[1] Chengcai Xing

Harnessing Traditional Business Culture Resources: Scalable Parameter Server Architecture with Distributed Machine Learning

Journal of Electrical Systems

Abstract: - This paper explores the development and utilization of Traditional business culture resources, focusing on Yan'an's rich historical significance and its potential political, cultural, educational, and economic value. Leveraging distributed machine learning systems within a parameter server architecture, the research addresses challenges related to scalability and robustness, particularly in the face of random node downtime and network interruptions. Through intelligent simulation and experimentation, the study demonstrates the effectiveness of employing machine learning techniques to achieve high accuracy in modeling Traditional business culture's development and utilization.

Keywords: Distributed machine learning; Traditional business culture resources; Digital protection; Optimization.

I. INTRODUCTION

At present, there are three main views on the definition of cultural resources in the academic circle. This definition fails to highlight the difference between culture and culture as a resource, which is too wide to highlight the particularity of cultural resources. The second is the theory of cultural materials, which points out that cultural resources are various materials with cultural attributes. The third is the theory of cultural elements, which points out that cultural resources are various cultural elements developed and utilized by human beings in various activities[1,2].

Whether the Traditional business culture can be deeply developed will be considered to a great extent.Think political education Traditional business culture resources development subject's idea, quality and ability influence, because it is the whole.The leader and main executor in the process of resource development. It plays the role of connecting link and communication bridge between the content and the object of education[3,4]. This requires ideological politics.The development subject of educational Traditional business culture resources should set up scientific development idea and strengthen the cultivation of development quality. Promote the construction of their own development capacity[5].

Traditional business culture resources are the cultural resources congealed by the blood and sweat of countless revolutionary ancestors.With a strong and brave patriotic feeling and dedication, not for the people feelings, and constantly explore and create.The new and innovative spirit keeping pace with The Times, these are the spirit of ideological and political education to be developed and constantly developing.Motivation and valuable wealth[6,7]. Under such a premise, we should adhere to the combination of inheritance tradition and development and innovation.To realize the innovation and deep development of the Traditional business culture resources. Finally adhere to inherit the excellent tradition, in the process of inheritance development. Because inheritance and development are the process of cultural innovation.In the two aspects, it is time to inherit the excellent tradition in the Traditional business culture resources of ideological and political education[8,9].

The above understanding of cultural resources defines the basic existence form and scope of cultural resources from different perspectives, and different definitions have their own rationality. The main research directions of distributed machine learning are synchronization mechanism, communication mechanism, data and model aggregation, and learning algorithm. Many distributed machine learning systems have been proposed by industry and academia. Then the current research status of distributed machine learning system is summarized. Finally, the organizational structure of the full text is explained[10]. The mature development of digital technology has injected fresh blood into the Traditional business culture resources.

[1] College of Business Administration, Zhengzhou University of Science and Technology, Zhengzhou 450064, Henan, China;

*Corresponding author: xcc861222@163.com;

In recent years, different disciplines have conducted in-depth research on digital technology from different perspectives and levels. At present, digital technology is being used in many disciplines. Which brings greater technical challenges while enjoying convenience. Digital technology refers to the use of high-tech equipment (cameras, scanners, computers, etc.) to convert and process the digital images and models of objects' entities, text materials and other related information.

A distributed machine learning system usually includes synchronization, communication, training, scheduling, data storage and other modules, often considering the special requirements of the system for robustness and algorithm accuracy.

To sum up, Traditional business culture resources have a profound historical background and rich spiritual connotation. They have the value and function of cohering the hearts of the times, stimulating the public emotions, and highlighting the spirit of the times. They are an important cultural support for a harmonious society and adapt to the cultural needs of building a socialist harmonious society.

