolutionarily. Also, in case of unsafe detection of microgrid, prediction of preventive control by other neural networks is suggested [5, 6].

II. Review of Literature

A microgrid is a collection of producer resources and loads. Various categories have been proposed for energy resources in microgrids. One of these cases is categorization based on how to connect energy sources to microgrids. Accordingly, one set of units is connected to the microgrid via a synchronous machine, and the other group is the one in which the power electronics interface provides the intermediary for connecting to the microgrid. In microgrids with power electronic interface generation resources for transient network performance or changes, especially in (DS) load demand, an energy storage system is usually required when the microgrid is used in an autonomous island mode [7-12]. The microgrid can be used in two modes connected to the network and Independent Island in the main network connection mode. The distribution system can be considered as slack 4 electric basses, and to maintain the balance of power in the microgrid, each difference can supply or absorb the production power.

But when due to the drop in voltages, errors, blackouts, and so on microgrid is slowly transferred to the operation state of the independent island, the balance of power in separate microgrids, especially in the occurrence of power and load disturbances, is considered as a vital issue for the continuation of safe operation of microgrids. If in an independent island state, due to power disturbances or increased load consumption, the production resources of the distribution in the microgrid are unable to provide power, the energy storage system can be used, which, of course, due to its limitations, should also be used to fall 5 times if required. However, the lowest amount of load loss and faster reaching the equilibrium model of power in the microgrid is a subject that should be achieved [13-15]. In the microgrid, to realize the desired installation and harvesting features of the resources, frequency and voltage droop control are used to adjust the actual and reactive power. In this method, the share of each source is obtained by the inverter interface based on the characteristics of the Droop curve, which leads to rapid response and allocation. Reference to each unit will prevent damage to distributed products. Frequency deviation can be limited by defining the frequency droop characteristic and even returning it to the name-value using the frequency reduction loop. Also, by using the voltage droop characteristic, the voltage changes of the terminal are limited, so the units of the distribution generation with the electronic power interface react to voltage deviation due to microgrid changes or local load within the permissible limits.

Therefore, by this method, the frequency and voltage of the microgrid can be adjusted in such a way that it prevents them from leaving the permissible value. Unlike traditional systems in microgrids, this method causes frequency and voltage deviations not considered as an indicator for evaluating microgrid security. Therefore, it is important to find methods for rapid detection of independent microgrid security, especially in the event of power and load disorders. Also, in the case of the non-safety of microgrids, immediate measures for the safe operation of microgrids are necessary to be investigated. To evaluate the security of microgrids by the traditional method, the most accurate method is solving a set of nonlinear equations, which is a very difficult and time-consuming computational method. But the use of AI-based tools is a good alternative to a quick and accurate description of microgrid security [15].

In frequency deviation and performance of storage equipment in microgrids have been investigated [16-19], and an index for evaluating microgrid security regarding uncontroverted transmission to a separate state during disturbances in the upper-hand medium voltage network is presented in this paper [20]. The use of artificial neural networks due to computational speed in online performance and its flexibility to predict corrective actions in unsafe operational modes to achieve an unsafe operational situation. The smooth transition between connected and separate functions is emphasized. To evaluate the security of traditional distribution networks, voltage deviation has been investigated. In this paper, [21] the artificial neural network is used to evaluate the security of the standard 9-bass network.

When a system is designed only with artificial neural networks, the network is a black box that needs to be defined. This is a highly computational and heavy process. After extensive experiences and exercises about the complexity of the desired network and the learning algorithm that should be used, and the degree of accuracy that is acceptable in this application, the designer can achieve relative satisfaction. If we participate in the functions of fuzzy logic in neural and learning networks and share the classification of neural networks into fuzzy systems, then the malpractice and defects of neural networks and fuzzy systems can be covered. The result will be an adaptive fuzzy neural network.

In an adaptive fuzzy neural network, first, the neural network part is used to learn it and classify abilities and link the pattern and modify the pattern. The neural network part automatically creates the rules of fuzzy logic and membership functions during the period of learning rotation. In general, even after learning, the neural network continues to modify membership functions and rules of fuzzy logic in a way that learns more and more from its input signals. On the other hand, fuzzy logic is used to infer and provide a definitive or non-fuzzy output (when fuzzy variables are created). In general, it can be said that microgrids are systems that are generated by the integration of distributed generation units, energy storage systems, and controllable loads in low voltage and medium voltage networks and can be operated in either grid-connected or independently. Microgrids have many advantages, including improving power quality and reliability, reducing losses and economic benefits, and reducing environmental pollution. In recent years, electric vehicles have also faced significant developments as an energy storage system as well as a public vehicle, which has been considered due to the needlessness of fossil fuels as well as the reduction of environmental pollution. According to the predictions, it seems that the existence of electric vehicles as an emerging phenomenon in the power grid should be investigated. Any microgrid can be purchased and sold with other microgrids and the main power exchange network. This will increase reliability and also help to maintain a balance between supply and demand. Energy resources in microgrids are composed of units such as wind power plants, photovoltaic power plants with power generation uncertainties, and units such as microturbines, fuel cells, heat, and power cogeneration plants that are polluting [22-25].

