Research Article

Security of Intelligent Sensors and Their Collaborative Roles in Human Resource Management in the Development of Smart Cities

Shuwu Wang, Huijuan Cao, Dandan Wang, and Aining Li

College of Business, Yantai Nanshan University, Yantai City 265713, China

Correspondence should be addressed to Shuwu Wang; wangshuwu@nanshan.edu.cn

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The study is aimed at solving the security problems caused by malicious network attacks in human resource management in the development of smart cities. First, the Stackelberg game theory model is used to describe the interaction between intelligent sensors and intelligent jammers, and the security of the information physics system is effectively evaluated. Second, a denoise autoencoder machine model that can be used in human resource management with demographic information is proposed to ensure the security of intelligent sensors. Finally, its performance is simulated and analyzed. The results show that the more packets successfully arrive at the estimator, the more favorable the estimation effect of the estimator is. The designed defense strategy is very effective in protecting the security of intelligent sensors. When the number of nearest neighbor \( K \) increases, MAE of four datasets first decreases and then tends to be stable. With the increase of \( K \), MAE of the algorithm proposed decreases from 0.8232 to 0.8095, 0.8086 to 0.7897, and 0.8563 to 0.8351, respectively. It decreases from 1.0169 to 1.0091 and then keeps stable. The recommendation algorithm proposed shows high accuracy in rating prediction and can quickly and effectively extract the hidden features of users and adjust the sparsity of data. Therefore, it can be applied to human resource management. This study provides a new idea for the research on the security of intelligent sensors and human resource management in the development of smart cities.

1. Introduction

In recent years, sensor technology has developed rapidly, and many computer-based information systems are established by using sensor networks. And there is no exception for the system used to develop smart cities. The system has greatly promoted urban construction and economic development. With the progress of the development of smart cities, urban infrastructure is expanded, the mobile Internet is gradually mature, and the development of smart cities is increasingly dependent on the Internet of Things (IoT) and cloud computing and other technologies, causing the problem of the information security [1–3].

The model for the development of smart cities changes the information service model of all parties in the city, which inevitably brings major changes to the concept of urban service. In this case, information security is becoming more and more important, and how to realize information sharing in the development of smart cities receives much attention from all walks of life [4–6]. The coordination and integration of information play a great role in protecting the information, and they can promote the sustainable development of smart cities [7]. The basic elements for the development of smart cities include intelligent technology, intelligent industry, intelligent service, intelligent management, and intelligent life [8]. IoT is used to install sensors and connect them to the Internet through specific information exchange and communication protocols to achieve intelligent identification, positioning, tracking, monitoring, and management [9, 10]. With the technical support of IoT, smart cities should have three characteristics, namely, instrumentation, interconnection, and intelligence. In this way, smart cities can be developed by integrating all these intelligent functions with the development of IoT [11]. The explosive...
growth of smart cities and IoT applications post many scientific and engineering challenges that require creative research from academia and industry, especially on developing efficient, scalable, and reliable smart cities based on IoT [12, 13]. And new protocols, architectures, and services are urgently needed to overcome these challenges.

In the development of smart cities, the network will pose a threat to the security of the information physics system, and the intelligent jammer will destroy the communication channel, which will cause data loss or error in the information physics system. Therefore, it is necessary to explore the security of the intelligent sensor.

The innovation is to solve the security problems caused by malicious network attacks in human resource management. The Stackelberg game theory model is used to describe the interactive decisions between intelligent sensors and intelligent jammers, so that the security of the physical information system is effectively evaluated. In the case of human resource security, a human resource security model can be integrated into human resource security management. This research provides a new idea for the research on the safety performance of intelligent sensors and human resource management in smart cities.

