Schematic Design of Comprehensive Economic Operation and Optimization Analysis System for Low-voltage Smart Distribution Area

Shuisheng Lai\textsuperscript{1}, Lefeng Cheng\textsuperscript{2}, Yuanmin Lin\textsuperscript{1}, Xin Wang\textsuperscript{1}, Zhengjia Li\textsuperscript{2}

\textsuperscript{1}Panyu Power Supply Bureau of Guangzhou Power Supply Bureau Co., Ltd, Guangzhou 510000, China
\textsuperscript{2} Suzhou Huatian Power Technology Co., Ltd, Suzhou 215000, China

ABSTRACT: Aimed at the problems that are generally existed in 10kV distribution network area, such as low automation and inaccessible remote monitoring, etc. An advanced distribution economic operation and optimization analysis system was developed based on smart area, which included smart distribution area, IDTT distribution terminal, communication network and main station construction. In aspect of smart distribution area construction, the original distribution area was updated and rebuilt, and based on which, the basic monitoring and analysis function of distribution area was achieved, moreover, a new type of smart distribution area based on ZIP-II-type of distribution terminal was designed. Its design principle and the main station construction scheme were discussed in details, and its main functions were summarized. Based on real-time monitoring, the whole system can make analysis on the area load rate, reliability rate, balance rate, and load increase trend, etc. as well as make timely response to the faults occurred in area, thus can achieve intelligent and refinement management on distribution area and provide guidance of the distribution area updating and rebuilding for the operation management units.

1 INTRODUCTION

The electrical primary equipment and secondary equipment and automation system have been operated in stable and maturation with several ten years development of distribution network, while the distribution automation was mainly focus on feeder line automation and remote control, and rarely on area operation and management in 10kV distribution lines, although the smart transformer terminal unit (TTU) has been installed in many areas, and the TTU can finish basic monitoring on the distribution area online, but which is failed to achieve distribution area comprehensive analysis and management and control from aspect of distribution area operation management (X. L. Huang et al. 2010, G. Yu et al. 2013, State Electricity Regulatory Commission of People’s Republic of China- GB/T 19963-2011 2012, and B. B. Shen, et al. 2012).

A large electrical automation scheme was studied aimed at centered city, and its basic solution in a large case application was given, which didn’t contain 10kV distribution area construction scheme (Z. Y. Shen et al. 2012); focus on new rural area low voltage area TTT recombine power compensation criteria, the Ref. (Z. W. Zhang et al. 2012) gave a scheme and developed a new type of rural power area multifunctional TTT with high integration and low cost, and the rationality and effectiveness were verified through the terminal model and simulative experiment platform; in Ref. (G. Q. Li et al. 2009), a distribution area geography information monitoring and analysis system was designed based on GRPS wireless communication technique, but its main function was online monitoring and analysis on distribution area, and was hard to achieve comprehensive management and monitoring on distribution area; meanwhile, a distribution area power quality monitoring and analysis system based on graphical interface was designed, but whose system function was only aimed at power quality monitoring (G. Q. Li et al. 2004); in order to calculate low voltage distribution area theoretical line loss and utilize the remote automation meter system to improve the line loss management level, a load electricity Newton-Rahpson power flow method was adopted to calculate the low voltage distribution area theoretical line loss, as well as the relationship between the line load current and line loss modified coefficient was adopted to establish the mathematical model with the distribution area theoretical line loss as variables, and which can calculate distribution area theoretical line loss and was able to provide information for distinguishing unknown line loss (T. L. Liu et al. 2015).

