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A Multi-Objective Power Grid Fault Emergency Rescue Method Based on Human-Vehicle Feature Matching

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Abstract. With the popularization and extensive use of power grid, people's lives and many factories generally rely on electricity, and once the power grid is damaged and fails, it will seriously endanger the social order and economic benefits. At present, the research on the rescue dispatch of electric vehicles as an emergency power source mainly focuses on path planning, and does not consider the comprehensive rescue ability of the rescuers dispatched, nor does it involve the matching degree of rescuers and rescue vehicles. In this paper, the rescue urgency is obtained through the analysis and evaluation of the fault point, the characteristics of the rescue vehicles and rescue personnel are analyzed to screen out the appropriate rescue vehicles and personnel, the Euler distance is used to solve the matching coefficient between the rescue vehicle and the rescue personnel, and finally the multi-objective power grid fault emergency rescue function considering the matching of human and vehicle characteristics is established.

Keywords. Electric vehicles, feature matching, emergency rescue, multi-target rescue.

1.Introduction

With the popularization and widespread use of power grids, all aspects of people's lives depend on electricity, and the damage to the power system and the interruption of power supply caused by extreme weather [1] will seriously endanger social order and national economic benefits. In view of the characteristics of mobile energy storage of electric vehicles, considering the losses generated in their operation, scheduling, and maintenance, it is shown that electric vehicles have strong feasibility as emergency power supply to supply power to fault loads [2], [3].

2. Heading

The existing emergency rescue dispatch methods mainly focus on the path planning of rescue vehicles and rescue locations [4], [5]. As a key part of the urban emergency

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defense system, the selection of rescuers and rescue vehicles is very important, and most of them only consider the impact of the characteristics of electric vehicles on rescue [6], while ignoring the comprehensive quality expected by rescuers. Moreover, the matching degree of rescue vehicles and rescue personnel seriously affects the rescue speed and the loss caused by power failure, and the matching mechanism between rescue vehicles and rescue personnel has not been established in the current study.

2.1. Determine the Urgency of the Rescue and the Total Load Demand of the Fault Load

Obtain the location of each fault power grid, consider the impact degree of power failure fault on the health and safety, economic loss and quality of life caused by each load, calculate the rescue urgency of K fault power grids, and the rescue urgency of each fault power grid is „ wherein, the impact degree of health and safety of each load, the impact degree of economic loss, and the impact degree of quality of life are respectively characterized by A_k , $A_k = (\omega_\alpha, \omega_\beta, \omega_\gamma) \bullet \begin{pmatrix} \alpha_k \\ \beta_k \\ \gamma_k \end{pmatrix}$ α_k , β_k γ_k . ω_α represents the weight of health and safetyin the urgency of the fault load, ω_β represents the weight of the economic loss in the urgency of the fault load, the weight of the quality of life in the urgency of the fault load, ω_γ represents the power demand of each fault grid in the evaluation area and the total active power demand of the k-th fault grid $\omega_\alpha + \omega_\beta + \omega_\gamma = 1$, and the node voltage of each fault grid Q_k P_k U_{ik} It needs to be satisfied $0.95U_{ik} \le U_k \le 1.05U_{ik}$, wherein is the U_k rated voltage of each fault grid, and the line current of each fault is I_k , and its constraint is that $I_k \le I_{k,\max}$ the $I_{k,\max}$ maximum current value allowed to pass through each fault line is expressed.

2.2. Establish an Evaluation Index System for the Comprehensive Ability and Quality of Rescue Personnel

Table 1. The evaluation index system for the comprehensive ability and quality of rescue personnel

Level 1 indicators	Secondary indicators	Metric definitions
Driving ability situation A	Traffic regulation mastery situation A1	Knowledge of traffic rules, laws and regulations, and other relevant knowledge
	Driving skills A2	Master basic driving skills such as using lights, meeting cars, changing lanes, making U-turns, driving in a straight line, and stopping
	A3 in the ability to judge road conditions	Response to random events on the road surface such as speeding, deceleration and avoidance, honking signal, and whether it can pass
Physical and mental condition B	Age range B1	Distinguish between three types of rescuers: young, prime, and middle-aged
	History of physical illness B2	Such as high blood pressure, diabetes, heart disease, cerebral infarction, asthma, etc