II. VRL — SGD ALGORITHM OPTIMIZATION

One of the core issues is empirical risk minimization. As shown in equation (1).

$$\min_{x\in R^d} \frac{1}{|D|}\sum_{\xi_i\in \mathrm{D}} f\left(x,\xi_i\right) \quad (1)$$

$$\mathrm{f(y)} = \exp\left[\frac{y\theta - b(\theta)}{a(\phi)} + c(y;\phi)\right] \quad (2)$$

The existence of a constant σ makes the following inequality hold, as shown in equation (3).

$$\mathrm{E}_{\xi\sim D_i}\left\|\nabla f_i(x,\xi) - \nabla f_i(x)\right\|^2 ,, \sigma^2, \forall x\in R^d, \forall i \quad (3)$$

That is, the function satisfies the following conditions, as shown in equation (4).

$$f_i(x) + \left\langle \nabla f_i(x), y-x\right\rangle + \frac{\mu}{2}\| x-y\|^2 ,, f_i(y), \forall x, y\in R^d, \forall i. \quad (4)$$

Optimization target form, as shown in equation (5):

$$\frac{1}{T}\sum_{t=1}^{T}\mathrm{E}\left[\left\|\nabla f\left(\hat{x}^{t-1}\right)\right\|^2\right] ,, \frac{2}{\gamma T}\left(f\left(\hat{x}^0\right) - f^*\right) + 4\gamma^2 k^2 G^2 L^2 + \frac{L}{N}\gamma\sigma^2 \quad (5)$$

If we set it in Local/SGD, we can get the following convergence results, as shown in equation (6):

$$\frac{1}{T}\sum_{i=1}^{T}\mathrm{E}\left[\left\|\nabla f\left(\hat{x}^{t-1}\right)\right\|^2\right] ,, \frac{2L}{\sqrt{NT}}\left(f\left(\hat{x}^0\right) - f^*\right) + \frac{4}{\sqrt{NT}}G^2 + \frac{1}{\sqrt{NT}}\sigma^2 = \mathrm{O}\left(\frac{1}{\sqrt{NT}}\right). \quad (6)$$

Therefore, it has the following properties as the iteration progresses, as shown in equation (7):

$$\begin{aligned} v^{t-1} &= \nabla'\left(x^{t-1},\xi_{i^t}\right) - \nabla f\left(\hat{x},\xi_{i^t}\right) + \frac{1}{n}\sum_{i=1}^{n}\nabla f\left(\hat{x},\xi_i\right) \\ {}_{x^{t-1}\to x^*,\hat{x}\to x^*,}& \nabla f\left(x^*,\xi_{i^i}\right) - \nabla f\left(x^*,\xi_{i^t}\right) + \frac{1}{n}\sum_{i=1}^{n}\nabla f\left(x^*,\xi_i\right) \to 0. \end{aligned} \quad (7)$$

For the first function, perform local gradient descent, as shown in equation (8) and equation (9):

$$t=1, x_1^1=\hat{x}^0-\gamma\nabla f_i\left(\hat{x}^0\right)$$
$$=\hat{x}^0-2\gamma\left(\hat{x}^0+2b\right) \quad (8)$$
$$=-\frac{b}{2}-\frac{2}{3}\left(-\frac{b}{2}+2b\right)=-\frac{3}{2}b$$

$$t=2, x_1^2=x_1^1-\gamma\nabla f_i\left(x_1^1\right)$$
$$=x_1^1-2\gamma\left(x_1^1+2b\right) \quad (9)$$
$$=-\frac{3}{2}b-\frac{2}{3}\left(-\frac{3}{2}b+2b\right)=-\frac{11}{6}b.$$

III. METHODS

A. Data selection

The development object, and the development method, which constitute the logical system of "who develops what develops how to develop". One method that can be used to deploy distributed machine learning applications is to use existing mature general distributed computing frameworks such as MapReduce and Spark. The basic process of MapReduce is shown in Figure 1.

