Electrical, Control Engineering and Computer Sciene

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Electrical, Control Engineering and Computer Science

Editor

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Preface

The 2015 International Conference on Electrical, Control Engineering and Computer Science (ECECS2015) was successfully held in Hong Kong, May 30–31, 2015. The ECECS2015 was organized by the American Society of Science and Engineering (ASEE). The ASEE is a non-profit society for engineers and scientists, which was founded originally in 2009 and has been undergoing rapid expansion in the recent years. The ECECS2015 is co-sponsored by Chongqing University of Science and Technology, The Hong Kong Polytechnic University, MVGR College of Engineering, Babol University of Technology, Helwan University, Xi'an Jiaotong-Liverpool University, and North China Electrical Power University. The ECECS conference serves as an excellent platform for the engineering and science community to meet with each other and to exchange theories, ideas, techniques and experiences related to all aspects of electrical engineering, control engineering and computer science.

This book contains 39 revised and extended research articles, written by prominent researchers participating in the conference. Topics covered include electrical engineering, control engineering, communication and computer networks, and computer science. All accepted papers went through strict peer-reviewing by 2–4 expert referees and the overall acceptance rate was 38.9%. The papers have been selected for this book because of quality and the relevance to the conference. The organizing committee of ECECS2015 would like to express our sincere appreciations to all authors for their contributions to this book. We would like to extend our thanks to all the referees for their constructive comments on all papers; especially, we would like to thank to organizing committee for their hard working.

Prof. Jian Liu
General Chair of ECECS2015
Wuhan Institute of Technology

Electrical and control engineering

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Structural design and motion simulation of a kind of AMT Clutch Actuator

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ABSTRACT: Taking the AMT Clutch Actuator of an experimental platform of a kind of full hybrid electric vehicle as an example, we design the structure of the Clutch Actuator, select the type of motor for the Clutch Actuator, design and verify the joint strength of the actuator, and carry out 3D modeling and motion simulation of the Clutch Actuator in this paper.

Keywords: Clutch Actuator; structural design; verification; motion simulation

1 INTRODUCTION

As an important component of the mechanical transmission system of the vehicle, the clutch has functions of transmitting torques, absorbing shocks, resisting torsions, disengaging and jointing, etc. [1–2] The requirements for the design of the clutch are as follows: the clutch realizes the smooth jointing between the engine and the transmission making the vehicle start smoothly; breaks off the connection between the engine and the transmission system quickly reducing the impacts between the gears of the transmission and making the shifting easy; protects the transmission system from impact and destruction when suffering heavy dynamic loads during working. [3] In this paper, we design an AMT Clutch Actuator of which the driving mode is electronically controlled and electrically powered.

2 STRUCTURAL DESIGN OF THE CLUTCH ACTUATOR

The working process of the Clutch Actuator is: firstly, the ECU receives the shifting command according to the driver's intention and the real situation of the vehicle. Then the ECU controls the motor, and the motor drives the linear module, and the layer board on the linear module moves, driving the push-pull rod on it, which controls the piston of the main hydraulic cylinder which connects with a liquid storage cylinder to move towards the left or the right to adjust the pressure in the main hydraulic cylinder. The push of the piston in the main hydraulic cylinder makes the pressure in the oil passage on the right side of the main cylinder change, which produces a push-pull force to the clutch, and makes it meet the requirements for control. The structure of the actuator is shown in Figure 1.

3 THE DESIGN AND VERIFICATION OF THE CLUTCH CONTROL ACTUATOR

According to the experimental data of the experimental bench model, the complete disengaging time of the clutch should be less than 0.4 s, and the maximum pressure of the front-end hydraulic cylinder of the clutch is 0.8 MPa, so the design

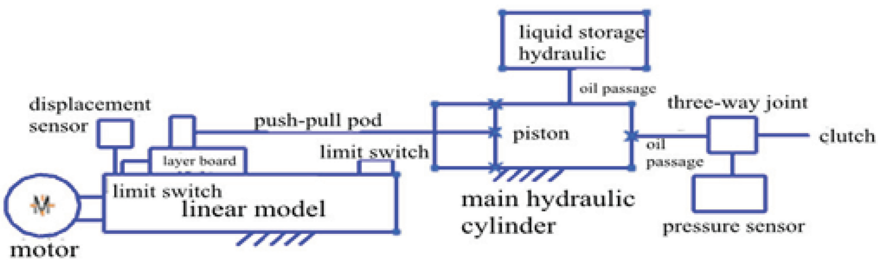

Figure 1. Samplified model for engine mounting.

