Scholar Publishing Group
Machine Learning Theory and Practice
https://doi.org/10.38007/ML.2021.020201
ISSN 2790-0983 Vol. 2, Issue 2: 1-8

Functional Design of Home Service Robot Based on FAHP-FAST Combination Method

Jie Zhang[1] and Bo Zhang[2]

[1]*Nanchang Institute of Science and Technology, Nanchang 330108, China*

[2]*Jiangxi Traffic Senior Technical School, Nanchang 330105, China*

605380043@qq.com

Keywords: FAHP-FAST Combination Method, Home Service Robot, Artificial Intelligence Device, Data-Driven Technology

Abstract: With the rapid development of advanced sensing technology, there are more and more ways to sense the health status of engineering equipment, which provides more possibilities for the acquisition of big data of equipment running FAHP-FAST combination. Therefore, the development of data-driven home service robot technology has ushered in a new opportunity, and the problem of home service robot with random degradation equipment for big data processing has attracted the attention of a large number of scholars. Firstly, this paper summarizes the research background, main methods and ideas, and core issues of home service robot based on the characteristics of FAHP-FAST. This paper analyzes the basic research ideas and development trends of home service robot technology based on hybrid model and data driven, home service robot technology based on FAHP-FAST, home service robot technology based on statistical data driven, and home service robot technology based on combination of FAHP-FAST and statistical data driven, at the same time, combined with the characteristics of random degradation equipment FAHP-FAST combined big data and the core problem of uncertainty quantification of home service robot, the limitations and common problems of current research are deeply analyzed. The research shows that the number of services of home service robots based on FAHP-FAST combination method is 36% more than that of machine learning discrete robots, and the mapping relationship between FAHP-FAST combination data and failure time of home service robots is established to realize home service robots, which provides a more efficient service mode for home service robots with random degraded devices under the background of big data.

1. Introduction

With the rise of Internet collaborative development wave, the number of community resources and personnel of home service robot is growing exponentially, which causes the information overload of home service robot. It is difficult to match suitable home service robots according to task requirements. Therefore, the introduction of design technology into the home service robot community came into being. Because the ordinary home service robot camera can not obtain the three-dimensional coordinates of the object, the binocular home service robot camera is used to collect the image information of the target object, and the mask technology is used to remove the background image information, retain the target image information and calculate its centroid, the coordinates of the centroid camera are transformed into the world coordinates, that is, the coordinates of the target object of the home service robot.

Wang HM proposes a method called FAHP-FAST, which enhances the design of developers by considering their professional knowledge and development habits [1]. Begel a proposes a developer recommendation system for open source repositories (DEV EC) hybrid design system, which combines the methods based on development activities and knowledge sharing activities to design suitable developers for open source projects [2]. Š Mite D's home service robot design based on collaborative filtering (CF) has achieved great success. Firstly, the similarity between the tasks to be completed and the tasks completed is calculated, and then the tasks to be completed are assigned to the similar home service robots [3]. Liu P proposed a design method of multi relationship fusion for home service robot, which considered multiple implicit relationships, then integrated these relationships based on joint matrix decomposition, and generated design results based on deep neural network [4]. Liu x proposes a strategy model based on meta learning, which first filters out those home service robots that are unlikely to participate in a given challenge, and then designs the top k home service robots that may win the challenge [5]. The existing methods pay more attention to the professional ability of home service robots and the interaction information between home service robots and tasks, and ignore the cooperation between home service robots, resulting in the poor quality of the overall task completion. In this paper, we consider the cooperation between home service robots and home service robots, and describe the cooperative development of home service robots as a RBC problem. Guided by the optimization of the overall task completion quality, we design the home service robots.

According to the characteristics of FAHP-FAST, this paper first summarizes the research background, main methods and ideas as well as the main problems of home service robot under big data. This paper analyzes the home service robot model and data-driven home service robot technology, home service robot technology based on FAHP-FAST, statistics driven home service robot technology, FAHP-FAST and statistics driven home service robot technology. Basic research ideas and development trends, combined with quantitative random degradation device and FAHP-FAST, are the core problems of the uncertainty of the home service robot combining big data, which are the limitations of the current research, even the common problems.

