Optimizing Multi-Dimensional SCADA Report Generation Using LSO-GAN for Web-Based Applications

Fanxiu Fang[1], Guocheng Qi[2], Haijun Cao[3], He Huang[4], Lingyi Sun[5], Jingli Yang[6], Yan Sui[7], Yun Liu[8], Dongqing You[9], Wenyu Pei[10]
Pipe China Oil and Gas Control Center, Beijing, 10020, China[1, 2, 4, 5, 6, 8, 9, 10]
Kunlun Digital Technology Co., Ltd. Beijing, 10020, China[3, 7]
School of Software, Tsinghua University, Beijing, 100084, China[4]

***Abstract*—This paper addresses the challenges of custom-generating multi-dimensional data SCADA (Supervisory Control And Data Acquisition) reports using web technologies. To improve efficiency, reduce maintenance costs, and enhance scalability, the paper proposes a custom generation method based on the LSO-GAN (Light Spectrum Optimizer - Generative Adversarial Network) model. The study begins by analyzing the requirements for multi-dimensional SCADA reports and proposes a web-based design scheme. The LSO algorithm is employed to optimize the GAN model, enabling efficient generation of customizable SCADA reports. The proposed LSO-GAN model was validated using relevant SCADA data, with experimental results showing that the method outperformed other models in terms of accuracy and generation efficiency. Specifically, the LSO-GAN model achieved an RMSE of 14.98 and a MAPE of 0.93, surpassing traditional models such as Conv-LSTM and FC-LSTM. The custom report generation method based on LSO-GAN significantly improves the customization and generation of multi-dimensional data SCADA reports, demonstrating superior performance in both accuracy and operational efficiency.**

Keywords*—Web technologies; SCADA systems; report customisation; spectral optimisation algorithms; adversarial generative networks

I. INTRODUCTION

Report is a dynamic display of data information through tables, graphs and other diverse formats, it is a form of expression of data statistics [1]. As an important tool for analysing and displaying information and printing, reports can be used to quickly organize and analyze data and become an important basis for development decisions in various industries [2].SCADA (Supervisory Control And Data Acquisition) system is a computer system used to monitor and control industrial processes [3]. SCADA systems based on Web technology in order to be accessed through a Web browser, they provide the ability to monitor and control remotely and are suitable for distributed control systems [4]. Multidimensional data reports are key components in SCADA systems, they allow users to analyse data from different perspectives and dimensions to better understand and optimise industrial processes [5]. Therefore, the study of customised methods for generating multidimensional data SCADA reports is beneficial to improve efficiency, reduce maintenance costs and increase scalability [6].

With the development of Internet and Web technologies and the diversification of users' needs for reports, the development of report generation methods has become the focus of attention of experts and scholars in the field, especially in the customisation of multi-dimensional data SCADA reports [7]. In the context of globalisation of information technology, the implementation technology of Web reporting tools has been constantly innovated and improved. At present, the Web reporting tool implementation technology is more, which is more widely used, the practicality of the better there are mainly the following three schemes [8]: (1) based on the COM components of the programme. Xie et al. [9] describe the VB environment based on the ADO pairs and COM components Excel data processing functions combined to achieve the report printing function. Chen et al. [10] developed an Excel-based put custom report dynamic library, using COM technology, the output of a new output report; (2) based on the ActiveX plug-in programme. Cuzzocrea et al. [11] combined with the Jasper Reports open source project to generate reports to meet the needs of dynamic generation of Web reports; (3) XML-based plug-in-free programme. Munz-Krner and Weiskopf [12] proposed an XML-based Web-oriented intelligent reporting system. Nasri and Weslati [13] studied the Web-based custom reporting tool design method. With the increasing data dimensionality in SCADA systems, the current report generation methods no longer meet the design requirements. For the current multi-dimensional data SCADA system requirements, this paper combines Web technology [14], intelligent optimisation algorithms [15] and neural network methods [16], and proposes a Web-based custom intelligent generation method for multi-dimensional data SCADA reports. The contributions of this paper include the following:

- (1) Describe the problem of multi-dimensional data SCADA report customisation and give relevant solutions to the problem;
- (2) Around the SCADA report customisation generation, combined with the LSO algorithm [17] and the GAN network [18], propose the SCADA report customisation generation algorithm based on the LSO-GAN;
- (3) Use the multi-dimensional data report relevant information to validate the report customisation algorithm. The results show that the method proposed in

this paper achieves the customisation of multi-dimensional data SCADA reports, and at the same time improves the intelligent generation efficiency by using LSO-GAN.

II. PROBLEM DESCRIPTION AND ANALYSIS

A. Requirements Analysis for Custom Reports on Multidimensional Data

The main engineering requirements for multidimensional data reporting enable a defined set of better report semantics to achieve custom report customisation (Fig. 1). Therefore, a good set of reporting tool software and methodology should fulfil the following functions: 1) report data management; 2) report design tools; 3) report file management; and 4) report integration and application [19], as shown in Fig. 2.

Fig. 1. Multi-dimensional data custom report style.

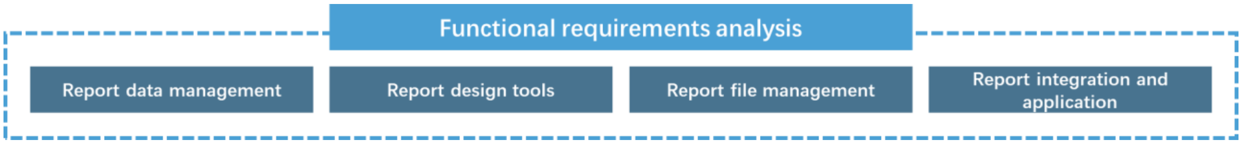


Fig. 2. Functional requirements analysis.

In addition to the analysis of functional requirements, it is also need to analyse the performance requirements of the tool, especially the custom reporting tool method of ease of use and security and reliability. 1) in terms of ease of use, report generation method needs to provide users with a friendly interface, mainly for: rapid formatting and content parsing, fast preview of the Web page, the data import and export of the report quickly; 2) security reliability, the main performance: identity verification, operation rights management, input information legality detection, deletion warning, real-time recording of important operations, as shown in Fig. 3.

B. SCADA Report Custom Generation Idea Design

1) Web-based custom reporting tool workflow: The overall workflow of the Web-based custom reporting tool is shown in Fig. 4.

