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Project Based Learning Using Power System Training Device

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Abstract: For an electrical engineer, training of power system configuration and operation is an essential problem. This paper proposes new training device which consists of separated circuit blocks (module). For example, induction generator, inverter, capacitor, measurement, are used. The trainee selects and assembles them to build a circuit then easy to conduct an experiment. This methodology is effective for group work so as it may be used for PBL (Project Based Learning) program. The concept and required skill to build this device are introduced in this paper.

Key Words: training device, PBL

Abstrak: Bagi insinyur kelistrikan, pelatihan tentang konfigurasi sistem tenaga dan operasi adalah penting. Tulisan ini mengusulkan perangkat pelatihan baru yang terdiri dari blok rangkaian terpisah (modul). Sebagai contoh, dalam modul ini digunakan generator induksi, inverter, kapasitor, pengukuran. *Trainee* memilih dan merakit untuk membangun sebuah sirkuit yang mudah untuk digunakan sebagai percobaan. Metodologi ini efektif digunakan untuk kerja kelompok sehingga dapat digunakan untuk PBL (Project Based Learning) Program. Konsep dan keterampilan yang diperlukan untuk membangun perangkat ini, diperkenalkan dalam makalah ini.

Kata kunci: perangkat pelatihan, PBL

Definition of Project Based Learning is not unique but commonly referred as a teaching method in which students gain knowledge and skills by working for an extended period of time to investigate and respond to an engaging and complex question, problem, or challenge. This paper is an attempt to apply PBL to electrical power system engineering field.

In terms of electrical power system engineering, there is a growing interest in renewable energy and energy-saving society. In addition, the eco power meter with features such as supply and demand control, visualization of power consumption for stable power supply and the suppression of peak power have received intensive attention. It is also expected that the needs for the power-related technologies will increase in the future. Therefore, there is a strong demand for its training; moreover, learning through real experience of electrical equipment is essential. For example, a power engineering laboratory experiment on transformer design which allows students to proceed through the entire design process including design, construction, modeling and analysis (Jewell, 1990); voltage-flicker teaching facility which can give students a realistic and practical concept (Chang, Wei-Nang,1998); an experience to teach pool-based electricity markets for power engineering students which makes students to play their role as power producers (Contreras, 2002); rotating machinery laboratories equipped with the visualization of the three-dimensional rotating equipment (Collin, 2009); laboratory-scale microgrid and distributed generation infrastructure.

METHODS

Traditional power system training devices have a disadvantage that the system configuration is not flexible. Examination of various case studies are difficult to carry out, moreover it is hard to understand the system's circuit configuration. Based on those problems, it is proposed that the power system

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equipment is divided into modules. Training is performed in combination of those modules (Fujita, 2012; Hoshino, 2013). The development of this feature is aimed to realize the visualization of power at the desktop. Again, the purpose of the study is to provide an environment for easy understanding of practical power system.

RESULTS AND DISCUSSION

There are three types of power system as training device: commercial product, subcontract product, and hand-made product. The commercial and subcontract products are expensive. The hand-made one has essential drawback of weak durability. In addition, since the system configuration is fixed, examination for variety of case studies is difficult to conduct. It is difficult for students to understand the overall system configuration. Furthermore, although flexible wiring is on advantage, it has a risk of danger due to faulty wiring.

Figure 1 shows the standard of module-type power system training device. It has a size of cube of 300 mm. Each terminal can be distinguished in different colours which are red (U-Phase), yellow (W-Phase) and blue (V-Phase). In addition, neutral-line and ground-line are in green and black colour, respectively. The module has a small transparent window at the

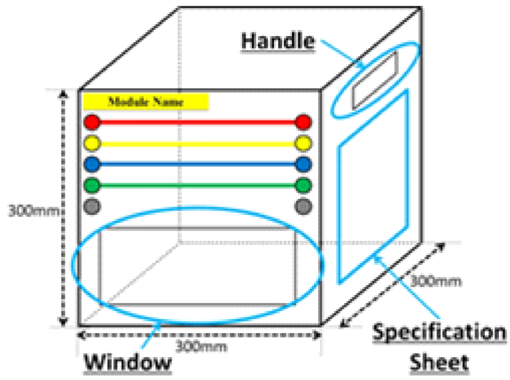


Figure 1. Standard of Module-Type Power System Training Device

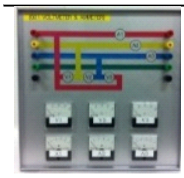
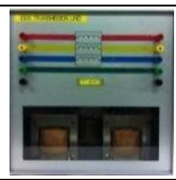
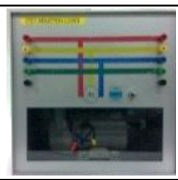
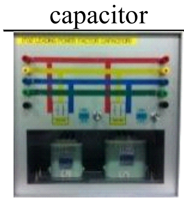
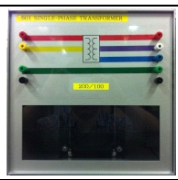
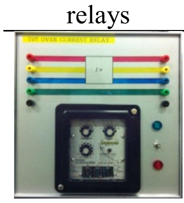
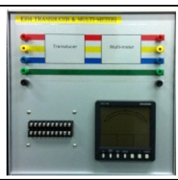
Volt & Ammeter	Transmission line	Induction motor
		
Leading-phase capacitor	Δ-Y connection transformer	Single-phase transformer
		
Overcurrent relays	Synchronism indicator	Digital multimeter
		

Figure 2. Module-Type Power System Training Devices

size of 250mm-width and 100mm-height in order to see the structure inside.