2. Literature Review

2.1. Research Status of the Safety of Intelligent Sensors in the Development of Smart Cities. Intelligent sensors play important roles in the development of smart cities. Ballard et al. [14] used the reverse design method and machine learning to redesign the data acquisition hardware to “lock” the best sensing data according to the cost function defined by the user or the design constraint, and a new computational sensing system is proposed. The system can relieve the burden of data and improve their sensing ability. Through iterative analysis of the sensing results driven by data, the low-cost and compact sensors are obtained. In urban development, the construction of smart cities has attracted the attention of the government and society. In the promoting of urban intelligence, intelligent lighting of urban roads has been the research focus of the construction and development of smart cities, and the studies on lighting sources and their control methods have made great achievements. Wu et al. [15] studied the software of the intelligent sensing robot system based on multidata fusion and proposed a path based on the ant colony algorithm for high precision and fast response of the robot. Path planning is carried out by the intelligent robot for obstacle avoidance, and the global optimization is carried out by the ant colony optimization algorithm. The safest and shortest path of the adaptive function, including obstacle reduction and path length, is finally obtained by using the ant colony optimization algorithm. Wang et al. [16] proposed an efficient and intelligent data fusion algorithm by reasonably combining the artificial neural network (ANN), genetic algorithm (GA), and particle swarm optimization algorithm (PSO) to lengthen the use time of the network. In the implementation of the algorithm, wireless sensors are used as the neurons in the neural network, ANN extracts the data collected by the sensors, and the number of the data sent to the base station or sink node is reduced by additional data fusion based on clustering routing. The development system of smart cities is aimed at achieving seamless and secure interconnection of sensors, actuators, and data processing resources to ensure digital, efficient, and reliable services. Habibzadeh et al. [17] overviewed the architecture of the developing system of smart cities by introducing its application, sensing, communication, data, and security/privacy planes. Customizing existing communication protocols and infrastructure to connect large-scale deployed sensors and data processing/storage resources brings communication challenges for the development of smart cities.

2.2. Research Status of Human Resource Management. Dual strategies are increasingly used by more relevant organizations in the international market to improve their abilities for exploration and development. However, their flexible working modes bring new challenges to the current human resource management. Ferraris et al. [18] pointed out that the enterprise human resource management system focuses on providing incentives and development capabilities for the management of smart cities. For the projects, the interconnected exploratory and developmental human resource management systems provide customized management tools to support social integration and knowledge management between internal and external employees. Liu et al. [19] realized the optimal configuration of enterprise management of human resources, improved the efficiency of the optimal configuration model in the adaptive neural network based on Field Programmable Gate Array (FPGA) in mining and controlling the information of enterprise human resources, and realized the multifunctional configuration of enterprise human resources. Turner et al. [20] investigated five kinds of human resource management practices: systematic selection, extensive training, performance evaluation, high relative remuneration, and delegation of authority when predicting the injury rate. Roundy and Burke-Smalley [21] proposed a human resource management model for the entrepreneurial ecosystem. Theoretically, it is believed that people in the ecosystem should jointly manage the human resources of the entrepreneurial community. The economic rent theory explains how to encourage people in the entrepreneurial ecosystem and adopt the method of metaorganization human resource management, thereby coordinating talent acquisition, learning, development, performance management, reward, and retention. Amrutha and Geetha [22] analyzed the current situation and research gaps according to the literature on green human resource management. They figured out specific activities to realize the sustainable development of the organization and society. They also conducted content coding and cluster analysis. The results show that there are three clusters in the implementation of green human resource management, namely, green human resource management practices, employees’ green behavior at workplaces, and the organization’s sustainable development. And further analysis shows that social sustainability is studied less than economic and environmental sustainability.
In summary, a good combination of ANN, GA, and PSOA can extend the network’s life. However, there are also some shortcomings. For example, there is still little research on the collaborative research of human resource management and the security performance of intelligent sensors. Since smart sensors play an essential role in smart cities, it is necessary to explore the security of intelligent sensors. The Stackelberg game theory model is used to describe the interactive decisions between intelligent sensors and jammers and solve the security problems caused by malicious network attacks, so that the security of the physical information system is effectively evaluated. Based on the security performance of intelligent sensors, an improved collaborative filtering algorithm is used to discuss human resource management.

