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Summary of Electric Vehicle Distribution Path Optimization Research

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Abstract

With the rise of green logistics, the research on the application of electric vehicles has attracted great attention. Electric vehicle routing problem (EVRP) is one of the core issues in electric vehicle operation management and logistics optimization. Firstly, the current status of electric vehicle routing development is introduced, and then the research status of vehicle routing optimization research is introduced. The current research status of electric vehicle path optimization, and finally, the future development trend of electric vehicle path optimization is expected.

Keywords

Electric vehicle; Vehicle routing problem; Distribution path optimization.

1. Introduction

The rapid economic growth and the increase in the number of people have led to an increasingly serious problem of environmental pollution and energy crisis. According to the "2018 China Motor Vehicle Environmental Management Annual Report", the number of motor vehicles in the country reached 310 million in 2017 (including 1.53 million new energy vehicles), which will directly aggravate the crisis of urban traffic congestion, air pollution and energy security. [1]. At present, 70% of China's oil consumption is mainly used in motor vehicles. The number of motor vehicles is growing continuously, and the demand for oil is also increasing, resulting in an ever-increasing energy crisis.

With the advent of the era of electric vehicles, many countries plan to ban the sale of fuel vehicles. Switzerland, Belgium and Germany, a major auto industry, plan to ban the sale of fuel vehicles in 2030. The Netherlands and Norway, as well as the United Kingdom and France, respectively, said that they would ban fuel vehicles in 2025 and 2040. Accelerate the popularization of new energy vehicles and become the consensus of the world to achieve sustainable development in the transportation sector. New energy vehicles, especially pure electric vehicles, will become the main strategic direction for the transformation of China's automobile industry. In 2017, the notice of the “Action Plan for Promoting the Healthy and Stable Development of Road Freight Industry (2017-2020)” clearly stated that the strengthening of vehicles for urban distribution The management provides green access rights to new energy logistics distribution vehicles that meet the standards, and encourages cities to carry out urban green freight distribution demonstration operation sites [2].

The development of green logistics aims to reduce the adverse impact of logistics activities on the ecological environment, and to achieve the unification of economic, social and environmental benefits while improving the efficiency of logistics and distribution. On the one hand, with the development of renewable energy such as wind energy and solar energy, the use of pure electric logistics vehicles for logistics distribution activities can effectively alleviate the dependence of traditional vehicles on non-renewable energy such as fossil fuels. On the other hand, reasonable

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planning of the distribution network can effectively reduce the distance traveled by vehicles and the emission of hazardous gases, improve the efficiency of the use of distribution vehicles, and reduce environmental pollution. In 2017, the head of Jingdong said that in the next five years, all delivery trucks will be replaced with pure electric vehicles. The new energy smart logistics vehicle (ACE) program released by the rookie network aims to build 1 million new energy logistics vehicles for logistics express delivery activities, and has already piloted in Shenzhen and Chengdu. With the development of pure electric vehicles, the adoption of pure electric logistics vehicles in the urban distribution field has become a development trend.

At present, most research related to vehicle routing problems has remained in the research field of traditional gasoline vehicles or traditional diesel vehicles. As a relatively new research direction, at this stage, it is less likely to improve the technical level of electric vehicles in a short period of time. Compared with traditional fuel vehicle logistics and distribution, electric vehicle logistics distribution has many advantages such as fuel saving, environmental protection and mitigation of urban traffic pressure. However, due to the impact of battery performance and unsound infrastructure, electric vehicles are used for logistics distribution services. There are also several disadvantages: compared to traditional internal combustion engine vehicles, the battery capacity of electric vehicles is very low, resulting in very limited distance travel; the current number of public charging stations or power stations is very limited; the time required for charging is compared Long, time cost is relatively high. Because of these limitations, it is of great practical significance to study the logistics distribution optimization problem of existing electric vehicles. At present, the research on the logistics and distribution of electric vehicles at home and abroad is still in the exploration stage. This paper also reviews the current status of electric vehicle development, vehicle routing optimization research, and electric vehicle routing optimization research status.