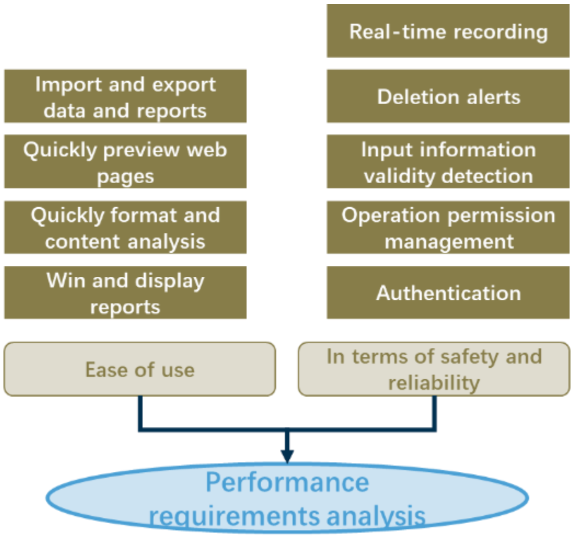


Fig. 3. Analysis of performance requirements.

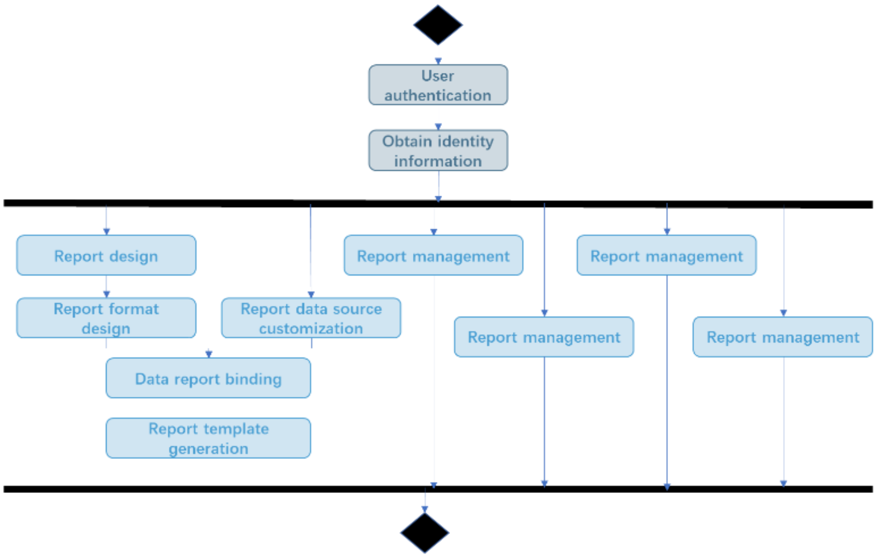


Fig. 4. Reporting tool flow.

As can be seen in Fig. 4, the user logs into the system for user authentication, obtains user identity and permission information, and enters the main interface of the SCADA reporting software. Depending on the user's privileges, one or more of the management functions, such as report customisation, report template management, report browsing and printing, report file export and system management, can be performed [20].

2) *Steps for customising multidimensional data reports:* Customising a multidimensional data report typically involves the following steps (Fig. 5): 1) identifying the purpose and user requirements of the report; 2) collecting and organising the required data sets; 3) selecting a tool that supports web development; 4) designing the visual layout of the report; 5) developing the report functionality; 6) testing and optimising; and 7) deploying and maintaining [21].

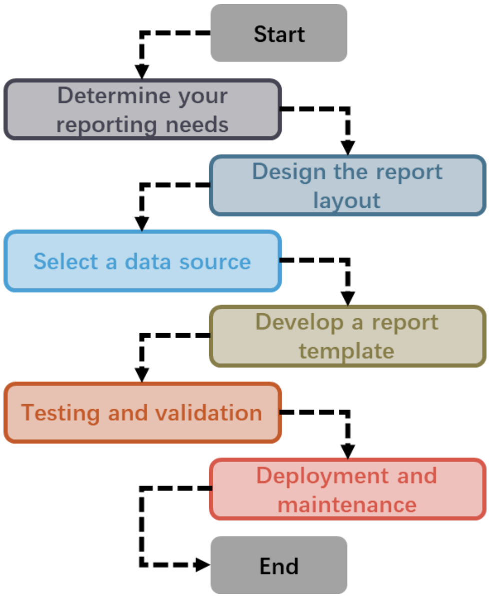


Fig. 5. Custom report workflow.

3) *Customised SCADA report generation and analysis:* In order to be in practical applications, many reports are basically the same in format and script, and the main difference lies in the different equipment of the data source. In order to further improve the efficiency of report generation, this paper uses deep learning technology and intelligent optimisation algorithms to introduce SCADA report custom generation algorithms, the specific analysis is shown in Fig. 6.

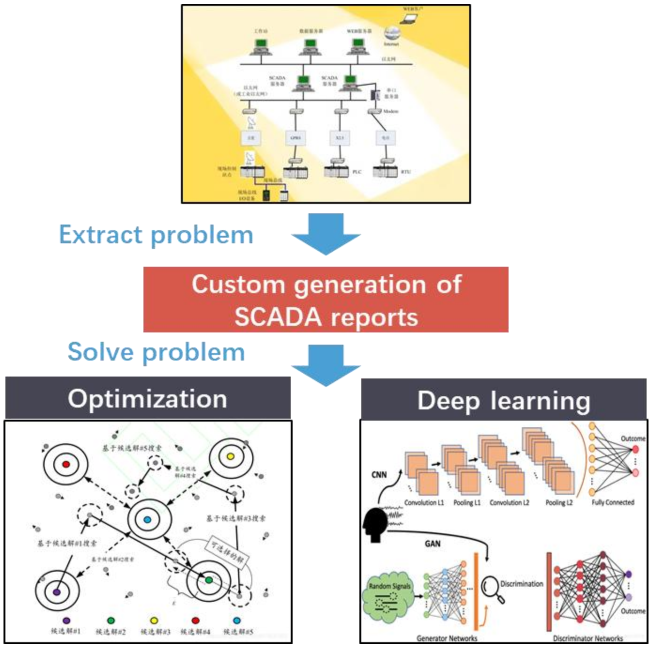


Fig. 6. Analysis of key technologies for customised generation of SCADA reports.