	History of psychiatric illness B3	Such as depression, schizophrenia, obsessive-compulsive disorder, anxiety disorder, etc
	Psychological condition B4	Stress trauma, psychological sensitivity, social sensitivity,
	Emotional intelligence status B5	Self-emotion awareness, emotion recognition and expression, self-emotion management
	Basic competency B6	Perception ability, attention, memory ability, thinking judgment ability, motor reaction ability, etc
Road Safety Awareness C	Safe driving knows C1	Awareness of the importance of safe driving
	Safe driving habits C2	Check the status of the rescue vehicle before driving, etc
	Safe driving inclination C3	For example, if you pursue the thrill of speeding, you will not continue to drive the rescue vehicle once it is abnormal
Driving experience situation D	Vehicle Performance Familiarity D1	Understand and grasp the performance parameters, model size, advantages and disadvantages of rescue vehicles Daily maintenance of rescue vehicles
	Regional road condition familiarity D2	Familiar with the location of the roads and rescue vehicle supply places in the area, and be proficient in rescue and evacuation routes
	The range of years of employment is D3	Distinguish between rescuers with 1-3 years, 4-7 years, 8 years and above
Integrated Rescue Capability E	Personnel first aid knowledge mastery E1	Such as cardiopulmonary resuscitation, simple trauma bandaging, etc
	Electrician safety knowledge mastery E2	For example, take good care of electrical tools, replace insulating tools regularly, and be familiar with the maximum current carrying capacity of each electrical equipment
	Maintenance Technical Competence E3	Maintenance speed, maintenance accuracy, etc
	Communication skills E4	Ability to cooperate with colleagues during work and communicate with people affected by disasters

Calculate the comprehensive rescue ability and quality value of M rescuers respectively

$$H_m = (G_{Am}, G_{Bm}, G_{Cm}, G_{Dm}, G_{Em}) \cdot \begin{pmatrix} \omega_A \\ \omega_B \\ \omega_C \\ \omega_D \\ \omega_E \end{pmatrix} \quad (1)$$

H_m

2.3. *Establish a Matching Model of Rescue Vehicles and Rescue Personnel*

- Establish a feature set for the c-th rescue vehicle X_c

$X_c = \{X_{1c}, X_{2c}, X_{3c}, X_{4c}, X_{5c}\}$, indicating the age of the C rescue vehicle, the power type of the C rescue vehicle, the model of the C rescue vehicle, the braking sensitivity of the C rescue vehicle, and the X_{1c} power consumption per kilometer of the X_{2c} X_{3c} C X_{4c} rescue vehicle X_{5c} [8].

- Establish a set of characteristics of the mth rescuer Y_m.

$Y_m = \{Y_{1m}, Y_{2m}, Y_{3m}, Y_{4m}, Y_{5m}\}$, indicates the age of the mth rescuer, indicates the entry period of the mth rescuer, indicates the driving ability of the mth rescuer, indicates the physical and mental quality Y_{1m} of the mth, Y_{2m} and indicates the driving experience of the mth Y_{3m} Y_{4m} rescuer Y_{5m}. The standardized Euclidean distance was used to solve the matching coefficient between the rescue vehicle and the rescuer [9].

A five-dimensional vector $x_c\left(x_{11}, x_{12}, x_{13}, x_{14}, x_{15}\right)$ spatialization table is used to collect the synthesis X_c, in which x_{11} the feature descriptor of the rescue vehicle's service life, the feature descriptor of the rescue vehicle's power type, the feature descriptor of the rescue vehicle model, and x_{12} the feature descriptor of the rescue vehicle's braking sensitivity x_{13} x_{14} x_{15} is a characterization sub for the power consumption per kilometer of the c-rescue vehicle. Using the standardized Euler distance formula

$$D_{cm} = \sqrt{\sum_{k=1}^{5}\left(\frac{x_{1k} - x_{2k}}{S_k}\right)^2} \tag{2}$$

the distance of and is solved, where the x_c standard deviation of the k-th dimension is described, y_m and the matching coefficient between the c-th vehicle and the m-th rescuer S_k is used D_{cm}