In aspects of smart area and its automation construction, based on smart area functional demand, L. Huang (2013) designed a fault location and protection system and also contained smart area...
system and smart user management system, and rebuilt the primary and secondary equipment in testing conventional area, and the smart area total system structure was established, as well as efficiency analysis, the data measured by system can be provided for power corporations to make various scheme, while the established system was still conventional area automation system and didn’t utilize smart data collection equipment and make research on old area system rebuilding; J. Y. Gao (2014) introduced the unified data platform and distribution smart terminal technique and a new kind of technique of utilizing inter-phase load adjustment type of secondary leakage protection to regulate three-phase unbalance load, and utilized smart TTU to calculate three-phase unbalance current value commands for secondary leakage protection phase selection switch action, so as to achieve that the load was transmitted from heavy load phase to light load phase, resulting in the three-phase load of power grid always approximately existed in the optimal balance state, the proposed scheme had obvious improvement on three-phase load unbalance, voltage qualified rate and power supply reliability after rebuilding the area, finally realized remote monitoring on distribution area environment, but it was only completed part smart function. Aimed at this, Y. F. Ren (2014) improved the information and automation and interaction degree of Mengjin power grid from four aspects, including area electricity consumption information collection, smart distribution area construction, integrated schedule and distribution, and market-distribution-schedule mode optimization, meanwhile, aimed at rural area grid market-distribution-schedule management mode optimization, which was discussed by C. G. Zhai et al. (2012) and the comprehensive rural area grid market-distribution-schedule management and optimization mode was established.

In aspects of smart area data collection and monitoring terminal, R. C. Yue et al. (2014) developed a smart area terminal based on OMAPL138, which can improve terminal total performance and the on-chip bus structure can also solve problems between CPU communication bottleneck; and a smart area monitoring terminal based on μC/OS and a smart power consumption comprehensive simulation platform presentation and implementation scheme were studied, respectively (B. Ren & B. B. Fang 2013, J. Shao 2010), and which can control area equipment and operation state effectively, as well as regulate field operating equipment in intelligence and achieve area smart, economic and reliable operation.

Based on current existed problems, implemented smart rebuilding and construction work in distribution area, thus, a distribution network economic operation and optimization advanced analysis system based on smart area was developed, and which can implement real-time monitoring on area operation state; meanwhile, a study was made aimed at aspects of area load rate, reliability rate, balance rate and load increasing trend and which were monitored by the designed advanced analysis system in real-time, thus it can generate timely response on occurred faults, and finally achieved intelligent and refinement management of distribution areas.

2 DESIGN OF OVERALL SYSTEM ARCHITECTURE

The designed distribution network economic operation and optimization advanced analysis system based on smart area mainly contains smart distribution area, IDTT distribution terminal, communication network and main station, the system overall structure is shown in Figure 1 as follows.

![System Architecture Diagram](image)

Figure 1. The overall architecture design of system.

According to Figure 1, the construction work of smart distribution area is mainly included the following aspects, which are

1) The construction work is mainly aimed at two aspects of upgrading and rebuilding the original areas and adopting new types of smart comprehension distribution areas, and the subject is distribution box.

2) The IDTT smart distribution terminal is located in the distribution box, which has high integration, advanced technique, strong function, and is applied in transformer work operation monitoring and electricity utilizing management.

3) The communication network adopts remote communication channel GRPS/CDMA which is wireless communication network (J. H. Zhao et al. 2012), this communication mode is used in the
palace where the GPRS/CDMA network information covers.

4) The main station is mainly applied to perform monitoring, management, control and maintenance work in real time in distribution areas, which includes the collection server, data server, work station, and Web server, etc.

3 THE CONSTRUCTION OF SMART LOW-VOLTAGE DISTRIBUTION AREA

3.1 Upgrading and reconstruction of the original distribution area

Aimed at current status and demands of distribution area, firstly, it is need to achieve its basic monitoring and analysis function, which includes voltage, current, active power, reactive power and power factors monitoring and analysis. The designed and productive wall-hooked smart area monitoring devices are applied in upgrading and rebuilding the original areas, and its principle schematic diagram is shown in Figure 2. This mode has low investment and high cost performance. It’s necessary to further upgrade and rebuild the distribution area in a later period, for example, achieve smart switch communication, harmonic monitoring, metering, and centralized meter reading, etc. we can implement the work in steps according to actual conditions, and which doesn’t have any impact on achieved function of original area. This kind of upgrading and rebuild mode shown in Figure 2 is installed conveniently and performed simply, and which is major scheme adopted in current area upgrading and rebuilding work.