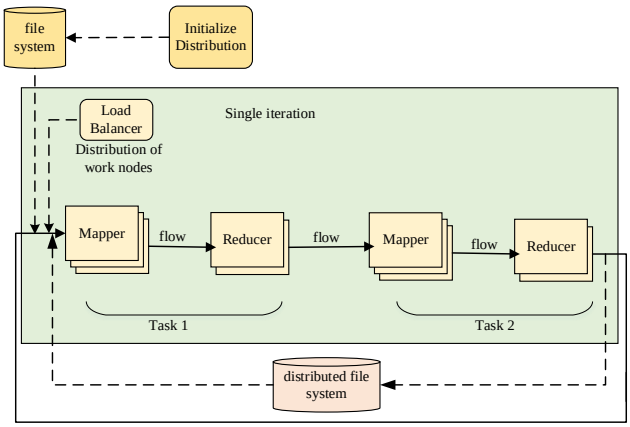

Fig. 1 Typical process of MapReduce

The new machine learning distributed system is a parameter server architecture. The parameters mentioned here refer to key value pairs (keys, values) used to describe model parameters in machine learning, or two-dimensional matrices, or multidimensional matrices. At the same time, multidimensional matrices are also called tensors. Figure 2 shows the architecture of a typical parameter server.

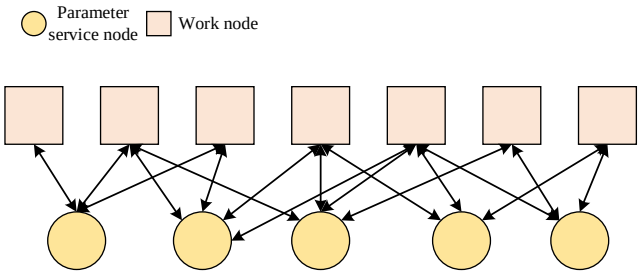

Fig.2 Abstract description of parameter server architecture

Therefore, it is an unbiased estimate to calculate the gradient with all data by using the method of putting back the training set data, which also guarantees the correctness of the random gradient descent theory. The overall

framework of the system has been introduced in the previous chapter, Figure 3 shows the role of modules in each layer of the system logic structure has been described.

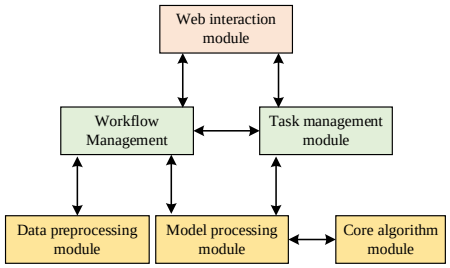

Fig. 3 Optimized structure of key modules

B. Research assumptions

First, digital technology has now entered a variety of disciplines, and has achieved good results. It has accelerated people's work efficiency. The file management and information management of college students all reflect the rapidity and timeliness of digital technology. If we can effectively combine digital protection technology and apply it to the protection of Traditional business culture resources, we will vigorously save some dying martial arts, make it reappear and recover, and show it in the public's view more widely. Divide the data set, process different data subsets for each model replica, and periodically perform interactive merging of each model replica. As shown in Figure 4, data is divided, and global parameters are maintained by all service nodes.

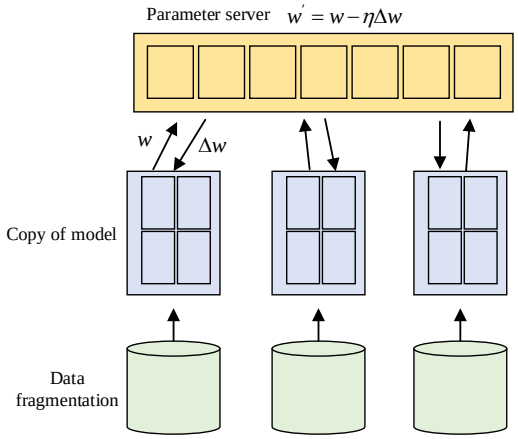

Fig.4 Distbelief's parameter server architecture optimization

First, select the corresponding distribution function according to the characteristics of the data to be regressed or classified, for example, select the Gaussian distribution for the continuous data, then establish the relationship between the linear prediction quantity and the prediction variable by constructing the connection function to obtain the fitting function, then construct the maximum likelihood function, and use the gradient descent method or Newton method to solve the parameters. If the model is successfully constructed, the test data can be regressed or classified by fitting function, as is shown in Figure 5.

