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Research on Urban Architecture Design under the Concept of Smart City



Abstract: - After the digital city and smart city concepts, the latest proposed smart city concept is a general summary of the advanced form of urban information development, which plays an important role in the economic transformation of cities, social governance, improvement of residents' quality of life and energy conservation and environmental protection. The smart city puts forward new requirements for the architectural design of the city, and how to reasonably use the smart city concept in the architectural design is still a major issue for architects and professionals to think about. To this end, this paper proposes a state tracking based full working condition modeling method for nonlinear industrial systems. For the problem that the amount of historical data is too large and it is difficult to screen the modeling data, a sliding window is designed to screen the steady-state data, and a fast recursive algorithm of standard deviation in the window is derived; the influence mechanism of unknown disturbances on the system is analyzed, and the data modeling by dynamic regression to the steady state is selected, and a data-driven modeling algorithm that can eliminate the influence of disturbances is proposed; the model information contained in the process industrial big data is used to apply the higher order function to fit each A linear variable parameter transfer function model based on the characteristic parameters is proposed. The identification of an industrial process is shown to be effective. The main points of urban architectural design should be noted under the concept of smart city from four aspects: safety, diversity, environmental protection and emotionality.

Keywords: smart city, process industrial big data; steady-state condition screening; state observer; nonlinear system; full working condition modeling

I. INTRODUCTION

At present, the characteristics of smart cities recognized by the industry are IOT perception, integration and collaboration[1][2]. Smart city is the perfect combination of digital city intelligence and Internet of Things. From the perspective of urban development, smart city is a new model that can organically combine the society, economy and nature of the city to promote its harmonious development. At present, the most basic path of smart city development is technology intelligence, residents' knowledge and environment wisdom[3]. Therefore, smart city is the high-end form of modern city development. From the perspective of system theory, a smart city is an ecosystem of new technologies, which includes citizens, enterprises and governments. The modern city system is a complex system rich in knowledge and information processing capability. Smart city construction is essentially an urban transformation guided by technological innovation, which plays an important role in solving the real problems in the process of economic transformation in China and provides a powerful contribution to promoting sustainable and healthy urban development [4]. In conclusion, no matter which understanding of the connotation of smart city, its ultimate purpose is to achieve the scientific development of the city and the happy life of the citizens[5].

The prominent feature of the construction activities under the influence of the smart city concept is the integration of digital information technology into the architectural design and construction, so that the problems encountered in the functional, technical, economic and usage aspects of the building can be analyzed and solved in a scientific and efficient way, and then the design and implementation plan can be formulated in a more targeted manner to ensure the completion of the construction project with high quality[6]. The buildings under the concept of smart city have individual appearance and strong practicality, which can provide better aesthetic experience and quality services for city residents[7]. Smart cities can also promote the development and progress of the traditional construction industry, and the addition of new disciplines such as big data and artificial intelligence has led to innovation and change in the traditional construction industry, for example, it can intelligently analyze the aesthetic and practical performance needs of citizens for buildings and develop reasonable construction plans in conjunction with urban development to help urban construction move forward [8]. The vast number of practitioners in the construction industry has also progressed with the times. From the source of talent supply, many domestic colleges and universities, represented by Harbin Institute of Technology, have opened "intelligent architecture and

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construction" majors, trying to cultivate new talents that meet the development needs of the construction industry in the new era with the concept of multidisciplinary crossover[9]. Therefore, the construction practitioners serving the construction of "smart city" must master more new knowledge and advanced technology, and be brave to practice and innovate in order to cope with the difficulties and challenges under the new situation[10].

The concept of smart city puts forward higher requirements for architects, and architectural design workers should pay attention to the cultivation of professional quality and constantly expand and improve their professional abilities. First of all, the traditional architectural design knowledge system should be upgraded[11]. Smart city has the characteristics of comprehensive IOT and in-depth intelligence, so architects need to have not only knowledge of the construction industry, but also a lot of new knowledge such as information technology[12]. Architects combine architectural design with smart cities, which means that brand-new technologies are integrated into the architectural field, including Internet of Things, intelligence and other technologies, and traditional architectural design will evolve and transform in the direction of integrated architectural design. In addition, the smart city concept promotes the initiative and urgency of cross-industry learning and communication among architects[13]. In the past, architects were used to fighting alone and creating their own works behind closed doors. The architectural design under the new concept must integrate interdisciplinary and cross-disciplinary knowledge and information, and is a complex work involving people from a wider range of professional backgrounds[14].