2. Electric vehicle development status

The United States is the most developed country in the automotive industry, and its automobile production and possession are among the highest in the world. In order to improve the mutual competitiveness of the electric vehicle manufacturing industry, the US government has proposed the "PNGV Plan (New Generation Automotive Partnership Program)" and "FreedomCar Program (Fuel Cell Vehicle Cooperation Program)", hoping to enhance pure electric vehicles and hybrid vehicles. The fuel economy advantage. Although the sales trend in some countries is rising rapidly, the market share of electric vehicles has already caught up with or higher than the United States. However, the United States remains the world's largest electric vehicle market to date. According to the US electric vehicle sales data published on the EVSales website, in 2018, the US electric vehicle sales reached 358,645 units, a surge of 80% from 2017.

Europe attaches great importance to greenhouse gas emission reduction strategies and has very strict CO_2 emission standards, which also determines the importance Europe attaches to the development of electric vehicles. The European Union has successively introduced plans for the EU fuel cell research and development demonstration plan and the European electric vehicle city transportation system plan, fully mobilizing the scientific research and development atmosphere of each country. In 2017, European electric vehicle sales reached 307,400 units, a 39% increase compared with 2016. The German market grew its fastest growth in 2017, an increase of 108% compared with 2016, becoming the second largest electric vehicle market in Europe after Norway.

Japan is also a big country in the automotive industry. Since the 1970s, Japan has been developing a research and development plan for electric vehicles such as the "Public Pollution Vehicle Development and Popularization Action" and "New Generation Automotive Strategy 2010" based on the national strategy. It is expected to improve the technical level of electric vehicles and promote the industrialization of electric vehicles. . Japan plans to reach 13.5 million "next-generation vehicles" with electric vehicles as the mainstay by 2020.

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As the world's largest investor in clean energy, China has become one of the fastest growing markets for electric vehicles in the world. In 2017, the sales of electric vehicles in the Chinese market reached 580,000 units, a growth rate of 72%. During the “eighth five-year plan period”, electric vehicles were officially listed in the national research project, and the investment in electric vehicles has increased significantly since then. During the "10th Five-Year Plan" and "Eleventh Five-Year Plan" period, from the perspective of ensuring energy security, improving environmental pollution, improving the competitiveness of the automobile industry and realizing the leap-forward development of China's automobile industry, the "863" plan and "Electric Vehicles" were launched. Science and technology projects, "energy-saving and electric vehicle major projects" and other scientific research projects, invested nearly 2 billion yuan in science and technology funding, formed a pure electric, hybrid, fuel cell three technical routes for the "three vertical", with multiple energy The three common technologies of assembly control system, drive motor and its control system, electric battery and its management system are the research and development pattern of “three horizontal” electric vehicles. According to the requirements of the “Energy Conservation and New Energy Vehicle Development Plan (2011-2020)”, the total number of electric vehicles in the country will reach 5 million in 2020. Electric vehicles belong to a new type of industry and need to pass through three stages: technological breakthroughs, demonstration and promotion, and commercial innovation.

Pure electric logistics vehicles are in the second stage. Although the number of pure electric logistics vehicles has experienced explosive growth, the development of pure electric logistics vehicles is still in the stage of demonstration and promotion. The industry still has obvious market turmoil, technical know-how, fraudulent shadows, and commercial Many problems such as running the wall. Only by fundamentally solving a series of problems such as difficulty in charging, mileage worries, and low efficiency of operation and operation, and realizing business model innovation, can we truly promote pure electric logistics vehicles and achieve the advanced from “demonstration” to “operation”.