2. FAHP-FAST Combination Method and Service Robot Distribution Algorithm

2.1. Home Robot Detection Equipment Based on FAHP-FAST Combination Method

Tens of thousands of sensors are installed in the modern industrial manufacturing line to collect the running process information and product quality information of FAHP-FAST combined industrial equipment[6]. For example, large industrial robot manufacturers monitor millions of industrial robots by using cloud platform to obtain the real-time signals such as rotation speed, angle, position, temperature and vibration of each robot joint, it is necessary to process the data above TB level every day [7]. However, while these FAHP-FAST combination methods provide rich information for the perception of equipment health status and the design of home robots, the data quality is uneven due to the changeable equipment working conditions and mutual coupling of information, and the big data of state FAHP-FAST combination presents different statistical characteristics [8]. According to the characteristics of FAHP-FAST combined data [9].

Compared with other deep learning networks, convolutional neural network can process force signal, vibration signal, acoustic emission signal, optical signal and other high-dimensional raw data more effectively, and can automatically extract degradation feature information from FAHP-FAST combined data, it is suitable for processing FAHP-FAST combined big data and has the function of noise reduction [10]. At the same time, the amount of network parameters is relatively small, and the training is more convenient and efficient, so it is easy to build a deeper network structure [11]. However, the health features contained in FAHP-FAST combined data of random degradation equipment are often time-series related, while convolutional neural network has insufficient ability to extract time-series features in dealing with big data, it is easy to cause the loss of important temporal features, which is unfavorable to the design of home robot[12]. Therefore, convolutional neural network is often combined with other depth networks when applied to the design of home robot[13].

2.2. AI Home Service Robot Distribution Algorithm

Transfer the task Ω Publish to the home service robot community, first of all, the task Ω It is decomposed into a set of related subtasks, i.e Ω={Ω 1, Ω 2, Ω 3,..., Ω n}, Ω N represents the n subtask, and each subtask is completed by one or more home service robots. Then, the history information of the home service robot is obtained from the home service robot community to represent the m-th home service robot. Each home service robot can only complete one subtask at a time.

$$\Omega_{\mathrm{n}} = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i-\bar{x})(xj-\bar{x})}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(xi-\bar{x})^2} = \frac{n\sum_{i=1}^{n}\sum_{i\neq j}^{n} w_{ij}(x_i-\bar{x})(xj-\bar{x})}{\mathrm{m}^2\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \tag{1}$$

Where w means that the home service robot completes the subtask Ω The k capacity index value of n. Due to the different requirements of each employer, there are differences in the scores of home service robots for completing the same task, and the abilities of different home service robots are not the same, and the quality of completing the same task is also different [14]. Therefore, the ability measurement of home service robot to complete various tasks is the primary focus. Finally, the mapping relationship between home service robot and task is modeled by using e-cargo model to solve the design problem of home service robot [15]. The e-cargo model is applied to the design scene of home service robot, and all home service robots cooperate to complete the task, forming a development team. Based on the above definition, e-cargo is used for modeling.

$$l_{iou} = 1 - \frac{\sum_{a=1}^{H}\sum_{b=1}^{W} E\text{-}CARGO(a,b)GT(a,b)}{\sum_{a=1}^{H}\sum_{b=1}^{W}[E\text{-}CARGO(a,b)+GT(a,b)-E\text{-}CARGO(a,b)GT(a,b)]} \tag{2}$$

The task is decomposed into a set of related subtasks and published to the home service robot community; Then, a set of candidate home service robots is searched to design suitable home service robots for each task. The task is mapped to a role, and the task set corresponds to the role set. The home service robots are mapped to agents, and the home service robots are set Λ={Λ 1, Λ 2, Λ 3,..., Λ m} Corresponding proxy set a = {A1, A2, A3,..., am}; the task of home service robot is mapped to the role of agent and the ability index set of home service robot.

$$(\mathrm{In}-\mathrm{AW})\mathrm{y}=(\mathrm{In}-\alpha\mathrm{W})\mathrm{X}\beta+\Lambda \tag{3}$$

$$\ln \mathrm{M}_{\mathrm{it}}=a_0+a_1 du*\mathrm{A}+\sum_{i=1}^{N} b_j Xu+\varepsilon_u \tag{4}$$

Corresponding to the agent qualification value set M. So far, the e-cargo modeling is completed. Therefore, the method of solving group role assignment can be used to solve the design problem of home service robot, and finally the design result of home service robot can be obtained through CPLEX.