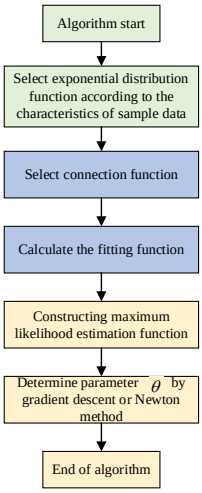

Fig. 5 Optimization of Digital Protection Linear Model Construction Process

With the arrival of the digital era, digital protection is a new type of channel for protecting information and data generated by modern equipment and technology, including computer technology, 3D technology, photography technology, etc. It collects all kinds of information and materials, converts them into digital and storable information through computer electronic processing, and can share them on the network to achieve real-time interactive sharing. The whole workflow of distributed machine learning system includes system initialization, parallel training of models, and system completion, as is shown in Figure 6.

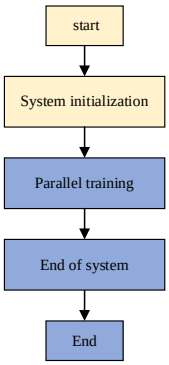

Fig. 6 Overall workflow optimization of distributed machine learning system

There are many Traditional business culture resources with a rich variety and far-reaching influence in various parts of China, among which "the red education base is the main position to carry spiritual and cultural resources and spread Traditional business culture".

For different types of cultural resources, the digital protection means are also different, but the digital mechanism used is the same, which is based on 0 and 1 binary digital technology. However, when it comes to each digital technology, the digital technology used, and its final role are not single. For example, the formation of database construction cannot be separated from the early digital acquisition technology; The functions of the database after completion are not single[11-12]. In addition to the digital storage function, it also includes the digital display function. Therefore, it needs to rely on other digital technologies to play a role together.

To sum up, compared with the material cultural heritage, there are only a few examples of the application of digital technology in Traditional business culture resources, and the two have not been well combined. More technologies are mainly used with low complexity.

IV. EXPERIMENT

A. Task process scheduling sub module

Traditional information resources contain many important historical materials, which have been paid more and more attention. Grasping digital technology step by step is a new concept for applying it to traditional information storage. Electronic technology and computer systems to transform various traditional information materials into digital information, maintain them in a digital form, establish a digital information resource management database, and manage the computer system uniformly, to protect and develop them. By summarizing common distributed and parallel machine learning algorithms, these algorithms are roughly classified according to communication mode and aggregation mode. The asynchronous communication uses shared memory and locks to ensure the correctness of the model update. However, single machine optimization and hardware upgrade have limited improvement on training performance. With the development of distributed technology, parallel training model has become a new research direction. Table 1 shows some common distributed and parallel machine learning algorithms and their characteristics.

Table 1 Common distributed and parallel machine learning algorithms and their characteristics

Algorithm name	Single machine optimization	Parallel mode	communication mode	Aggregation mode
Synchronize SGD	SGD	data	synchronization	Gradient summation
ADMM	unlimited	data	synchronization	Add all models
EASGD	SGD	data	Synchronous/asynchronous	Add all models
Asynchronous SGD	SGD	data	asynchronous	Add all models
adadelay	SGD	data	asynchronous	Partial model addition
Hogwild	SGD	data	Asynchronous lock free	Add all models

Distributed machine learning uses parallel training of multiple nodes within or across the cluster to accelerate training through cooperation between working nodes. Communication is an essential link to achieve node cooperation. However, the network state and network transmission speed in distributed systems are often limited, and communication will become the bottleneck of distributed machine learning. In the core algorithm module, the algorithm model is the core data structure. The query or scheduling of the algorithm model in the workflow management module and task management module will involve the model structure of the algorithm. Therefore, the algorithm model table is the most important one of the several basic tables of the system operation, and its structure is shown in Table 2.