III. CUSTOMISED SCADA REPORT GENERATION

A. *Adversarial Generative Networks*

Adversarial Generative Networks (GANs) [21] were proposed by Goodfellow et al. and are shown in Fig. 7. The basic

GAN architecture consists of two fundamental components: a generator $G\left(z;\theta_g\right)$ and a discriminator $D\left(x;\theta_d\right)$ which work against each other. The generator captures the distribution P_g of data x from the noise variable $P_z\left(z\right)$ and generates fake data that looks real and can deceive the discriminator; the discriminator distinguishes whether different categories are fake or not and acts as a classifier to model the probability of each category.

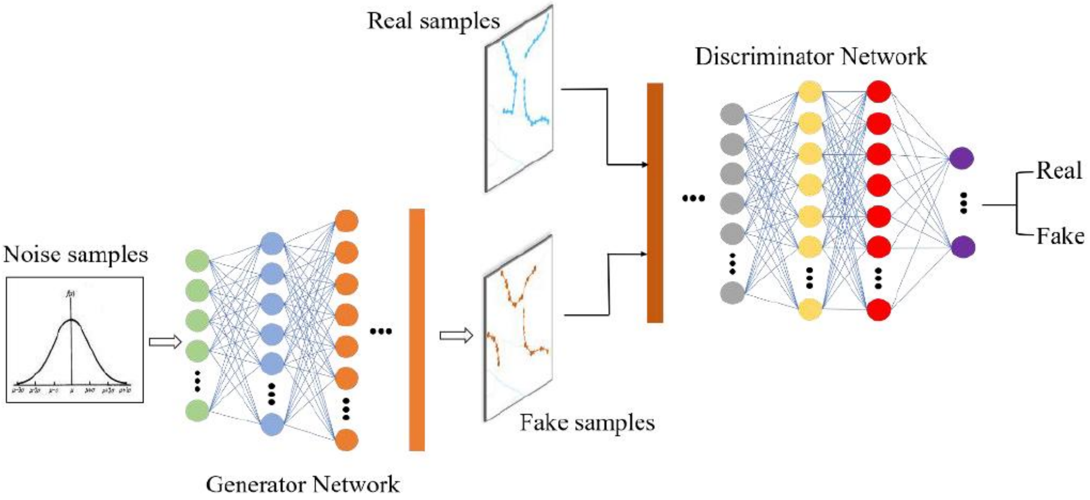


Fig. 7. Schematic diagram of GAN structure.

Ideally, the generator G can generate fake data with the data $G\left(z\right)$ and it is difficult for the discriminator to distinguish whether the data generated by G is real or not. Finally, the two components reach dynamic equilibrium, i.e. $D\left(G\left(z\right)\right)=0.5$:

$$\min_{G}\max_{D} V\left(D,G\right)=E_{x\sim pdata(x)}\left[\log D\left(x\right)\right]+E_{z\sim p(x)}\left[\log\left(1-D\left(G\left(z\right)\right)\right)\right] \tag{1}$$

GANs use only backpropagation and do not require complex Markov chains to compare with other generative models such as Boltzmann machines [22]. The main advantage of GANs is that they can automatically learn the distribution of the data from the original set of samples, generating clearer and more realistic samples. Even complex distributions can be learnt by a GAN if it is trained well enough.

GAN training process: during the training process, the generator and the discriminator are updated alternately. First, the weights of the discriminator are fixed and the generator is trained to produce more plausible data; then, the weights of the generator are fixed and the discriminator is trained to better distinguish real data from generated data [23]. This process is repeated until an equilibrium point is reached, at which point the generator is able to produce samples that are virtually indistinguishable from the real data, as shown in Fig. 8.

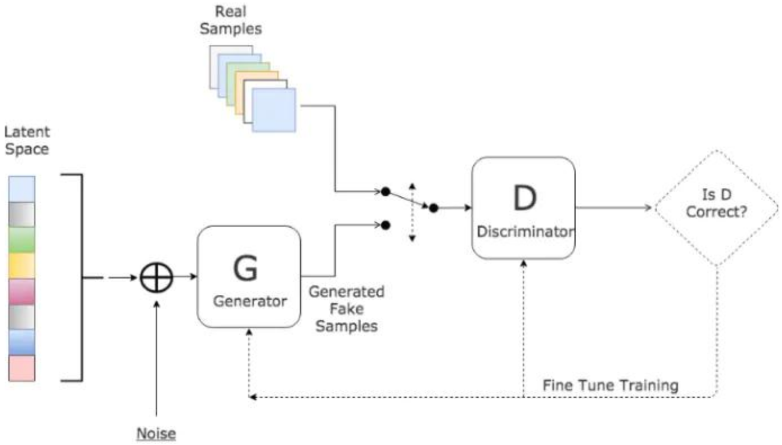


Fig. 8. GAN training process.

GANs are widely used in many fields such as image generation, image restoration, style migration, video generation, etc [24], as shown in Fig. 9. They are not only capable of generating high-quality images, but also play a role in tasks such as image segmentation and video prediction. With the deepening of research, variants and improved versions of GANs have emerged to address the problems of the original GAN models in terms of training stability and pattern collapse.

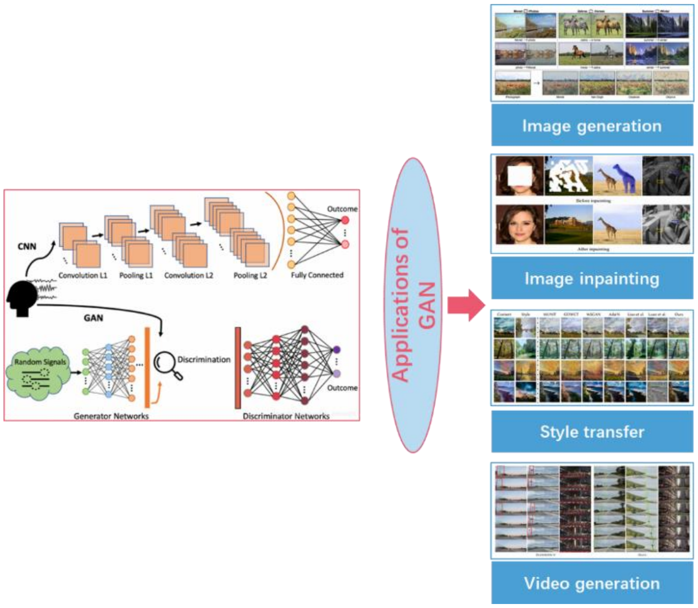


Fig. 9. GAN application.

