Hindawi
Mathematical Problems in Engineering
Volume 2022, Article ID 5677634, 6 pages
https://doi.org/10.1155/2022/5677634

Research Article

Automatic Control Model of Power Information System Access Based on Artificial Intelligence Technology

De Yong Jiang,[1] **Hong Zhang**,[1] **Harish Kumar**,[2] **Quadri Noorulhasan Naveed**,[3] **Chandan Takhi**,[4] **Vishal Jagota**,[5] **and Rituraj Jain**[6]

[1]*Yancheng Institute of Technology, Yancheng, Jiangsu 224007, China*
[2]*Noida International University, Noida, India*
[3]*College of Computer Science King Khalid University, Abha, Saudi Arabia*
[4]*IK Gujral Punjab Technical University, Kapurthala, Punjab, India*
[5]*Department of Mechanical Engineering, Madanapalle Institute of Technology and Science, Madanapalle, Andhra Pradesh, India*
[6]*Department of Electrical and Computer Engineering, Wollega University, Nekemte, Ethiopia*

Correspondence should be addressed to De Yong Jiang; deyongjiang57@163.com and Rituraj Jain; jainrituraj@wollegauniversity.edu.et

Received 27 January 2022; Revised 1 March 2022; Accepted 8 March 2022; Published 25 March 2022

Academic Editor: Vijay Kumar

Looking at the issues of low efficiency, poor control performance, and difficult access control of the traditional role-based access control model, an artificial intelligence technique-based power information system access control model has been designed. The detector is designed by artificial intelligence technology, combining artificial neural network, and artificial immune algorithm, which provide the basis for checking the access request module. It has been proved that the design model can effectively support the access and modification of legitimate users and prevent illegal users from accessing, and the control accuracy is high. The use of artificial intelligence (AI) in the power sector is now reaching emerging markets, where it may have a critical impact, as clean, cheap, and reliable energy is essential to development. Artificial intelligence can be proven very efficient for resolving the control and decision-making issues in high complex systems.

1. Introduction

The power grid has grown into a typical huge complex system with vast dimensions, thanks to the availability of renewable energy, the adaptable use of energetic loads (such as electric cars), and wide-scale regional connectivity. The power system, gas system, and heating structure are becoming increasingly interconnected, and an incorporated energy system (IES) with power generation as the center will emerge. In most circumstances, establishing an exact computer simulation or just describing it using a computational formula is challenging. Machine learning, fuzzy systems, evolutionary programming, Boolean algebra, expert systems, and other AI-based (AI) technologies have achieved significant advances in study goal, learning capability, and computational power in latest days. They have been used in smart factories, cognitive medical care, and other disciplines, with promising results. The State Authority's New Installment of Artificial Intelligence Development Project has positioned artificial intelligence study as a national policy. Artificial intelligence innovation is being used in power and energy storage systems, merging smart sensors and physical form, data driven coupled with prototype system, and auxiliary intention coupled with effective procedures, effectively improving the able to handle complex structures, ensuring the performance of procedure and management information system mode transformation, changing the conventional power usage mode, and promoting the energy transition. The artificial intelligence innovation symbolized by intelligent systems and artificial neural networks was implemented in the sector of electricity generation in the 1980s, which was only the second batch of AI-based research

in this area. Each neuron provides one output as a function of inputs in ANN mathematical models, which imitate the human biological neural network for information processing. After being trained, each form of neural network is capable of completing a function based on observations encountered in real life, such as function approximation, classification, and data processing. Its main advantages are the capacity to learn algorithms, online dynamic system adaptation, rapid parallel processing, and intelligent data interpolation. However, due to the limitation of database, algorithm performance, and hardware computing power, the practical effect of the method has some deficiencies and defects [1]. Artificial immune system (AIS) is a field focused with abstracting the structure and function of the immune system to computer systems and examining how these systems might be used to solve computational issues in mathematics, engineering, and information technology.