Table 2 Algo model algorithm model table structure

Field Name	Field Type	Field Description
model_ id	varchar	Model ID, primary key
parameters	varchar	Parameter table id of training model
algo_ id	int	Identification of algorithm, representing the algorithm type corresponding to the training model
algo_ name	varchar	Algorithm name of training model
data_ frame	varchar	Training data frame ID of training model
description	varchar	Model description
status	int	Model status, training not started, training in progress or training completed

B. Design of interactive components

Resource development cannot be separated from protection. Protection is the premise of development, and development is for better protection. We should actively strive for the support of policies, funds and projects in the

central and provincial levels, set up special funds and special institutions and professional teams in local finance, spare no effort to protect the Traditional business culture resources in Yan'an, promote the development in the protection, and scientific Traditional business culture resources in Yan'an. For some application data messages, the scale of the application data is very large. When there is only one message sending daemon thread, it is easy to cause the message sending to take too long, resulting in the long waiting time for other system messages with short data size. Therefore, when sending a long message, the runtime system automatically splits the long message and maintains the sending status of each segment of a long message to ensure that the data receiver can correctly combine the messages, as shown in Table 3.

Table 3 Usage of message header

Abbreviation of message usage type	Description of the purpose of the message	Message initiator/receiver role
REGISTER_ NODE	The logical node reports to the master node	Three logical nodes of the system
NODE_ INFO_ LIST	Node topology information	Three logical nodes of the system
NODE_ INFO_ ACK	Node topology information receipt information	Three logical nodes of the system
SYSTEM_ READY	System initialization completion information	Three logical nodes of the system
TENSOR_ PARTITION	Tensor partition information	Three logical nodes of the system
JOB_ DONE	System end information	Three logical nodes of the system
PULL_ TENSOR	Pull parameter information	Tensor management module
UPDATE_ TENSOR	Update parameter information	Tensor management module
ACQUIRE_ KEYS	Task scheduling information	Dispatching management module
ENGINE_ STATISTICS	Parameter Service node load information	Dispatching management module
ENGINE_ BARRIER_ WAIT	Phase group synchronization information	Stage management module
ENGINE_ CONTINUE	Phase group synchronization cancellation information	Stage management module

Adhere to the principle of coordinated development of Traditional business culture and superior resources. In addition to the Traditional business culture resources that attract the attention of giants, papercut, Yangge in northern Shaanxi. The development of Traditional business culture resources must be coordinated with historical culture, folk culture, ecological civilization, etc., and comprehensively developed to maximize social and economic benefits. V in Table 4 represents the size of vocabulary, that is, the number of words in all different texts; L stands for the number of all words. The words here generally refer to strings that are not separated by blank characters; The L/D band represents the average length of the text.

Table 4 Statistics of Data Set

Dataset	V	L	D	L/V	L/D
Common Crawl	673497	1147291316	2773795	1704	415
NYTimes	10637	99542126	299753	979	333
PubMed	141044	737869084	8200000	5232	90

The development of the Traditional business culture resources of political education needs to extract the same ideological policy from the massive Traditional business culture resources.To manage the material and spiritual and

cultural resources corresponding to education, but the current integration of these resources is insufficient.The utilization rate of Traditional business culture resources of ideological and political education in material form is low. To the challengeIt is also proved that system can be deployed on multiple general-purpose computers to solve machine learning applications with larger data scale, as is shown in Figure 7.

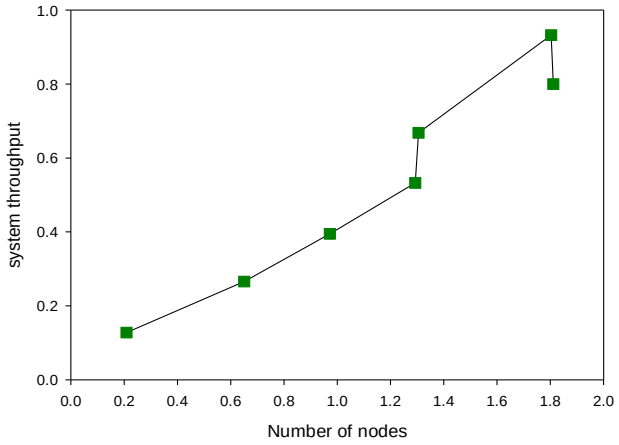

Fig. 7 Scalability of the system in the distributed situation

The selection and optimization parameters are extremely important. The design of algorithm parameter table can reflect the expansion ability of the algorithm. Table 5 is the database table structure of K-means algorithm parameters. Users need to read and write the database when querying the algorithm model or setting parameters[13-15].