B. LSO-GAN Network

1) LSO algorithm: Light Spectrum Optimizer (LSO) [25] is a meta-heuristic algorithm, an optimisation algorithm based on spectral analysis, which simulates the spectral distribution and peak search process in spectral analysis. The algorithm adaptively adjusts the resolution of the search space and the search speed in order to find the optimal solution quickly and accurately, which has the characteristics of fast convergence and high solution accuracy. The optimization process of the LSO algorithm includes the optimization strategies such as initialization, generation of new coloured rays, and dispersion of the coloured rays, which are shown in Fig. 10.

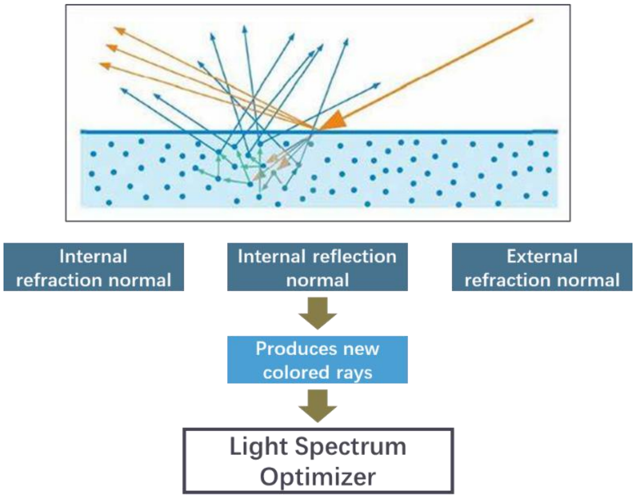


Fig. 10. Analysis of optimisation strategy of LSO algorithm.

a) Initialisation: The LSO algorithm uses a random initialisation strategy to model the white light population:

$$x^0 = lb + RV_1 \times (ub - lb) \tag{2}$$

where x^0 denotes the white light initialisation population, lb and ub denote the search lower and upper bounds respectively, and RV_1 denotes the random vector.

b) The direction of the rainbow spectrum: After initialisation, the internal refraction normal vector, internal reflection normal vector and external refraction normal vector are calculated as follows:

$$x_{nA} = \frac{x_t^r}{norm(x_t^r)} \tag{3}$$

$$x_{nB} = \frac{x_t^p}{norm(x_t^p)} \tag{4}$$

$$x_{nC} = \frac{x^*}{norm(x^*)} \tag{5}$$

Where x_{nA} , x_{nB} and x_{nC} denote the internal refraction normal vector, internal reflection normal vector and external refraction normal vector respectively, x_t^r denotes the current randomly selected ray, x_t^p denotes the current ray individual, and x^* denotes the current optimal ray individual. $norm$ denotes the normalisation method.

For incident light, it is calculated using the averaging method with the following formula:

$$X_{mean} = \frac{\sum_{i=1}^{N} x_i}{N} \tag{6}$$

$$x_{L0} = \frac{X_{mean}}{norm\left(X_{mean}\right)} \tag{7}$$

where x_{L0} denotes the incident light, X_{mean} denotes the average position information of the light population, and N is the population size magnitude.

The mathematical model for the calculation of internal and external refracted and reflected rays is as follows:

$$x_{L1} = \frac{1}{k^r}\left(x_{L0} - x_{nA}\left(x_{nA} \cdot x_{L0}\right)\right) - x_{nA}\left|1 - \frac{1}{\left(k^r\right)^2} + \frac{1}{\left(k^r\right)^2}\left(x_{nA} \cdot x_{L0}\right)^2\right|^{\frac{1}{2}} \tag{8}$$

$$x_{L2} = x_{L1} - 2x_{nB}\left(x_{L1} \cdot x_{nB}\right) \tag{9}$$

$$x_{L3} = k^r\left(x_{L2} - x_{nC}\left(x_{nC} \cdot x_{L2}\right)\right) + x_{nC}\left|1 - \left(k^r\right)^2 + \left(k^r\right)^2\left(x_{nC} \cdot x_{L2}\right)^2\right|^{\frac{1}{2}} \tag{10}$$

Where x_{L1} , x_{L2} and x_{L3} denote refracted, internally reflected and externally refracted rays respectively, and k^r denotes the refractive index, a random spectral colour can be defined:

$$k^r = k^{red} + RV_1\left(k^{violet} - k^{red}\right) \tag{11}$$

where RV_1 denotes a random number.

c) Generation of new coloured rays (Exploration search mechanism): After calculating the light direction, the random vector is used to calculate and select the candidate solution location information as modelled below:

$$x_{t+1} = \begin{cases} x_t + \varepsilon RV_1^n GI\left(x_{L1} - x_{L3}\right) \times \left(x_{r1} - x_{r2}\right) & p < rand \\ x_t + \varepsilon RV_2^n GI\left(x_{L2} - x_{L3}\right) \times \left(x_{r3} - x_{r4}\right) & p \geq rand \end{cases} \tag{12}$$

Where x_{r1} , x_{r2} , x_{r3} and x_{r4} denote randomly selected light individuals, RV_1^n and RV_2^n denote uniformly distributed vectors, ε denotes the scaling factor, and GI is the adaptive control factor based on the inverse incomplete function.

$$\varepsilon = a \times RV_3^n \tag{13}$$

$$GI = a \times r^{-1} \times P^{-1}\left(a, 1\right) \tag{14}$$

$$a = RV_2\left(1 - \frac{t}{T\max}\right) \tag{15}$$

Where RV_3^n denotes normally distributed random numbers with 0 as the mean and 1 as the standard deviation, a denotes adaptive parameters, r denotes random numbers, P^{-1} is the inverse incomplete function, t is the current number of iterations, and $T\max$ is the maximum number of iterations. Different values of a have different values of adaptive control factors, which mainly control the balance of development and exploration behaviour operations, the specific curve changes are shown in Fig. 11.