The demand for cutting-edge research and technology in the electrical grids industry has steadily increased. Automation and intelligent technology have become the major application technologies as a result of the eras' development demands [2, 3]. From Turing's famous Turing test in 1950 to Deep Blue's stunning victory over the world chess champion in 1997 to Aiphago, developed by DeepMind of Google, beating the South Korean player Lee Sedol in the game of go in 2016, artificial intelligence has entered the public eye several times, each time triggering a research boom. Artificial intelligence allows machines to simulate human logical visualization and advanced knowledge, which can be categorized into three levels, i.e., computational intelligence, perceptual intelligence, and cognitive intelligence. Computational intelligence is to make machines/computers with high-performance computing power, even beyond human computing power to deal with massive data; perceptual intelligence is to enable machines to perceive the surrounding environment, including hearing, vision, and touch; speech recognition and image recognition are related to this category; cognitive intelligence helps to enable machines to have human rational thinking ability and make correct decisions and judgments. AI decision-making occurs when data processing, such as identifying trends and suggesting courses of action, is done in part or totally by an AI platform rather than a person in order to quantify data and provide more accurate forecasts and judgments. The convergence of these three capabilities will eventually allow machines to achieve human-like intelligence to fully assist or even replace humans in their work. To realize the above functions, the new generation of artificial intelligence focuses on the evolution of fuzzy logic, expert systems, machine learning, and other technologies.

Artificial intelligence technology in power system controlling the operation may improve the effectiveness of electronic automation management, minimize the chances of electrical accidents, and allow the electricity system to operate smoothly for a longer period of time, lowering the cost of grid operation and maintenance [4, 5]. According to the development requirements of modern power system and the characteristics of artificial intelligence technology, an access control model of power information system is designed on the basis of comparing a large number of literature at home and abroad with the help of AI technology. It has been proved that the designed model can intercept illegal users effectively and the access control effect is good.

Artificial intelligence technology in the use of the process is mainly to use computer technology to imitate the human brain and then through the computer to replace a specific human function. Artificial intelligence involves a wide range of research, including robots and speech and image recognition. The use of artificial intelligence technology can make machinery and equipment more intelligent and solve some tasks that human beings cannot complete by themselves, to improve the overall efficiency of work. In addition, artificial intelligence technology plays a critical role in the development of new energy, optimization of power systems, and medical and health care.

The use of artificial intelligence in electric power system automation technology can effectively reduce the error in the operation process; it is the artificial intelligence technology advantage of one of the strengths of the obvious; its main reason is, because of artificial intelligence technology in the process based on computer operation and control, the computer itself has a high control ability. Therefore, in the specific use process, the stability of relevant parameters can be effectively improved in the operation process, to reduce the operation error caused by the instability of the operation parameters and effectively solve the problem of error prone in the manual operation process [6].

The fundament of noteworthy research in the area of artificial intelligence technology in electrical controlling the operation is an understanding of the latest research standing of electronics automation and control innovation, AI applications, and related application fields, as well as an examination of the fundamental concepts of combining cognitive computing with electronics automation and control conditions [7, 8]. In recent years, due to the rapid development of China's social economy, many industries have begun to use artificial intelligence technology, which promotes the rapid improvement of artificial intelligence technology. In the information society, the AI-based technology mainly depends on the computer technology to carry on the operation; this technology is also from the computer technology continuously optimized and obtained. During the development of electric power system automation system mainly using artificial intelligence technology as the main development direction, for the electric power enterprise, need, according to the actual situation of automation using the ability to continuously improve, the increase of AI-based technology in the automation system running leads to rapid development of electrical engineering in electric power system automation and continuously optimizes the problems in intelligence. With the progress of artificial intelligence and related technologies, especially the breakthrough of machine learning, the third wave of artificial intelligence has been set off, which will comprehensively promote the new progress of the implementation of artificial intelligence in the field of electricity and energy from the breadth and depth.

2. Application of Artificial Intelligence Technology in Power System

The renewable power business has grown significantly with respect to the different in energy structure. Because of the high amount of distributed generators and the widespread availability of electric cars, the grid structure has become more complicated and flexible, with highly uncertain, significant nonlinear effects, and complicated coupling relationships. Power networks represent intelligent major developments, and their criteria for power distribution technology are efficient, simple, and dependable. Traditional technology, on the contrary, has several drawbacks, such as limited dependability, a lack of long-term verification, and an unclear process. As a result of its benefits and qualities, automation has now become a strong instrument for solving complex energy system issues and is an important method for improving the safety, dependability, and economy of the next generation of power grids. Artificial intelligence innovation is initially widely employed in power distribution management, forecasting, marketing, and other industries throughout the testing phase.