Dr. Abbas Tahir et al. conducted a study titled "Optimal load spreading in optimal microgrid considering uncertainty in the presence of electric vehicles" to distribute the optimal load from a multi-objective algorithm to reduce the operating costs and emissions of units in two conditions in the presence of electric vehicles and regardless of electric vehicles, and the results showed that the presence of electric vehicles leads to lower costs and it becomes contaminated [23]. In [24], a random multi-course investment planning model/for the islanded microgrid is presented. The application of the model in dealing with various uncertainties is increased through a hybrid optimization framework in which long-term uncertainty of energy price fluctuations is taken by a random programming approach, and short-term changes in the production and load of renewable energy are taken into consideration. Dynamic information on load growth, unit cost change, and device degradation is considered to make the decision more practical and economically attractive [25-26]. The multi-period investment planning model is formulated as a mixed-integer linear programming problem, and decision-making conservatism can be flexibly adjusted by fixing the strength of the model. Simulation results based on real data show that the proposed model shows better economic performance and synergy than the traditional multi-year optimization model, with the total cost of planning decreasing by approximately 3.6%, the initial cost of investment decreasing by approximately 36.6%, and the use of renewable energy increased by approximately 5.4%. In addition, sensitivity analysis for load growth rate, loan ratio, unit cost, and uncertain budgets further confirms the application of the proposed model under different conditions.

III. SUGGESTED MODEL

In this research, a new strategy is proposed to investigate the dynamic security of microgrid as a short-term decision-making model, and the occurrence of power and load disorders, as well as the use of the adaptive evolutionary neural-fuzzy network, are investigated. Also, in case of unsafe detection of microgrid, it is suggested to predict preventive control by other neural networks. In Fig. 1, the initial configuration of the microgrid can be observed.

The microgrid is a combination of several alternating energy sources connected to a common bass. The microgrid structure must be specified. To test the proposed approach and obtain a short-term decision-making model, this research considers energy sources like wind power plants, solar or photovoltaic energy, and battery sources. All energy sources are connected to the DC bass. The energy generated by wind energy is connected to DC, which is carried out using a rectifier. In auxiliary tools, the AC bass is connected to the distributed converter. The DC bass is connected to the AC bass using a power reverser. The critical load is also connected to the AC bass using the UPFC device. The UPFC integration power circuit presented is shown in Fig. 2.

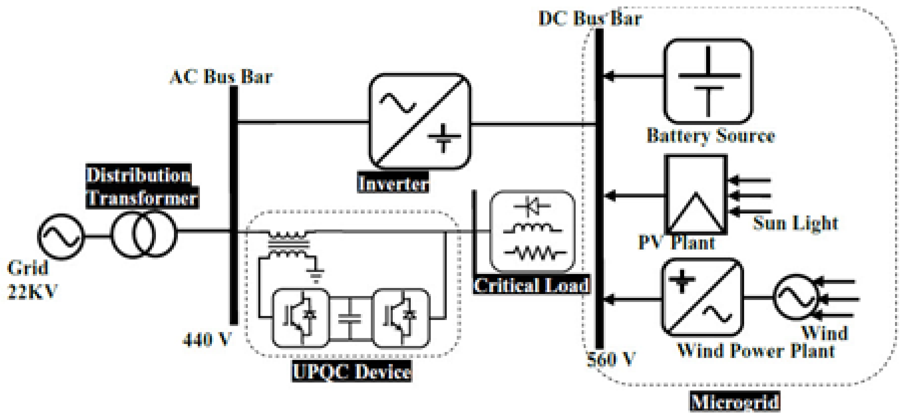

Fig. 1. Initial microgrid configuration.

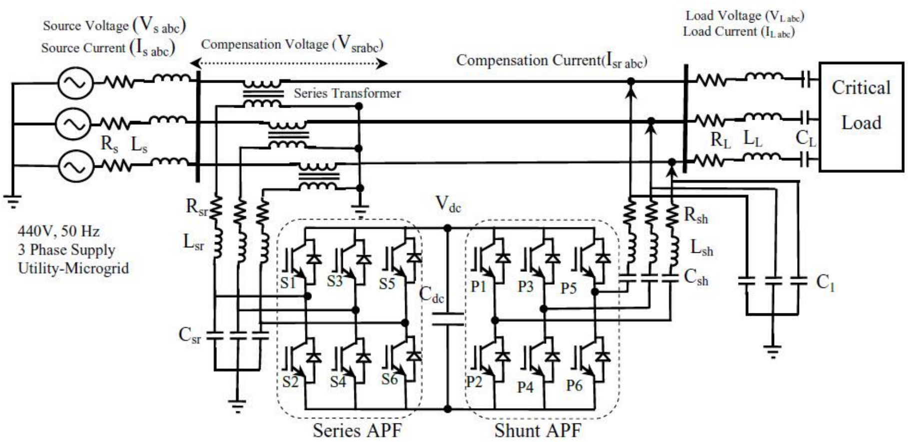

Fig. 2. UPFC Construction.