of the actuator should meet the requirements of the maximum disengaging speed and the strength under the corresponding disengaging pressure. [4–5]

3.1 *Selection of the motor type of the Clutch Actuator*

In order to control the jointing speed and displacement of the clutch more accurately, we select the stepping motor. Subdivision control is adopted, so the developed control accuracy of the stroke displacement of the clutch can achieve 0.025 mm. According to the known conditions, the maximum pressure of the front-end hydraulic cylinder of the clutch is 0.8 MPa, and the diameter of the piston in the hydraulic cylinder of the actuator is 16 mm, so the following can be obtained based on this.

$$F_{\max} = P_{\max} \times A = 160N \tag{1}$$

$F_{\max}$ refers to the maximum push-pull force of the push-pull rod of the actuator; A refers to the sectional area of the hydraulic cylinder.

The stroke of the clutch is $L = 30$ mm, the complete disengaging time of the clutch = 0.4 s. So the linear speed of the push-pull rod can be obtained. $v = L/t = 0.075$ m.

According to the calculations of the above formulas, the parameters of the driving motor of the Clutch actuator can be calculated. the power of the driving motor of the clutch: $P = F_{max} \times V$, which is calculated to be 12 W.

According to the calculated motor power, we select the Y200 L 1–2 stepping motor with a power of 30 W and a revolving speed of 2950 rpm. The front end of the push-pull rod is driven by a screw. Use the M10 × 0.5 metric fine screw thread for screw drive.

3.2 *Design and verification of the actuator's connection strength*

Use two M8 bolts initially for the threaded connection between the hydraulic cylinder and the guide plate. Bolts are being pulled. The bolts are under pre-tightening force and operating pulling force. Considering that they may need additional tightening under the total pulling force, thereby the strength condition of the bolt here is:

$$\sigma_e = \frac{5.2F_{\max}}{\pi d_1^2} \le [\sigma] \tag{2}$$

In the formula, d_1 is the diameter of the bolt which is 8 mm. Induced it into calculation and the conclusion is $\sigma_e = 4.14 \text{ MPa} < [\sigma] = 36 \text{ MPa}$, so the connection is safe.

Select M8 bolt initially for the threaded connection between the short axis and inhaul cable, and shear the bolt. The shear-resisting strength condition of the bolt is:

$$\tau = \frac{4F_{\max}}{\pi d_0^2 m} \le [\tau] \tag{3}$$

In the formula, m is the bolt shank's shearing area, and $m = 2$; d_0 is the diameter of the bolt shank's shearing area, and $d_0 = 8$ mm. Induced it into calculation, and the conclusion is $\tau = 1.59 \text{ Mpa} \le [\tau] = 45 \text{ Mpa}$, so the shear strength is safe. The extruding strength condition for the surface of the contact area between bolt shank and the wall of hole is:

$$\sigma_p = \frac{F_{\max}}{d_0 h} \le [\sigma_p] \tag{4}$$

In the formula, h is the minimum height of the extruding area between bolt shank and the wall of hole, and $h = 6$ mm. Induce it into calculation, and the conclusion is $\sigma_p = 3.33 \text{ MPa} \le [\sigma_p] = 90 \text{ MPa}$, so the extruding strength is safe.

The connection between the short axis and the layer board select two M6 bolts initially for connecting, and shear the bolts. The shear strength condition is as formula (3). In the formula, m = 1. Induce it into calculation, and the conclusion is $\tau = 5.66 \text{ MPa} \le [\tau] = 45 \text{ MPa}$, Extruding strength condition is as formula (4). In the formula, h = 13.5 mm. Induce it into calculation, and the conclusion is $\sigma_p = 0.99 \text{ MPa} \le [\sigma_p] = 90 \text{ Mpa}$, so the bolt connection here is safe.

4 3D MODELING AND SIMULATION OF THE CLUTCH ACTUATOR'S

4.1 *Overall model of the Clutch Actuator*

This article uses UG N6.0 for Clutch Actuator's 3D solid modeling, and adopts the top-down method to design the assembly. The specific design scheme, mechanism schematics and specific parameters of the clutch operating mechanism have all been explained in detail in the preceding text. Next is the modeling and simulation of the mechanism. The overall model of Clutch Actuator is shown in Figure 2. In this overall model, each component's screw bolt and screw thread connection are left out, only indicated with circular holes, and are replaced with constraint order.