Figure 2. Upgrading and reconstruction of the original low-voltage distribution area.

3.2 Design of new type of smart low voltage distribution area based on ZJP-II-type distribution terminal

If the original smart distribution boxes cannot meet the requirements of power development, then it’s necessary to upgrade the original distribution areas (J. Shao 2010, J. H. Zhao et al. 2012), then we can adopt the designed and productive ZJP-II distribution terminals to build a new-type of smart low voltage distribution area, which is major composed of smart protection switches, smart distribution terminals, the main meters, the capacitor switching composite switches, and the reactive power compensation capacitors, etc. as well as has features of compact type, integration and intelligence, etc. The case body adopts stainless steel, with working temperature is -30°~+85°, and performs waterproof, dustproof and moisture-proof, etc. and has higher EMC indexes, so as to adaptive for stronger electromagnetic environment (Z. Q. Yao et al. 2011, Y. H. Bai 2015, K. S. Dong et al. 2015).

Among the new-type distribution area based on ZJP-II terminals, the smart protection switch can realize short circuit protection, over load protection and residual current protection, and achieve reclosing function, and at the same time, can output the current, voltage, power factor and residual current, etc., and it also has selective communication interface and realizes remote-control interruption and setting remote management.

The smart distribution terminal is central field data acquisition, processing and transmission, and which can collect the voltage, current, active power, reactive power and power factor in low voltage bus, and also can collect the switch data and meter data, thus achieve automatic reactive power compensation and cabinet and meter conditions monitoring, as well as fault information uploading actively, and remote control, and remote parameters setting, and remote maintenance, etc. and communicates with the main station system through the GPRS network, the principle is shown in Figure 3.

Figure 3. The schematic diagram of new type of smart comprehensive low-voltage distribution area.

4 DEVELOPMENT OF THE SMART NEW-TYPE OF DISTRIBUTION TERMINAL

The IDTT smart distribution terminal adopts advanced measurement and control technique and GPRS/CDMA wireless communication technique, which can achieve city and rural distribution area...
information collection, processing and control conveniently. The terminal has high integration and small volume, which can be installed easily and be integrated into the JP cabinet, prefabricated combined substation, and distribution transformer cabinet, etc. The terminal can perform acquisition, analysis and storage on each kind of data in public distribution areas, and according to power grid real-time data, the terminal can implement automatic reactive power compensation and power quality monitoring. The terminal also can monitor and control the low voltage residual current breakers data based on communication technique, and based on carrier communication, the user meters can be read and the terminal also supports remote control and remote software upgrading and main meters transcription, etc.

The terminal mainly contains 9 parts: the control processing module, communication module, and incoming line AC sampling, and outlet line AC sampling module, DC analog acquisition module, reactive power compensation control module, input and output module, carrier communication module and power module, the terminal structure diagram is shown in Figure 4, and aimed at this diagram, several main functional modules are introduced briefly as follows.

The GPRS module communicates with the main station through the GPRS/CDMA network, and the terminal information is transmitted to main station, and executes the commands from main station.

The AC sampling module includes incoming line AC acquisition module and outlet AC line sampling module, and respectively collects the voltage and current from incoming line and outlet line, and after sampling by the sampling circuits, the sampling signals are transmitted to special meter chip, and then we can obtain basic parameters and which are transmitted to the processing module and various kinds of data are analyzed and saved in the Flash chip in processing module and waiting for collection from main station, at the same time, the processing module also executes the commands down from main station. The processing module also contains standard RS232 interface and infrared interface, which can be used for field commissioning and maintenance work.