3. Materials and Methods

3.1. Security Estimation of the State-Coupled Information Physical System under Intelligent Interference Attacks. The application of intelligent sensors in the human resource department can help human resource specialists perform almost all their responsibilities, such as recruiting, monitoring, or paying employees. The human resource team can use networking equipment to monitor and track the health status of employees. Wearable devices can collect various data, such as food intake, walking distance, and important data of employees. Based on the data collected, human resource specialists can find out the root causes of some health problems and take appropriate measures to avoid them. Staff’s safety can be ensured using intelligent sensors. For example, IoT sensors can monitor the pressure in natural gas pipelines to avoid any leakage due to excessive pressure. The human resource specialists use IoT sensors to track employees’ attendance and make payroll. They can also attach radio frequency identification (RFID) tags with sensors to employee badges, including the employees’ information and their absence. The application of intelligent sensors in human resource management provides human resource specialists with many benefits, but some network security threats also accompany these benefits.

In the development of smart cities, the intelligent interference attacks will pose a threat to the security of the information physics system, and the intelligent jammer will destroy the communication channel, making the data in the information physics system lost or incorrect. Intelligent sensors are very important in maintaining network security and avoiding cyber-attacks, so it is necessary to study the security of intelligent sensors in the network [23]. The Stackelberg game theory model is used to describe the interaction between intelligent sensors and intelligent jammers, and the security of information physics systems is effectively evaluated.

Intelligent sensors send the local state estimation to the estimator along the communication channel, and they may be attacked by the intelligent jammer in the process. If the intelligent sensor is a defender, it knows that it may be attacked by the intelligent jammer and has obtained all the information related to the intelligent jamming. The security functions of the intelligent sensor and the intelligent jammer are designed. Both of them want to maximize their benefits. In this case, the intelligent sensor plays the role of a leader, so that it can gain the best power transmission strategy, and the intelligent jammer becomes a follower [24–26]. Therefore, when the system is attacked by the jammer, the maximum benefit of the optimal response strategy against the intelligent jammer can be calculated by the following equation:

$$\max_{J_i \geq 0} v_{iJ}(U_i, J_i) = -\frac{\alpha_i U_i}{\sigma_i^2 + \beta_i J_i} - Z_i J_i.$$  \hspace{1cm} (1)

When the intelligent sensor knows that there is intelligent interference in advance, the following equation can be used to maximize the benefit:

$$\max_{U_i \geq 0} u_{iJ}(U_i, J_i(U_i)) = -\frac{\alpha_i U_i}{\sigma_i^2 + \beta_i J_i(U_i)} - Z_i U_i.$$  \hspace{1cm} (2)

In equation (2), $U_i$ is the transmission power of the $i$-th intelligent sensor, $J_i$ is the attack power of the $i$-th intelligent sensor by the intelligent jammer, $F_i$ is the unit transmission power of the intelligent sensor, $Z_i$ is the unit transmission power of the intelligent jammer, $\sigma_i^2$ is the noise, and $\alpha_i$ and $\beta_i$ are the gain of energy transmission. The values of the above parameters are greater than 0.

The signal-to-noise ratio (SNR) and bit error rate (BER) should be known to analyze the communication state of the channel, and they can be calculated by the following equations:

$$Y_i = \frac{\alpha_i U_i}{\beta_i J_i + \sigma_i^2},$$  \hspace{1cm} (3)

$$P_{ib} = 2Q\left(\sqrt{\frac{Y_i}{\beta_i}}\right).$$  \hspace{1cm} (4)

$Y_i$ and $P_{ib}$ are SNR and BER in the communication channel of the $i$-th intelligent sensor, respectively. The functions $Y_{ib}$ and $Q(x)$ can be calculated by:

$$Y_{ib} = Y_i f_{ib},$$  \hspace{1cm} (5)

$$Q(x) = \frac{1}{\sqrt{2\pi}} \int_{x}^{\infty} \exp\left(-\frac{\eta^2}{2}\right) d\eta.$$

(6)

$f_{ib}$ and $B_{ib}$ are the data transmission rate and bandwidth of the communication channel of the $i$-th intelligent sensor, respectively. The packet loss rate of the $i$-th communication channel is calculated by:

$$\theta_i = 1 - \left(1 - P_{ib}\right)^{b_i+1} = 1 - \left(1 - 2Q\left(\sqrt{Y_{ib}}\right)\right)^{b_i+1}.$$  \hspace{1cm} (7)

