ISSN: 2472-3703 DOI: 10.6911/WSRJ.202309_9(9).0002

Review on the Development of Integrated Application for Seismic Service and Information Technology

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Abstract

With the development and innovation of information technology at express speed, the efficient integration of seismic service and information technology is one of the principal means to broaden the breadth of seismic services. In order to quickly grasp the research progress for earthquake service in the field of informatization, based on the CNKI data resource platform, this paper searches with key words of information technology,such as earthquake emergency response, intelligent optimization and artificial intelligence(AI). Representative literatures are investigated and sorted out, and the main research directions and technical application contents of earthquake service in China are summarized in the field of informatization.The results show that, based on the traditional information technology, the rapid development of earthquake service informatization and electronization is rapidly promoted, and AI is the core technology to realize the intelligent seismic business in the future.

Keywords

I Earthquake; Information technology; AI; CNKI.

1. INTRODUCTION

In the world, The earthquake disaster is one of the most destructive natural disasters, which has a threat to human life and property that cannot be ignored[1]. According to statistics, between 2000 and 2019, the number of deaths from earthquake disasters worldwide was 721,318, accounting for more than 50%[2]. China has a vast territory and diversified geological environment, and earthquake disasters have the characteristics of high frequency, wide range and high intensity. Related disasters caused by earthquakes have an irreversible impact on social and economic development[3]. According to the China Earthquake Administration statistics, between 2000 and 2022, there were 148 earthquakes of magnitude 6 or above and 13 earthquakes of magnitude 7 or above in China[4]. At the same time, with the development of information technology, based on 5G communication, artificial intelligence, mobile terminal development, etc., a full range of service information applications have been carried out around the needs of various industries, effectively improving work efficiency and quality. Therefore, the efficient integration of earthquake service and information technology is an important way to promote the application and work efficiency of earthquake work in an all-round way, and also an important way to reduce the risk of earthquake disasters and improve there response speed after earthquakes.

Based on the CNKI platform[5] and taking the current popular information technology as the key words, such as information technology and artificial intelligence, this paper investigated and sorted out the main research direction and application progress for seismic service under

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202309_9(9).0002

each information technology. The results show that the current electronic seismic service based on information system has developed more mature, and the information integration and innovation based on artificial intelligence technology has a certain prospect in the filed of earthquake service.

2. THE DEVELOPMENT DIRECTION OF INFORMATIZATION FOR EARTHQUAKE SERVICE

As shown in Figure 1and Figure 2, it shows the mainstream architecture used in the development of information system at present. Focusing on the basic daily work management for earthquake service as the starting point, all kinds of engineers and technicians develop information management systems based on the Client/Service(C/S) or Browser/Service (B/S) architecture through various program development language, which is the main means of information construction on earthquake service. Above means mainly converts many service-related data into electronic and information management, transforms traditional manual business into electronic online mode, realizes remote and mobile electronic office, reduces labor costs, and effectively improves work efficiency.