The terminal can read the data from the distribution main meters and user meters. The distribution main meters can be directly read through RS485 interface, and the electric meter data on user side are collected by the collector and then are transmitted to the terminal through carrier technique, the data are demodulated by the carrier communication module of terminal and then transmitted to the processing module for analysis.

5 MAIN STATION CONSTRUCTION SCHEME

5.1 Overall architecture design

The main station is based on the function of supervisory control and data acquisition (SCADA), and its structure adopts C/S and B/S mixed mode, and the data presentation mode is combined the power girder logic diagram with geographic information diagram, which achieves distribution area data automatic acquisition, events automatic warning, load limiting warning, remote control, parameters management, load analysis, three-phase unbalance analysis and power supply quality analysis, etc. so as to realizes smart and refinement management on distribution area (X. H. Chen et al. 2014, Z. Q. Yao et al. 2013). The system structure diagram is shown in Figure 5.

The hardware configuration of main station system contains the collection server, database server, application server, working station, and Web server. The whole system adopts redundant database and network structure, and the collection server and application server can adopt several modes of single machine and double machine thermal equipment and clusters according to the size of system scale. The system adopts load balance technique based on distributed task management and service mechanism. Any computer in system occurs fault will not affect the function of other nodes, and the system performance can be easily completed in way of adding computer nodes, and the system capacity expansion is finished through the human-computer...
interface configuration, so that the system has better stability, reliability and extensibility.

5.2 Collection server

The collection server communicates through the network and smart distribution terminal, and completes data collection tasks such as rule parsing and conversion from original code to engineering value, etc. and then the analytic data, according to demands, are sent to the server or directly saved in historical database for other service analysis and query. If the number of smart distribution terminal need to be collected is large, then the collection server adopts cluster mode, and respectively collects the data in area, and then are gathered to the server and database (Z. Q. Yao et al. 2010, S. P. Hao et al. 2014).

5.3 Application server

The application server can finish the following work, for example, the real-time data judgment, computation and sampling procession, historical data save and retrieval, warning production and events judgment, and various statistics and analysis of data. The data can produce the optimization operation measures and rebuilding schemes based on basic data and statistics analysis. The application server can also be made corresponding expansion according to the size of information need to be processed, the number of functional modules, and user required performance, etc. for example, in large system, the configuration server clusters can rapidly realize various analysis and functional module procession.

5.4 Web server and clients

According to technique development and user actual demands, the distribution area monitoring and management gradually converted from C/S mode to B/S mode, thus, the presentation and interaction function of Web server can achieve all the function needed to be completed in worker station and operator station, and make each Web client connected to the MIS network monitor the real-time and historical information in distribution area through the IE explorer tool and according to authorization, finally realizes Web-based control and set and other operations, etc.

It’s obvious that the Web client can finish system operational maintenance and configuration modification; display each kind real-time and non-real-time diagrams and tables of power grid primary connection figures; complete remote measurement, leakage parameters setting, protective open and close operations, record and print; examine power grid primary and secondary equipment parameters and other relative protective setting information; realize real-time word and sound warning, record and print the warning information of the events sequence record. The whole function of Web client is convenient for system maintenance and deployment and user application.

5.5 GSM modem

The significant area operational information, such as distribution area loss of power and over load information, etc. according to user definition, which can be timely sent to the smart mobile terminals of some relative personnel through the GSM modem and in way of short message (J. Liu et al. 2014), thus can make timely response on power operational faults and improve procession time effectiveness of abnormal situations.