$b_i + 1$ represents that there are $b_i$ bits data and 1 bits check code in the packet.
The equilibrium solutions of the intelligent sensor and the intelligent jammer in the Stackelberg game are obtained to optimize the results of the solution, and strategy pairs \( (U^SE_i, f^SE_i) \) are calculated by:

\[
U^SE_i = \begin{cases} 
\frac{\alpha_iZ_i}{4\beta_iF_i^2}, & F_i \leq \frac{\alpha_i}{2\sigma_i^2} \\
Z_i\frac{\sigma_i^2}{\alpha_i^2}, & \frac{\alpha_i}{2\sigma_i^2} < F_i \leq \frac{\alpha_i}{\sigma_i^2} \\
0, & F_i > \frac{\alpha_i}{\sigma_i^2}
\end{cases}
\]

\[
f^SE_i = \begin{cases} 
0, & F_i > \frac{\alpha_i}{\sigma_i^2} \\
\frac{\alpha_i^2}{2F_i\sigma_i^2} - \frac{\sigma_i^2}{\beta_i}F_i, & \frac{\alpha_i^2}{2F_i\sigma_i^2} < F_i \leq \frac{\alpha_i}{\sigma_i^2} \\
\frac{\alpha_i^2}{2\sigma_i^2}, & F_i \leq \frac{\alpha_i}{2\sigma_i^2}
\end{cases}
\]

\( \sigma_i^2 \) is the noise, and \( \alpha_i \) and \( \beta_i \) are the gains of energy transmission, respectively. \( F_i \) is the unit transmission power of the intelligent sensor, and \( Z_i \) is the unit transmission power of the intelligent interference.

The information physics system includes three nodes. The model of the system is implemented by the following equations:

\[
x_{i,k+1} = A_ix_{i,k} + G_id_{i,k} + w_{i,k},
\]

\[
y_{i,k} = C_ix_{i,k} + v_{i,k}.
\]

In the above equations, \( i \) symbolizes the \( i \)-th node, \( k \) stands for the \( k \)-th node, \( x_{i,k+1} \in R^{n_i} \) represents the state value, \( y_{i,k} \in R^p \) is the observation value of the \( i \)-th intelligent sensor, and \( d_{i,k} \) is the coupling relationship between the established nodes in the system.

The coupling relationship between the nodes is studied by numerical simulation, and \( i = 1, 2, 3 \) represents the three subsystems. The corresponding parameters of the three subsystems are as follows: \( A_i \) can be -0.6, -0.6, and -0.55, respectively. \( C_i \) is 1; \( G_i \) can be 0.8, 0.9, and 1, respectively; \( \alpha_i \) can be 0.5, 0.6, and 0.4, respectively; \( \beta_i \) can be 0.25, 0.4, and 0.1, respectively; \( \sigma_i^2 \) can be 0.1, 0.1, and 0.2, respectively; \( f_i \) and \( Z_i \) are set as 1; \( f_{i,b} \) can be 5.4, 7.9, and 10, respectively; \( B_{i,b} \) can be 1, 1, and 3, respectively.

3.2. Collaborative Filtering Recommendation Algorithm for the Tag Weight of the Denoise Autoencoder

3.2.1. Collaborative Filtering Recommendation Algorithm Based on Deep Learning. Since it has good scalability and is easy to use, the collaborative filtering recommendation algorithm is widely used in the e-commerce commodity trade of the Internet of Things (IoT), and it also can be applied to human resource management, such as the ITU recruitment and Boss direct recruitment. It can be used to optimize the human resource information management system, by which the work efficiency of the human resource department is improved [27, 28]. Collaborative algorithms mainly include model-based collaborative algorithms and memory-based collaborative algorithms, as shown in Figure 1.

The proposed algorithm can improve the autoencoder’s performance based on deep learning. Its working principle is to use the autoencoder to reduce the noise in the user’s learning process and add demographic information to assist the learning in the training process. And the tag weight of a set of items registered by the user is calculated according to the TF-IDF (term frequency-inverse document frequency), and then, a weight matrix is constructed. Finally, the two similarities are weighted to obtain a new similarity. The calculation process of the algorithm is shown in Figure 2.