2.1. Artificial Intelligence Technology and Power System Scheduling. Targeting at a contemporary power grid with a vast scale and complicated structure, the major goal of dispatching is to assure the platform's safe and reliable operation, user voltage regulation dependability, and system economics. The fundamental challenge is to fix the optimization problem of a complicated web, set the optimal solution in the computer formula as per the planning purpose, encounter the restriction situations of the physical and logical network activity, and create the optimum design strategy that use the optimization approach [9]. Artificial intelligence, or AI, has the ability to lessen energy waste, lower electricity prices, and accelerate the introduction of clean renewable energy sources in global power networks [10, 11]. The dispatching technique based on intelligent technology relates to the electrical network forecasting function, and the energy infrastructure forecasting issue may be separated into unit conjunction efficiency, unit transmitting enhancement, and so on. AI might help with power system design, operation, and control. It is employed in the planning of power generation, transfer, and distribution. It adjusts the stimulation parameters to address the issues of voltage management and reactive power compensation. Several problems in power sources cannot be solved using conventional approaches [12, 13].

2.2. Power Information System Access Control Model. The design model describes the domain, access request, and detector through binary string, including three modules of detector selection, access request checking, and detector management. Selecting the detector module is mainly used to establish the detector and provide the basis for checking the access request module. The check access request module is mainly used to determine whether there is a detector matching the access request and to judge whether the access request is legitimate, and at the same time, the obtained results are transmitted to the detector management module. The detector controlling module is mainly used to adjust the mature detector set with the help of inspection results and improve the inspection efficiency and accuracy of access requests.

2.2.1. Detector Design. The key to the automatic control model of power information system access is how to build the detector. The negative selection method and the clone selection method are now the most widely used detector selection methods, both of which are applied to systems with an unmodified self-set. The self-set will alter when data in the power information system increase or decrease. Artificial intelligence technologies, along with an artificial neural network and an artificial immunity mechanism, were used to create the detector [14].

2.2.2. Establish a Reasonable Artificial Neural Network Central Model. Artificial neural network is a kind of three-layer feedforward neural network established by radial basis function, which mainly consist input, hidden, and output layer, as shown in Figure 1. An artificial neural network can solve complex control problems. Among other things, the self-learning technology can be used to improve supply chains, manufacturing processes, smart grids, and traffic management systems. Power outages, financial network outages, and supply chain delays are just a few of the many difficulties that complex systems encounter, all of which are difficult, if not impossible, to govern using present methods. Control systems based on artificial intelligence (AI) can help with the optimization of complex processes as well as the development of new business models.

The input layer is mainly used to receive the input signal of the power information system, which is formed by the signal source node. Here, the input signal of the power information system is the corresponding authority of different users in the system. The hidden layer is used to process the signal of the input layer, and the number of nodes can be set by the actual problem. The output layer is mainly used to receive the signal processed by the hidden layer and then obtain the output of the artificial neural network by using linear transformation. In the artificial neural network, the conversion function between the input layer and the hidden layer is the radial basis function, which is a nonlinear function with radial symmetric attenuation at the center point [15]. Then, the nonlinear basis function is used. The linear combination completes the nonlinear mapping.

The artificial neural network takes the radial basis function as the basis function of the hidden layer. After the input value passes through the input layer, the neurons in the hidden layer will not directly receive the input vector, so the interval between the input vector and the center of the basis function should be measured. If the interval is too large, the basis function cannot be activated. The input vector is mapped into the hidden space by using the radial basis function. It is a linear mapping relationship between the hidden space and the output space of the artificial neural

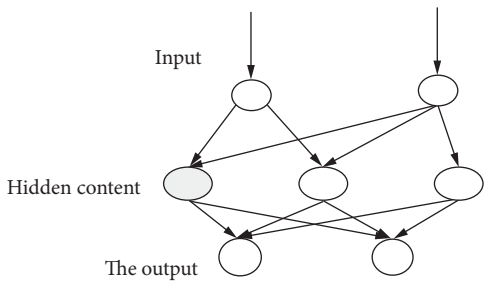

Figure 1: Topological structure of artificial neural network.