The UPFC integration is designed or shared from two voltage source reversers or VSI with a DC bond capacitor. A VSI is a series with a connected transformer connection source whose functions are as an APF series. APF series is responsible for compensation for PQ outbreaks at common points. Other VSIs are connected in parallel, located between the APF series and the load that acts as the Shunt APF. APF Shunt is responsible for compensating for problems related to the quality of power associated with customers and regulating dc bond voltage. In conclusion, presented in the short-term decision-making model, the passive series capacitor plays a shunt or an important role in supporting Shunt's APF. In the loading section, the passive series capacitor supports the flow of reaction power in the stirring. The main purpose of the control technique presented in this study is to set both series and shunt APF for optimal power distribution in microgrids for a short-term decision-making model. Therefore, the microgrid control technique in this study is classified into series and shunt control techniques, which will be combined with the neuro-fuzzy network at the end. The series control technique is designed to adjust the rate of loads in the short-term decision-making model. The diagram block of the series control technique is shown in Fig. 3.

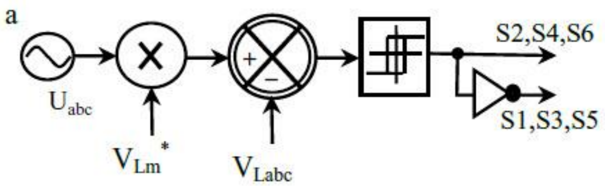

Fig. 3: Series Control Technique.

The series control technique regulates load voltage using a process such as a reference signal generation and works by recording PQ distortion tools and generating pulses for the VSI series. The reference loading voltage is formed by generating the voltage size or sine signal of the phase unit, whose relationship is in the form of equation (1) [27-28].

$$\begin{bmatrix} {V_{La}}^* \\ {V_{Lb}}^* \\ {V_{Lc}}^* \end{bmatrix} = \begin{bmatrix} {V_{Lm}}^* \sin(\omega t) \\ {V_{Lm}}^* \sin(\omega t + 120) \\ {V_{Lm}}^* = \sin(\omega t - 120) \end{bmatrix} \quad (1)$$

According to the relationship (1), the number 120, the order is 120 °C. The PQ distortion tool is recorded from different references and real load voltage with the help of relationship (2). Pulses for the VSI series are produced from disturbance tools using hysteresis controllers[4].

$$\begin{bmatrix} V_{Ca} \\ V_{Cb} \\ V_{cb} \end{bmatrix} = \begin{bmatrix} {V_{La}}^* \\ {V_{Lb}}^* \\ {V_{Lc}}^* \end{bmatrix} - \begin{bmatrix} V_{La} \\ V_{Lb} \\ V_{Lc} \end{bmatrix} \quad (2)$$

The proposed shunt control technique is designed to regulate the current source and bond voltage or V_{dc}. The diagram block of the shunt control technique is shown in Fig. 4.

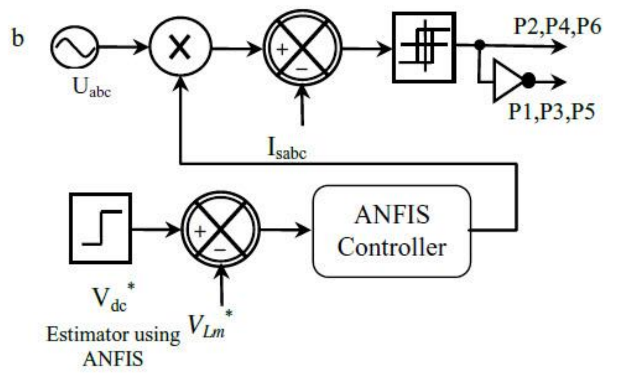

Fig. 4. Shunt Control Technique.

Shunt's APF target function is obtained, such as the process of estimating the voltage of the dc-link reference or V_{DC}^*, V_{DC} Controller, generating the flow of the reference source, recording PQ distortion types from customers, and producing pulses for the shunt VSI. In the proposed technique, the neuro-fuzzy network, or ANFIS, is trained for estimation V_{DC}^* and V_{DC}^* Controller. ANFIS controller is trained to produce the base of real components of resources current. Reference source flow creates the basic production of real components of resource flow and a three-phase sinusoidal vector using relationship (3).

$$\begin{bmatrix} I_{Sa}^* \\ I_{sb}^* \\ I_{sc}^* \end{bmatrix} = \begin{bmatrix} I_1^* \sin(\omega t) \\ I_1^* \sin(\omega t + 120) \\ I_1^* \sin(\omega t - 120) \end{bmatrix} \quad (3)$$

PQ distortion is recorded and obtained from different references, and real source flows with the assistance of relationship (4) and pulses for VSI shunt are produced from PQ distortion associated with customers using hysteresis flow controller [27, 29].