2.4. A regional Road Network Model Considering the Matching Coefficient of Rescue Vehicles and Rescue Personnel and the Road Safety Factor was Established

- The graph theory method is used to model the faulty transportation network:

$$\begin{cases} G = (V, L, T, W) \\ V = \{v_i, v_k \mid i, k = 1, 2, \cdots, n\} \\ L = \{v_{ik} \mid v_i \in V, v_k \in V, i \neq k\} \\ T = \{t \mid t = 1, 2, \cdots, 24\} \\ W = \{l_{ik}^t \mid v_{ik} \in E, t \in T\} \\ l_{ik}^t = D_{cm} \bullet R_{ik}^t \bullet \delta_t \end{cases} \tag{3}$$

- Based on the basis of graph theory [10], all disaster fault points are converted into an undirected graph according to the location $G = (V, L, T, W)$, which represents the set of all V traffic nodes in the area, the set of all rescue starting points, the set of all v_i fault points, the collection v_k of all traffic sections, and L the starting v_{ik} point from rescue To the traffic section between the fault point, T is the time series set, t represents the i real-time update time of road conditions, each hour is divided into a time period point, less than one hour is calculated as one hour, updated 24 times a day, represents k the road section weighted value set, is the W l_{ik}^{t} weighted length of the road section from the ith rescue starting point to the kth fault point after considering the matching coefficient between the rescue vehicle and the rescue personnel, and is blocked by the fixed road R_{ik}^{t} After fusing the time-consuming coefficient of real-time traffic index representation δ_t and the matching coefficient between the rescue vehicle and the rescuer, the road loss time of the mth rescuer and the cth rescue vehicle from the ith rescue starting point to the kth fault point is obtained, where is D_{cm} the average driving speed of the mth rescuer and the cth $t_{ik}^{cm}=\frac{l_{ik}^{t}}{v_{cm}}=\frac{D_{cm}\bullet R_{\mathrm{ik}}^{t}\bullet\delta_t}{v_{cm}}$ rescue vehicle v_{cm} .

2.5. A multi-dimensional Matching Rescue Model is Established with the Goal of Optimal Matching of Rescuers and the Minimization of Comprehensive Loss of Faults in the Region

- Establish a matching objective function.

$$\max f_1\left(H_m,D_{cm}\right)=\sum\left(H_m\bullet\omega_m+D_{cm}\bullet\omega_{cm}\right) \tag{4}$$

which represents the weight of comprehensive rescue ability and quality in the total matching, and the weight of the matching coefficient between the rescuer ω_m and the rescue vehicle in the total matching, ω_{cm} and the $\omega_m+\omega_{cm}=1$ matching function of the rescuer $f_1\left(H_m,D_{cm}\right)$.

- Establish the lowest-cost objective function

$$\min f_2\left(t_{ik}^{cm},\ t_{cm}\right)=\sum A_k\bullet Q\bullet\left(t_{ik}^{cm}+t_{cm}\right)+2\sum\left(t_{ik}^{cm}\bullet\overline{v_{cm}}\bullet Q_c\right)+\sum Q_{c0} \tag{5}$$

$f_2\left(t_{ik}^{cm},\ t_{cm}\right)$ Represents the total t_{cm} cost, represents the rescue support time consumed by the c vehicle with the m rescuer, the road loss time from the ith rescue starting point to the kth t_{ik}^{cm} fault load for the first vehicle and the m rescuer, represents the cost loss per c minute generated by the load in the fault, and represents the Q cost loss per kilometer generated by the c rescue vehicle Q_c Q_{c0} Indicates the O&M cost of vehicle c.

2.6. Compute Instance Analysis

- Rescue urgency solved

There are 4 fault loads, 6 rescue personnel, and 6 rescue vehicles.

Table 2. Rescue urgency of four fault loads

load	The extent of the impact on health and safety	The extent of the impact of the economic loss	The extent to which quality of life is affected	Relief swifts
1	0.8	0,7	0.8	0,77
2	0.5	0.5	0.3	0,46
3	0,2	0.3	0.4	0,27
4	0.5	0.3	0.4	0,42

- The comprehensive ability and quality value of rescuers is solved

In this example, six rescuers are taken as an example, and the comprehensive ability and quality evaluation results of the six rescuers are shown in Figure 1.