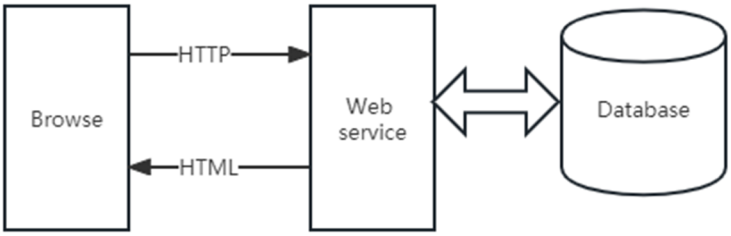

Figure 1. B/S architecture diagram

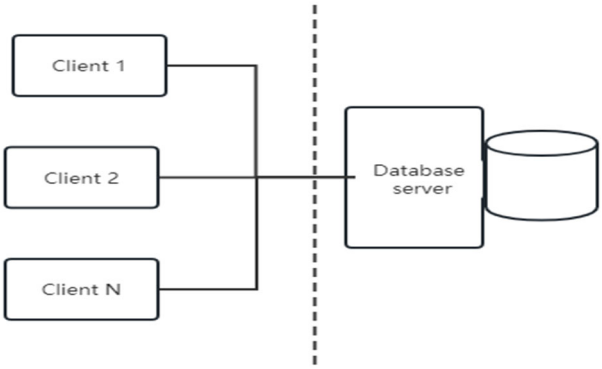

Figure 2. C/S architecture diagram

Kong Lingai[6] et al. designed and developed a set of information management system for earthquake observation equipment by PHP development language and MySQL data, based on B/S architecture, aiming at the shortcomings of work in human operation and maintenance management for current earthquake observation equipment. This system has functional modules, such as user management, equipment management, maintenance management and query statistics, and realized the automatic collection and storage of earthquake observation equipment and operation and maintenance fault data, replacing the traditional manual paper-based management mode and greatly improving the efficiency of equipment operation and maintenance.

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Based on the virtual platform technology, VMware workstation, Han Zhenhui[7] et al. overcame the defects of the previous multi-device and multi-task service system and integrated the multi-style earthquake emergency services into a single server operation mode, effectively improving the utilization rate of server resource and reducing the difficulty and cost of operation and maintenance for previous system.Liu Xiaodan[8] et al. introduced the mode of electronic information management into the access work of the materials warehouse at the earthquake service site, and further improved the quality and efficiency of earthquake emergency work.In the earthquake service information construction project, each project is independently planned for hardware and software device, which causes a lot of resources waste.Shuai Xianghua[9] et al. built a public service platform for earthquake information based on cloud computing and big data technology,which realized unified management of information infrastructure resources.This platform provided common basic services in various types for systems,and effectively reduced the difficulty of cloud-based development for developer.Accoding to the low work efficiency of equipment operation and maintenance caused by the various types and complex composition of current earthquake precursor observation instruments, Li Chawei[10] et al., combined with the operation and maintenance management requirements of real equipment and instruments , adopted the software mode of wechat mini program to develop the mini program of equipment warehousing. The mobile equipment operation and maintenance is realized, and the management efficiency of equipment in emergency environment is further improved.Based on C# language, Li Guangke[11] et al. developed a duty management information system with functions,such as electronic duty log filling, data collection and query management, which ensured that the maintenance personnel had an overall grasp for the station network and improved work efficiency and data product quality.

3. DECISION AND OPTIMIZATION BASED ON INTELLIGENT ALGORITHM

In the world, It is a hot issue that to construct optimization model for decision and optimization problems in real life by using many optimization algorithms. At present, many domestic scholars have adopted intelligent optimization algorithms, such as genetic algorithm, particle swarm optimization algorithm, immune algorithm, etc., to carry out multi-level intelligent decision optimization problems about earthquake service.

In order to improve the ability of earthquake emergency management, combined with the emergency logistics distribution demand under the real earthquake disaster environment, Teng Hongjun et al. based on the earthquake disaster risk assessment data, transformed the problem of earthquake emergency logistics distribution selection into an optimization problem which consider the efficiency of emergency services, and built an emergency logistics distribution center selection model under reasonable demand weights. The simulation experiment, by LINGO software, verifies the availability and fairness of its model[12].For realizing the rapid disposal of known highway damage points after the earthquake, Ma Chenyuan[13] et al., based on genetic algorithm, built a combinatorial optimization model with the emergency disposal time and capacity reduction of highway damage points as the optimization objective, and the emergency response level as the weight factor. The scheduling scheme generated by the model can enable the known highway damage points to be disposed of quickly. At the same time, the random highway damage points are known in the emergency process, and the resources not invoked in the scheme can also ensure that they can be quickly disposed.In order to improve the resilience of the distribution network under earthquake disasters, Wang Shouxiang et al[14]. calculated the loss probability of the tower pole according to the same information,such as the focal location and earthquake magnitude. Then, load recovery rate and emergency power supply supporting force are used as evaluation criteria to compute the capacity recovery level of distribution network. Finally, based on the optimization model of distribution network resilience under earthquake disaster, the optimal grid emergency repair strategy and

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emergency generator vehicle scheduling scheme are realized based on particle swarm optimization algorithm.