$$\begin{bmatrix} I_{Ca} \\ I_{Cb} \\ I_{Cb} \end{bmatrix} = \begin{bmatrix} I_{sa}^* \\ I_{sa}^* \\ I_{sa}^* \end{bmatrix} - \begin{bmatrix} I_{sa} \\ I_{sb} \\ I_{sc} \end{bmatrix} \quad (4)$$

After the UPFC connection, the source voltage and current can be found together in one phase and released from harmonic distortion using relationship (4). Series parameters and Shunt APF can also be obtained from relationships (6) and (7) [28, 30].

$$V_s \prec 0 = Z_s I_s \prec since\ \emptyset_s = 0, \begin{bmatrix} P_s \\ Q_s \end{bmatrix} = \begin{bmatrix} V_s I_s \\ 0 \end{bmatrix} \quad (5)$$

$$V_{sr} \prec (\emptyset_{sr}) = (Z_{sr} + Z_s) I_s \prec 0 = V_R \prec 0 - V_s \prec 0; \begin{bmatrix} P_{sr} \\ Q_{sr} \end{bmatrix} = \begin{bmatrix} V_s I_s \cos(\emptyset_{sr}) \\ V_s I_s \sin(\emptyset_{sr}) \end{bmatrix} \quad (6)$$

$$I_{sh} \prec \emptyset_{sh} = I_L \prec \emptyset_L - I_s \prec 0, \begin{bmatrix} P_{sr} \\ Q_{sr} \end{bmatrix} = \begin{bmatrix} V_s I_s \cos(\emptyset_{sr}) \\ V_s I_s \sin(\emptyset_{sr}) \end{bmatrix} \quad (7)$$

Therefore, after compensation, the actual load and reaction force load are calculated as relationship (8) and (9).

$$P_L = V_s I_s (1 - cos(\emptyset_{sr})) + V_L I_s (1 - cos(\emptyset_{sr}) - cos\,\emptyset_{sh}) - V_s I_s\, cos\,\emptyset_{sh} \quad (8)$$

$$Q_L = V_L I_s (sin(\emptyset_{sr}) - sin\,\emptyset_{sh}) + V_L I_L\, sin\,\emptyset_{sh} - V_s I_s\, sin(\emptyset_{sr}) \quad (9)$$

In the following, it is necessary to apply the neuro-fuzzy network or ANFIS to this microgrid system to predict the optimal power distribution as well as the risks for the short-term decision-making model. ANFIS is a hybrid artificial intelligence technique capable of formulating a map and target data using the adaptive control structure of the neural network and fuzzy logic. In general, a FIS architecture has two inputs in the form of (x, y) and two rules in the form of (r_1, r_2) and five layers of feedback, including adaptive or square and non-adaptive or circular modes. The rules of combined education combine the gradient descent method and Least Square Estimation. The adaptive network, under the supervision of the LSE algorithm or estimating the lowest squares, assumes that it has an output. In hybrid educational algorithms, such as the back-propagation training algorithm, optimization of hidden layers and output layer parameters can be performed by applying the LSE technique. The hybrid educational algorithm not only reduces the dimensions of search space in the gradient method but also helps to reduce the time in convergence.

IV. RESULTS

First, general settings for simulation should be provided. The microgrid requires settings that are parametrically inserted into the program in (5) to (10) forms. This data is embedded as an Excel file and enters the existing codes and Simulink.

TABLE I. GENERAL DATA AND BASIC MICROGRID SETTINGS

General Data	
Slack	149
Vnom (kV)	4.16
InternationalSystem	0
DeltaLF	0
V_slack_ph_A	1.01
V_slack_ph_B	1.01
V_slack_ph_C	1.01
Ang_slack_ph_A	0
Ang_slack_ph_B	-120
Ang_slack_ph_C	120

TABLE II. SETTINGS OF NODES CONNECTED TO THE MICROGRID AND THEIR CONFIGURATION TYPE

Node A	Node B	Length (ft.)	Config.
149	1	400	1
1	2	175	10
1	3	250	11
3	4	200	11
3	5	325	11
5	6	250	11
1	7	300	1
7	8	200	1
8	9	225	9
14	10	250	9
14	11	250	9
8	12	225	10
8	13	300	1
9	14	425	9
34	15	100	11
15	16	375	11
15	17	350	11
13	18	825	2
18	19	250	9
19	20	325	9
18	21	300	2