3. Functional Design of Home Service Robot Based on FAHP-FAST Combination Method

3.1. Research Methods

This paper first summarizes the research background, main methods and ideas as well as the main problems of home service robot under big data. This paper analyzes the home service robot model and data-driven home service robot technology, home service robot technology based on FAHP-FAST, statistics driven home service robot technology, FAHP-FAST and statistics driven home service robot technology. Basic research ideas and development trends, combined with quantitative random degradation device and FAHP-FAST, are the core problems of the uncertainty of the home service robot combining big data, which are the limitations of the current research, even the common problems.

3.2. Experimental Design

For robot teaching and learning tasks, we must first know the initial position and target position of the target object in the task, that is, we need to obtain the coordinates of the target object. However, the traditional calibration method is slow and low precision. This paper uses visual information to realize the automatic recognition of the target object and obtain the corresponding coordinates. Aiming at the problem that it is difficult to reproduce and generalize the teaching trajectory when the initial position is the same as the target position, the segmented learning method based on DMP model is adopted to imitate the teaching trajectory, and the motion trajectory similar to the teaching trajectory is planned, so as to realize the generalization of the robot in the position space.

In this paper, the binocular camera is used to capture the object image and import the image information, including the background RGB image and the background depth image when the object is not added, and the foreground RGB image and the foreground depth image after the object is added. At the same time, the binocular camera and the background should be in the same position before and after the object is added. Frame the region of interest on the foreground RGB image, and record the two-dimensional image coordinates R (x, y) of the upper left corner of the region. The next step is target recognition and position recognition for the objects in the region. The image mask has a pixel value of 1 in the object and 0 in the background, so the number of rows, columns and total number of each pixel with a value of 1 can be detected. According to the principle of centroid calculation, the two-dimensional image coordinates of the object top centroid relative to the region of interest are calculated by using image mask.

4. Results and Analysis

The experiment set different conflict rate, different number of tasks and the number of service ratio of home service robot, compared the solution time of this method with exhaustive method and greedy method, N / A means that there is no result in more than 30 minutes, and compared the number of times that the solution value of this method is greater than or equal to greedy method, the experimental data is shown in Table 1.

Table 1. The number of service robot solutions and greedy method

Item	Time	Optimal solution	Modular	Quality	Exhaustive
Depth	3.96	2.05	2.17	2.35	3.92
DMP	3.58	4.6	3.32	2.78	5.45
Pixel	3.16	2.05	1.41	5.77	1.51
Mask	3.32	1.04	2.84	2.42	1.32
Threshold	6.44	4.64	6.73	1.84	2.69