network [16]. The output of the artificial neural network is formed by the linear weighting processing in the hidden unit, and the output result is whether the accessing user is a legitimate user. There are many kinds of basic functions, and Gaussian functions with good smoothness and radial symmetry are selected. The formula is as follows:

$$R(x) = \exp\left(\frac{\|x - c_i\|}{2\sigma^2}\right), \quad (1)$$

where R(x) is used to describe the output of the i^{th} hidden node of the artificial neural network, X is used to describe an n-dimensional input vector, c_i is used to describe the center vector of the basis function of the ith hidden node, which is consistent with the x-dimension, σ_i is used to describe i perceived smoothing factors, which directly affect the width of the center point of the radix, and $\|x - c_i\|$ is used to describe the Euclidean norm of the vector $x - c_i$, the interval between X and c_i.

The value of R(x) can reach the highest point when it is at c_i and gradually attenuates with the gradual increase of the interval between x and c_i until it decreases to 0. In other words, only in the case that X is in a local region of the input space, the hidden node basis function will be activated to obtain the corresponding response.

After the above operations, the artificial neural network has completed the nonlinear mapping between the input layer and the hidden layer, which is described by $x \longrightarrow R(x)$. The transformation from the hidden layer to output layer needs to complete linear mapping through $R(x) \longrightarrow y_k$, and the formula is described as follows: $y_k \sum R(x)\gamma_{ik}$. In the above analysis, y_k represents the value of the artificial neural network's first output node and y_{ik} represents the artificial neural network's output weight.

Since the Gaussian function is a nonlinear function, for all input vectors X, only the center adjacent to X in the hidden layer will be activated. In the case of a relatively large interval between X and c_i, R(X) can be regarded as 0. The weight y_{ik} can be adjusted only when the interval between X and c_i is small and when R(X) exceeds the set threshold. When the input data are transferred from the hidden layer to the output layer, there are only a few weights that affect the output of the artificial neural network so that the artificial neural network can effectively improve the learning efficiency and has the advantage of local optimization weights.

In the artificial neural network, the number and location of the hidden layer artificial neural network center will have a direct impact on the approximation ability of the artificial neural network. Meanwhile, the artificial neural network center should be guaranteed to be distributed in the entire input space. However, because the number of artificial neural network centers is very large, the computation amount will be greatly increased. At the same time, the generalization ability of artificial neural network will be greatly reduced. Therefore, a reasonable artificial neural network center should be selected to construct the artificial neural network.

3. Experimental Results and Analysis

Two sets of samples from the actual power information system were used to test the performance of the proposed artificial intelligence-based power information system access automatic control model. The test data are described in Table 1.

Figures 2 and 3 describe the output results obtained from the input test dataset 1. Because the amount of test sample data is too large, it cannot effectively reflect the relationship between the actual output results and the real output results. In the figure, the circles represent the actual output and the lines represent the real output. The lines are displayed if the real output is an illegal user, otherwise the lines are not displayed. When the actual output is an illegal user, the circle is at position 1. When the actual output is a legitimate user, the circle is at position 0.

On the basis of the above experiments, the experimental results of the two training datasets are given, as shown in Table 2.

As can be seen from Table 2, when the model in this study is used for access control of power information system, the control accuracy rate is more than 90%, and the false alarm rate is relatively low. To verify the effectiveness of the model in this study on access control, the PKI model and the IBE model were compared and tested. During the initialization of the PKI model, public and private keys need to be provided for all visitors, which is highly complicated, requires the collection of public keys of all visitors, and is easy to be invaded [17]. Compared with the PKI model, the IBE model can manage visitor information without providing a public key or private key and issuing a certificate for visitors during initialization [18]. However, the IBE model needs to assign the secret key to each visitor, which has high overhead and low degree of automation and has an impact on system security [16]. For the power information system, 100 legal users and 50 nonillegal users are added [18]. The model in this study, the IBE model and the PKI model were used to test the access security of 150 users logging in the system and using the system, and the access security indicators were counted. The results were described in Table 3.

According to the analysis of Table 3, the number of illegal users successfully logged in, and the number of illegal users who can modify their information, the number of legitimate users who cannot access are all 0 and the number of legitimate users who cannot modify their information is 1, indicating that the model in this study can effectively support the access and modification of legitimate users and prevent the access of illegal users [19].

Table 1: Experimental data.