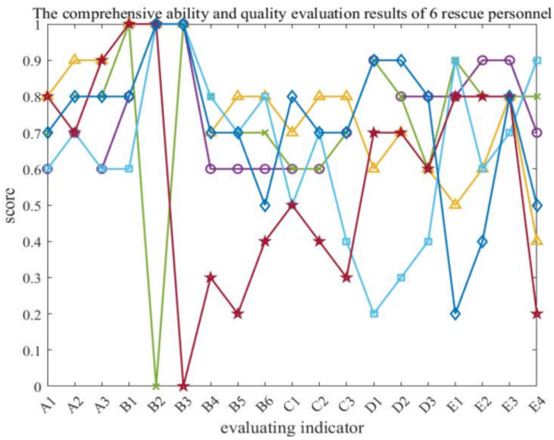

Figure 1. The comprehensive ability and quality evaluation results of 6 rescue personnel.

After calculation, the first-level index scores of the first rescuer were 0.87, 0.86, 0.78, 0.65, and 0.60, and the value of his comprehensive rescue ability and quality H_1 was 0.735;The first-level index scores of the second rescuer are 0.63, 0.74, 0.63, 084, and 0.84, and their comprehensive rescue ability and quality value H_2 It was 0.768, and the first-level index scores of the third rescuer were 0.77, 0.74, 0.63, 0.80, 0.82, the comprehensive rescue ability quality value was 0.752, and H_3 the first-level index scores of the fourth rescuer were 0.63, 0.82, and 0.57, 0.28, 0.75, the comprehensive rescue ability quality value is 0.600, H_4 the fifth rescuer first-level index score is 0.81, 0. 38, 0.39, 0.68, 0.68, the comprehensive rescue ability quality value is 0.574 H_5, and the first-level index score of the sixth rescuer is 0.77, 0.76, 0.80, 0.88, 0.50, and its comprehensive rescue ability quality value is H_6 0.749.

- Rescue vehicle and rescuer matching model solving

In this paper, 6 alternative vehicles and 6 rescuers are taken as examples, and the characteristics of the 6 alternative vehicles are shown in Table 3, and the characteristics of 6 rescuers are shown in Table 4.

Table 3. Characterization of the six alternative vehicles

Vehicle serial number	x_{11}	x_{12}	x_{13}	x_{14}	x_{14}
1	1	0.5	1	0.8	0.8
2	1	1	0,7	0,9	0,6
3	0,7	1	1	0,7	0.8
4	0.4	1	1	0,6	0.4
5	1	1	0.4	0,7	0,6
6	0,7	0,6	1	0,7	0,7

Table 4. Characterization of six rescuers

Personnel serial number	x_{21}	x_{22}	x_{23}	x_{24}	x_{25}
1	1	0,6	0,87	0,86	0,78
2	0.8	0.8	0,63	0,74	0,63
3	1	0,6	0,77	0,74	0,63
4	0,6	0.4	0,63	0,82	0,57
5	1	0,6	0,81	0,38	0,39
6	0.8	0.8	0,77	0,76	0,80

Using the standardized Euler distance formula

$$D_{cm} = \sqrt{\sum_{k=1}^{5}\left(\frac{x_{1k} - x_{2k}}{S_k}\right)^2} \tag{6}$$

the distance to and x_c is solved, y_m where the S_k standard deviation of the k-th dimension is described. It is used to characterize the matching coefficient of the D_{cm} C vehicle and the M rescuer, and the matching coefficient of 6 alternative vehicles and 6 rescuers is shown in Figure 2

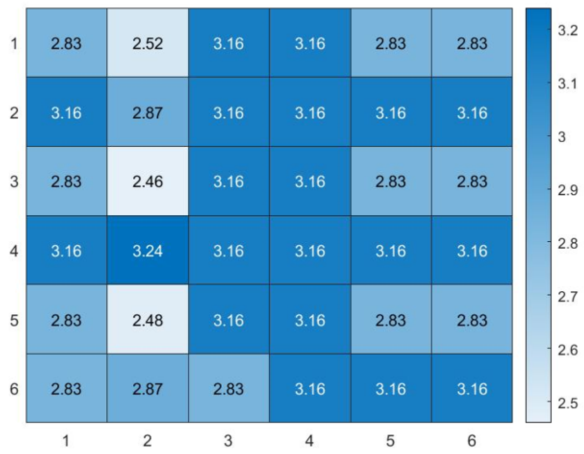

Figure 2. Matching coefficient between 6 candidate rescue vehicles and 6 rescue personnel.