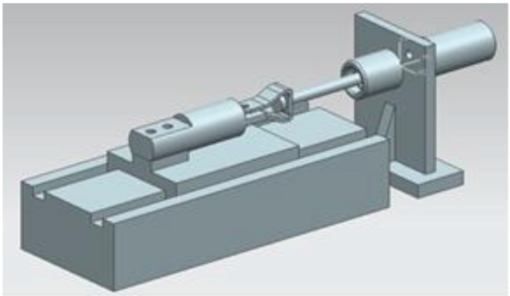

Figure 2. Overall model of Clutch Actuator.

4.2 *Simulation analysis of the Clutch Actuator*

Mechanism motion analysis module [motion], which is UG NX6.0 self-carried, provides mechanism simulation analysis and text production function. With a three-dimensional model of Clutch Actuator having been set up in the preceding text, the simulation analysis now follows.

Operate UG NX, open the set-up actuator mechanism model, and select [start]/[motion simulation] in the menu. Then single-click the right key in the assembly model of motion navigation, select [create a simulation] to create a simulation, and with a [motion-1] acquired, it enters the motion simulation mode.

First of all, assign link rods. Single-click the right key on [motion-1] to create link rods. With the link rods created, each independent space link rod has six degrees of freedom, and we need connect the link rods with kinematic pairs, which will form a certain constraint among the link rods, making the motion chain that is made up of the link rods have a definite motion, so as to create a mechanism.

Next, set up the sliding pair. Right-click on [motion-1] and then choose the sliding pair in the drop-down box of [create a new kinematic pair]. Later choose the connecting rod that needs to move. Using the line or the plane in its direction of motion as the chosen object can directly generate the kinematic pair, after which you can choose the direction of motion. Later, choose the truck mode to be function in the driver dialog. Then choose the function manager to create a new function. Choose the motion function in the box after inserting. Create a STEP function and the body of this STEP function is STEP (time, 0, 0, 0.4, 60) + STEP (time, 0.4, 0, 1.4, 0) + STEP (time, 1.4, 0, 1.8, –60).

When the connecting rod and the kinematic pair are available, create a new budget scheme. What needs to be noticed is that the number of steps should be set to 1000 steps, which is beneficial to the observation of the simulation result. When the system settlement is finished, the simulation animation is available, verifying the rationality of the clutch control actuator.

5 CONCLUSION

This paper introduces a AMT Clutch Actuator applied to full hybrid electric vehicle experimental platforms. It carries out design calculation and strength check and gets the basic structure and dimensions. It uses UG NX6.0 to design the structure and generates the three-dimensional model of AMT Clutch Actuator and conducts motion simulation in the end, verifying the rationality of this clutch control actuator.

REFERENCES

[1] Wang Xiaochuang, Tang Guangdi et al. Research on A Kind of Hybrid Power Motor Automatic Clutch Actuator [J]. Mechanical Drive, 2013.

[2] Lun, Cheng Xiusheng, Ge Anlin, et al. Clutch Control in the Process of AMT Shifting [J]. Automobile Technology, 2006.

[3] Tian Ye. AMT Automatic Shifting Speed Control System Design [J]. Shanxi Electronic Technology, 2009.

[4] Zhang Hui, Liu Zhenjun, Qin Datong. Heavy Duty Motor AMT Hydraulic Shifting Executing Agency Analysis and Design [J]. Hydraulic and Pneumatic, 2007.

[5] Jin Long. AMT Electric Clutch Actuator Dynamic Property Simulation Research [D]. Jilin University, 2007.

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Comparative study of electrical characteristics in southern, central, and northern areas of Jiangsu province

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ABSTRACT: This paper selects Nanjing, Changzhou, and Xuzhou as the representatives of cities in central, southern, and northern areas of Jiangsu province, respectively. The purpose of research is to discover electrical characteristics in different areas in Jiangsu province by comparing marketing data of Nanjing, Changzhou, and Xuzhou. Matlab is adapted to process large amounts of marketing data. The result shows that the average capacity in Nanjing and Changzhou is larger than that in Xuzhou. Similarly, the line loss rate in Nanjing and Changzhou is lower than that in Xuzhou.