TABLE III. CONFIGURATION SETTINGS ONE BY ONE NODE IN MICROGRID FOR LOAD PLAYBACK

Conf	Line	R11	R12	R13	R22	R23	X11	X12	X13	X22	X23
1	1	0.4576	0.1566	0.1585	0.4666	0.5566	1.0766	0.5667	0.1545	2.6412	0.4214
2	1	0.4666	0.1580	0.1560	0.4615	0.1515	1.0452	0.4334	0.5007	2.0651	0.3645
3	1	0.4453	0.1515	0.1586	0.4574	0.1560	1.0451	0.1471	0.4344	2.0307	0.5017
4	1	0.4453	0.1580	0.1585	0.4666	0.1568	1.0651	0.4336	0.1543	2.6442	0.5017
5	1	0.4666	0.1560	0.1580	0.4574	0.1515	1.0452	0.5007	0.4224	2.0780	0.3645
6	1	0.4536	0.1511	0.1566	0.6615	0.5560	1.0566	0.1661	0.5007	2.6651	0.4314
7	1	0.4576	0.0000	0.0000	0.0000	0.0000	1.0786	0.0000	0.1643	0.0000	0.0000
8	1	0.4576	0.1533	0.0000	0.4615	0.0000	1.0780	0.1692	0.0000	2.0651	0.0000
9	1	1.1042	0.0000	0.0000	0.0000	0.0000	1.1075	0.0000	0.0000	0.0000	0.0000
10	1	0.0000	0.0000	0.0000	1.1292	0.0000	0.0000	0.0000	0.0000	2.3475	0.0000
11	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
12	1	1.5366	0.5051	0.4234	2.5324	0.5144	0.7531	0.1775	0.1157	0.7563	0.3775
13	0	0.1000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

TABLE IV. TABLE 4. RELATIONSHIP VALUES FOR MICROGRID

Node	Y=1. D=0	Alfa (PQ=0, I=1, Z=2)	Ph-1 (kW)	Ph-1 (kVAr)	Ph-2 (kW)	Ph-2(kVAr)	Ph-3 (kW)	Ph-3 (kVAr)
1	1	0	40	20	0	0	0	0
2	1	0	0	0	20	10	0	0
4	1	0	0	0	0	0	40	20
5	1	1	0	0	0	0	20	10
6	1	2	0	0	0	0	40	20
7	1	0	20	10	0	0	0	0
9	1	0	40	20	0	0	0	0
10	1	1	20	10	0	0	0	0
11	1	2	40	20	0	0	0	0
12	1	0	0	0	20	10	0	0
16	1	0	0	0	0	0	40	20
17	1	0	0	0	0	0	20	10
19	1	0	40	20	0	0	0	0
20	1	1	40	20	0	0	0	0
22	1	2	0	0	40	20	0	0
24	1	0	0	0	0	0	40	20
28	1	1	40	20	0	0	0	0
29	1	2	40	20	0	0	0	0
30	1	0	0	0	0	0	40	20
31	1	0	0	0	0	0	20	10

TABLE 5. POSITIONING OF MICROGRID NODES IN THE X AND Y-AXIS

Node	Pos X	Pos Y
1	99.0114	323.3191
2	99.1995	283.8511
3	99.0114	382.8936
4	99.0114	401.5106
5	125.7460	382.8936
6	156.5490	384.3830
7	123.4213	318.1064
8	155.3866	312.8936
9	145.5064	274.9149
10	110.0540	271.9362
11	63.5589	254..638
12	140.2757	337.4681
13	187.3520	306.9362
14	101.3361	248.8511
15	206.5312	368.7447
16	218.7361	397.0426
17	233.8470	358.8085
18	148.9936	184.0638
19	111.2163	193.0000

TABLE 6. CLOSED-LOOP MODE OF NODES IN MICROGRID

NODE1	NODE2	Closed=1
18	135	1
150	149	1
13	152	1
60	160	1
97	197	1

Then, the microgrid diagram block should be modeled for optimal load distribution in the Simulink environment. The microgrid must be designed. This design is carried out in Simulink, which is the original and completed model in Fig. 5.

The main components of this model are two variable controllers in fuzzy and neural forms called MVR. The upper MVR is for the fuzzy part and the lower MVR for the neural part, which combines to provide a structure of the neural-fuzzy network and receive their commands from the command line when executing existing codes. Sub synthetics are observed in this Simulink. The subsystem, which is two parts, receives the Micro net information once and receives it once in the form of a neuro-fuzzy network. A view of this system is Fig. 6.

The neuro-fuzzy controller is in the form of (13) and is a view of the complete UPFC structure in the form of (14) on which the settings are applied based on the initial data of Tables 1 to 6. When Simulink is executed, the source voltage and voltage load are shown as output, which is in the form of Figs. 9 and 10.

In general, the data entered for node connections in the microgrid can be shown in Fig. 11. Also, the errors in the microgrid are in the form of (18) in terms of percentage at the time of transmission and optimal distribution of loads at the microgrid level.

Also, system analyses can be seen from left to right, including voltage in percentage (U), Drop or MGU value, Drop power rate with you and MGU in percentage, and THD rate in percentage (U). The analysis output is displayed in the MATLAB command line, which is Fig. 13.