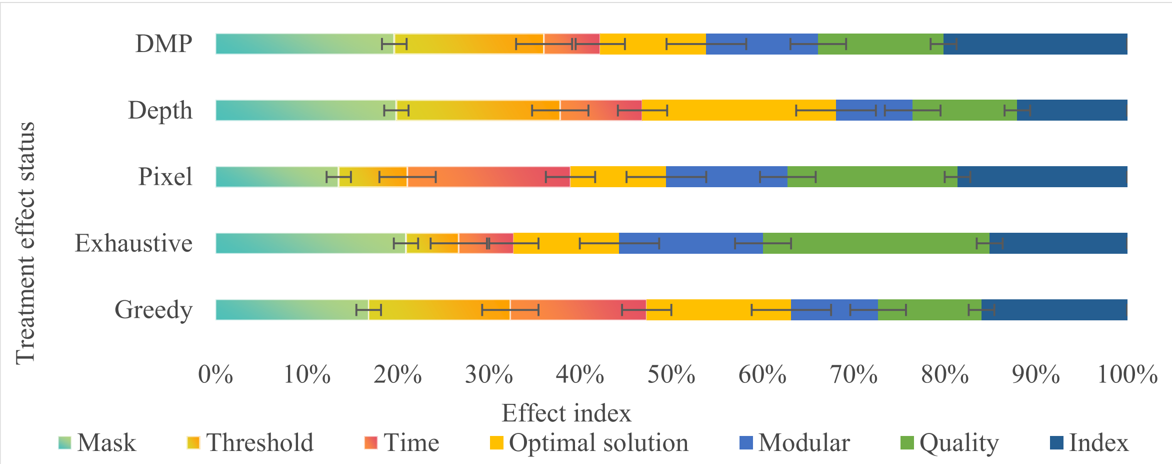

Figure 1. The impact of the increase in the number of home service robots

As shown in Figure 1, it can be seen that with the increase of the number of home service robots, the solution time is also increasing. Firstly, compared with the exhaustive method, the performance of the proposed method is better than that of the exhaustive method. Because the exhaustive method considers all the cases in each step, it takes a lot of time, and only when m = 10, the exhaustive method can get the desired result in 30 minutes. Therefore, the exhaustive method is not applicable to the actual home service robot community. Further observation of the conflict rate shows that with the increase of the conflict rate, the time consumed by this method is also increasing, while there is no correlation between the time consumed by the exhaustive method and the conflict rate.

As shown in Table 2, compared with the greedy algorithm, the greedy algorithm only considers the local optimal solution in a small range, so the solution time is faster, but the magnitude of MS can be ignored. However, the number of times of greedy method to obtain the optimal solution is far less than that of this method, and when the problem increases to a certain scale, the greedy method can not obtain the global optimal solution. Therefore, this method is superior to the greedy method.

Table 2. Local optimal solution of greedy algorithm

Item	Mask	Threshold	Time	Optimal solution	Modular	Quality	Index
Greedy	4.47	4.14	3.98	4.23	2.53	3.02	4.26
Exhaustive	4.47	1.24	1.29	2.48	3.37	5.32	3.23
Pixel	3.48	1.95	4.61	2.71	3.44	4.8	4.8
Depth	6.19	5.62	2.81	6.63	2.63	3.58	3.77
DMP	6.01	5.04	1.89	3.57	3.76	4.22	6.18

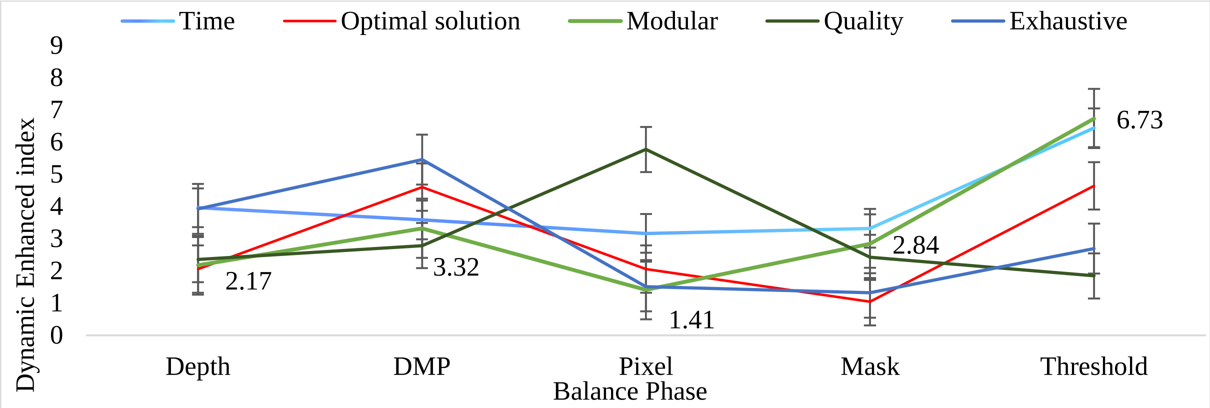

Figure 2. The complexity of FAHP-FAST modular mass

As shown in Figure 2, according to the complexity characteristics of FAHP-FAST modular quality, the quality attribute shows a multi-level structure, and the change of its multi-level is an important factor affecting the quality of SMN modularization. It is not comprehensive to reflect the connotation essence of product quality attributes by a single overall ranking of product quality, which fails to reflect the characteristics of other local quality attributes. As a result, it will lead to the lack of quality attribute information at the micro level. In this paper, the FAHP-FAST modular quality attribute of home service robot is taken as an example. Based on the references, the macro level quality attribute is mapped to the micro level, and the quality characteristics, quality level and quality behavior of the first level index are subdivided twice to form the FAHP-FAST modular quality attribute multiple decomposition tree, to comprehensively reflect the essential characteristics of FAHP-FAST modular quality attributes.