Keywords: comparison; marketing data; line loss rate; average capacity

1 INTRODUCTION

Due to different economic development levels and industrial structures among regions, the electrical characteristics of each region are different. Taken the Jiangsu province as an example, area in southern Jiangsu is much more economically developed while the industrial base of northern Jiangsu area is relatively weak and the first industry still occupies a considerable proportion in industrial structure. Area in central Jiangsu is in between. In this paper, Nanjing, Changzhou, and Xuzhou are selected as study samples. Nanjing is the capital city of Jiangsu province and also the typical city in central Jiangsu area; Changzhou is the typical city in southern Jiangsu area; Xuzhou is the typical city in northern Jiangsu area. The differences of electrical characteristics among these three cities reflect the differences of that in different areas of Jiangsu province, even China. Therefore, a comparative study of electrical characteristics among Nanjing, Changzhou, and Xuzhou is significant in guiding the management of electricity in different cities. When it comes to the electrical characteristics, Wang explored the electrical characteristics between the different region markets in America by multifractal approaches (Wang 2013). However, there are more electrical characteristics, such as line loss rate and average capacity and so on, and differences of that among typical cities in China still worth studying.

This paper analyzes marketing data of December 2015 from 94198 low-voltage districts in Nanjing, Changzhou, and Xuzhou. Marketing data of power company includes parameters of every district like total number of electricity users, total capacity, number of residential electricity users, number of non-residential electricity users, total capacity of residential users, total capacity of non-residential users, and line loss rate. These parameters are first parameters, which are acquired directly by data system of power company. There are second parameters derived from first parameters, including residential capacity ratio and average capacity. The second parameters are based on the following definitions:

$$Rcr = \frac{Rc}{(Rc + Nc)} \tag{1}$$

In Eq. 1, Rcr stands for the residential capacity ratio, Rc for the total capacity of residential users, and Nc for the total capacity of non-residential users.

$$Dc = \frac{Rc}{Nr} \tag{2}$$

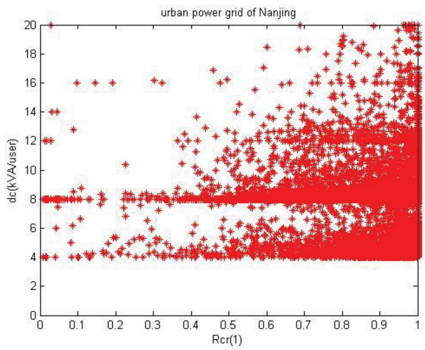
In Eq. 2, Dc stands for the average capacity, Rc for the total capacity of residential users, and Nr for the number of residential electricity users.

Since residential capacity ratio, average capacity, and line loss rate can reflect, respectively, composition of electricity users, level of electricity consumption, and comprehensive management level in electricity, these three parameters are employed to analyze electrical characteristics of three cities.

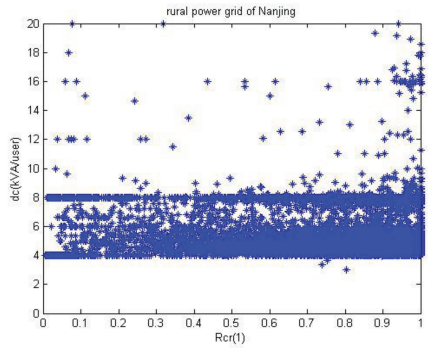
2 COMPARATIVE ANALYSIS OF ELECTRICAL CHARACTERISTICS OF THREE CITIES BASED ON AVERAGE CAPACITY

According to the marketing data from urban and rural power grid in three cities, scatter plots of average capacity-residential capacity ratio are plotted by use of matlab, as shown in Figure 1.

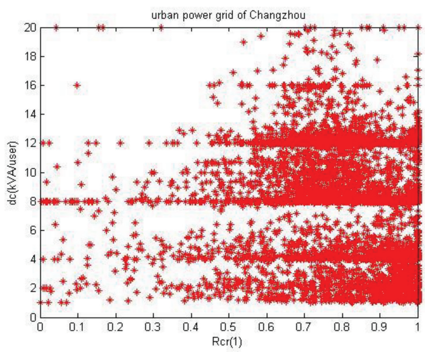
Figure 1 depicts the distribution of average capacity with residential capacity ratio. Each spot denotes a district. It is evident from Figure 1 that points congregate in some certain average capacities and the distribution of points differs among cities. The average capacity of Nanjing urban districts mainly congregates in 4 kVA, 8 kVA, and 12 kVA while that of rural districts mainly congregates in 4 kVA, 8 kVA; average capacity of