6 SYSTEM FUNCTION DESIGN

6.1 The software interface design

The designed distribution network economic operation and operation analysis advanced based on smart distribution area contains the following functions, such as, distribution monitoring, remote control and maintenance, distribution features analysis, load analysis, warning, supervised tour, reporting function, weight value management, interconnection function, distribution smart terminal maintenance, etc. these functions are achieved based on low voltage area user electricity consumption data measured by the data acquisition terminals, the data contains three-phase voltage on power side (UA/UB/UC), incoming line AC acquisition port three-phase current (Ia/, Ia/, Ia/) , each channel three-phase current in outlet line AC acquisition port 1 (Ia/, Ia/, Ia/, Ia/), each channel three-phase current in outlet line AC acquisition port 2 (Ia/, Ia/, Ia/, Ia/, i=1,2,3), each channel three-phase current in outlet line AC acquisition port 3 (Ia/, Ia/, Ia/, Ia/, Ia/), each channel three-phase current in outlet line AC acquisition port 4 (Ia/, Ia/, Ia/, Ia/), each channel three-phase current in outlet line AC acquisition port 5 (Ia/, Ia/, Ia/, Ia/, i=4,5,6), and each channel three-phase current in outlet line AC acquisition port 6 (Ia/, Ia/, Ia/, Ia/). The digital input DI (DI1-DI16 and four DI-) port data, digital output DO warning RS485 port data, electrical capacitor current analog data, Ethernet port data, capacitor switching port data, etc. and these data can be collected by smart distribution area terminals in real time, and then communicate with main station system in way of GRPS/CSMA communication method, the connection mode of each voltage and current digital port in smart distribution box (cabinet) with each port in smart distribution terminal is shown in Figure 6.
According to Figure 6 and Figure 7, the main function of the designed distribution network economic operation and optimization advanced analysis system based on smart distribution area can be introduced simply as follows.

### 6.2 Distribution monitoring function

Monitor area three-phase voltage, three-phase current, each phase active / reactive power, power factor, zero sequence current, distribution box gate state, environment temperature, low voltage switch state, leakage current, etc. calculate and count the maximum, minimum and emergence time of each data; the measured data is shown as curves, tables, and reports, which are shown in Figure 8, Figure 9, and Figure 10.

The data shown in Figure 8 to 10 are collected and saved in smart distribution terminal. The main station can timely collect the real-time and historical data sampled by distribution terminal, and also can collect the historical sampling data in last 30 days. The back terminal collection modes are auto-clocked-collecting, manual collecting, and auto-supplement collecting. The time of auto-clocked-collecting is set by users, and the default time is each five minutes for a data collection. The users also can manually collect the current data in main station in any time. When the auto-clocked-collecting mode is failed in collecting historical data, the system can perform complementary collection automatically according to the strategies set by users. If it is failed, then the failed complementary collection list is given.

![Figure 8. The three-phase current curves.](image)

![Figure 9. The three-phase voltage curves.](image)
6.3 Remote control and maintenance function

Based on wireless communication, the main station can set each kind of operating configuration parameter of terminal remotely, which can remotely achieve terminal program upgrading. According to the functions of communication expansion and smart switch communicate technique, the main station can read the switch states in real time, as well as information of whether protector acts, meanwhile, the background control and setting commands are sent to switch through terminal, resulting in remote switch open and close, and remote protective fixed values limitation setting and protective commission and exit setting under authorization conditions (W. B. He 2012). Thus achieve low voltage outlet lines monitoring and management and improve distribution area operating efficiency and reduce maintenance cost.

6.4 Distribution transformer (DT) features analysis function

It is can be summarized as follows, monitor and manage the operation states of total DTs; track load variation of DT and the main indexes which impact DT features, such as unbalance rate, voltage qualified rate, heavy-load rate, distribution transformer iron loss, copper loss and zero sequence current, etc. and the features of all of the operation states, load variation and main indexes are constantly made transverse and longitudinal tracks and displayed for analysis. Each kind of analysis calculation is shown as follows.

a) Voltage qualified rate of DT

The power quality of DT is directly related to electricity users, and it presents large voltage fluctuation, high lines loss, and long low voltage power supply radius, which causes large voltage reduction. According to national standard, the three-phase voltage of power supply in 10kV and below this voltage level cannot exceed ±7% of rated voltage, and the 220V voltage cannot exceed +7% of rated voltage and lower than 90%, and when the voltage is higher, the DT iron loss is increased and when the voltage is lower, the DT copper loss and lines loss increase, thus the voltage qualified rate has a direct impact on DT optimization operation (T. Li 2007). The DT analysis function can analyze the voltage qualified rate, the qualified time, the voltage maximum value and minimum value and its occurrence time effectively.