- The regional road network model is solved considering the matching coefficient of rescue vehicles and rescue personnel and the road safety factor

Table 5 shows the relationship between the time consumption coefficient and the time period.

Table 5. Time PERIOD of time consuming coefficients

Time	Time-consuming factor δ_t	Time	Time-consuming factor δ_t
00：00-01：00	0.5	12：00-13：00	1,0
01：00-02：00	0.1	13：00-14：00	1,1
02：00-03：00	0.1	14：00-15：00	0,9
03：00-04：00	0,2	15：00-16：00	0,9
04：00-05：00	0,2	16：00-17：00	1,1
05：00-06：00	0.4	17：00-18：00	1,3
06：00-07：00	0.8	18：00-19：00	1,3
07：00-08：00	1,2	19：00-20：00	1,1
08：00-09：00	1,2	20：00-21：00	0,9
09：00-10：00	0,9	21：00-22：00	0.8
10：00-11：00	0.8	22：00-23：00	0.8
11：00-12：00	1,1	23：00-24：00	0,6

This paper assumes that the rescuers must all depart from the same rescue site, and the rescuers and rescue vehicles aredispatched to the rescue at 16:00, and the time consumption coefficient δ_t is 1.1, $R_{11}^{16}=14$ and the road resistance from the rescue starting point to the four fault points is , $R_{12}^{16}=19$ $R_{13}^{16}=17$ $R_{14}^{16}=16$ The average driving speed (km/h) of the 6 rescuers matched with the 6 alternative rescue vehicles is shown in Figure 3.

Matching method	velocity	Matching method	velocity	Matching method	velocity
$\overline{v}_{11}$	55	$\overline{v}_{21}$	50	$\overline{v}_{31}$	55
$\overline{v}_{12}$	58	$\overline{v}_{22}$	53	$\overline{v}_{32}$	55
$\overline{v}_{13}$	54	$\overline{v}_{23}$	50	$\overline{v}_{33}$	55
$\overline{v}_{14}$	60	$\overline{v}_{24}$	58	$\overline{v}_{34}$	58
$\overline{v}_{15}$	53	$\overline{v}_{25}$	48	$\overline{v}_{35}$	55
$\overline{v}_{16}$	53	$\overline{v}_{26}$	50	$\overline{v}_{36}$	50
$\overline{v}_{41}$	56	$\overline{v}_{51}$	55	$\overline{v}_{61}$	52
$\overline{v}_{42}$	55	$\overline{v}_{52}$	60	$\overline{v}_{62}$	58
$\overline{v}_{43}$	54	$\overline{v}_{53}$	52	$\overline{v}_{63}$	56
$\overline{v}_{44}$	55	$\overline{v}_{54}$	58	$\overline{v}_{64}$	58
$\overline{v}_{45}$	55	$\overline{v}_{55}$	52	$\overline{v}_{65}$	54
$\overline{v}_{46}$	55	$\overline{v}_{56}$	60	$\overline{v}_{66}$	58

Figure 3. Average driving speed under different matching methods.

The Dijkstra algorithm is used to solve the shortest driving path length between the rescue starting point and the fault point in the region under the condition of matching different rescue personnel, and combined with the average riving speed, the road loss time from the rescue starting point to the fault point in the region is determined when each rescue vehicle matches different rescue personnel. Figure 4 shows the duration of road wear and tear after the matching of 6 rescuers with 6 alternative rescue vehicles.