5. Conclusion

In this paper, a multi module hierarchical house of quality model of home service robot based on FAHP-FAST is proposed to reveal the quality collaborative interaction law of multi-dimensional modular robot. Fuzzy DEMATEL method and fahp-qfd method are used to solve the problem of asymmetric autocorrelation matrix of customer demand and quality attributes, and the initial weight of FAHP-FAST modular quality attributes is obtained, the key quality attributes are identified according to the weight. The research on the weight calculation method of quality attributes in complex products and multi-level processes is helpful to solve the problem of FAHP-FAST modular quality attribute identification, which includes inter module organizational behavior quality characteristics, multi module product quality characteristics and multi module service quality characteristics. The traditional quality attributes are product oriented quality characteristics, which pay more attention to the requirements of product physical characteristics, and take the realization of product functional characteristics as the final solution. Considering that FAHP-FAST provides customers with integrated system solutions for products and services, its quality attributes must cover customers' requirements for products and services.

Funding

Project funding: Science and technology research project of Jiangxi Provincial Department of Education (No. GJJ181064).

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

References

[1] Wang H M, Yin G, Xie B, et al. Research on Network-Based Large-Scale Collaborative Development and Evolution of Trustworthy Software. Scientia Sinica (Information is, 2019, 44(01): 1-19.

[2] Begel A, Bosch J, Storey M A. Social Networking Meets Software Development: Perspectives from Github, Msdn, Stack exchange, and Topcoder. IEEE Software, 2019, 30(1): 52-66. https://doi.org/10.1109/MS.2013.13

[3] ŠMITE D, MOE N B, ŠĀBLIS A, et al. Software Teams and Their Knowledge Networks in Large-Scale Software Development. Information and Software Technology, 2017, 86(45): 71-86. https://doi.org/10.1016/j.infsof.2017.01.003

[4] LIU P, ZHANG P C, WANG N X. Structure and Evolution of Developer Collaboration Network in Cloud Foundry OSS Community. Complex Systems and Complexity Science, 2019, 16(04): 31-43.

[5] LIU X, LI B, HE P. Evolution Analysis of Developer Collaboration Network in Open Source Software Community. Journal of Chinese Computer Systems, 2019, 36(09): 1921-1926.

[6] ALJEMABI M A, WANG Z. Empirical study on the evolution of developer social networks. IEEE Access, 2018, 6(4): 51049-51060. https://doi.org/10.1109/ACCESS.2018.2868427

[7] Mens T, Cataldo M, Damian D. The Social Developer: Thefuture of Software Development [guest editors' introduction]. IEEE Software, 2019, 36(1): 11-14. https://doi.org/10.1109/MS.2018.2874316

[8] LI G, WANG J, ZHENG Y, et al. Crowdsourced data management: Asurvey. IEEE Transactions on Knowledge and Data Engineering, 2016, 28(9): 2296-2319. https://doi.org/10.1109/TKDE.2016.2535242

[9] Cosentino V, Izquierdo J L C, CABOT J. A Systematic Mapping Study of Software Development with Git Hub. IEEE Access, 2017, 5(4): 7173-7192. https://doi.org/10.1109/ACCESS.2017. 2682323

[10] AHMED F, KILIC K. Fuzzy Analytic Hierarchy Process: A Performance Analysis of Various Algorithms. Fuzzy Sets and Systems, 2019, 362(4): 110-128. https://doi.org/10.1016/j.fss.2018. 08.009

[11] ZHU H, ZHOU M C. Role-Based Collaboration and Its Kernel Mechanisms. IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews), 2019, 36(4): 578-589. https://doi.org/10.1109/TSMCC.2006.875726

[12] SUN X, YANG H, XIA X, et al. Enhancing Developer Recommendation with Supplementary Information Via Mining Historical Commits. Journal of Systems and Software, 2017(8), 134: 355-368. https://doi.org/10.1016/j.jss.2017.09.021

[13] XIE X, YANG X, WANG B. Softrec: Multi-Relationship Fused Software Developer Recommendation. Applied Sciences, 2020, 10(12): 4333-4336. https://doi.org/10.3390/app 10124333

[14] ZHANG Z, SUN H, ZHANG H. Developer Recommendation for Top Coder Through a Meta-Learning Based Policy Model. Empirical Software Engineering, 2020, 25(1): 859-889.https://doi.org/10.1007/s10664-019-09755-0

[15] ZHU H, ZHOU M C. Roles in Information Systems: A survey. IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews), 2020, 38(3): 377-396. https://doi.org/10.1109/TSMCC.2008.919168