II. STUDY ON THE CONSTRUCTION OF SMART CITY MANAGEMENT SYSTEM

A. Information Collection Process

The distribution of smart city pipe networks is relatively uneven, and different solutions can be used according to specific needs[15]. In order to achieve efficient management of the smart city pipe network and play an important coordinating role, it is necessary to collect real-time information on the operation of the entire smart city pipe network and upload real data and information to the relevant information management platform[16]. The efficiency of information utilization is improved by analyzing and mining this collected information through the core processing system. Today, there are many ways to store information about the pipe network of a smart city, mainly in the form of traditional graphical drawing presentation as well as modern electronic storage. As can be seen from the actual development, the cost of electronic information storage is decreasing, storage space is expanding, and reliability is increasing. Therefore, electronic storage form will be the main mode of future information storage[17]. For the detection process of underground pipe network, a unified standard should be established for data collection and processing, so that the information data of the whole smart city pipe network can be interoperable, which is also an important basis for creating a smart city pipe network system.

B. Information Storage

The power of the smart city pipe network is governed by multiple units, and different units adopt different working modes, and the relevant data standards have not yet been unified, which not only brings greater difficulties to the efficient use of data, but also leads to a substantial increase in the overall cost of data and information storage[18]. One of the more important things in the process of realizing the construction of smart city pipe network is to realize the information interoperability of the whole smart city pipe network. A more scientific solution is to apply cloud technology to solve this problem, using distributed networks and grid computing to ensure the security of data storage. Different units are encouraged to upload all data and information to the database system of the entire smart city pipe network construction to achieve resource sharing[19].

C. Information Display

The pipeline network of the smart city is basically built under the ground of the city road, then in the process of unified management, it is possible that the specific spatial distribution cannot be deeply understood through two-dimensional graphics. Under the concept of smart city, some three-dimensional modeling technologies, such as BIM technology, can be applied to directly generate three-dimensional pipeline models based on some real data collected or some drawing information data already obtained to build a perfect three-dimensional database system[20]. Through the GIS data visualization function, the spatial information of the underground pipeline network can be displayed scientifically, which is beneficial for the relevant engineering construction personnel to understand the relevant construction profile in time, especially the combination of different pipeline networks and

distance data can be displayed scientifically. The information display stage has a very important role in promoting the construction of the information management system of the smart city pipe network, and can improve the effect of this work.

D. Information Analysis

After getting a large amount of information about the pipeline network of the smart city, it is also necessary to focus on strengthening the analysis and mining of this data and information, so that these data and information can have specific application effects. The data information can show the real situation of the operation of the smart city pipeline network, so as to predict the possible risks in the process of future development, and take targeted measures to solve in advance to avoid causing major accidents. For example, in the process of electricity or gas pipeline network, some intelligent monitoring equipment can be applied to achieve real-time monitoring of the overall work, once the relevant monitoring signal exceeds the set threshold value to trigger the alarm, the specific situation will be transmitted to the command and control center, so as to carry out the corresponding processing work. The software that needs to be used in the whole system monitoring process not only needs to be able to achieve real-time interaction of data and information, but also needs to have alarm capability as well as historical query, graphic analysis, log view, etc. Building a smart city pipe network information processing system can improve the effect of the traditional work mode and show great accuracy. And after a period of operation, the accumulated data information obtained can be predicted by applying big data information to fully improve the utilization of data information. The system structure of the software function software of the monitoring center is shown in Figure 1.