3. Vehicle Path Optimization Research

In 1959, Dantzig and Ramser [3] added the time window to the vehicle routing problem. In 1989, Min et al. [4] explored the problem of simultaneous delivery and pickup vehicle routing (VRPSPD). The classic book distribution case is one of the problems solved. Angelelli and Mansini [5] combined time windows with simultaneous pick-up delivery to create a vehicle path problem study with time windows. Jozefowieza et al. [6] looked through a large amount of literature and summarized the research results of multi-objective vehicle routing problem in extending classical academic problems, describing classical academic problems and practical cases, and expounding the target types and algorithms. Pillac et al. [7] studied the dynamic vehicle routing problem (DVRP), explained the difference between the processing of new orders, the objective function and other static problems, and summarized the transportation of goods and services by other experts and scholars on the dynamic vehicle routing problem. The application of the other aspects, as well as the solution for its regular re-optimization and continuous re-optimization. Ene, Aksoy et al. [8] studied the green vehicle routing problem (G-VRPTW), aiming to improve the attention of the logistics industry to environmental protection. Therefore, considering the factors such as the technical data of the distribution vehicle and the acceleration of the vehicle, A mathematical model with the goal of minimizing fuel consumption and CO2 emissions was constructed. Mohamed et al. [9] proceeded from the overall process of urban distribution, comprehensively considered the route planning and vehicle loading plan in urban distribution, and proposed a hybrid model that simultaneously optimized the vehicle path and loading task. Anna et al. [10] transformed the route planning problem of urban distribution vehicles into the problem of urban area division. It was found that the size of the area division and the density of customer points in the area would affect the total distance traveled by the vehicle. Dechampai et al. [11] approach to solve the problem of universal delivery vehicle routing. Due to the complexity of the considerations, EG-Q-DVRP-FD was extended to a two-stage heuristic algorithm called MESODMEG-Q-DVRP-FD. Dorling et al. [12] proposed a cost function to help drone delivery practitioners balance costs and delivery time, considering our energy model

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and drone reuse, and applying it to simulated annealing (SA) In the heuristic, to find the suboptimal solution of the actual scene. Cinar et al. [13] applied the C&W algorithm to a cumulative VRP (CumVRP-LD) with a finite duration, where the load and distance are also considered in the objective function. Then a two-stage construction heuristic algorithm including K-means clustering algorithm is proposed to improve the computational performance of CumVRP-LD modified C&W algorithm.

Liu Yunzhong et al. [14] divided the research on vehicle routing problems into two categories. One is to study the vehicle routing problem as an independent link, and the other is to study the vehicle routing problem with other links such as inventory. The former is The basis of the latter, and the author mainly conducted an in-depth analysis of the former. Wu Tengyu et al [15] in the process of 020 platform take-out delivery service, the demand can not be determined and the delivery vehicle must return to the original point to pick up the goods, the problem is analyzed on the positive semi-axis and the lower boundary of the general network, the TAIB algorithm and the IGNORE algorithm are designed. The conclusion can provide a basis for the real-time scheduling decision of the delivery truck in reality. Hu Qiaoyu et al. [16] took the two-level logistics system as the research object, and focused on the customer needs of random nature, and optimized the vehicle path for each level in the system. This complex stochastic optimization problem is solved, and an efficient optimization method based on Monte Carlo simulation is designed. The simulation process is embedded in the neighborhood search process of the heuristic algorithm. Liu Yanqiu et al. [17] constructed a new variable-dimensional matrix coding structure according to the characteristics of various customer demand point transportation modes under the partial joint transportation strategy, and modified the probability selection operation mode in the traditional algorithm to propose a new intelligence. The optimization algorithm is compared with the results of the enumeration method and the genetic algorithm. Zhang Wenbo et al. [18] improved customer satisfaction by improving the punctuality of services for vehicle routing problems with time windows under dynamic demand. Consider the two-stage planning strategy: firstly, the improved genetic algorithm is used to obtain the initial vehicle path; then the simulated annealing algorithm is used to obtain the real-time optimized vehicle path scheme. Zhang Meng et al. [19] established a path optimization model for dangerous goods transport vehicles based on the minimum target with the smallest accident and the minimum transportation cost. Based on the ε-constraint method, an accurate algorithm for obtaining the Pareto optimal solution is designed. The polynomial time approximation algorithm for large-scale problems is further designed and the approximate ratio of the algorithm is analyzed. Wang Daoping [20] in order to solve the problem of multi-center vehicle path optimization combination decision-making in distribution center location and time window, a multi-objective integer programming model for distribution center location and vehicle routing is established by using bi-level programming method. The minimum site cost is taken as the upper-level planning target, and the minimum vehicle distribution cost is taken as the lower-level planning target, and the improved ant colony algorithm is used to solve the problem.