3.2.2. Denoising Autoencoder with Demographic Information. Demographic information includes gender, age, graduated universities, hobbies, etc. These variables are discontinuous and nonlinear. If \( Qu \) is a demographic information matrix, the feature information will be quantified when \( Qu \) is constructed. The data need to be standardized to extract users’ features easily. The z-score algorithm is used, and its equation is
μ represents the average of all user vectors, σ represents the standard deviation of all user data, and $x^*$ represents the normalized vector.

The denoise autoencoder is used to learn the hidden features of users. That is, noise is added to the input layer, and the values of some nodes in the input layer are set to 0 according to a certain proportion. The final training results are improved by reconstructing errors and predicting the error in back propagation. The loss function is calculated by the following equation:

$$L_{α, β}(x, \hat{x}) = α \left( \sum_{i \in C(\hat{x}) \cap k(x)} [g(\hat{x})_i - x_i]^2 \right) + β \left( \sum_{i \not\in C(\hat{x}) \cap k(x)} [g(\hat{x})_i - x_i]^2 \right) + \lambda \|W\|^2.$$  

(13)

$C(\hat{x})$ represents the set of input data after noise is added, $k(x)$ is the dataset that has been graded, $g(\hat{x})_i$ is the output results trained by the denoise autoencoder, $α$ is the prediction error coefficient, and $β$ is the reconstruction error coefficient. $\lambda \|W\|^2$ is a regular term, and it is used to prevent overfitting in the training process [29]. The structure shown in Figure 3 is combined with the network structure and the weight of the tag with the demographic information, so that the hidden layer, the output layer, and the preprocessed demographic information are fully connected. The calculation equation is as follows:

$$x^* = \frac{x - \mu}{\sigma}.$$  

(12)

Figure 2: The calculation process of the algorithm.

Figure 3: Denoising autoencoder fused demographic information.
Figure 4: Continued.
PDAE\( (r_i, p_i) = gW_2 \{ f (W_1 (r_i, p_i) + b_1) + p_i \} + b_2 \). \hspace{1cm} (14)

\( p_i \) is the demographic information of each user, \( r_i \) is the user’s rating vector, and \( W_1, W_2, b_1, \) and \( b_2 \) are the network training parameters of the autoencoder.

3.2.3. Calculation of Users’ Similarities and the Prediction of Ratings. The cosine similarity equation is used to calculate the similarity between the user’s implicit feature vectors learned by the autoencoder. The calculation equation is as follows:

\[
sim_{u, v} = \frac{N_u \cdot N_v}{||N_u|| \cdot ||N_v||}. \hspace{1cm} (15)
\]

\( N_u \) is the feature vector of user \( u \) learned by the autoencoder, and \( N_v \) is the feature vector of user \( v \).

The similarity between the user’s tag weight matrices is calculated as follows:

\[
sim_{P_u, P_v} = \frac{P_u \cdot P_v}{||P_u|| \cdot ||P_v||}. \hspace{1cm} (16)
\]

\( P_u \) is the label weight matrix of user \( u \), and \( P_v \) is the label weight matrix of user \( v \).

Then, the two similarities are weighted, and the equation used is as follows:

\[
sim(u, v) = \alpha \cdot \sim_{u, v} + (1 - \alpha) \cdot \sim_{P_u, P_v}. \hspace{1cm} (17)
\]

In equation (17), \( \alpha \) represents the equilibrium coefficient. When \( \alpha = 1 \), it means that the similarity is calculated only according to the user’s feature vector. When \( \alpha = 0 \), it means that the user similarity is calculated based on the tag weight. For different datasets, the values of \( \alpha \) are selected differently.