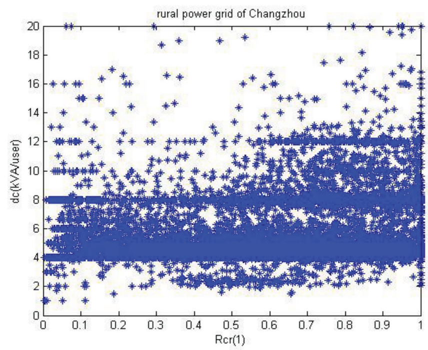
(a)Urban power grid of Nanjing



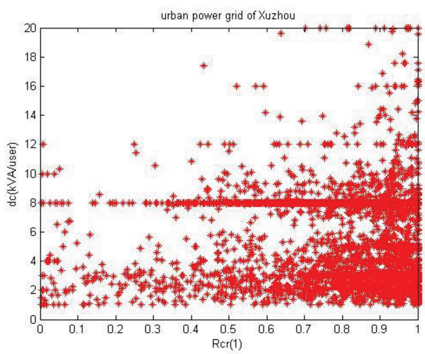
(b) Rural power grid of Nanjing



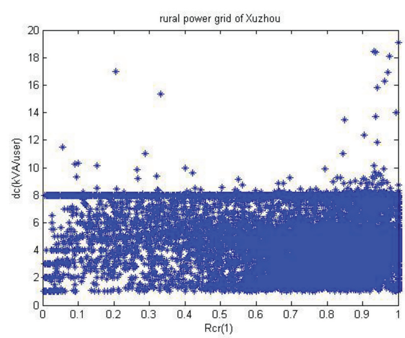
(c)Urban power grid of Changzhou



(d) Rural power grid of Changzhou



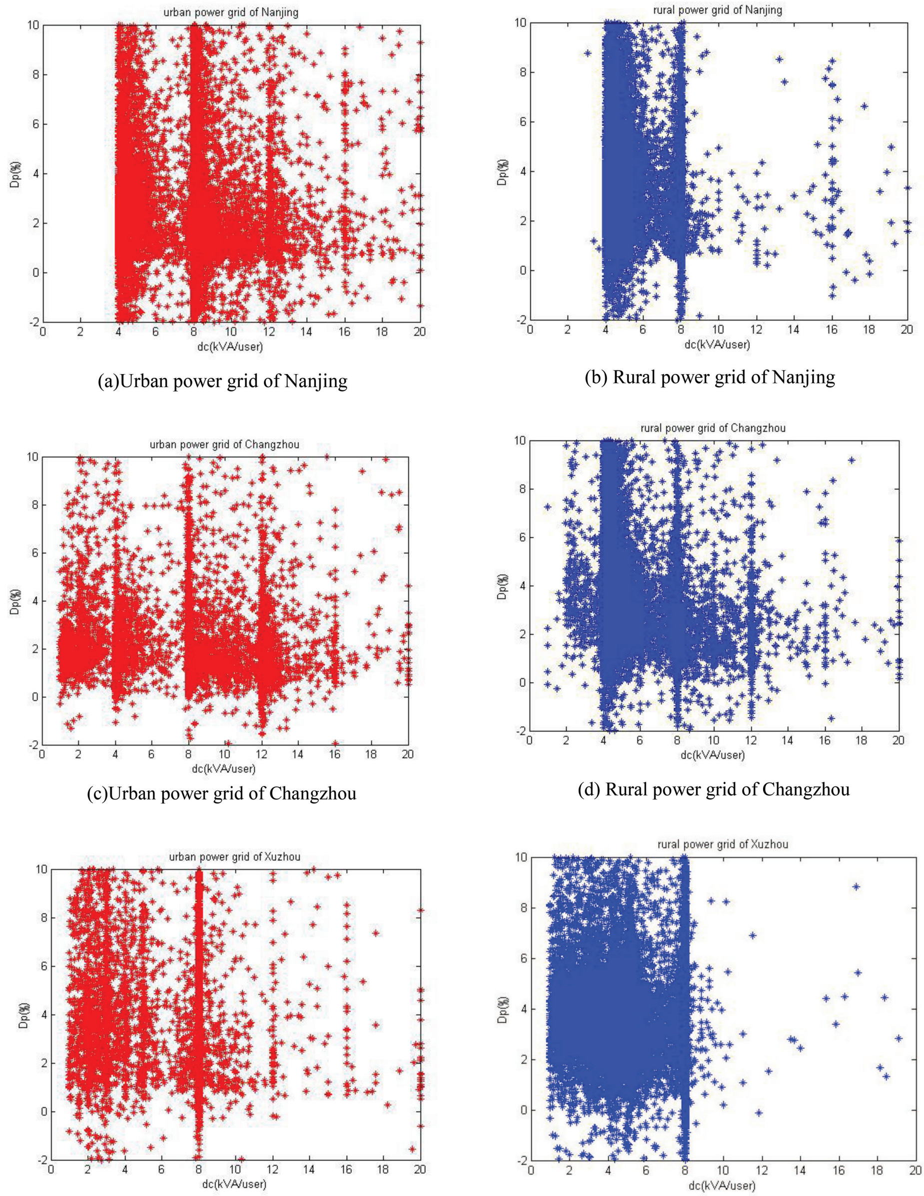
(e)Urban power grid of Xuzhou



(f) Rural power grid of Xuzhou

Figure 1. Distribution of average capacity with residential capacity ratio.