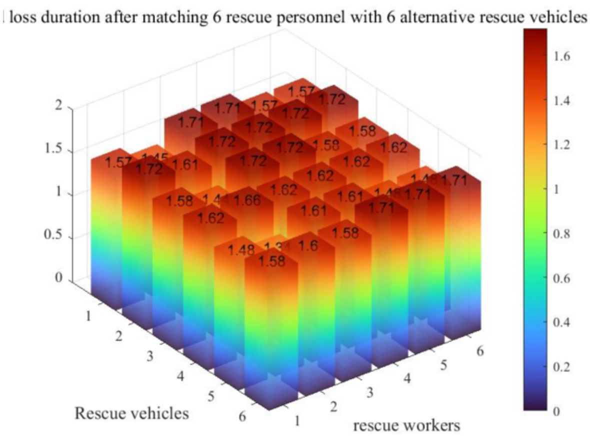

Figure 4. Road loss duration after matching 6 rescue personnel with 6 alternative rescue vehicles.

- The multi-dimensional matching rescue model is solved with the goal of matching rescuers with the best matching and the smallest comprehensive loss of faults in the region

The best matching of rescuers needs to consider the comprehensive rescue ability quality value of the rescuers dispatched H_m and the matching coefficient with the rescue vehicle, and D_{cm} establish the matching objective function:,

$$\max f_1(H_m, D_{cm}) = \sum(H_m \bullet \omega_m + D_{cm} \bullet \omega_{cm}) \tag{7}$$

where $\omega_m + \omega_{cm} = 1$ represents the rescuer matching function $f_1(H_m, D_{cm})$, the value of the rescuer matching function is shown in Figure 5.

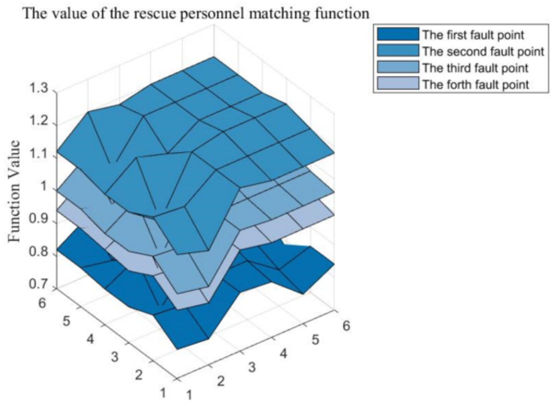

Figure 5. The value of the rescue personnel matching function.

Among them, the function value of car 1 and driver 2 is 1.72, the function value of car 3 and driver 1 is 1.72, the function value of car 4 and driver 3 is 1.72, and the function value of car 5 and driver 6 is 1.72The No. 6 car and No. 6 driver function value is 1.72, and these combinations are preliminarily selected.

The minimum total loss needs to consider the rescue urgency of A_k the fault load and the road loss time to reach the fault load t_{ik}^{cm}, and establish the objective function with the lowest cost

$$\min f_2(t_{ik}^{cm},\ t_{cm}) = \sum A_k \bullet Q \bullet (t_{ik}^{cm} + t_{cm}) + 2\sum(t_{ik}^{cm} \bullet \overline{v_{cm}} \bullet Q_c) + \sum Q_{c0}$$

$f_2(t_{ik}^{cm},\ t_{cm})$ Represents the total cost, which t_{cm} is the rescue support time consumed by the c vehicle and the m rescuer, as shown in Table 6.

Table 6. The rescue support duration consumed under each matching method

Matching method	Duration	Matching method	Duration	Matching method	Duration
t_{11}	**1.3**	t_{21}	**1.4**	t_{31}	**1.3**
t_{12}	**1.2**	t_{22}	**1.3**	t_{32}	**1.2**
t_{13}	**1.4**	t_{23}	**1.6**	t_{33}	**0.8**
t_{14}	**1.1**	t_{24}	**1.7**	t_{34}	**1.0**
t_{15}	**1.2**	t_{25}	**1.6**	t_{35}	**1.1**
t_{16}	**1.2**	t_{26}	**1.5**	t_{36}	**1.3**
t_{41}	**1.6**	t_{51}	**1.0**	t_{61}	**1.7**
t_{42}	**1.6**	t_{52}	**0.8**	t_{62}	**1.5**
t_{43}	**1.7**	t_{53}	**0.7**	t_{63}	**1.5**
t_{44}	**1.5**	t_{54}	**0.8**	t_{64}	**1.2**
t_{45}	**1.4**	t_{55}	**1.2**	t_{65}	**1.7**
t_{46}	**1.8**	t_{56}	**1.3**	t_{66}	**1.6**