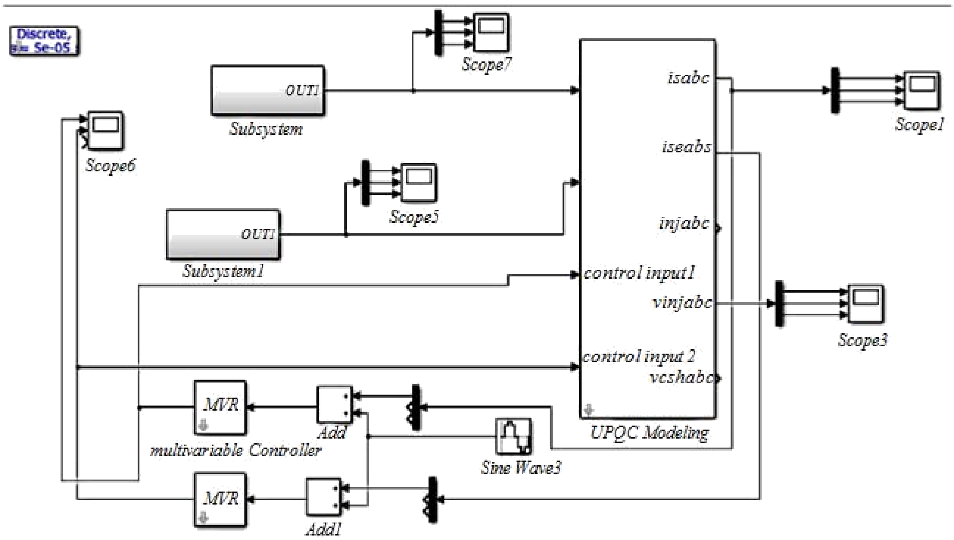

Fig. 5. Microgrid Simulink model for optimal load playback with UPFC

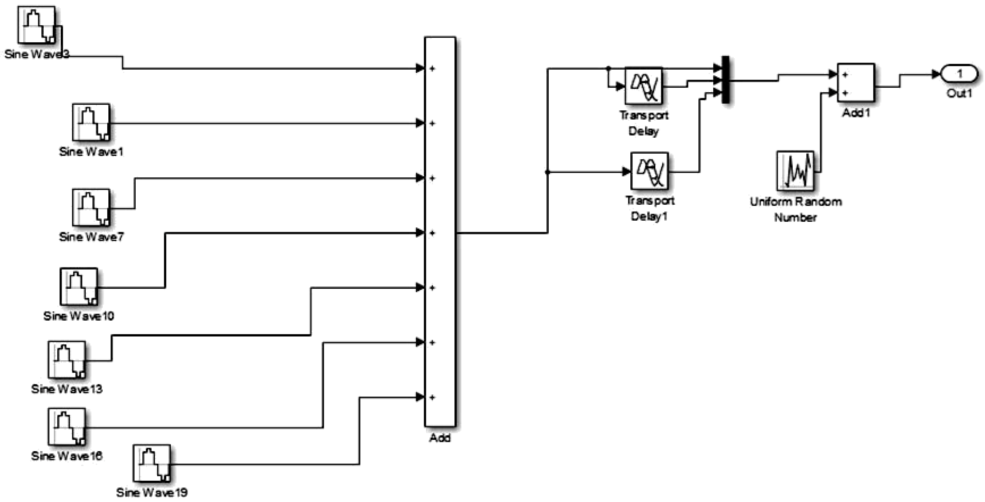

Fig. 6. Microgrid subsystem to draw outputs as sinusoidal functions

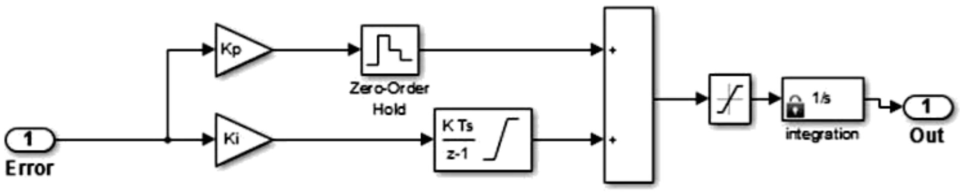

Fig. 7. Neuro-Fuzzy Controller

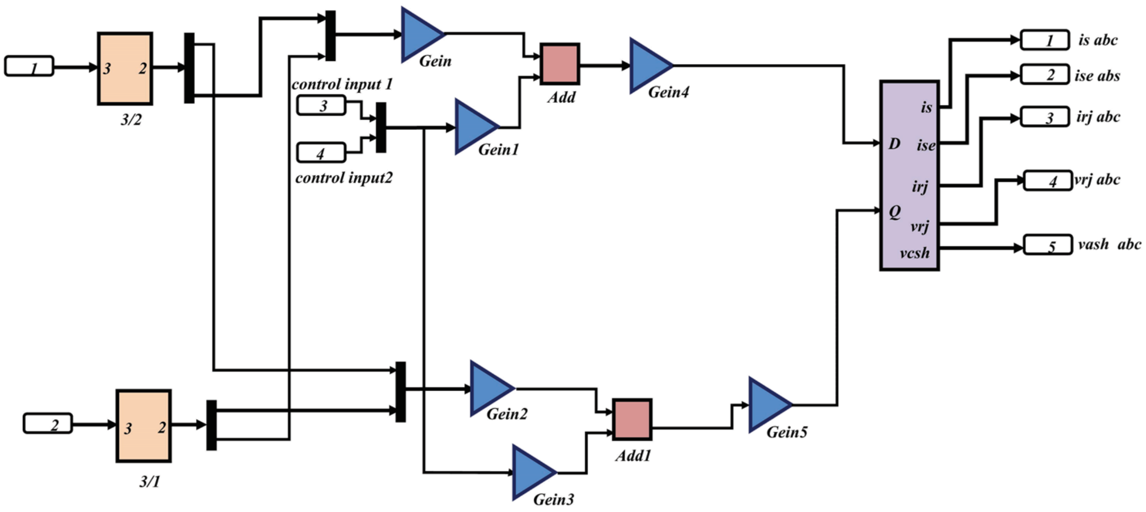

Fig. 8. A view of the full UPFC structure with full settings

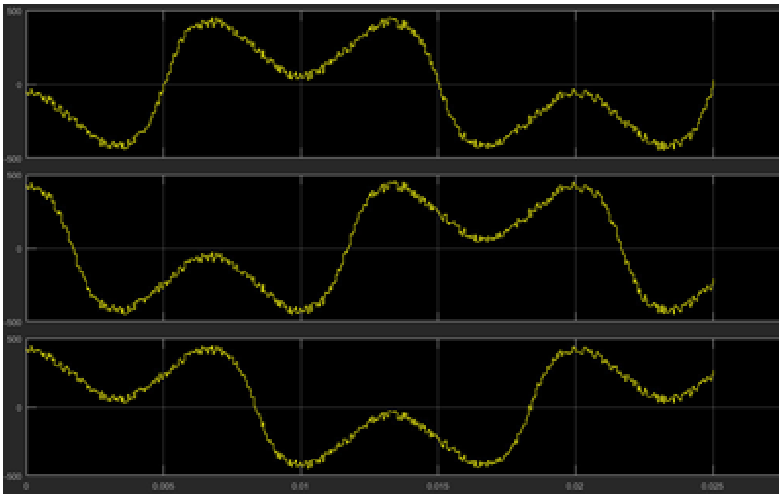

Fig. 9. Source voltage

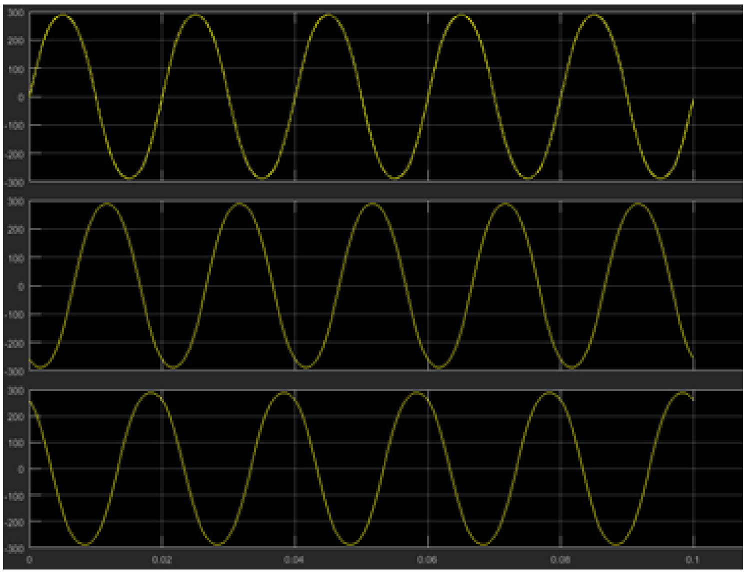

Fig. 10. Voltage load

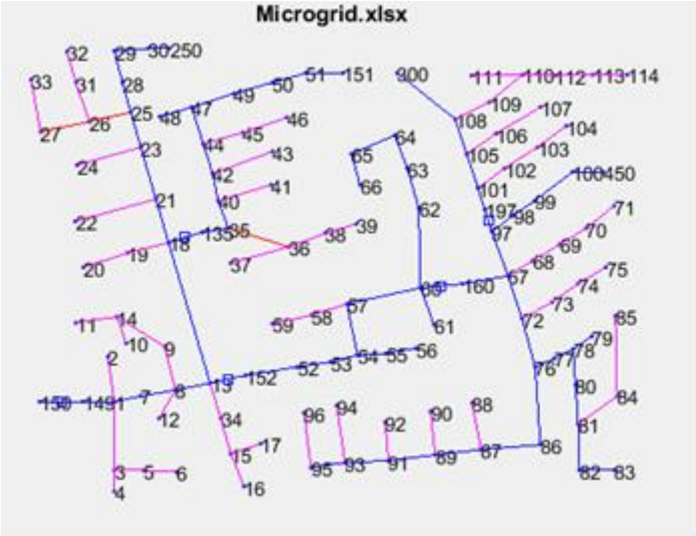

Fig. 11. Connections of nodes in the microgrid

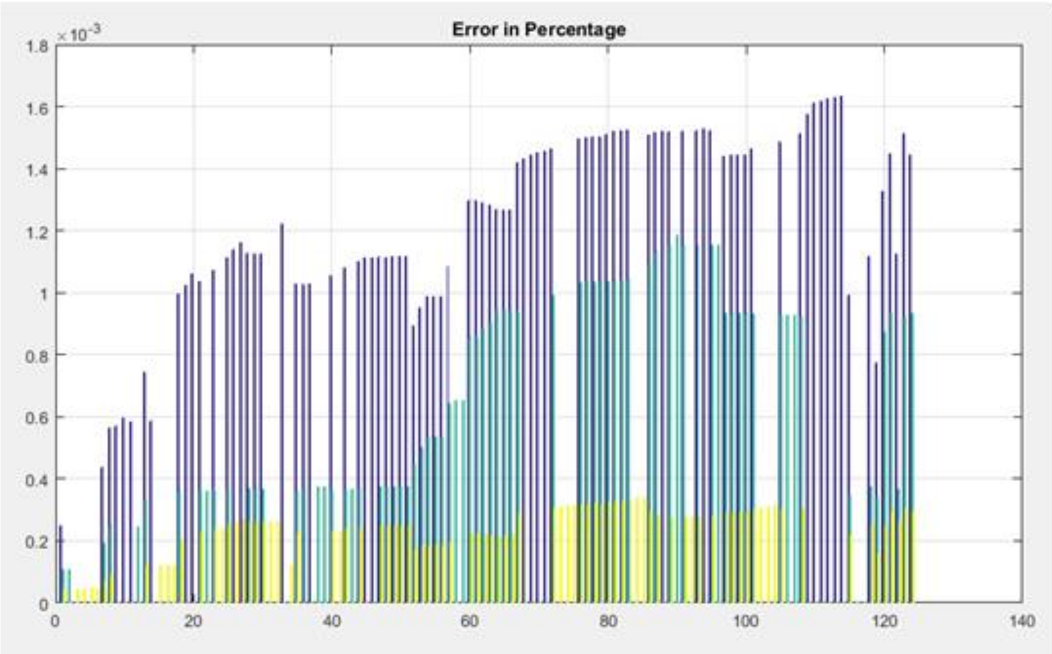

Fig. 12. Errors in a microgrid in percentage at the time of optimal transmission and distribution of loads

N1	0.9971 < -0.6474	1.0074 < -120.3275	1.0009 < 119.6171
N2	.	1.0072 < -120.3319	.
N3	.	.	0.9993 < 119.5851
N4	.	.	0.9988 < 119.5748
N5	.	.	0.9980 < 119.5601
N6	.	.	0.9974 < 119.5473
N7	0.9876 < -1.1228	1.0056 < -120.5896	0.9951 < 119.3643
N8	0.9814 < -1.4381	1.0043 < -120.7637	0.9912 < 119.1905
N9	0.9799 < -1.4675	.	.
N10	0.9779 < -1.5070	.	.
N11	0.9776 < -1.5133	.	.
N12	.	1.0040 < -120.7694	.
