Construction of Virtual Simulation Practice Teaching Platform for New Energy Distributed Generation

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Abstract. In order to meet the current students' needs for new energy distributed generation learning, this paper builds a new energy distributed generation virtual simulation practice teaching platform based on computer technology. The article begins with the goals and principles of platform construction, and specifically describes the process and structure of building a virtual simulation practice teaching platform. This platform can provide students with verification, comprehensive and innovative virtual experiments, so that students can learn the working principle of wind power and solar power in the platform. The platform also has system models of various new energy distributed generation methods to ensure that the platform can provide students with correct knowledge guidance.

Keywords: new energy · distributed power generation · virtual simulation · teaching

1 Introduction

In the teaching of new energy distributed power generation, the key teaching is wind power generation and solar power generation. In this course, students are required to study electromechanical, electric power, hydraulic, computer, control, numerical weather prediction and other disciplines. For new energy distributed generation courses in colleges and universities, there is no perfect experimental teaching instrument in the current teaching field. This course requires students to have an in-depth understanding of scientific principles in experimental operations. In the photovoltaic power generation technology part of the course, students need to measure the output power of solar power generation under different light intensities and different temperature conditions. However, many colleges and universities today do not have professional photovoltaic power generation simulation equipment, so they cannot provide students with suitable experiments. condition. In the course, it is also necessary to connect the wind and solar power generation to the power grid, which will bring hidden dangers to the safety of the experimental operators and the power grid. In the teaching of new energy distributed generation in colleges and universities, we cannot rely solely on the traditional physical

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experiment method for teaching. The virtual simulation teaching platform can simulate the operation of wind farms and solar power plants in real situations, and show it to students in three-dimensional graphics mode. The virtual simulation platform can ensure the integrity of students' practical teaching, and can ensure the safety in the process of practical teaching.

2 Construction Goals and Principles of Virtual Simulation Practice Teaching Platform for New Energy Distributed Generation

The virtual experiment content in the virtual simulation practice teaching platform of new energy distributed generation must be closely combined with the course requirements. The platform should provide students with multiple experimental contents, including simulation of wind energy characteristics, simulation of various working conditions of wind farms, simulation of wind turbines, simulation of wind power control systems, simulation of current and voltage characteristics of photovoltaic arrays, converter simulation, energy management and control technology, small wind power generation system design and production, inverter equipment array, maximum power point tracking technology simulation, etc.

The simulation experiment in this platform needs to have the characteristics of strong scientificity, strong systematicness, good simulation experiment teaching effect, and intuitive and clear physical model. The simulation experiment in the platform needs to have strong interactivity to enhance the initiative and innovation of students' learning.

The practical teaching guidance in the platform should be combined with the occupation. The teaching design in the platform must first investigate the needs of enterprises and occupational positions, and use the real workflow as the basis of simulation experiments.

In the new energy distributed generation course, many related disciplines are involved, and these disciplines have their own knowledge groups. Students need to learn the knowledge of multiple disciplines in order to better learn the new energy distributed generation course. The teaching structure in the platform should be scientific and rational, reflecting the overall structure of knowledge.

3 Building a Virtual Simulation Practice Teaching Platform

Based on course requirements and students' needs, the structure of the simulation experiment resource library of this platform is shown in Fig. 1.

The main platform used to build this platform is the Windows operating system. The main development software used by the platform is Visual C++ 6.0 and GDI+ function library. For the development of 3D models, this platform uses the Unity3D 3D engine and MySQL database. The computing platforms used in this platform are PSCAD software, EES software and Matlab software. The computing platforms are mainly used to build wind turbine models, photovoltaic array models, grid-connected models, and wind turbine models.

The functional modules of this platform are shown in Fig. 2.

In this system, the photovoltaic power generation technology is mainly used as the main content to build a virtual simulation experiment case. In the design of experimental

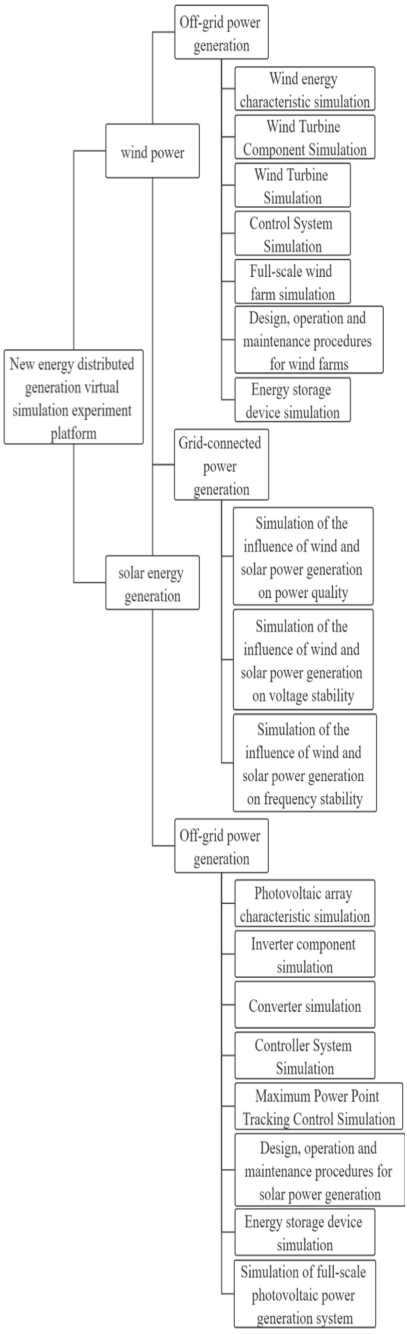

Fig. 1. Structure diagram of resource library of new energy distributed generation virtual simulation practice teaching platform