4. Research Status of Electric Vehicle Path Optimization

The path optimization problem derived from the use of electric logistics vehicles as transportation vehicles is called the electric logistics vehicle path optimization problem, referred to as EVRP. According to different charging methods, AngelFelipe et al. [21] will generate different charging costs and charging efficiencies, and establish a partial charging path planning model for electric logistics vehicles that considers fast, medium-speed and slow-speed charging, emphasizing the importance of choosing the right charging technology. Sex. However, the model of this document only considers the maximum working time of the delivery staff, and does not consider the customer's service time window. Goeke et al. [22] used the approximate energy estimation method to calculate the electric vehicle's electric quantity. On this basis, the path optimization model of pure electric vehicle and traditional fuel vehicle mixed distribution was established. Sepideh Pourazarm et al. [23] split the electric vehicle path planning into the distribution path selection problem and the charge quantity determination problem. Firstly, the hybrid integer nonlinear programming model of single vehicle was established to verify the effectiveness of the method, and then the customer satisfaction

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was the highest. The multi-vehicle electric vehicle path optimization problem with the goal and the lowest total cost of the distribution system is compared, and the two cases are compared and analyzed. Hiermannm et al. [24] assumed that the electric power consumption of the electric logistics vehicle is a linear function of the length of the road segment, and constructed a multi-vehicle EVRP model with time window constraints with the minimum number of vehicles and the minimum total driving distance. MerveKeskin et al. [25] established a partial charging path optimization model with the smallest mileage of electric logistics vehicles, and solved it by large-scale neighborhood search algorithm. However, factors such as departure cost, time window cost and charging cost were not considered in the model. Lin et al. [26] considered the relationship between cargo load and power consumption, and established an electric vehicle route planning model with minimum vehicle use cost, driving cost and power consumption cost. When Janelin et al. [27] constructed the EVRP model, it not only considered the customer's pick-up and delivery requirements, but also considered the impact of speed and load on power consumption. In order to reduce the complexity and solution time of the model, the objective function is linearly transformed by the relationship between the load and the decision variables. Keisukemurakami et al. [28] considered the road gradient, traffic lights, vehicle speed, vehicle maintenance and other factors to establish a hybrid vehicle routing model with the lowest total cost. Then the heuristic algorithm combining variable neighborhood search and tabu search is used to obtain the approximate solution of the model.

Dong Yuwen et al. [29] set up a mathematical model for the green vehicle routing problem considering the carrying capacity and travel constraints of new energy vehicles, while designing small vehicles with limited coverage and limited energy replenishment stations. A two-stage heuristic algorithm solves the CGVRP problem. Jia Yongji et al. [30] proposed a customer satisfaction evaluation function based on time sensitivity coefficient for the problem of multi-target exclusive electric vehicle routing. A new mixed integer programming model for this problem was constructed with the goal of minimizing vehicle no-load mileage while maximizing customer satisfaction. Guo Fang et al [31] incorporated the charging time and battery loss cost of electric logistics vehicles on the way of distributing goods into the objective function and established a linear programming mathematical model, and proposed a multi-stage heuristic algorithm MCWIGALNS to solve the problem. Zhang Yanwei et al. [32] took the mixed category of vehicle delivery goods into consideration and established a linear programming mathematical model. Two improved heuristic algorithms MCWS and MHGA for solving this problem are proposed. Finally, the accuracy of the model and algorithm results is verified by multiple sets of small-scale examples. Wang Qiwei et al. [33] considered the customer service time window, electric vehicle loading capacity, mileage limit and site selection of the power station, and established a site-path optimization model with the minimum total cost as the target, and designed a combined neighborhood search. Algorithms, threshold acceptance methods, and particle swarm algorithms are used to solve this problem. Chen Lixing et al. [34] proposed an orderly charging strategy based on the new electricity price mechanism to motivate users to adjust the charging time, considering the operating status of the charging station and the charging habits of electric vehicle users. Zhang Pengwei et al. [35] focused on the “re-entry” of charging facilities, and constructed an electric vehicle traveling salesman problem model without estimating the maximum number of re-entry times of charging facilities, introducing path feasibility determination methods and increasing charging facility selection and repetition strategies. An improved ant colony algorithm is designed to solve the problem. Shao Sai et al. [36] adjusted the route online in real time based on the route update strategy of update time, established the charging model as the route distribution charging station with charging demand, and gave the example simulation route update process. Jie et al. [37] studied the path problem of multi-model electric vehicle with time window, established a mixed integer programming model, and used the branch pricing algorithm to find its optimal solution. Yang et al. [38] proposed the optimization of the location and distribution path of the electric vehicle logistics distribution system, established the integer programming model, and designed the tabu search-improved Clarke-Wright's two-stage heuristic algorithm to solve the model. The two criteria are compared by examples. Jie Yuchen et al.