N13	0.9731 < -1.8756	1.0020 < -121.0084	0.9854 < 118.9030
N14	0.9782 < -1.5005	.	.
N15	.	.	0.9840 < 118.8754
fx N16	.	.	0.9830 < 118.8555

Fig. 13. Microgrid system analysis after optimal load transfer and distribution

IV. CONCLUSION

Microgrids have many advantages, including improving power quality and reliability, reducing losses and economic benefits, and reducing environmental pollution. Optimal load distribution in power systems and microgrids is an important issue. This necessity comes from a place where a lack of optimal load distribution can lead to economic and environmental problems on a large scale. Voltage fluctuations are one of the most important problems that can lead to the loss of equipment. The presence of internal and external disturbances in microgrids can lead to an increase in frequency in the form of instantaneous occurrences, which exacerbates severe load changes and errors. In microgrids, UPFC is needed to use UPFC for optimal load playback, but there are still weaknesses in these systems. Therefore, it is necessary to develop a short-term decision-making model. It is essential to provide an optimal structure that can train and detect errors and continue to prevent any internal and external disturbances. Providing control strategies for this purpose is an issue that has been discussed by scientific societies for many years. Due to uncertainty in microgrids, fuzzy structures can be used, but since there is no improvement capability in fuzzy systems, therefore, a hybrid method with it can be an interesting problem. Therefore, this study aimed to use a neural network along with fuzzy logic called neurophysical or ANFIS. The neural network can automatically create a learning structure during the period of rotation in the structure of fuzzy membership functions and create an unFuzzy-making operator that offers an interesting result. After the learning structure of the neural network, the input signals in the neural network constantly recall the functions of membership and fuzzy Scientology. Simulation has been carried out in MATLAB and Simulink environments, which shows that optimal load distribution, taking into account frequency and voltage playback and fault detection, can lead to optimization operations in power systems and microgrids as a short-term programming model.

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