b) DT three-phase load unbalance

The three-phase load unbalance phenomenon is generally existed in urban and rural power grid in China, and the DT three-phase unbalance will lead to part transformers’ uneconomic operation and high transformer fault rate, and large voltage variation in certain area and even burning users’ equipment. The three-phase load unbalance is defined that the phase maximum load deducts three-phase average load and then the calculation result is divided by the average load, its calculation formula is

\[ D_p = \frac{I_m - I_p}{I_p} \]  

(1)

where \( I_p = (I_A + I_B + I_C)/3 \) and \( I_A, I_B \) and \( I_C \) are respectively phase current; \( I_m \) is maximum load current of each phase; \( I_p \) is three-phase average load current.

We can make an effective analysis on the degree of three-phase unbalance, and analyzes its maximum unbalance value and occurrence time, as well as serious unbalance total time, and serious unbalance time period, and then produces statistical tables, so as to provide foundation for load adjustment.

c) DT zero sequence current (X. Y. Wang 2013)

The DT adopts Y/Yn0 connection mode, due to three-phase unbalance, the zero sequence current form loop with transformer through the neutral line, which will cause additional loss of transformer, and leads to the transformer temperature rise increases, and threatens transformer safety and life, therefore, during the operation of DT, the current in neutral line should not exceed 25% of transformer rated current, and when the zero sequence current exceeds, it should timely generate warning signals.

d) DT current heavy-load rate

The safety and operation life of DT is directly influenced by the distribution load, if which runs over load in a long time, then it will cause DT winding temperature rise, and oil temperature increases, and accelerates deterioration of oil quality, as well as insulation decreases, and at the same time, it will accelerate the aging of the coil insulation and the insulation among the iron cores, resulting in its life is shortened, and even burning out DT.

Therefore, the approach to make statistical analysis of DT current heavy-load rate can present safe operation state of transformer (X. Y. Wang 2013). Regulate that when the current in any phase of A, B, C exceeds the current heavy-load rate value, record the heavy-load state as one time, then the current heavy-load rate can be defined as

\[ \eta_{zz} = \frac{n_{zz}}{n_{ABC}} \]  

(2)
where $\eta_{\text{CM}}$ is current heavy-load rate, $n_{\text{CM}}$ is number of current heavy-load, $n_{\text{ABC}}$ is number of comprehensive collection nodes of three-phase current, and the threshold value of $\eta_{\text{CM}}$ is 70% of DT rated current, namely, $I_{\text{th}}=I_{0}\times70\%$.

e) DT economic operation analysis (X. Y. Wang 2013, D. Liu, Z. H. Ding & L. T. Teng 2004)

During DT economic operation, its active power loss and reactive power loss are both changed with nonlinear variation of load, and the variable nonlinear curve always has a lowest point, which calls economic load coefficient. The national standard GB/T 13462-1992 “Guidelines for economic operation of power transformers in mining enterprises” proposed the concepts of transformer economic operation interval and its optimal operation section (namely the best optimal economic operation interval), and the operational intervals of transformer are divided into the best optimal economic operation interval, economic operation interval and the worst operation interval.

The determination method of transformer operation interval is shown as follows. The best economic operation interval is $1.33\beta_0 \leq \beta \leq 0.75$; the economic operation interval is $\beta_2 \leq \beta \leq 0.75$; the worst operation interval is $0 \leq \beta \leq \beta_2$; among the formula, $\beta$ is DT load rate, $\beta_0$ is economic load coefficient, and $\beta_2=\frac{p_0}{p_k}$. Thus, according to the operation time of DT in each operation interval, we can evaluate the economic operation situation of DT.

f) DT no-load loss and load loss

In 10kV urban and rural distribution network, the transformer loss mainly contains two parts, namely, no-load loss and load loss, and these loss are account for 50% of total load in distribution network, the percent is so high and that cannot be neglected, especially in electricity utilization valley, the load is few, and operation voltage is high, then the no-load loss is larger, which is very not conducive to optimal operation of DT.