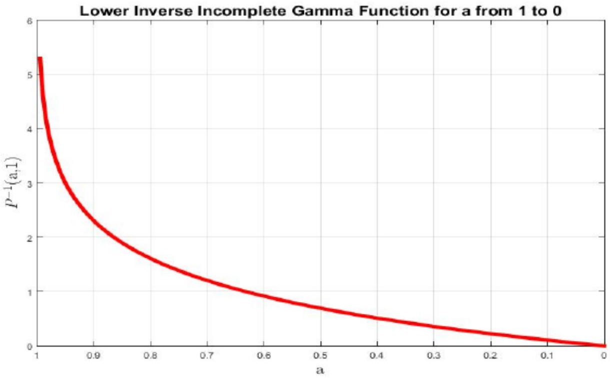


Fig. 11. Inverse incomplete function variation curve.

d) Coloured light dispersion (Exploitation search mechanism): The optimisation model for the colour light dispersion phase is calculated as follows:

$$x_{t+1} = \begin{cases} x_t + RV_3 \times \left(x_{r1} - x_{r2}\right) + RV_4^n \times \left(R < \beta\right) \times \left(x^* - x_t\right) & R < P_e \\ 2\cos\left(\pi \times r_1\right)\left(x^*\right)\left(x_t\right) & Otherwise \end{cases} \tag{16}$$

where RV_3 is a random number chosen between 0 and 1, RV_4^n is a random vector, x^* denotes the best ray individual, x_{r1} and x_{r2} denote randomly chosen ray individuals, r_1 denotes a random number, P_e denotes a predetermined probability, and R is a random number.

The final scattering phase is to generate new ray individuals based on random ray individuals and current individuals:

$$x_{t+1} = \left(x_{r1}^p + \left|RV_5\right| \times \left(x_{r2} - x_{r3}\right)\right) \times U + \left(1 - U\right) \times x_t \tag{17}$$

Where RV_5 denotes normally distributed random numbers and U denotes that 0's and 1's are random vectors.

Switching Eq. (22) with Eq. (21) based on the difference in calculated fitness values is as follows:

$$x_{t+1} = \begin{cases} Eq.(21) & R < P_s \,|\, F' < R_1 \\ Eq.(22) & Otherwise \end{cases} \tag{18}$$

$$F' = \left| \frac{F - F_b}{F_b - F_w} \right| \tag{19}$$

Among them, F' denotes the normalised value of the fitness value of the current light individual (the relationship between F' and R_1 is shown in Fig. 12), F , F_b and F_w denote the fitness values of the current individual, the optimal solution individual, and the worst solution individual, respectively, the predetermined probability P_s is used to promote the acceleration of the first dispersal stage and the second dispersal stage to the vicinity of the optimal solution, and R_1 and R are random numbers.

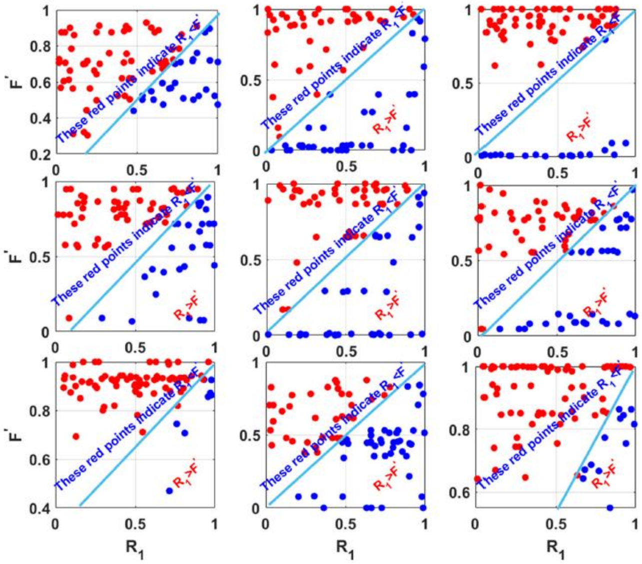


Fig. 12. Schematic diagram of the relationship between R1 and F'.

The pseudo-code of the LSO algorithm is shown in Table I.

TABLE I. PSEUDO-CODE OF LSO ALGORITHM

```
Algorithm 1: LSO algorithm pseudo-code
Inputs: ray population size N, maximum number of iterations Tmax;
Generating initialised random population rays;
t=0;
While t<Tmax
    Evaluate light adaptation values;
    t=t+1;
    Update the optimal solution;
    Calculate the ray normal vector;
    Calculate refracted, internally reflected and externally refracted rays;
    Update refractive index, scaling factor, adaptive control factor, adaptive parameters;
    Generate random numbers p, q;
    Update the light using the Exploration search mechanism;
    Evaluate light adaptation values;
    t=t+1; update the optimal solution;
    Update the light using the Exploitation search mechanism;
End while
Output: optimal light and its adaptation value.
```

2) LSO-GAN network: In order to improve the efficiency of GAN network generation, this paper adopts the LSO algorithm to optimise the GAN hyper-parameters, and uses the RMSE as the fitness value to improve the optimisation of the GAN using the LSO optimisation strategy, and the specific optimisation structure is shown in Fig. 13.

Fig. 13. Principle of LSO-GAN structure.

C. LSO-GAN in Multi-Dimensional Data SCADA Report Customisation

In order to improve the efficiency of report generation, this paper adopts LSO-GAN network to build multi-dimensional data SCADA report custom generation model, the specific application is shown in Fig. 14. Based on LSO-GAN network multi-dimensional data SCADA report custom generation method mainly includes five parts: multi-dimensional data SCADA report design requirements analysis, report layout design, data selection and processing, SCADA report generation, generation model performance analysis. As the key part of the multi-dimensional data SCADA report customisation problem, SCADA report generation uses LSO-GAN network to construct multi-dimensional data SCADA report customisation generation model by training the acquired SCADA data, and realises the intelligent generation of SCADA report customisation.