4. RESEARCH AND APPLICATION BASED ON AI

The AI technology,such as convolutional neural network and deep learning, is a new field that has developed rapidly in the past decade, and a some of service application based on AI have attracted more and more researchers' attention. The network structure of deep learning is composed of a large number of related connections between neurons which are constantly learning and training according to the light (weight) in the learning process.At present, as shown in Figure 3, many domestic scholars have solved a wide range of seismic service application problems by constantly optimizing the convolutional neural network.

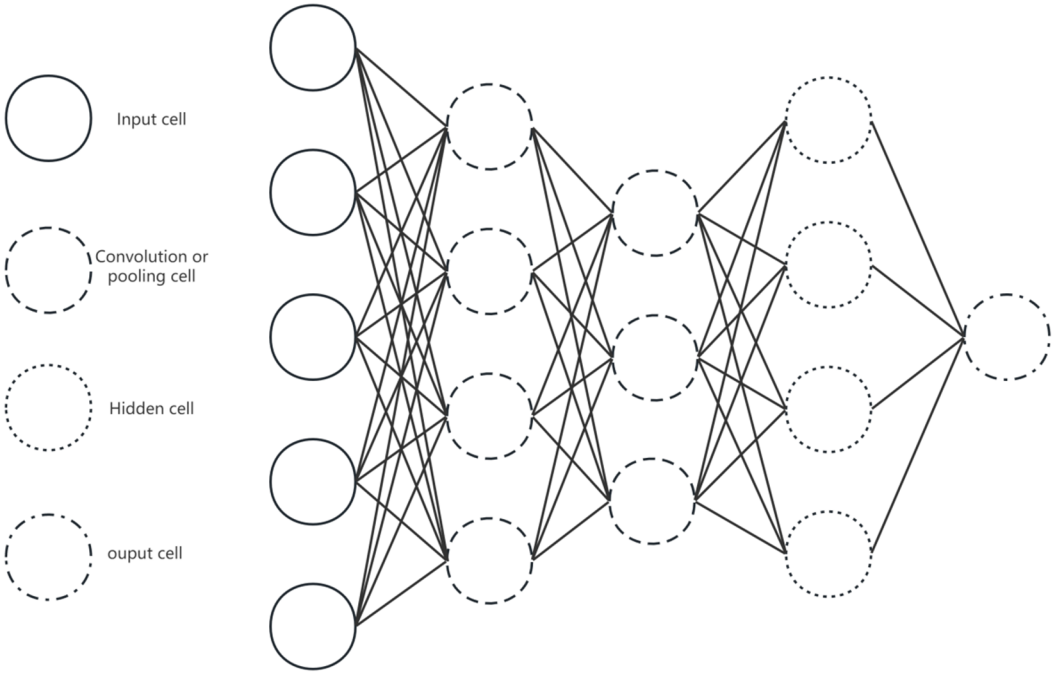

Figure 3. Convolutional neural network architecture diagram

Based on historical earthquake case data, Chen Shaojin et al.[15] by conducted principal component analysis on core indicators,such as earthquake magnitude, focal depth and epicenter intensity, built an extreme death prediction model for earthquake by used particle swarm optimization. Based on long short-term memory network,Hu Jinjun[16] proposed a real-time prediction model for earthquake intensity. The accuracy of the model reaches 96.47% through the test of the correlative seismic cases.Cui Jiahao et al., based on the method of target Detection, applied an improved FCOS(Fully Convolutional One-Stage Object Detection) neural network model to realized automatic picking function of superposition velocity in velocity spectrum[17].

5. CONCLUSION

Basd on the data of CNKI platform, this paper summarized the application of current mainstream technologies in seismic service.The results show that in recent years, domestic researchers mainly focus on the informatization of earthquake service, the integration of AI and earthquake service, and the decision optimization under the earthquake emergency scenario.Among them, the realization of electronic and paperless based on information system has covered a wide range of seismic service and developed maturely. For the decision-

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making problem of intelligent optimization algorithm in a specific earthquake environment, domestic scholars mainly focus on emergency management, program formulation and path planning, etc. With the continuous development of bionic intelligent algorithm, there is still a certain space for development. In addition, on a global scale, as AI gradually becomes the main driver force of innovation in various industries, the deep integration of earthquake service and AI technology has a prospect that cannot be ignored.