Therefore, the indexes data are utilized to make analysis, scheduling, and comparison on each kind of index on objective DT in given time range, and after the operation, the principal components of the total operation indexes of DT are made further analysis, and the comprehensive principal component which impacts the transformer is found, thus the comprehensive index of each DT can be ranked.

6.5 Load analysis function

The designed system performs analysis on the collected data of DT, and fully grasps the load variation situations, and then the power marketing strategies can be adjusted timely, according to the data available degree and application convenience, the load feature analysis indexes which are more suitable for load management system features are extended and applied.

The load features analysis contains load index and load curve. The common indexes are maximum load, minimum load, average load, load curve and load rate. Each index can be made daily, monthly and yearly analysis. The collected DT load information is utilized to provide the statistics of light load, heavy load, over-load time, and times of DT load; the year-on-year analysis and month-on-month analysis of DT load are made; and the area total load, average load and regional load are analyzed according to the power supply stations governed the power supply bureau, the load analysis diagram is shown in Figure 11.

Figure 11. The load analysis diagram.

6.6 Warning function

The designed system has functions of access control alarm, over load alarm, over current alarm, over (light) voltage alarm, voltage (current) three-phase serious unbalance alarm, and transformer voltage lack-phase alarm, larger sequence current alarm, larger leakage current alarm, terminal fault alarm, transformer power failure (power-on) alarm, remote measurement value exceeds specified limit alarm (such as current, voltage, temperature, etc.), communication channel abnormal alarm, and system process abnormal alarm, etc.

The alarm modes have graphics alarm, characters alarm and sound alarm, etc.; the alarm can be printed and also sent to the phones of related personnel through short messages. The alarm is saved in historical database and according to the type, area and time conditions, the user can finish alarm query and print.

6.7 Patrol arrival monitoring function

Based on the bar code and RFID tag, the PDA or smart mobile phones are used to perform bar code scanning and positioning, so as to monitor that whether the patrol personnel arrive at the transformer and distribution boxes for patrol monitoring and examination during the patrol arrival process [30], meanwhile, the patrol trace and arrival time of patrol personnel can be viewed and replayed, thus can improve the management ability and level of distribution equipment patrol.

6.8 Reporting function

The designed system can be compatible with several reports of Excel, and we can use Excel templates to produce the reports which are needed by users, the
utilization is convenient and the data definition is flexible. The internal reports have functions of statistic and formula calculation, and which supports the unification of figures and tables. The common used reports are, area operation data report, current and voltage statistic daily report and monthly report and current and voltage daily and monthly report, and electrical degree daily and monthly report, and active power and reactive power daily report, and power factor daily report and user-defined report, etc.; the generated reports can be printed and also be exported as Excel files and be saved.

7 CONCLUSIONS

It can be concluded from this paper that

a) Aimed at smart low voltage area construction, a distribution network economic operation and optimization advanced analysis system based on smart area was designed.

b) A new type of smart distribution area based on IDTT distribution terminal was designed, and which was combined with communication network and main station construction, can achieve distribution area operation state monitoring in real time, and finish DT monitoring, remote control and maintenance, DT features analysis, load analysis, warning, patrol arrival monitoring and reporting function, etc.

c) The designed system can make analysis of load rate, reliability, balance rate, and load growing trend in distribution area, and make timely response on the faults occurred in distribution area, and solved problems existed in distribution area, such as low automation degree and failed to remotely monitor operation situations, etc. which provides scientific and advanced technique measures for the operation management unit in aspect of achieving distribution area delicacy management, and has certain reference significance.

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