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[39] considered the problem of electric vehicle's mileage, charging time and delivery time in practical applications, studied the path problem of electric vehicle with time window, established the corresponding mixed integer programming model, and then improved The branch pricing algorithm is used to find its optimal solution. Lu Jianyi et al. [40] considered that electric vehicle users would charge the vehicle by bypassing a certain distance, and established a two-layer integer programming model with the smallest sum of the cost of building a fast charging station for electric vehicles and the overall cost of passengers. . An adaptive genetic algorithm including local iterative search is designed to solve the model. Guan Wei et al. [41] proposed a utility function combining charging station capacity and deviation distance. Based on the Logit model, a reasonable allocation of multiple charging requirements was made. The charging station queuing time and electric vehicle mileage constraints were comprehensively considered to maximize the total user utility. The target establishes a charging station location model in a competitive environment, and uses an immune optimization algorithm to solve the model. Guo Ge, Ge Xianlong et al [42-43] introduced the research status of electric vehicle routing problem; from the different perspectives of charging optimization, path optimization and fleet configuration optimization, and classified and discussed various solving methods; finally, for electric vehicles Prospects for the future development of path optimization.

5. Current major problems and future research directions

As an emerging vehicle, the path optimization of electric vehicles has broad research and application prospects. At present, EVRP is still in its infancy, and this section focuses on possible future research directions in this field.

1) Electric vehicle path optimization based on dynamic logistics information

At present, the research on electric vehicle path optimization is aimed at static determination system. The feasibility of this kind of planning scheme in actual logistics distribution is very low. This is because various information in real distribution has dynamic uncertainty, and many of them affect The path planning of electric vehicles, such as customer information, road conditions, charging station status, vehicles and drivers, etc., may change at any time. Among the various solutions, the problem input, optimization objectives and optimization constraints are all determined. It is the research focus to integrate the uncertain problems in reality into the solution method.

2) Electric vehicle path optimization considering charging restrictions.

From the point of view of charging station configuration, the charging station has limited charging facilities and charging technology options. When charging in dense traffic areas, the vehicle may need to wait in line for a long time, resulting in random charging demand and charging station service. Electric vehicle charging scheduling and path optimization are the key to realizing the path optimization of truly efficient electric vehicles.

In recent years, the development of intelligent transportation systems, unmanned vehicles and vehicle networking technologies has created favorable conditions for the coordinated operation and coordinated mission planning of electric vehicles. On the one hand, real-time traffic information can be used to plan travel time and route in logistics and transportation services. And charging journey; on the other hand, vehicles can also exchange driving status and traffic information, and cooperate. How to integrate the electric vehicle logistics optimization strategy into the entire intelligent transportation system and smart grid is the future research direction. Theoretical and technical research is necessary and urgent.

References

[1] Information on::http://www.vecc-mep.org.cn/huanbao/content/944.html.

[2] Information on:: http://www.mot.gov.cn/.

[3] Dantzig G B, Ramser J H. The Truck Dispatching Problem[J]. Management Science, 1959, 6(1):80-91.

ISSN: 2414-1895 DOI: 10.6919/ICJE.202001_6(1).0016

[4] Min H . The multiple vehicle routing problem with simultaneous delivery and pickup[J]. Transportation Research Part A General, 1989, 23(5):377-386.

[5] Dantzig G B, Ramser J H. The Truck Dispatching Problem[J]. Management Science, 1959, 6(1):80-91.