Table 5 Structure of kmeans_parametersK means algorithm parameter table

Field Name	Field Type	Field Description
model_ id	varchar	Unique model ID of parameter configuration
training_ frame	varchar	ID of training data frame
validation_ frame	varchar	The ID of the evaluation data frame
k	int	Expected number of clusters
init_ mode	enum	Selection method of initial clustering center
kfolds	int	K fold cross check
max_ iterations	int	Maximum training iterations
seed	bigint	Random seed during cluster initialization
max_ runtime_ secs	double	Maximum running time allowed for model training, 0 is off
epsilon	double	Threshold of algorithm iteration convergence

The value of ideological and political education is more and more prominent, but it also appears in the development of Traditional business culture resources.Some problems and deficiencies, and the emergence of these problems for the discussion of ideological and political education Traditional business culture resources open.Hair has certain reference significance. Therefore, the author from the analysis of ideological and political education Traditional business culture resources development main.Body, object and method of the existence of the error, find the reason for the existence of error, and then to systematize clear solution.To provide the basis for the thinking of the problem.

The performance test of the system is mainly conducted by comparing with the Mahout of Hadoop cluster, using the same training data set for the same algorithm model training,. Based on the number of different computing nodes, different computing platforms cluster the same dataset, as is shown in Figure 8.

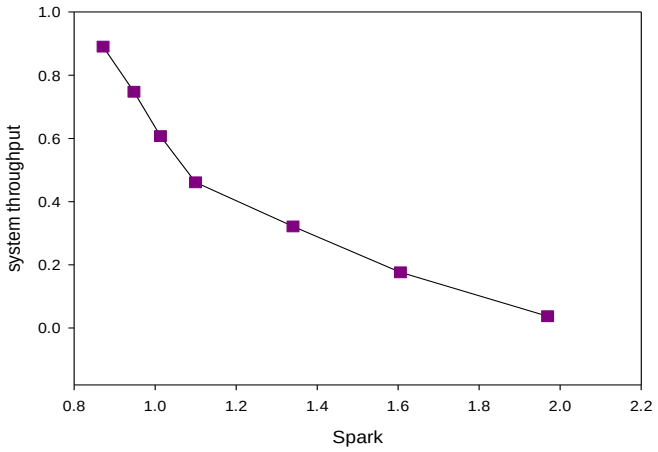

Fig.8 Performance comparison of Kmeans algorithm under Hadoop and Spark

To sum up, scattered and potential Traditional business culture resources through the main body, achieve of Traditional business culture education, and further promote the transformation of China's Traditional business culture resource advantages into the educational advantages of ideological and political education.

V. CONCLUSION

The ideological and political education derived from the development of Traditional business culture resources holds significant research value, yet it remains a complex and long-term endeavor. Despite numerous studies on Traditional business culture and its resources, there is a consensus on the necessity of digital protection for these resources. However, the practical application of digital technology remains inadequate. To address this gap, comprehensive solutions are required. While this paper offers general recommendations, the specific digital technologies and solutions must be tailored to individual circumstances. Efforts should focus on exploring advanced digital technologies and innovative solutions to effectively merge Traditional business culture resources with digital platforms. Through ongoing research and implementation, we can enhance the preservation of intangible cultural heritage and strengthen the role of digital technology in safeguarding Traditional business culture resources.

ACKNOWLEDGMENT

This work was supported by 2024 Henan Province Soft Science Research Program Project (Project Number: 242400410558).