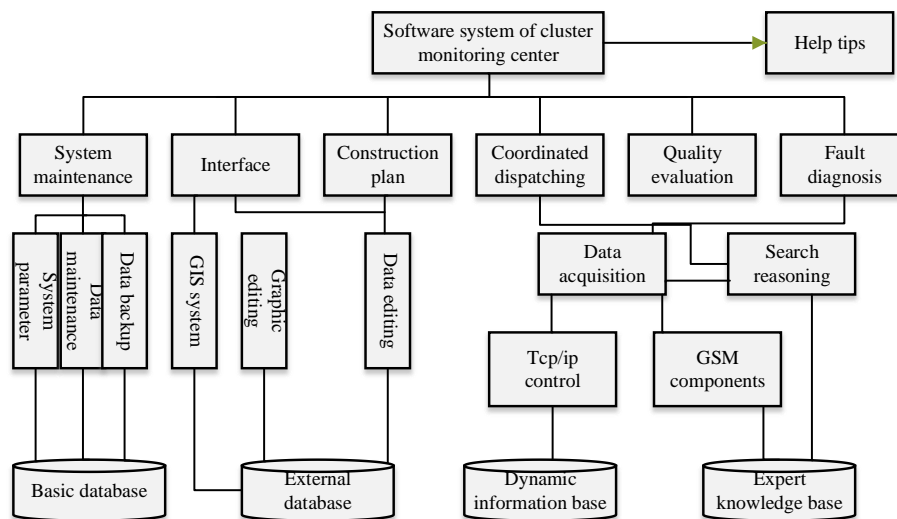


Figure 1 Monitoring Center

The communication system data link is shown in Figure 2.

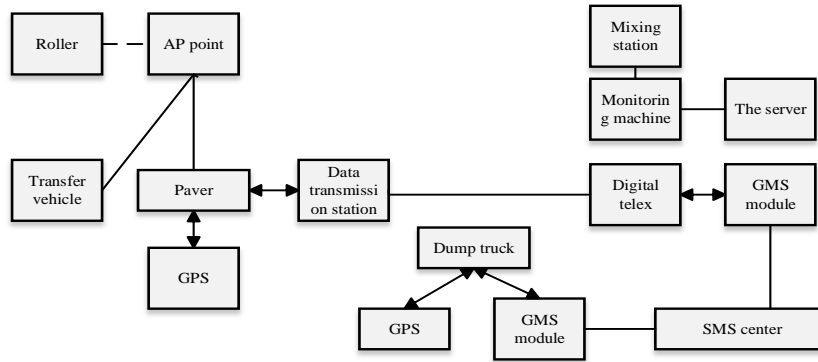


Figure 2 Communication system

The monitoring software collects information in the following ways:

The rollers, pavers and transfer trucks at the construction site form a local area network, one of which is used as the master station and connected to a digital radio, through which all information is sent and received. The monitoring center communicates with the digital radio using a serial port. The messages sent from the monitoring center to the pavers are also transmitted via the same path. The messages are packaged and unpacked. The message body is stored in the message buffer.

GPS information is transmitted to the monitoring center via the GSM system. Other information from the dump truck is also transmitted via the GSM system. Monitoring center computer with GSM receiver card. Packetization and unpackitization of messages. The body of the message is stored in the message buffer.

The user can talk to the system through a series of menus, on-screen prompts and visual objects. Two operating modes are set:

Manual mode and automatic mode. Generally, it works in automatic mode, and switches to manual mode when special operation is needed, and switches to automatic mode automatically when manual operation is completed. The interface is divided into: display area, status bar, toolbar; display area shows information including: construction section electronic map, construction machinery location, construction machinery status and important parameters, construction volume (bar graph), construction progress (horizontal line graph), construction plan (network graph), fault alarm record, historical data query, operation command record, environmental information (text). Toolbar: GIS, online quality evaluation, and construction planning setup wizard are provided as shown in Figure 3.

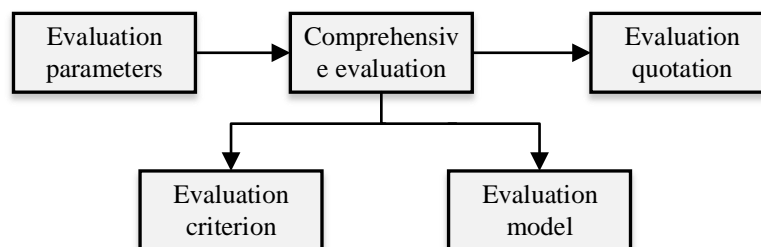


Figure 3 Architecture diagram

III. LINEAR PARAMETRIC TRANSFER FUNCTION MODEL (LPV-TF) FITTING

The nonlinearity of the industrial system model is related to the working conditions, and the characteristic parameter x , which represents the characteristics of the working conditions, is selected as the basis for the nonlinear transformation of the model, and the nonlinear model can be set as shown in equation (1):

$$G_s(x(k)) = \frac{b_0(x(k)) + b_1(x(k))s + \dots + b_m(x(k))s^m}{a_0(x(k)) + a_1(x(k))s + \dots + a_{n-1}(x(k))s^{n-1} + s^n} e^{-\tau(x(k))s} \quad (1)$$

Where: m is the numerator order; n is the denominator order, and to ensure the stability of the system, $m < n$.