Training data	The number of (a)	The test data	The number of (a)
Training dataset 1	7000	The test data 1	125617
Training dataset 2	7000	The test data 2	153621

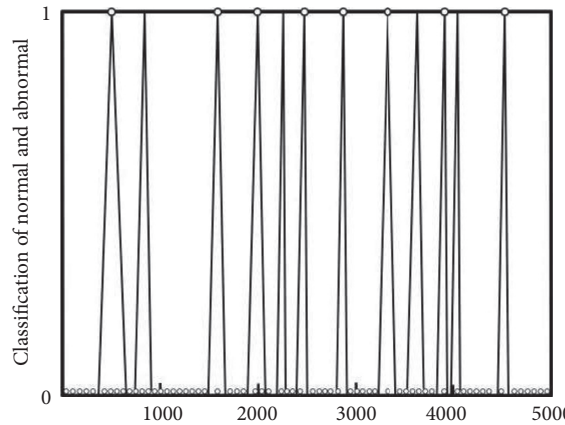

Figure 2: A partial enlarged view of the actual output and real output of test dataset 1.

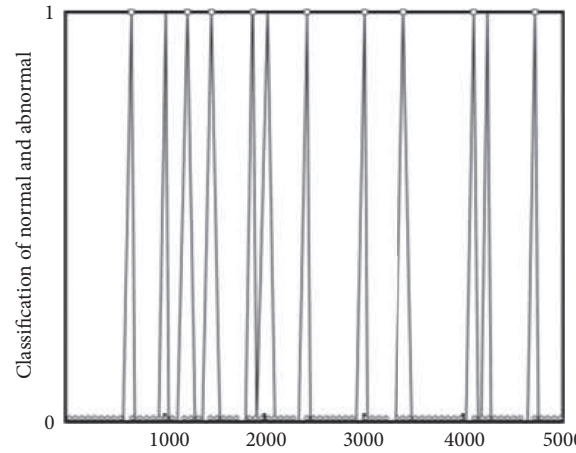

Figure 3: A partial enlarged view of the actual output and real output of test dataset 2.

Table 2: Experimental results.

The dataset	Precision (%)	The rate of false positives (%)	Nonresponse rates (%)
Training dataset 1	96.23	5.23	0.23
Training dataset 2	95.15	3.21	0.85

Table 3: Access control security testing.

Model	Number of illegal users logged in successfully/person	Number of illegal users/person who can modify information	Number of unreachable legitimate users/people	Number of legitimate users/people who cannot modify information
PKI model	8	6	17	9
IBE model	6	8	10	7
Model	0	0	0	1

4. Conclusions

At present, artificial intelligence technology has good adaptability and flexibility to solve the problems of nonlinear, strong uncertainty, strong coupling, multivariable, and other characteristics contained in modern power system and will play an important role in improving the operation efficiency of the power system, improving its safety, reliability, and intelligence level. On this basis, artificial intelligence technology will also penetrate more into the energy system to truly realize the intelligence of smart energy. An automatic access control model of the power information system based on artificial intelligence technology is proposed. To achieve autonomous control of power system access, the detector is created by integrating an artificial neural network with an artificial immune mechanism. It has been demonstrated that the design module can properly implement access control. The most advanced use of AI technology is the creation of smart machines using a comprehensive combination of smart perception, huge data analysis, computer vision, natural language processing, and other skills. While electric robots have indeed been developed for power assessment operations, live device repair, and some other usage situations, they lack autonomous ability and can only execute the activity in a normal layer according to the programming. As a result, making discoveries in critical technologies including such independent learning and independent behavior patterns, as well as developing electric humanoid machines with human-like behavior capacity, will be an essential route for the future integration of advanced AI technologies.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

References

[1] A Glowacz, "Diagnostics of synchronous motor based on analysis of acoustic signals with the use of line spectral frequencies and K-nearest neighbor classifier," *Archives of Acoustics*, vol. 39, no. 2, pp. 189–194, 2014.

[2] U. Iqbal and A. H. Mir, "Efficient and dynamic access control mechanism for secure data acquisition in IoT environment," *International Journal of Computing and Digital Systems*, vol. 10, no. 1, pp. 9–28, 2021.

[3] P. Kumar, L. Kansal, G. Singh Gaba, M. Mounir, A. Sharma, and P. K. Singh, "Impact of peak to average power ratio reduction techniques on Generalized Frequency Division Multiplexing for 5th generation systems," *Computers & Electrical Engineering*, vol. 95, no. 2021, Article ID 107386.