Changzhou urban districts mainly congregates in 2 kVA, 4 kVA, 8 kVA, 12 kVA while that of rural districts mainly congregates in 4 kVA, 8 kVA, 12 kVA; average capacity of Xuzhou urban districts mainly congregates in 2 kVA, 8 kVA while that of rural districts mainly congregates in the section of 1~8 kVA. Urban districts of Nanjing and Changzhou have a relatively higher level of average capacity with lots of districts above 8 kVA, the whole, compared with Xuzhou. This indicates that Nanjing and Changzhou have much higher level of electricity consumption and standard of living than Changzhou. In addition, comparing the points of Nanjing and Changzhou, a significant difference between two cities is that Nanjing urban districts have a far greater proportion of pure-residential



(a)Urban power grid of Nanjing

(b) Rural power grid of Nanjing

(c)Urban power grid of Changzhou

(d) Rural power grid of Changzhou

(e)Urban power grid of Xuzhou

(f) Rural power grid of Xuzhou

Figure 2. Distribution of line loss rate with average capacity.

districts whose residential capacity ratio are above 0.85 than Changzhou. This indicates that industries are widespread in Changzhou. This difference between Nanjing and Changzhou also mirrors the difference in economic development model, which industry in Changzhou makes more contribution to local economy. The difference among rural power grids is basically in line with such among urban power grids.

3 COMPARATIVE ANALYSIS OF ELECTRICAL CHARACTERISTICS OF THREE CITIES BASING ON LINE LOSS RATE

Line loss rate given in this paper is in terms of general line loss rate (Gu 2008). Line loss rate-average capacity scatter plots are plotted by use of matlab, as shown in Figure 2.

In Figure 2, *Dp* stands for line loss rate. Figure 2 depicts the distribution of line loss rate with average capacity. In comparison with Xuzhou, line loss rate of Nanjing and Changzhou is relatively lower with line loss rate congregates in section between 0 and 4%. However, such clustering is not discovered in Xuzhou, indicating higher line loss rate. In addition, compared with Changzhou, Nanjing has a greater proportion of districts with line loss rate above 5%. The most likely reason is that old downtown covers a large area of Nanjing where refurbishment of power grid is difficult to implement. Overall, the line loss rate from low to high in order is: Changzhou, Nanjing, and Xuzhou, which is consistent with development level of cities. This is because economically developed regions have a huge advantage in construction of power grid and attraction of high-quality management personnel while the equipment and management capability of personnel are the significant influences on line loss rate.

4 CONCLUSIONS

1. The level of average capacity reflects regional living standard and level of electricity consumption. For Jiangsu province, areas in southern and central Jiangsu have a much higher level of average capacity with lots of urban districts above 8 kVA while most districts in Xuzhou are below 8 kVA.
2. Difference in regional economic development model is reflected in the distribution of average capacity with residential capacity ratio. Take the difference between Nanjing and Changzhou, for instance, due to the strong manufacturing industry; districts with relatively lower residential capacity ratio in Changzhou have a greater proportion than Nanjing.
3. Line loss rate is consistent with development level of cities. For Jiangsu province, line loss rate from low to high in order is: Changzhou, Nanjing, and Xuzhou. Thus, power companies in southern and central Jiangsu have a much higher comprehensive management level in electricity compared with power companies in northern Jiangsu.

REFERENCES

Gu, Yu-gui, et al. "Study on Calculation of Line Loss Rate." Electric Power Technologic Economics, 20 (2008): 34–37.

Wang, Fang, et al. "Cross-correlation detection and analysis for California's electricity market based on analogous multifractal analysis." Chaos: An Interdisciplinary Journal of Nonlinear Science 23.1 (2013): 013129.

Wang, Fang, et al. "Multifractal detrended cross-correlation analysis for power markets." Nonlinear Dynamics 72.1–2 (2013): 353–363.