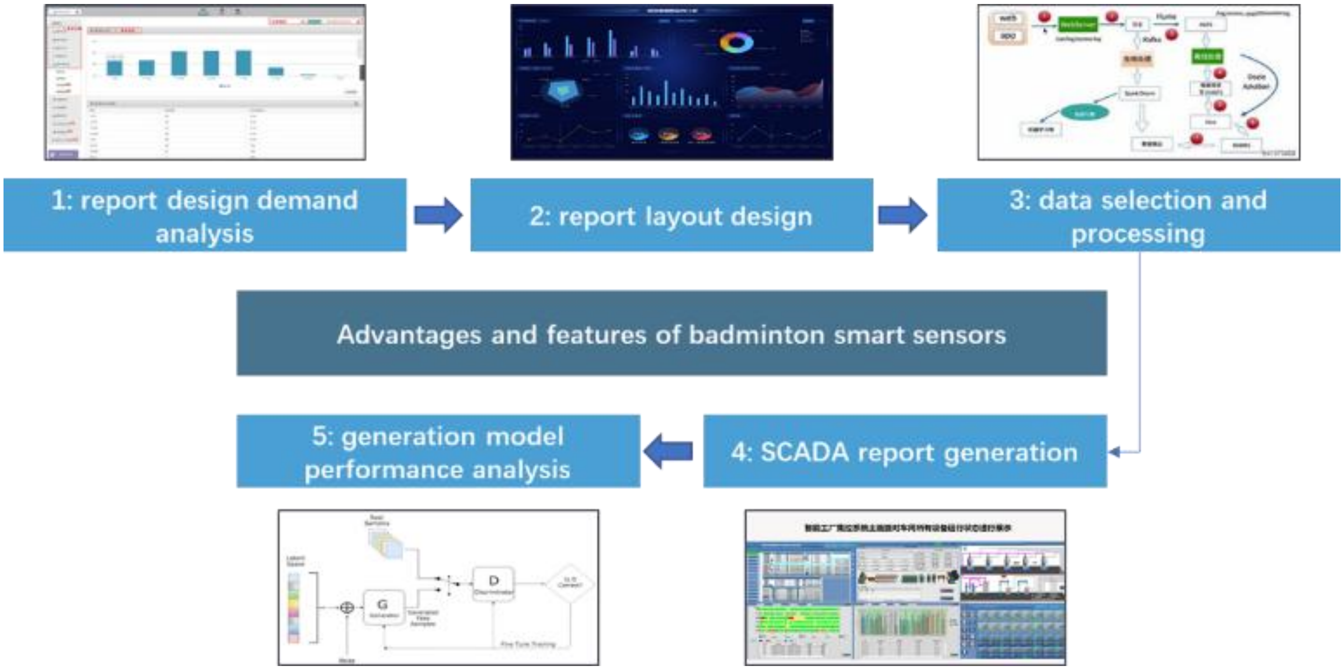


Fig. 14. LSO-GAN network application analysis.

IV. EXPERIMENTAL ANALYSIS AND DISCUSSION

A. *Environmental Settings*

In order to verify the high efficiency of the LSO-GAN network application proposed in this paper, this paper takes the SCADA system report data as the analysed data, and adopts Conv-LSTM, FC-LSTM, DyConv-LSTM, CNN-LSTM as the comparison algorithms of the LSO-GAN network, and the specific parameter settings are shown in Table II.

TABLE II. COMPARISON NETWORK PARAMETER SETTINGS

Arithmetic	**Parameterisation**
ConvLSTM	A GAN structure is used with ConvLSTM for generator and discriminator, Tanh activation function is used for generator and the discriminator output consists of Sigmoid activation function using Adam optimiser with learning rate 0.0002, batch size 64 and iteration number 400.
FC-LSTM	A GAN structure is used with FC-LSTM for the generator and discriminator, using the Adam optimiser with a learning rate of 0.0002, a batch size of 4 and an iteration count of 400.
DyConv-LSTM	A GAN structure is used, with DyConv-LSTM for generator and discriminator, Adam optimiser, learning rate 0.0002, batch size 16, and number of iterations 400.
CNN-LSTM	A GAN structure is used with CNN-LSTM for the generator and discriminator, Adam optimiser with a learning rate of 0.0002, batch size of 64 and 1000 iterations.
LSO-GAN	The population size of the LSO algorithm is chosen to be 100 and the maximum number of iterations is set to 400.

B. *Presentation and Discussion of Results*

1) Analysis of the effect of custom report generation: In order to verify the feasibility of the report custom generation effect, this paper takes the enterprise SCADA system report design as a case study, and obtains the effect diagrams in Fig. 15 and Fig. 16.

Fig. 15 gives the effect of SCADA system report user function privilege configuration. Administrators can bind functional rights for roles in the Role Management - Function Configuration module, and then bind roles for users in the Personnel Management - Edit Personnel module, at which time users have the rights to the configured functions. Figure 16 shows the effect of the multi-dimensional data report of SCADA system. Users in this page according to the needs of flexible configuration of the number of conditions, page configuration is complete, click the "query" button, the system to implement the logic of the number of query results in the form of a list of displays to meet user needs.

级联选择：[redacted]】数据分析, 全部, [redacted]

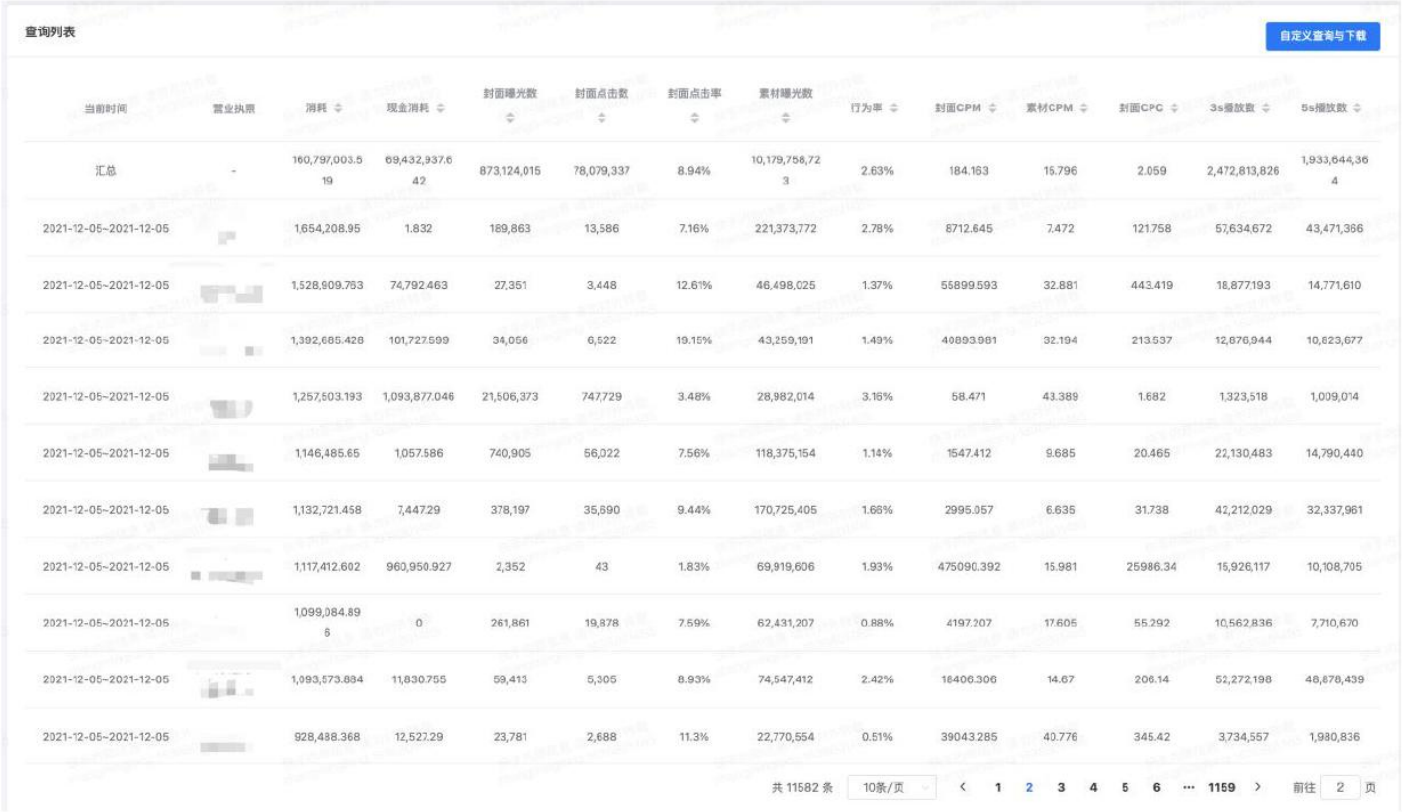
☐ 全部
☑ [redacted] 数据分 [redacted]
☐ [redacted] 客户管 [redacted]
☑ 全部
☑ [redacted] 大盘分析
☑ [redacted] 销售日 [redacted]