[6] K ristian Schopka, Herbert Kopfer. An Adaptive Large Neighborhood Search for the Reverse Open Vehicle Routing Problem with Time Windows [J]. Journal of the Operational Research Society, 2015,16: 243-257.

[7] Jozefowiez N , Fr éd éric Semet, Talbi E G . Multi-objective vehicle routing problems[J]. European Journal of Operational Research, 2008, 189(2):293-309.

[8] Pillac V , Gendreau M , Gu éret, Christelle, et al. A review of dynamic vehicle routing problems[J]. European Journal of Operational Research, 2013, 225(1):1-11.

[9] K ü? üko?lu, ?lker, Ene S , Aksoy A , et al. A memory structure adapted simulated annealing algorithm for a green vehicle routing problem[J]. Environmental Science and Pollution Research, 2015, 22(5):3279-3297.

[10] Mohamed Guedriaab,Nicolas Malheneb,Jean-Christophe Deschampsb Freight Transporant:From Optimized Routes to Robust Routes[J].Transportation Research Procedia,2016,(12):413-424.

[11] Anna Franceschettia,Dorothee Honhonb,Gilbert Laportea,Tom Woenselc,Janc Fransooc Strategic fleet planning for city logistics[J].Transportation Reseach PartB:Mcthodological,2017,95:19-40.

[12] Dechampai D,Tanwanichkul L, Sethanan K, et al. A differential evolution algorithm for the capacitated VRP with flexibility of mixing pickup and delivery services and the maximum duration of a route in poultry industry[J]. Journal of Intelligent Manufacturing, 2017, 28(6):1357-1376.

[13] Dorling K , Heinrichs J , Messier G G , et al. Vehicle Routing Problems for Drone Delivery[J]. IEEE Transactions on Systems Man & Cybernetics Systems, 2017, 47(1):70-85.

[14] Cinar D,Gakis K,Pardalos P M . A 2-phase constructive algorithm for cumulative vehicle routing problems with limited duration[J]. Expert Systems with Applications, 2016:S0957417416300859.

[15] LIU Yunzhong, XUAN Huiyu. A Review of Models and Algorithms for Vehicle Routing Problem[J]. Journal of Industrial Engineering and Engineering Management, 2005, 19(1): 124-130.

[16] Wu Tengyu, Chen Jiajun, Qi Jie, Yu Haiyan. The problem of real-time delivery route selection for distribution vehicles in O2O mode[J]. Systems Engineering Theory and Practice, 2018, 38(11): 2885-2891.

[17] Hu Qiaoyu, Yang Wei, Liu Wei. Research on two-level vehicle routing problem considering random customer demand[J]. Industrial Engineering and Management, 2018, 23(05): 74-81.

[18] LIU Yanqiu, XU Shida, CAI Chao. Research on Logistics Vehicle Routing Optimization under Partial Joint Transportation Strategy[J]. Operations Research and Management, 2018, 27(08): 10-19.

[19] Zhang Wenbo, Su Qin, Cheng Guanglu. Vehicle routing problem with time window based on dynamic demand[J]. Industrial Engineering and Management, 2016, 21(06): 68-74.

[20] Zhang Meng, Wang Nengmin. Research on Path Optimization of Dangerous Goods Transportation Vehicles Avoided by Major Accidents[J]. Operations Research and Management, 2018, 27(08): 1-9.

[21] WANG Daoping, XU Zhan, YANG Wei. Research on Logistics Distribution Location-Path Problem Based on Two-Phase Heuristic Algorithm[J]. Operations Research and Management Science, 2017, 26(04): 70-75+83.

[22] Felipe, ángel, Righini G , A heuristic approach for the green vehicle routing problem with multiple technologies and partial recharges[J]. Transportation Research Part E: Logistics and Transportation Review, 2014, 71:111-128.

[23] Goeke D,SchneiderM. Routing a mixed fleet of electric and conventional vehicles[J]. European Journal of Operational Research,2015, 245(1):81-99.

[24] Pourazarm S,Cassandras C G , Wang T . Optimal routing and charging of energy-limited vehicles in traffic networks[J]. International Journal of Robust and Nonlinear Control, 2016, 26(6):1325-1350.