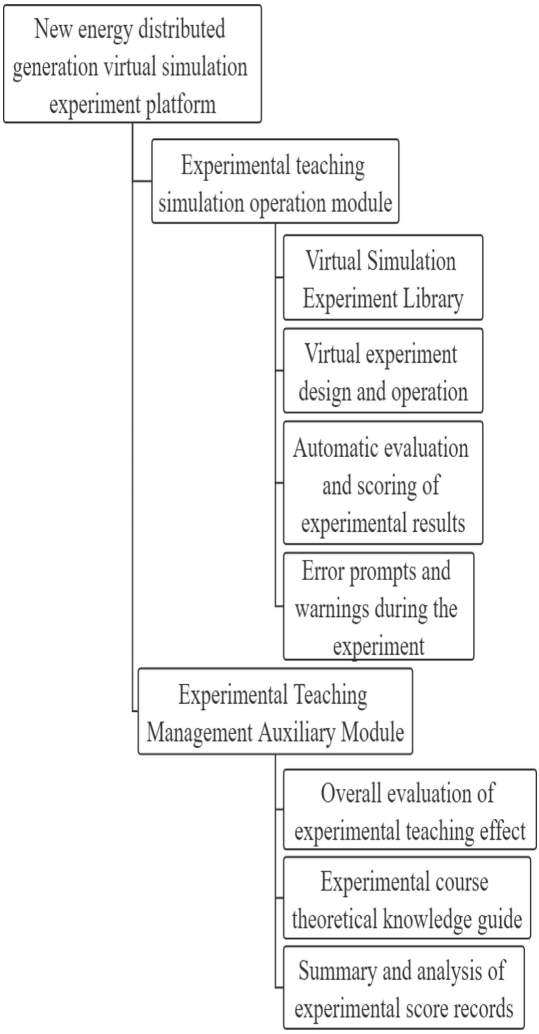

Fig. 2. Functional modules of the new energy distributed generation virtual simulation platform

teaching tasks, this system combines the opinions of enterprise research and professional teaching knowledge committee, and selects the photovoltaic array current and voltage characteristics of photovoltaic power generation system, the maximum power curve under different light intensity and temperature conditions, the maximum power point tracking and other experiments. The content is regarded as the key learning task of virtual simulation experiment.

4 Photovoltaic Power Generation Model

The principle of photovoltaic power generation is to let sunlight irradiate on the material of PN structure, and excite electron holes to connect with the external circuit to form a current. The photovoltaic effect is generated, and the photovoltaic cell can generate the corresponding electromotive force at both ends. Through the arrangement and combination of photovoltaic cells, inverter equipment and power distribution equipment can be constructed, and finally a complete photovoltaic power generation system can be constructed.

Photovoltaic cells are mainly composed of semiconductor silicon, selenium and other materials, and the cells can directly convert sunlight into electricity. In an ideal situation, a current source with an anti-parallel diode and a parallel resistor would constitute the equivalent law of a photovoltaic cell.

From Kirchhoff's law, we can know that the output current I of the photovoltaic assembly is as follows:

$$I = I_g - I_d - I_{sh}$$

The formula for the diode current is as follows:

$$I_d = I_o[\exp(\frac{V + IR_{sr}}{nkT_c lq}) - 1]$$

$$I_o = I_{oR}(\frac{T_c{}^3}{T_{cR}{}^3})\exp[(\frac{1}{T_{cR}} - \frac{1}{T_c})\frac{qe_g}{nk}]$$

The parallel branch current formula is as follows:

$$I_{sh} = \frac{V + IR_{sr}}{R_{sh}}$$

I_g is the photogenerated current. The relationship between photogenerated current and solar radiation G and cell temperature Tc is as follows:

$$I_g = I_{scR}\frac{G}{G_R}[1 + \propto_T (T_c + T_{cR})]$$

A photovoltaic array is a type of converter that can convert solar energy into electrical energy, and is mainly made of photovoltaic effect semiconductors. The photovoltaic cell components in the photovoltaic array can be combined as required to adjust the voltage and current, which ultimately affects the output efficiency. The simulated photovoltaic power generation modules in this platform are mainly formula-based guidance (Figs. 3 and 4).