已选菜单：

KA直客业绩看板 ×
品运效率看板 ×
小财取数 ×
业绩看板 ×
实时数据查询 ×
渠道分析看板 ×
ttttt ×
aaab ×
小财取数新菜单测试 ×
小店运营分析 ×
魔数测试1 ×
魔数测试2 ×
报表管理 ×
魔数测试3 ×

* 用户姓名：张明龙
用户快手id：[redacted]
用户快手号：必须填入用户快手id与用户快手号中任意一项
用户邮箱：zhangminglong@kuaishou.com
用户手机号：[redacted]
绑定角色：
【[redacted]】管理员 ×
【[redacted]】[redacted]... ×
【[redacted]】初始角色 ×
【[redacted]】管理员 ×
【[redacted]】系统管理员 ×
【[redacted]】初始角色 ×
绑定功能资源：测试权限-测试 ×
所属组织架构：测试 ×

Fig. 15. Custom reporting user function permission configuration effect.



当前时间	营业执照	消耗	现金消耗	封面曝光数	封面点击数	封面点击率	素材曝光数	行为率	封面CPM	素材CPM	封面CPC	3s播放数	5s播放数
汇总	-	160,797,003.519	69,432,937.642	873,124,015	78,079,337	8.94%	10,179,758,723	2.63%	184.163	15.796	2.059	2,472,813,826	1,933,644,364
2021-12-05~2021-12-05	[redacted]	1,654,208.95	1.832	189,863	13,586	7.16%	221,373,772	2.78%	8712.645	7.472	121.758	57,634,672	43,471,366
2021-12-05~2021-12-05	[redacted]	1,528,909.763	74,792.463	27,351	3,448	12.61%	46,498,025	1.37%	55899.593	32.881	443.419	18,877,193	14,771,610
2021-12-05~2021-12-05	[redacted]	1,392,685.428	101,727.599	34,056	6,522	19.15%	43,259,191	1.49%	40893.981	32.194	213.537	12,876,944	10,623,677
2021-12-05~2021-12-05	[redacted]	1,257,503.193	1,093,877.046	21,506,373	747,729	3.48%	28,982,014	3.16%	58.471	43.389	1.682	1,323,518	1,009,014
2021-12-05~2021-12-05	[redacted]	1,146,485.65	1,057.586	740,905	56,022	7.56%	118,375,154	1.14%	1547.412	9.685	20.465	22,130,483	14,790,440
2021-12-05~2021-12-05	[redacted]	1,132,721.458	7,447.29	378,197	35,690	9.44%	170,725,405	1.66%	2995.057	6.635	31.738	42,212,029	32,337,961
2021-12-05~2021-12-05	[redacted]	1,117,412.602	960,950.927	2,352	43	1.83%	69,919,606	1.93%	475090.392	15.981	25986.34	15,926,117	10,108,705
2021-12-05~2021-12-05		1,099,084.896	0	261,861	19,878	7.59%	62,431,207	0.88%	4197.207	17.605	55.292	10,562,836	7,710,670
2021-12-05~2021-12-05	[redacted]	1,093,573.884	11,830.755	59,413	5,305	8.93%	74,547,412	2.42%	18406.306	14.67	206.14	52,272,198	48,878,439
2021-12-05~2021-12-05	[redacted]	928,488.368	12,527.29	23,781	2,688	11.3%	22,770,554	0.51%	39043.285	40.776	345.42	3,734,557	1,980,836

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Fig. 16. Multi-dimensional data report display effect.

2) Algorithm performance analysis: In order to verify the report generation effect of LSO-GAN network, this paper adopts Conv-LSTM, FC-LSTM, DyConv-LSTM, CNN-LSTM as the comparison algorithms, and evaluates the models in terms of RMSE, MAPE, training time, generation time, etc., and the specific results are shown in Table III, Fig. 17 to Fig. 20.

Table III gives the comparison of performance results of different SCADA multidimensional data report definition generation networks. From Table III, it can be seen that in terms of RMSE, the SCADA multidimensional data report definition generation method based on LSO-GAN network is better than other networks and has a value of 14.98, and in terms of MAPE, LSO-GAN network is better than Conv-LSTM, FC-LSTM, DyConv-LSTM, and CNN-LSTM, and has a value of 0.93.

TABLE III. COMPARISON OF THE PERFORMANCE OF DIFFERENT REPORT CUSTOM GENERATION NETWORKS

Arithmetic	RMSE	MAPE
Conv-LSTM	15.98	0.89
FC-LSTM	16.79	0.86
DyConv-LSTM	28.67	2.25
CNN-LSTM	26.77	1.52
LSO-GAN	14.98	0.93

Fig. 17 gives the comparison of the accuracy of different networks for different time periods. From Fig. 17, it can be seen that the RMSE value of SCADA multidimensional data report definition generation method based on LSO-GAN network is less than other algorithms, which indicates that LSO-GAN network has better generation accuracy.