Figure 2 shows the module-type power system training devices. It is possible to conduct experiment on power system by combining those modules. The adjoining modules are coupled by using the jumper lines.

Building module information is following:
Types: about 25,
Design period: 1week to 1 month.,
Cost: 300-5000 dollars,
Weight: 3-20 kg,
Storage: not required,
Standard voltage: 3-phase ,200V,
Maximum power: 1kW,
Power supply: 1-phase, 100V.

Control And Measurement

Figure 3 shows the proposed concept of "Visualization of electric power by module-type power system training device" in order to monitor and collect circuit variables and provides comprehensive information without complicated wiring. Visualization-purpose module which consists of wireless power meter and multi-meter is used to collect and accumulate system variables. The slave machine transmits the variables to the master machine. The accumulated date can be monitored by PC with RS232C connection. Minimum sampling time is 1 [s]. The power system visualization software offers processing of various data such as instantaneous and RMS voltage and current, frequency, power, and its integrated value.

This kind of system is employed as BEMS (Building Energy Management System) and this research transfers it to combination of several module-type experimental devices. The concepts of the proposed methods are follows (1) understanding of BEMS configuration and specification, (2) easy understanding of power management, and (3) facilitate data collection from experimental device.

However, this is passive monitoring and application is limited. In order to realize active control, introducing platform software is essential. Therefore, LabVIEW is introduced. At this moment, line switching with voltage, current, and, power monitoring is being developed.

PBL Development

In order to foster students with global viewpoints, PBL is getting attention. Figure 4 illustrates

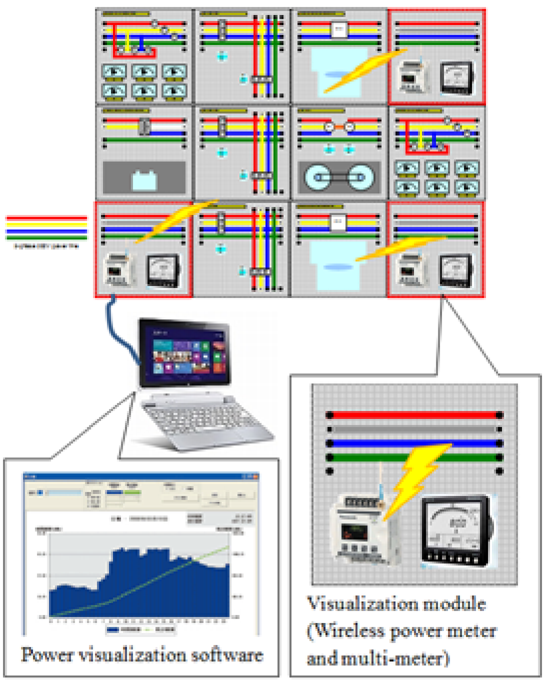
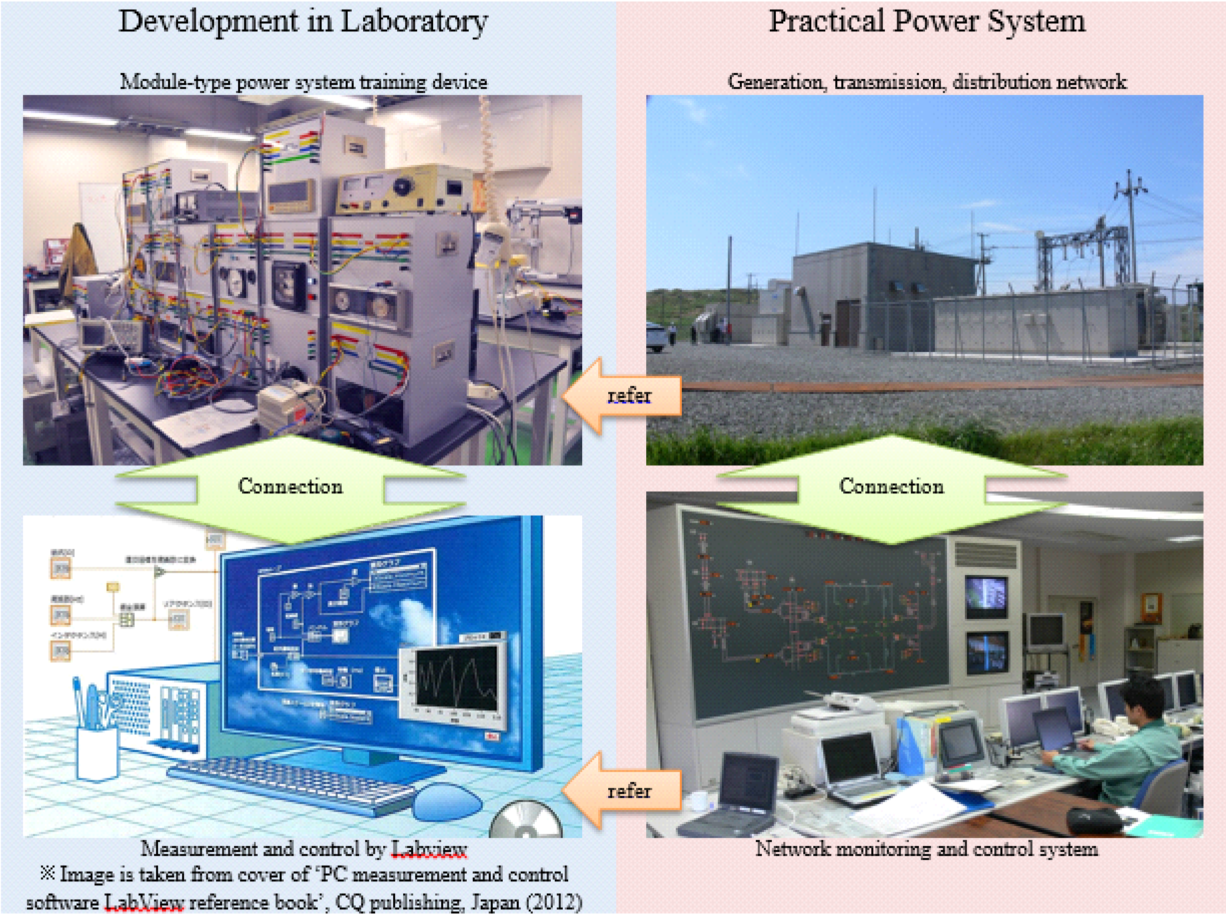