[25] Hiermann G,Puchinger J , Ropke S. The Electric Fleet Size and Mix Vehicle Routing Problem with Time Windows and Recharging Stations[J]. European Journal of Operational Research, 2016, 252(3):995-1018.

[26] Keskin M,Çatay B. Partial recharge strategies for the electric vehicle routing problem with time windows[J]. Transportation Research Part C, 2016, 65:111-127.

ISSN: 2414-1895 DOI: 10.6919/ICJE.202001_6(1).0016

[27] Lin J, Wei Z, Wolfson O. Electric Vehicle Routing Problem ☆[J]. Transportation Research Procedia, 2016, 12:508-521.

[28] Jane L,Weizhoua,Ouri Wolfsonc.Electric vehicle routing problem[J]. Transportation on Research Prociedia 12(2016)508-521.

[29] Keisuke Murakami.A new model and approach to electric and diesel-powered vehicle routing[J].Transportation Research PartE,2017,107:23-37.

[30] Dong Yuwen, Yan Shuai. Green Vehicle Routing Problem Considering Carrying Capacity and Stroke Constraint[J]. Industrial Engineering and Management, 2017, 22(01): 43-49.

[31] Jia Yongji, Guo Wenjuan, Yang Dong. Modeling and Optimization of Multi-objective Exclusive Electric Vehicle Routing Problem[J]. Industrial Engineering and Management, 2017, 22(05): 1-8.

[32] Guo Fang, Yang Wei, Yang Chao. Research on the path optimization of electric vehicles considering charging strategy and battery loss [J]. China Management Science, 2018, 26 (09): 106-118.

[33] Zhang Yanwei, Huang Zhihong. Research on Path Optimization of Electric Vehicles Considering Goods Category[J]. Journal of Wuhan University of Technology (Information and Management Engineering Edition), 2018, 40(01): 75-80.

[34] WANG Qizhen,LI Ying,LI Hui.Study on the location problem of electric vehicle substation with soft time window[J].Industrial Engineering and Management,2019(01):1-10.

[35] Chen Lixing, Huang Xueliang. An Orderly Charging Strategy for Electric Vehicles in Expressway Charging Stations[J]. Electric Power Automation Equipment, 2019(01): 1-7.

[36] Zhang Pengwei, Li Ying. Research on the problem of electric vehicle traveling salesman considering the re-entry of charging facilities [J]. Operations Research and Management, 2018, 27 (02): 54-64.

[37] Shao Sai, Bi Jun, Guan Wei. Vehicle Routing Problem Based on Dynamic Demand of Electric Vehicles[J]. Journal of Jilin University (Engineering Science Edition), 2017, 47(06): 1688-1695.

[38] Jie Chenchen, Yang Wei, Yang Chao. Research on Branch Pricing Algorithm for Multi-model Electric Vehicle Vehicle Routing Problem[J]. Systems Engineering - Theory & Practice, 2016, 36(07): 1795-1805.

[39] Yang Wei,Feng Pengxiang,Sun Wei,Yang Chao.Research on Site Selection and Path Optimization of Electric Vehicle Logistics Distribution System[J].China Management Science,2015,23(09):87-96.

[40] Jie Chenchen, Yang Wei, Lu Jianyi. The Problem of Electric Vehicle Vehicle Routing Based on Branch Pricing Algorithm[J]. Operations Research and Management, 2016, 25(04): 93-100.

[41] LU Jianyi, YANG Chao, QU Yuchen. Location problem and adaptive genetic algorithm of electric vehicle fast charging station considering detour characteristics[J]. Operations Research and Management, 2017, 26(01): 8-17.

[42] Shao Sai, Guan Wei, Bi Jun. The Location Problem of Competitive Charging Stations Considering Queuing Time and Mileage Constraints[J]. Journal of Transportation Systems Engineering and Information, 2016, 16(06): 169-175.

[43] Guo Ge, Zhang Zhenlin. Research and Development of Electric Vehicle Path Optimization[J]. Control and Decision, 2018, 33(10): 1729-1739.

[44] Ge Xianlong, Li Zuwei. A Review of Research on Logistics Distribution Optimization Based on Electric Vehicles[J]. Mathematics Practice and Theory, 2018, 48(13): 33-42.