Let the order of the higher fitting function be l , so that:

$$a_i(x(k)) = \alpha_{i,1}[x(k)]^l + \alpha_{i,2}[x(k)]^{l-1} + \dots + \alpha_{i,l}x(k) \quad (2)$$

Where: $i=0,1,\dots,n-1$.

By applying the previous method to modeling, p representative system models are obtained for the full range of operating conditions, and the corresponding characteristic parameters of each model are shown in equation (3):

$$x(k_1), x(k_2), \dots, x(k_p) \quad (3)$$

The least squares method can be applied to find the coefficients of equation (6), and the result is shown in equation (4):

$$M_i = W_i R_i^T (W_i R_i^T)^{-1} \quad (4)$$

Among them:

$$M_i = [\alpha_{i,1} \quad \alpha_{i,2} \quad \dots \quad \alpha_{i,l}]$$

$$W_i = [a_i(x(k_1)) \quad a_i(x(k_2)) \quad \dots \quad a_i(x(k_p))]^T \quad (5)$$

$$R_i = [X(k_1) \quad X(k_2) \quad \dots \quad X(k_p)]^T$$

Similarly, the coefficients corresponding to b_j and τ can be obtained without further elaboration

Let, $V_i = \begin{bmatrix} \beta_{j,1} & \beta_{j,2} & \dots & \dots \\ j_{j,l} \end{bmatrix}$, $D = [\gamma_1 \quad \gamma_2 \dots \gamma_l]$ then we have the full The working condition model is shown in equation (6):

$$G_x(s) = \frac{\sum_{j=0}^m V_j X(k) s^j}{s^n + \sum_{i=0}^{n-1} M_j X(k) s^i} e^{-DX(k)s} \quad (6)$$

IV. INDUSTRIAL CONTROL SYSTEM MODEL ANALYSIS

The circuits of an industrial control system contain various types of controllers, actuators that perform specific control operations, sensors that are responsible for data acquisition in the production process, and bus networks or local area networks that are responsible for data transmission. Since there are many external variables in the control system, the control process model can be simplified by using the control principle modeling method, and the simplified model of the specific production control loop is:

$$\begin{aligned} x(t+1) &= Ax(t) + B\eta(t) \\ y(t) &= \lambda x(t) \end{aligned} \quad (7)$$

Where $x(t) = x_m(t) \in R^n (m \in [0, n])$ is the production loop control state parameter $\eta(t) = \eta_p(t) \in R^n$ is the input control variable, $A \in R^{n \times n}$ is the state matrix, and $B \in R^{n \times p}$ is the input matrix .

$y(t) = y_k(t) \in R^n (k \in [0, n])$ is the sensor measurements in the system and $\lambda \in R^{n \times k}$ is the output matrix. The three matrices A, B and B represent the relevant information of the system. The model is a simplified model of the control system ignoring external noise, and the relevant factors will be analyzed later in the paper.

There are various ways of production process based attacks, and the fundamental way is to add attack variables to the control closure loop to achieve the collapse and destruction of the control closure loop. In this paper, we focus on the injection type of attack regarding false control information. The production control loop attack is illustrated in Figure 4.

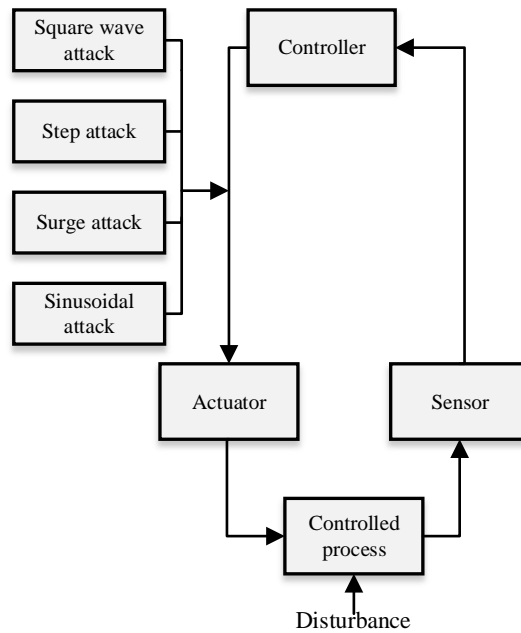


Figure 4 Production control loop attack diagram

Figure 4 mainly depicts the operation of the complete industrial control system model. Adding a false control information injection type attack to the controller and actuator thus destroying the data integrity and control loop stability, the function expression is:

$$x(t+1) = Ax(t) + B\eta(t) + \Delta_{\text{attack}} \quad (8)$$

It can be seen that the process attack model is to change the control state by increasing the amount of deviation Δ_{attack} under the normal and stable process state. Here, the author analyzes the following process control type attacks with reference to previous studies.

(1) Surge attack

$$\tilde{y}_i(t) = \begin{cases} y_i(t), t \neq t_a \\ y_i(t_a) + C_{\max}, t = t_a \end{cases} \quad (9)$$

Where, t_a is the set period value, C_{\max} is the amount of surge deviation.

(2) Step Attack

$$\tilde{y}_i(t) = \begin{cases} y_i(t), t \notin T_{\text{act}} \\ y_i(t) + c_i, t \in T_{\text{act}} \end{cases} \quad (10)$$

Where T_{act} is the step time range variable, c_i is the step deviation amount.

(1) Geometric attack

$$\tilde{y}_i(t) = \begin{cases} y_i(t), t \notin T_{\text{act}} \\ y_i(t) + \alpha_i \phi(t), t \in T_{\text{act}} \end{cases} \quad (11)$$

Where T_{act} is the geometric attack time range variable and $\alpha_i \phi(t)$ is the geometric equation.

Based on various existing studies and definitions, this paper proposes to use the BC-1stM uncertainty-free inverse cloud algorithm in the improved cloud model to model the normal process state of features in all dimensions, and to implement real-time attack detection by this algorithm.

V. APPLICATIONS

Smart city final superheater model is a typical large inertia, long time lag, nonlinear system, apply the method of this paper to model this system, in order to ensure optimal operation of the unit, the main steam pressure, main steam flow, flue gas flow, fuel quantity, etc. have a certain correspondence with the unit load, so the unit load is selected as the operating conditions characteristic parameters, select the load, pressure for steady-state operating conditions screening, screening procedure parameters as shown in Table 1.

Table 1 Parameters of the screening process

Steady state data screening program	Amount of data in sliding window n	Window data floating range λ	Maximum allowable variation of mean ϕ
Main steam pressure /Mp	1000	0.2	0.003
Active power /MW	1000	10	0.025
Inlet temperature / °C	100	1.6	0.02
Outlet temperature /°C	100	1.6	0.02

Three typical operating conditions, 300 MW, 450 MW and 600 MW, are selected for modeling, and the modeling data are selected after screening the steady-state operating conditions as shown in Figure 5. Considering that the output has pure delay, the pure delay time should be modified in the optimization process and the data should be shifted according to this time, and the time reserved for shifting is 100 s.