t_{ik}^{cm} The c road loss time for the first car with the mth rescuer from the ith rescue starting point to the kth fault Q load;Represents the cost loss per minute generated by Q the load at the time of failure, take 100 yuan/hour, the higher the rescue urgency, the higher the cost loss of the fault load; Q_c Represents the cost loss of the first rescue vehicle per kilometer, Q_c take 1 yuan/ kilometers, Q_{c0} indicating the fixed O&M costs of the cth vehicle. Q_{c0} Take 100 yuan.

After calculation, when the No. 1 rescue vehicle and the No. 2 rescuer go to the second fault location, the No. 1 rescue vehicle and the No. 1 rescuer go to the fourth fault site, when the No. 5 rescue vehicle and the No. 6 rescuer go to the first fault location, and when the No. 6 rescue vehicle and the No. 6 rescuer go to the third fault site for rescue, the multi-objective function is satisfied, and the maximum value of the matching function is 6.88, the minimum value of the total cost is 1495.37.

References

[1] R. Wei, H. He, L. Wang, Y. Luo, W. Wu and H. Hou, "Review of Power Grid Importance Identification and Cascading Fault under Natural Disasters Based on Complex Network Theory," 2023 Panda Forum on Power and Energy (PandaFPE), Chengdu, China, 2023, pp. 1338-1343.

[2] J. Jiang, W. Chen, G. Wu and Y. Jiao, "Power Supply Service: Assessing the Feasibility and Merits of Applying Electric Emergency Power Vehicles," 2019 4th International Conference on Control and Robotics Engineering (ICCRE), Nanjing, China, 2019, pp. 60-64.

[3] Hu S,Liao K,Yang J,Li B,Yang W(2023).Power supply restoration strategy of urban power grid based on V2G technology. Dianli Zidonghua Shebei/Electric Power Automation Equipment, 43(6), 53–61.

[4] Yang F,Chong D.(2022).Emergency Vehicle Dynamic Path Selection Based on Two-stage Objective Optimization Model. Jiaotong Yunshu Xitong Gongcheng Yu Xinxi/Journal of Transportation Systems Engineering and Information Technology, 22(3), 84–92.
[5] Yang B,Wu L,Xiong J,Zhang Y,Chen L(2023). Location and path planning for urban emergency rescue by a hybrid clustering and ant colony algorithm approach[Formula presented]. Applied Soft Computing, 147.
[6] Jin G,Li S,Li G,Xin Y,Liu Y,Zhou H,Xie F,Ma Y(2023). Emergency optimal dispatch of AC/DC hybrid distribution network considering spatio-temporal energy controllable characteristics of electric vehicle clusters. Dianli Zidonghua Shebei/Electric Power Automation Equipment, 43(7), 102–109.
[7] GAO,Qi-ming. DISTRIBUTION NETWORKSUPPLY VEHICLE IN MULTI FAULT REPAIR OFOPTIMAL DISPATCH OF EMERGENCY POWER [D] Yanshan University,2019.
[8] E. S. Xydas, C. E. Marmaras, L. M. Cipcigan, A. S. Hassan and N. Jenkins, "Electric vehicle load forecasting using data mining methods," IET Hybrid and Electric Vehicles Conference 2013 (HEVC 2013), London, 2013, pp. 1-6.
[9] HUANG Hai-bo,NIE Xiang-fei,LI Xiao-ling,ZHANG Yue,XIONG Wen-yi.Study on Bidirectional Feature Matching Bzsed on Standardized Euclidean Distance [J]. Computers & Telecommunications 2018, (11): 35-40.
[10] S. Zhou, Z. Xue, L. Ai, Y. Hu and A. Cao, "Distribution Network Fault Location Method Based on Graph Theory and Deep Learning under Charging Load Access," 2021 IEEE 5th Conference on Energy Internet and Energy System Integration (EI2), Taiyuan, China, 2021, pp. 1237-1241