Figure 3. Visualization of Electric Power by Module-Type Power System Training Device



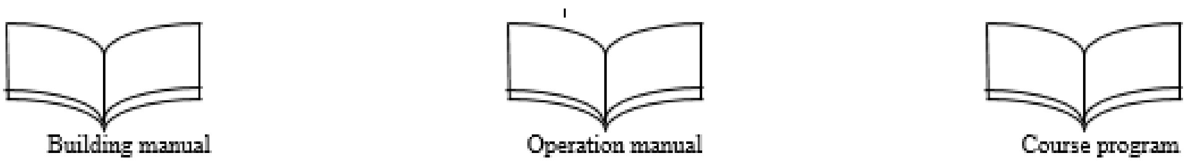
[4a] Function Upgrading of Module-Type Power System Training Device

Image photo

Program example

1st day	Contents of experiment
2nd day	Procedure of experiment
3rd day	Theoretical understanding
4th day	Conduct fundamental experiment
5th day	Evaluation of experiment
6th day	Setting applied theme
7th day	Procedure of experiment
8th day	Conduct experiment
9th day	Evaluation of experiment
10th day	Conclusion

[4b] Development of International PBL Program



[4c] Complete of Material

Figure 4[a,b,c]. Extension to International PBL

the whole concept of this project including PBL concept.

Assuming 10 days program, we call for students. Depends on the student study level, this program should be flexible as well as variation number of students.

Up to now, we developed 8 topics such as protection relay, unbalanced operation, harmonics, and synchronization.

CONCLUSION

In the future, these modules will be used to realize comprehensive PBL program to increase the opportunity of international communications. It is expected that this concept will offer various experiments in the future. This new module style is expected to give more experimental experience for electrical engineers rather than only numerical simulation study.

REFERENCES

Chang, W-N. (1998). A Flexible Voltage Flicker Teaching Facility for Electric Power Quality Education. *IEEE Transactions on Power Systems*, *13*(1), 27–33.

Collin, E.R. (2009). *Senior Member, IEEE.* An Energy Conversion Laboratory Using Industrial-Grade Equipment. *IEEE Transactions on Power Systems*, *24*(1), 3–11.

Contreras, J. (2002). Power Engineering Lab: Electricity Market Simulator. *IEEE Transactions on Power Systems*, *17*(2), 223–228.

Fujita, Y., & Hitotsumatsu, G. (2012, September). *Proposal of New Module-Style Power System Training Device*, UPEC 2012(47th International Universities' Power Engineering Conference).

Hoshino, T. & Fujita, G. (2013, September). *Visualization of Electric Power by Module-type Power System Training Device*. Power Engineering Conference (UPEC), 48th International Universities'.

Jewell, W.T. (1990). Transformer Design in the Undergraduate Power Engineering Laboratory. *IEEE Transactions on Power Systems*, *5*(2), 499–505.

Mohammed, O.A., Nayeem, M.A., & Kaviani, A.K. (2010). *A Laboratory Based Microgrid and Distributed Generation Infrastructure for Studying Connectivity Issues to Operational Power Systems*, Power and Energy Society General Meeting, 2010 IEEE, July.