[4] J. Bhola, S. Soni, and J. Kakarala, "A scalable and energy-efficient MAC protocol for sensor and actor networks," *International Journal of Communication Systems*, vol. 32, no. 13, pp. 1–16, 2019.

[5] M. Yang, P. Kumar, J. Bhola, and M. Shabaz, "Development of image recognition software based on artificial intelligence algorithm for the efficient sorting of apple fruit," *International Journal of System Assurance Engineering and Management*, pp. 1–9, 2021.

[6] H. Kim, M. Ghergherchi, S. W. Shin et al., "The automatic frequency control based on artificial intelligence for compact particle accelerator," *Review of Scientific Instruments*, vol. 90, no. 7, 74707 pages, 2019.

[7] X. Ren, C. Li, X. Ma et al., "Design of multi-information fusion based intelligent electrical fire detection system for green buildings," *Sustainability*, vol. 13, no. 6, p. 3405, 2021.

[8] V. Jagota, M. Luthra, J. Bhola, A. Sharma, and M. Shabaz, "A secure energy-aware game theory (SEGaT) mechanism for coordination in WSANs," *International Journal of Swarm Intelligence Research*, vol. 13, no. 2, pp. 1–16, 2022.

[9] P. Ström, K Kartasalo, H Olsson et al., "Artificial intelligence for diagnosis and grading of prostate cancer in biopsies: a population-based, diagnostic study," *The Lancet Oncology*, vol. 21, no. 2, pp. 222–232, 2020.

[10] U. Iqbal and S. Shafi, "Formally validated authentication protocols for WSN," in *Advances in Big Data and Cloud Computing*, pp. 423–432, Springer, New York, NY, USA, 2019.

[11] Y. Xiao, Z. Jun, H. Lei, A. Sharma, and A. Sharma, "A novel method of material demand forecasting for power supply chains in industrial applications," *IET Collaborative Intelligent Manufacturing*, vol. 3, no. 3, pp. 273–280, 2021.

[12] D. Bhargava, B. Prasanalakshmi, T. Vaiyapuri, H. Alsulami, S. H. Serbaya, and A. W. Rahmani, "CUCKOO-ANN based novel energy-efficient optimization technique for IoT sensor node modelling," *Wireless Communications and Mobile Computing*, vol. 2022, Article ID 8660245, 9 pages, 2022.

[13] M. N. Kumar, V. Jagota, and M. Shabaz, "Retrospection of the Optimization Model for Designing the Power Train of a Formula Student Race Car," *Scientific Programming*, vol. 2021, Article ID 9465702, 9 pages, 2021.

[14] Y. . Ding, "Performance analysis of public management teaching practice training based on artificial intelligence technology," *Journal of Intelligent and Fuzzy Systems*, vol. 40, no. 5, pp. 1–14, 2020.

[15] S Wu, W Hu, and L Zhang, "An intelligent key feature selection method of power grid based on artificial intelligence technology," *Zhongguo Dianji Gongcheng Xuebao/Proceedings of the Chinese Society of Electrical Engineering*, vol. 39, no. 1, pp. 14–21, 2019.

[16] K. Alzaareer, A. Q. Al-Shetwi, C. Z. El-Bayeh, and M. B. Taha, "Automatic generation control of multi-area interconnected power systems using ANN controller," *Revue d'Intelligence Artificielle*, vol. 34, no. 1, pp. 1–10, 2020.

[17] Z Lv, Y Han, A. K Singh, G. Manogaran, and H. Lv, "Trustworthiness in industrial IoT systems based on artificial intelligence," *IEEE Transactions on Industrial Informatics*, vol. 17, 1 page, 2020.

[18] V Veerasamy, N Wahab, R Ramachandran et al., "A Hankel matrix based reduced order model for stability analysis of hybrid power system using PSO-GSA optimized cascade PI-PD controller for automatic load frequency control," *IEEE Access*, vol. 8, 1 page, 2020.

[19] B. Xue and Z. Wu, "Key technologies of steel plate surface defect detection system based on artificial intelligence machine vision," *Wireless Communications and Mobile Computing*, vol. 2021, no. 6, Article ID 5553470, 12 pages, 2021.