The training optimisation time and test generation time of different SCADA multidimensional data report custom generation methods are given in Fig. 18 and Fig. 19 respectively. From Fig. 18 and Fig. 19, it can be seen that the LSO-GAN network is ranked first in terms of both training optimisation time and test generation time, which are 38.4921s and 0.02772, respectively. This shows that the LSO-GAN network is the most efficient in generating reports.

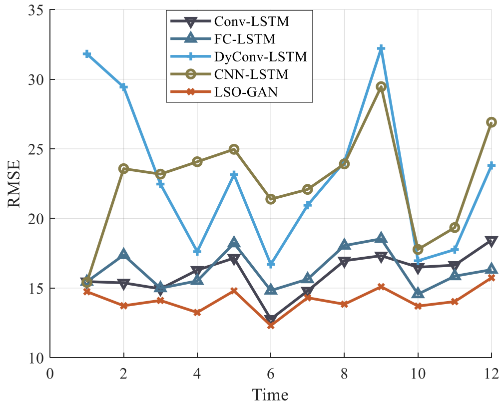


Fig. 17. Comparison of model accuracy performance of the compared algorithms.

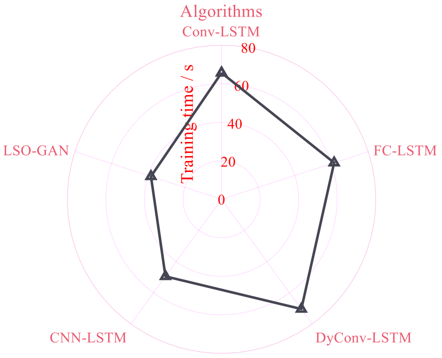


Fig. 18. Comparison of training time for different report custom generation networks.

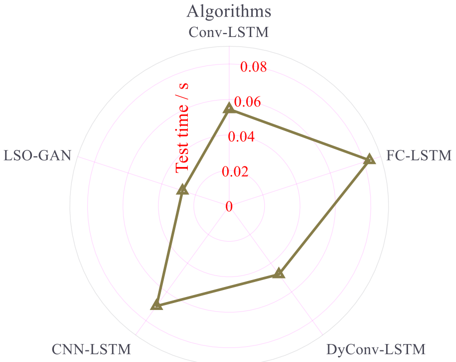
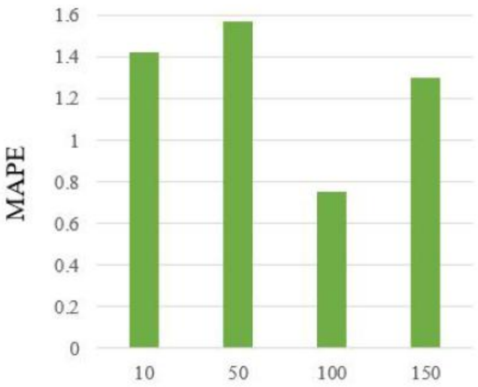
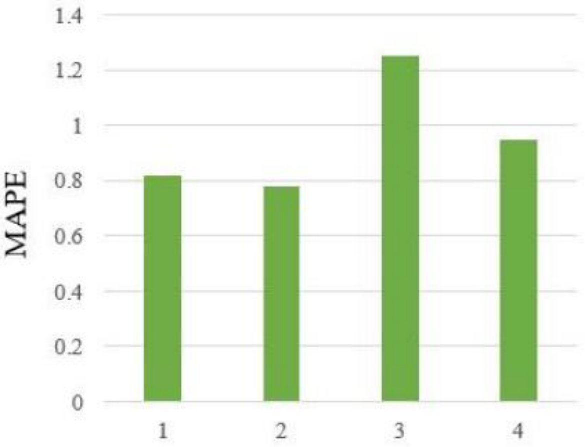


Fig. 19. Comparison of time spent on different report customisation generation networks.

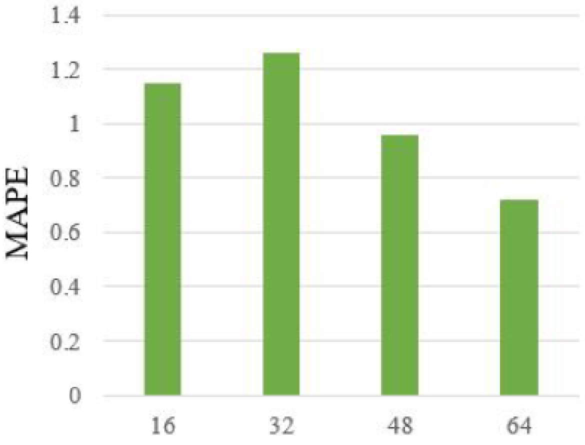
Fig. 20 gives the effect of different parameters on the generative performance of the LSO-GAN algorithm. From Fig. 20, it can be seen that the error is high when the noise dimension is too low or too high; the model using 2-heads of self-attention has better performance than the model using 1-heads of self-attention layer, but with the increase of the number of heads, the error is increasing; the model is very sensitive to the hidden features, and the more hidden features in the dynamic convolution layer, the better the performance is, which indicates that the more the weights in the dynamic convolution, the better the ability to capture the statement Model.



(a) Noise dimension



(b) Number of heads of attention



(c) Number of hidden layers

Fig. 20. Effect of parameters on report generation.

V. CONCLUSION AND OUTLOOK

The document discusses a method for customizing the generation of multi-dimensional SCADA (Supervisory Control and Data Acquisition) reports based on web technologies. By introducing the Light Spectrum Optimizer Generative Adversarial Network (LSO-GAN) model, the method aims to improve report generation efficiency, reduce maintenance costs, and enhance scalability. The study demonstrates that LSO-GAN outperforms traditional models like Conv-LSTM and FC-LSTM in terms of accuracy and generation efficiency, achieving an RMSE of 14.98 and a MAPE of 0.93 in experiments.

- The study analyzes the requirements for multi-dimensional SCADA report customization and designs a web-based generation workflow.
- The LSO-GAN model, which integrates the Light Spectrum Optimizer algorithm, improves the hyperparameter optimization of GANs, significantly enhancing the efficiency and intelligence of report generation.
- Experimental validation shows that the method excels in accuracy, training time, and generation time, especially for handling and generating multi-dimensional data.

In the future, we could work on expanding the model's application to other domains with different multi-dimensional datasets to validate its broader applicability; investigating ways to simplify the model while maintaining efficiency, thus reducing deployment and operational costs; exploring enhanced security measures, particularly in scenarios involving sensitive data, to improve the robustness of the report generation system.

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