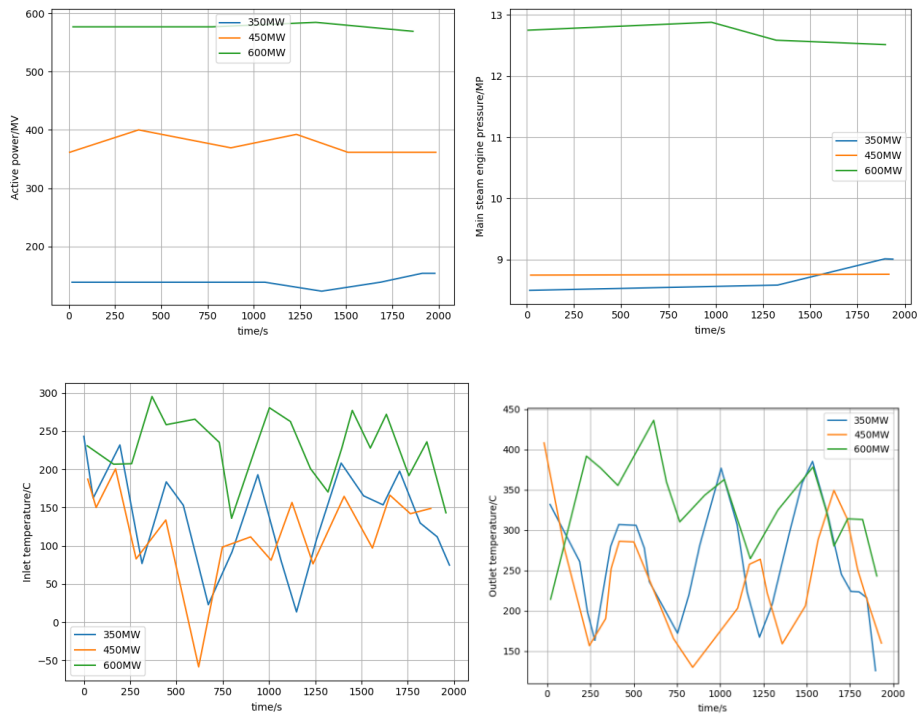


Figure 5 Final stage superheater modeling data curve

The modeling data segmentation, ab segment data 400 groups, bc, cd segment data are 800 groups. The model identification results are shown in Table 2.

Table 2 Model optimal parameters

Working condition/ MW	n	k_0	T_0	τ
300	7	2.14	33.38	17
450	7	2.18	24.52	14
600	7	2.24	13.48	8

The identification result curve is shown in Figure 6.

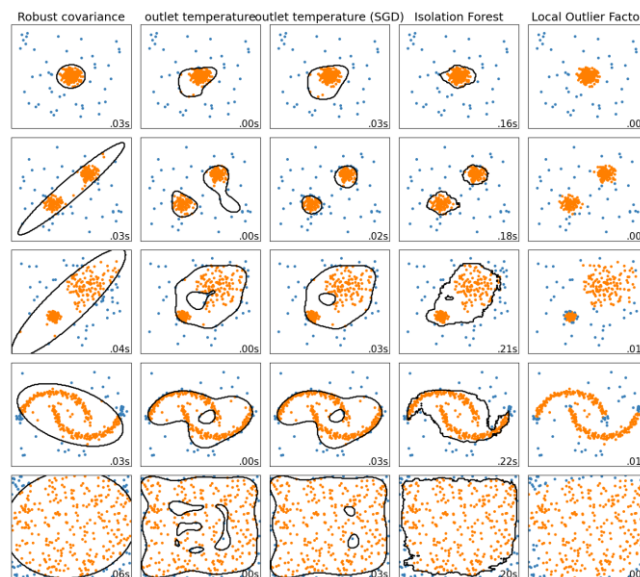


Figure 6 Identification result curve

It should be noted that the accuracy of the model built by this modeling method is related to the number of typical working conditions selected, and the more typical working conditions selected, the more accurate the model built. In this section, only three typical conditions are selected for modeling and model fitting, mainly to reproduce the modeling process proposed in this paper and to guide the practical application of this method. Since there are enough historical data of the process industry available, the number of typical conditions can be selected according to the modeling accuracy requirements in practice[21,22].

In addition, compared with the least squares and its improved algorithms, this method only applies the historical system operation data to model the system without adding perturbation signals to the system, so there is no impact on the system, and the model is a parametric model, which has better generality than the data-driven recognition algorithms such as neural networks and support vector machines.

VI. CONCLUSION

The concept of smart city is proposed to meet the requirements of higher level development and construction of future cities, therefore, the combination of urban architectural design and the concept of smart city is the inevitable result. Many new functions and experiences are unimaginable in the past, which will be another "revolution" in the history of architectural development. At the same time, the concept of smart city also puts forward higher requirements for the architectural design of the city, many issues still need to be solved, we still need to continue to learn from the experience of future practice, multi-start, both to consider the technical feasibility, but also pay attention to energy saving and environmental protection and safety. It is believed that the architectural design combined with the smart city will make the city develop in the direction of more comfortable, safe and high-end.