According to the optimized similarity, \( k \) nearest neighbor users of the target users can be obtained, and the ratings of the users are predicted. The calculation equation is as follows:

\[
r_{uj} = \bar{r}_u + \frac{\sum_{v \in U_k} \sim(u, v) \times (r_{vj} - \bar{r}_v)}{\sum_{v \in U_k} |\sim(u, v)|}. \hspace{1cm} (18)
\]

\( \bar{r}_u \) and \( \bar{r}_v \) are the average scores of \( u \) and \( v \) for each item, \( r_{vj} \) is the true score from other users for item \( j \), and \( v \) is the \( k \) nearest users of user \( u \).

The datasets used in this experiment are the MovieLens 1M dataset, book-crossing dataset, MovieLens 100k dataset, and electronic product dataset in the Amazon dataset. Their sparsity has been calculated before the experiment, and it is high. Three different types of data are used for experiments, and they are described as follows:

The first dataset is about movies and is provided by the GroupLens team of the University of Minnesota. Among them, MovieLens 1M and MovieLens 100k datasets are selected. MovieLens 1M has 6040 users, 3952 rated films projects, and 1000209 comments. Each user rates at least 20 movies. The types of films include comedy, action, romance, crime, etc. Each film is marked by one or more tags of this type, and the score range is 1 to 5. MovieLens 100k has
943 users, 1682 rated movie items, and 100000 comments. Other information is consistent with the MovieLens 1M dataset. There are 18 movie tags in both datasets.

The second dataset is about books and is proposed by the University of Freeburg in Germany. The dataset has 278858 users and 271379 books, with 1149780 corresponding scoring data. The dataset contains three data scales, namely, users’ data (user ID, gender, age, and geographical location with unique identification), books’ data (book number, name, year, and type), and book scoring scales (users’ ID, books’ ID, and their scores, in which the scoring range is from 1 to 10).

The third dataset is about e-commerce. It includes 142.8 million product reviews and metadata from Amazon from May 1996 to July 2014. The dataset contains three scales, which are users’ data scale (users’ ID, gender, age, and geographical location), commodity scale (commodity ID, name, description, selling price, brand, picture, size), and the commodity scoring scale (users’ ID, commodity ID, scores, and evaluation, in which 1-5 star/stars represent (s) the score).

The experimental environment is as follows: the operating system is Window10, CPU configuration is Core (TM) i5-10210U @ 1.60 GHz, memory is 8 GB, the experimental program is Python 3.0, the step length is 0.1, and equilibrium coefficient $\alpha$ is between 0 and 1.

4. Results and Discussion

4.1. Effectiveness Analysis of the Defense Strategy. The coupling state of the intelligent sensor is estimated to verify

![Figure 5: State quality curves of different nodes: (a) state quantity curve of node 1; (b) state quality curve of node 2; (c) state quantity curve of node 3.](image)
the effect of the proposed algorithm. The results are shown in Figure 4.

Figure 4 shows that there is little difference in the coupling state of node 1, node 2, and node 3 between the estimated value and the actual value, and the curves are basically consistent, indicating that the defense strategy designed has a good effect on the estimation of the coupling state of $d_{1,k}$, $d_{2,k}$, and $d_{3,k}$.

The trajectory and the estimation value of the actual state are shown in Figure 5.

Figure 5 shows that the real values of the states of nodes 1, 2, and 3 are very close to the actual values, and the curves are basically consistent, which indicates that the defense strategy designed is good for estimating the state of the system. The more packets successfully arrive at the end of the estimator, the better the estimation effect of the estimator is. Therefore, the defense strategy designed is very effective to protect the safety of intelligent sensors.

4.2. Determination of Equilibrium Coefficient $\alpha$ in the Improved Similarity. Figure 6 shows that when balance coefficient $\alpha$ takes different values, the corresponding MAE value of the prediction is also different. The proportion of the training set and the test set directly affects the MAE value
of the prediction. The overall MAE value decreases first and then increases. In the MovieLens 100k dataset, the overall MAE value is the largest when the test set is 0.4, the overall MAE value is relatively small when the test set is 0.1, and the corresponding MAE value is the smallest when balance coefficient $\alpha$ is 0.7. In the MovieLens 1M dataset, the overall MAE value is relatively small when the test set is 0.2, and the corresponding MAE value is the smallest when balance coefficient $\alpha$ is 0.6. In the book-crossing dataset, the overall MAE value is relatively small when the test set is 0.1, and the corresponding MAE value is the smallest when equilibrium coefficient $\alpha$ is 0.8. In the dataset of electronic products, the overall MAE value is relatively small when the test set is 0.1, and the corresponding MAE value is the smallest when balance coefficient $\alpha$ is 0.8.