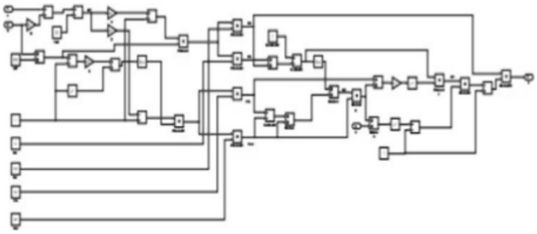

Fig. 3. Photovoltaic cell parameter design (original data)

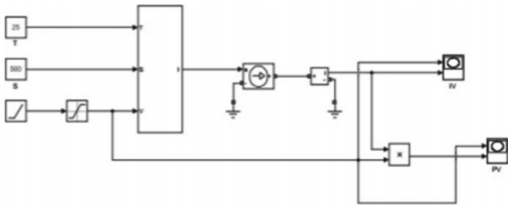

Fig. 4. Simulation model of photovoltaic cell characteristics (original data)

5 Conclusions

In this paper, a virtual simulation modeling platform is used to build a new energy distributed generation teaching platform. This platform takes the training of innovative electrical engineers and photovoltaic engineers as the main goal, and uses scientific and reasonable virtual simulation experiments to improve students' learning quality. The development of this platform is not perfect. The main focus of the virtual simulation experiment is the principle of photovoltaic power generation. In the next step, the platform will continue to increase the diversity and number of experiments to provide a more complete virtual experiment for new energy distributed courses.

References

1. Chen Xihao. Simulation technology of photovoltaic power generation integrated into power grid system [J]. China Science and Technology Information, 2022(03): 71-73.
2. Ding Qian. Thoughts on the Application of New Energy Photovoltaic Power Generation Technology [J]. Smart City, 2021, 7(24): 76-77. DOI: https://doi.org/10.19301/j.cnki.zncs.2021.24.035.
3. Jia Guohai. Ideological and political teaching reform of new energy power generation and grid-connected technology courses [J]. Agricultural Engineering and Equipment, 2021, 48(06): 53-55.
4. Kang Siwei, Dong Wenkai, Guo Shiran, Sun Hongjun, Xie Xiaorong. Small disturbance and stable critical short-circuit ratio of new energy power generation grid-connected system based on virtual synchronous machine control [J]. Electric Power Construction, 2022, 43(03): 131-140.

5. Ke Xianbo, Cheng Lin, Niu Shuanbao, Zhang Zhenyu, Han Hualing, Jia Yichao. New energy fast frequency modulation parameter dynamic correction algorithm based on test and operation data [J/OL]. Control Theory and Application: 1-7 [2022-04-01]. http://kns.cnki.net/kcms/detail/44.1240.TP.20220312.2136.002.html
6. Liu Jianwei. Research on the influence of distributed new energy generation on distribution network voltage [J]. New Industrialization, 2022, 12(01): 120-122. DOI: https://doi.org/10.19335/j.cnki.2095-6649.2022.1.043.
7. Pan Li, Du Ershun, Wang Jianxiao, Li Gengyin. Research on economic benefits of combined operation of wind power generation and solar thermal power generation [J]. Comprehensive Smart Energy, 2022, 44(01): 26-30.
8. Qin Shengsheng. Analysis of wind power grid-connected technology and power quality control [J]. Electronic Technology, 2022, 51(01): 110-111.
9. Tian Zhipeng. Analysis of the influence of grid-connected voltage of distributed photovoltaic power generation [J]. Integrated Circuit Application, 2022, 39(01): 152-153. DOI: https://doi.org/10.19339/j.issn.1674-2583.2022.01.059.
10. Xue Guangye. Research on the influence of photovoltaic grid-connected power generation on power quality of distribution network [D]. Changchun Institute of Technology, 2021. DOI: https://doi.org/10.27834/d.cnki.ggccc.2021.000034.
11. Yang Yan. Research on photovoltaic power generation and grid-connected technology [J]. Urban Housing, 2021, 28(S1): 180-181.
12. You Kaiqiang. Analysis of the influence of smart photovoltaic power generation on power system [J]. Modern Industrial Economy and Informationization, 2021, 11(11): 119-120. DOI: https://doi.org/10.16525/j.cnki.14-1362/n.2021.11.046.
13. Zhang Ming. Discussion on wind power generation and its technology development [J]. China Equipment Engineering, 2022(04): 200-201.
14. Zhao Jianyong, Li Han, Wu Min, Ma Runsheng, Zhao Wenqiang, Yu Ziwei. Improved method for measuring impedance characteristics of new energy power generation equipment [J/OL]. Electric Transmission: 1-7 [2022-04-01]. DOI: https://doi.org/10.19457/j.1001-2095.dqcd23945.
15. Zhu Lin, Han Tao, Dong Yinghua, Yu Yabo, Xue Yulong. Reliability assessment of photovoltaic power generation systems based on time-varying factors [J/OL]. China Electric Power: 1-9 [2022-04-01]. http://kns.cnki.net/kcms/detail/11.3265.TM.20220221.1015.004.html