ACKNOWLEDGMENTS

This paper was supported by the Earthquake Emergency and Information Youth Key Task for China Earthquake Agency (Grant Numbers CEAITNS202311).

REFERENCES

[1] JIA Hanxi, LIN Junqi, et al.The Review of Serious Earthquake Across the Globe[J]. Technology for Eaahquake Disaster Prevention,2019,14(4):821-828.

[2] LI Xiaoang. Research on Earthquake Disaster Risk Assessment in Gansu Province[D]. Institute of Disaster Prevention,2021.(In Chinese)

[3] Miao Cheng,Wang Jun. Life risk acceptability criteria for MS≥5.0 earthquake disaster in Chinese Mainland [J]. WORLD EARTHQUAKE ENGINEERING, 2022, 38 (4): 18-25. DOI:10.19994/j.cnki.WEE.2022.0078.

[4] China Earthquake Administration (CEA). China Earthquake Yearbook [M]. Beijing: Seismological Press, 1991-2020. (in Chinese)

[5] Tu Jiaqi,YANG xinya.et al . Research on the History and Development of China National Knowledge Infrastructure (CNKI)[J]. Library Tribune, 2019, 39(9): 1-11.

[6] Lingai Kong,Zichao Hu ,et al.Seismic observation equipment information management system based on WAMP[J].Information Technology and Informatization, 2022,No.272(11):37-40.

[7] Zhenhui HAN ,Feifei WANG ,et al. Application of Virtualization Technology in Earthquake Emergency Business Informatization [J]. Research and Exploration in Laboratory, 2022,41(10):138-141.DOI:10.19927/j.cnki.syyt.2022.10.028.

[8] LIU Xiaodan, ZHANG Shuo ,et al.Research on material management at earthquake site—Taking the information construction of earthquake site material warehouse of Hebei Earthquake agency as an example[J].Plateau Earthquake Research, 2021, 33(01):58-62.

[9] Shuai Xianghua,Dong Xiang,et al.design and Implementation of seismic information common service platform[J].Earthquake Research in China, 2021, 37(01):170-184.

[10] LI Cha-wei,Wu Yan-xia, et al. Research on seismic instrument management platform based on wechat mini program[J].Software Guide, 2020, 19(06):117-120.

[11] Li Guangke,Gong Haobo,et al.Design and implementation of duty management information system in Chongqing Earthquake agency[J].Technology for Earthquake Disaster Prevention, 2018, 13(04): 986-996.

[12] Teng Hongjun,Shu Zhile,et al.study on model optimization method of emergency logistics distribution system in earthquake disaster [J].Journal of Safety Science and Technology, 2023, 19(04): 160-167.

[13] MA Chenyuan,Wamh Bing.Multi-objective optimization of highway earthquake disaster emergency resource scheduling [J/OL]. Highway Engineering: 1-7 [2023-07-11].http://kns.cnki.net/kcms/detail/43.1481.U.20220615.1037.002.html.

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202309_9(9).0002

[14] WAN ShouXiang,WANg Lin,et al.Optimal Recovery strategy for distribution network to improve its resilience under earthquake disasters [J]. Proceedings of the CSU-EPSA, 2020, 32(06): 28-35.DOI:10.19635/j.cnki.csu-epsa.000323.

[15] CHEN Shaojin, LIU Ziwei,et al.Research on Prediction of Earthquake Death Toll Based on PCA-PSO-ELM Model[J/OL].Journal of Geodesy and Geodynamics:1-9[2023-07-11].https://doi.org/10.14075/j.jgg.2023.03.107.

[16] Hu Jinjun, Ding Yitian, et al.A Real-Time Seismic Intensity Prediction Model Based on Long Short-Term Memory Neural Network[J].Earth Science,2023,48(05):1853-1864.

[17] CUI Jiahao,YANG Ping,et al.research on automatic picking of seismic velocity spectrum based on deep learning[J].Chinese Journal of Geophysics,2022,65(12):4832-4845.