4.3. Improved Algorithm for Similarity Calculation and the Comparison with Other Algorithms. On the basis of the above, the effectiveness of the improved similarity algorithm is verified. The results are shown in Figure 7.

Figure 7 shows that when the number of nearest neighbor $K$ increases, the MAE values of the corresponding four datasets decrease first and then tend to be stable. In MovieLens 100k dataset, MovieLens 1M dataset, book-crossing dataset, and electronic product dataset, the MAE values of the proposed algorithm decrease from 0.8232 to 0.8095,
5. Conclusion

In the development of smart cities, the intelligent management of human resources affects the security of the information physics system. Therefore, the Stackelberg game theory model is used to describe the interaction between intelligent sensors and intelligent jammers, and the security of the physical information system is effectively evaluated. Then, a denoise autoencoder machine model that can be used in human resource management with demographic information is proposed when the intelligent sensors are safe and their performance is analyzed. The results show that the more packets successfully arrive at the estimator, the more favorable the estimation effect of the estimator is. The defense strategy designed is very effective to ensure the security of intelligent sensors. Compared with other algorithms, the proposed algorithm has high accuracy in rating prediction and can quickly and effectively extract the implicit features of users. Therefore, it can be applied to human resource management. This study provides a new idea for the research on the security of intelligent sensors and human resource management in the development of smart cities. The shortcoming is that the user’s item tag used in the recommendation algorithm does not involve the user’s marking time. In many cases, the user’s comment is the user’s real and objective feeling. The recommendation effect will be better if it can be applied to the recommendation system. In the follow-up study, evolutionary game, Bayesian law, and other methods will be considered to model and analyze the interactive decision-making between attackers and defenders.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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References

[1] A. Caragliu and C. F. Del Bo, “Smart innovative cities: the impact of smart city policies on urban innovation,” Technological Forecasting and Social Change, vol. 142, pp. 373–383, 2019.
[2] T. Kim, C. Ramos, and S. Mohammed, “Smart city and IoT,” Future Generation Computer Systems, vol. 76, pp. 159–162, 2017.
[3] A. Camero and E. Alba, “Smart city and information technology: a review,” Cities, vol. 93, pp. 84–94, 2019.
[4] J. Laufs, H. Borriion, and B. Bradford, “Security and the smart city: a systematic review,” Sustainable Cities and Society, vol. 55, p. 102023, 2020.
[5] B. P. L. Lau, S. H. Marakkalage, Y. Zhou et al., “A survey of data fusion in smart city applications,” Information Fusion, vol. 52, pp. 357–374, 2019.
[6] V. Fernandez-Anez, J. M. Fernández-Güell, and R. Giffinger, “Smart city implementation and discourses: an integrated conceptual model. The case of Vienna,” Cities, vol. 78, pp. 4–16, 2018.
[7] M. Nilssen, “To the smart city and beyond? Developing a typology of smart urban innovation,” Technological Forecasting and Social Change, vol. 142, pp. 98–104, 2019.
[8] Y. Jararweh, S. Otoum, and I. Al Ridhawi, “Trustworthy and sustainable smart city services at the edge,” Sustainable Cities and Society, vol. 62, p. 102394, 2020.
[9] C. Esposito, M. Ficco, and B. B. Gupta, “Blockchain-based authentication and authorization for smart city applications,” Information Processing & Management, vol. 58, no. 2, p. 102468, 2021.
[10] S. Singh, P. K. Sharma, B. Yoon, M. Shojaifar, G. H. Cho, and L.-H. Ra, “Convergence of blockchain and artificial intelligence in IoT network for the sustainable smart city,” Sustainable Cities and Society, vol. 63, p. 102364, 2020.
[11] G. Masik, I. Sagan, and J. W. Scott, “Smart city strategies and new urban development policies in the Polish context,” Cities, vol. 108, p. 102970, 2021.
[12] L. Qi, C. Hu, X. Zhang et al., “Privacy-aware data fusion and prediction with spatial-temporal context for smart city industrial environment,” IEEE Transactions on Industrial Informatics, vol. 17, no. 6, pp. 4159–4167, 2020.
[13] D. Li, L. Deng, W. Liu, and Q. Su, “Improving communication precision of IoT through behavior-based learning in smart city environment,” Future Generation Computer Systems, vol. 108, pp. 512–520, 2020.
[14] Z. Ballard, C. Brown, A. M. Madni, and A. Ozcan, “Machine learning and computation-enabled intelligent sensor design,” Nature Machine Intelligence, vol. 3, no. 7, pp. 556–565, 2021.
[15] F. Wu, X. Liu, and Y. Wang, “Research on software design of intelligent sensor robot system based on multidata fusion,” Journal of Sensors, vol. 2021, Article ID 8463944, 10 pages, 2021.
[16] H. Wang, L. Song, J. Liu, and T. Xiang, “An efficient intelligent data fusion algorithm for wireless sensor network,” Procedia Computer Science, vol. 183, pp. 418–424, 2021.
[17] H. Habibzadeh, T. Soyata, B. Kantarci, A. Boukerche, and C. Kaptan, “Sensing, communication and security planes: a new challenge for a smart city system design,” Computer Networks, vol. 144, pp. 163–200, 2018.
[18] A. Ferraris, N. Erhardt, and S. Bresciani, “Ambidextrous work in smart city project alliances: unpacking the role of human
resource management systems,” *The International Journal of Human Resource Management*, vol. 30, no. 4, pp. 680–701, 2019.