REFERENCES

[1] Komninos, N., Kakderi, C., Mora, L., Panori, A., & Sefertzi, E. (2022). Towards high impact smart cities: A universal architecture based on connected intelligence spaces. *Journal of the Knowledge Economy*, *13*(2), 1169-1197.

[2] Foresti, R., Rossi, S., Magnani, M., Bianco, C. G. L., & Delmonte, N. (2020). Smart society and artificial intelligence: big data scheduling and the global standard method applied to smart maintenance. Engineering, 6(7), 835-846.

[3] Jarić, I., Correia, R. A., Brook, B. W., Buettel, J. C., Courchamp, F., Di Minin, E., ... & Roll, U. (2020). iEcology: harnessing large online resources to generate ecological insights. Trends in Ecology & Evolution, 35(7), 630-639.

[4] Holmström, O., Linder, N., Kaingu, H., Mbuuko, N., Mbete, J., Kinyua, F., ... & Lundin, J. (2021). Point-of-care digital cytology with artificial intelligence for cervical cancer screening in a resource-limited setting. JAMA network open, 4(3), e211740-e211740.

[5] Gonzalez, R. A., Ferro, R. E., & Liberona, D. (2020). Government and governance in intelligent cities, smart transportation study case in Bogotá Colombia. Ain Shams Engineering Journal, 11(1), 25-34.

[6] Roberts, H., Cowls, J., Morley, J., Taddeo, M., Wang, V., & Floridi, L. (2021). The Chinese approach to artificial intelligence: an analysis of policy, ethics, and regulation. AI & society, 36(1), 59-77.

[7] Khalil, R. A., Saeed, N., Masood, M., Fard, Y. M., Alouini, M. S., & Al-Naffouri, T. Y. (2021). Deep learning in the industrial internet of things: Potentials, challenges, and emerging applications. IEEE Internet of Things Journal, 8(14), 11016-11040.

[8] Shepherd, M., Turner, J. A., Small, B., & Wheeler, D. (2020). Priorities for science to overcome hurdles thwarting the full promise of the 'digital agriculture'revolution. Journal of the Science of Food and Agriculture, 100(14), 5083-5092.

[9] Jingchun Zhou, Qian Liu, Qiuping Jiang, Wenqi Ren, Kin-Man Lam, Weishi Zhang. Underwater image restoration via adaptive dark pixel prior and color correction. International Journal of Computer Vision, 2023. DOI :10.1007/s11263-023-01853-3.

[10] Jingchun Zhou, Boshen Li, Dehuan Zhang, Jieyu Yuan, Weishi Zhang, Zhanchuan Cai. "UGIF-Net: An Efficient Fully Guided Information Flow Network for Underwater Image Enhancement," IEEE Transactions on Geoscience and Remote Sensing, vol. 61, pp. 1-17, 2023, Art no. 4206117, doi: 10.1109/TGRS.2023.3293912.

[11] Ali, J., Shan, G., Gul, N., & Roh, B. H. (2023). An Intelligent Blockchain-based Secure Link Failure Recovery Framework for Software-defined Internet-of-Things. Journal of Grid Computing, 21(4), 57.

[12] Ali, Jehad, Rutvij H. Jhaveri, Mohannad Alswailim, and Byeong-hee Roh. "ESCALB: An effective slave controller allocation-based load balancing scheme for multi-domain SDN-enabled-IoT networks." Journal of King Saud University-Computer and Information Sciences 35, no. 6 (2023): 101566.

[13] Ren, X., Ahmed, I., & Liu, R. Study of Topological Behavior of Some Computer Related Graphs. Journal of Combinatorial Mathematics and Combinatorial Computing, 117, 3-14.

[14] Nazeer, S., Sultana, N., & Bonyah, E. Cycles and Paths Related Vertex-Equitable Graphs. Journal of Combinatorial Mathematics and Combinatorial Computing, 117, 15-24.

[15] Zeng, Y., & Chu, B. The Appropriate Scale of Competition Between Online Taxis and Taxis Based on the Lotka-Volterra Evolutionary Model. Journal of Combinatorial Mathematics and Combinatorial Computing, 117, 25-36.