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REFERENCES

- [1] Qi, J., Jiang, G., Li, G., Sun, Y., & Tao, B. (2019). Intelligent human-computer interaction based on surface EMG gesture recognition. *Ieee Access*, 7, 61378-61387.
- [2] Gaska, K., & Generowicz, A. (2020). SMART Computational Solutions for the Optimization of Selected Technology Processes as an Innovation and Progress in Improving Energy Efficiency of Smart Cities—A Case Study. *Energies*, 13(13), 3338.
- [3] Harrison, C., Eckman, B., Hamilton, R., Hartswick, P., Kalagnanam, J., Paraszczak, J., & Williams, P. (2010). Foundations for smarter cities. *IBM Journal of research and development*, 54(4), 1-16.
- [4] Juan, Y. K., Wang, L., Wang, J., Leckie, J. O., & Li, K. M. (2011). A decision-support system for smarter city planning and management. *IBM Journal of Research and Development*, 55(1.2), 3-1.
- [5] Li, D., Deng, L., & Cai, Z. (2020). Intelligent vehicle network system and smart city management based on genetic algorithms and image perception. *Mechanical Systems and Signal Processing*, 141, 106623.
- [6] D'Aniello, G., Gaeta, M., Orciuoli, F., Sansonetti, G., & Sorgente, F. (2020). Knowledge-based smart city service system. *Electronics*, 9(6), 965.
- [7] Li, X., Liu, H., Wang, W., Zheng, Y., Lv, H., & Lv, Z. (2022). Big data analysis of the internet of things in the digital twins of smart city based on deep learning. *Future Generation Computer Systems*, 128, 167-177.
- [8] Shirowzhan, S., Tan, W., & Sepasgozar, S. M. (2020). Digital twin and CyberGIS for improving connectivity and measuring the impact of infrastructure construction planning in smart cities. *ISPRS International Journal of Geo-Information*, 9(4), 240.
- [9] Chang, K. C., Chu, K. C., Wang, H. C., Lin, Y. C., & Pan, J. S. (2020). Agent-based middleware framework using distributed CPS for improving resource utilization in smart city. *Future Generation Computer Systems*, 108, 445-453.
- [10] Zhang, C. (2020). Design and application of fog computing and Internet of Things service platform for smart city. *Future Generation Computer Systems*, 112, 630-640.

- [11] Alsamhi, S. H., Ma, O., Ansari, M. S., & Almalki, F. A. (2019). Survey on collaborative smart drones and internet of things for improving smartness of smart cities. *Ieee Access*, 7, 128125-128152.
- [12] Qayyum, S., Ullah, F., Al-Turjman, F., & Mojtahedi, M. (2021). Managing smart cities through six sigma DMADICV method: A review-based conceptual framework. *Sustainable Cities and Society*, 72, 103022.
- [13] Ejaz, W., Naeem, M., Shahid, A., Anpalagan, A., & Jo, M. (2017). Efficient energy management for the internet of things in smart cities. *IEEE Communications magazine*, 55(1), 84-91.
- [14] Lu, H. P., Chen, C. S., & Yu, H. (2019). Technology roadmap for building a smart city: An exploring study on methodology. *Future Generation Computer Systems*, 97, 727-742.
- [15] Zhu, F., Li, Z., Chen, S., & Xiong, G. (2016). Parallel transportation management and control system and its applications in building smart cities. *IEEE Transactions on Intelligent Transportation Systems*, 17(6), 1576-1585.
- [16] Kim, T. H., Ramos, C., & Mohammed, S. (2017). Smart city and IoT. *Future Generation Computer Systems*, 76, 159-162.
- [17] Qadir, Z., Ullah, F., Munawar, H. S., & Al-Turjman, F. (2021). Addressing disasters in smart cities through UAVs path planning and 5G communications: A systematic review. *Computer Communications*, 168, 114-135.
- [18] Jingchun Zhou, Dehuan Zhang, Weishi Zhang. Cross-view enhancement network for underwater images. *Engineering Applications of Artificial Intelligence*, 2023, 121, 105952.
- [19] 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.
- [20] Meqdad, M. N. (2021). Smart cities: Understanding policies, standards, applications and case studies. *Int J Electr Comput Eng (IJECE)*, 11(4), 3137-3144.
- [21] Hancke, G. P., de Carvalho e Silva, B., & Hancke Jr, G. P. (2012). The role of advanced sensing in smart cities. *Sensors*, 13(1), 393-425.
- [22] Eremia, M., Toma, L., & Sanduleac, M. (2017). The smart city concept in the 21st century. *Procedia Engineering*, 181, 12-19.