[19] P. Liu, W. Qingqing, and W. Liu, “Enterprise human resource management platform based on FPGA and data mining,” *Microprocessors and Microsystems*, vol. 80, p. 103330, 2021.

[20] N. Turner, J. Barling, J. F. Dawson et al., “Human resource management practices and organizational injury rates,” *Journal of Safety Research*, vol. 78, pp. 69–79, 2021.

[21] P. T. Roundy and L. Burke-Smaley, “Leveraging entrepreneurial ecosystems as human resource systems: a theory of meta-organizational human resource management,” *Human Resource Management Review*, p. 100863, 2021.

[22] V. N. Amrutha and S. N. Geetha, “A systematic review on green human resource management: implications for social sustainability,” *Journal of Cleaner Production*, vol. 247, p. 119131, 2020.

[23] F. Marmé, C. Solbach, L. Michel et al., "Utility of the CPS + EG scoring system in triple-negative breast cancer treated with neoadjuvant chemotherapy," *European Journal of Cancer*, vol. 153, pp. 203–212, 2021.

[24] X. Cui, "Cyber-physical system CPS architecture for real-time water sustainability management in manufacturing industry,” *Procedia CIRP*, vol. 99, pp. 543–548, 2021.

[25] C. Han, Y. Niu, T. Pang, and Z. Xia, "Intelligent anti-jamming communication based on the modified Q-learning,” *Procedia Computer Science*, vol. 131, pp. 1023–1031, 2018.

[26] A. Çetinkaya, K. Kikuchi, T. Hayakawa, and H. Ishii, "Randomized transmission protocols for protection against jamming attacks in multi-agent consensus,” *Automatica*, vol. 117, p. 108960, 2020.

[27] N. Bhalse and R. Thakur, *Algorithm for Movie Recommendation System Using Collaborative Filtering*, Materials Today Proceedings, 2021.

[28] C. Zhang, X. Duan, F. Liu, X. Li, and S. Liu, “Three-way naive Bayesian collaborative filtering recommendation model for smart city,” *Sustainable Cities and Society*, vol. 76, p. 103373, 2022.

[29] X. Yang, S. Wang, J. Han, Y. Guo, and T. Li, “RSAMSR: a deep neural network based on residual self-encoding and attention mechanism for image super-resolution,” *Optik*, vol. 245, article 167736, 2021.