

Planned Textbook of Automation Technology Specialty Teaching Research Association of China Vocational Technology Education Association  
中国职业技术教育学会自动化技术类专业教学研究会规划教材  
Achievement of 3D Teaching Resources Development of the "National Vocational Students Skills Competition 2013"  
“2013年全国职业院校技能大赛”立体化教学资源开发成果  
National Course Development Achievement of "Core Technology Integration" of Electro-Mechanical Specialty  
国家级教学成果机电类专业“核心技术一体化”课程开发成果  
R&D Achievement of Quality Monitoring & Assessment Center and Curriculum Resources Development of National Vocational Education  
国家职业教育“课程资源开发和质量监测评估中心”研发成果  
Special Award of National Teaching Achievements—Achievements of Skills Competition and Teaching Resources Development  
国家级教学成果特等奖——技能赛项与教学资源开发成果

# Industrial Robot and Intelligent Vision System Application

## 工业机械手 与智能视觉系统应用

Lü Jingquan Chief Editor

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Wang Jinfeng Chief Translator

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English Version

英文版

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CSTVE

中国职业教育学会  
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# Industrial Robot and Intelligent Vision System Application

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English Version



中国铁道出版社  
CHINA RAILWAY PUBLISHING HOUSE

This textbook is one of the teaching resources planned and guided by Automation Technology Specialty Teaching Research Association of China Vocational Education Technology Association. It is also used as the ninth 3D teaching resources focusing on students' practical and innovative ability, suitable for electro-mechanical specialty of higher vocational education, facing National Vocational Students Skills Competition, with the competition item achievement as a carrier.

The teaching resource starts from the core technology application of industrial robot and intelligent vision system (IRIVS) and gradually develops into project practices and then to project implementation, i.e. installation of industrial robot, industrial robot setting and programming, installation and testing of the intelligent vision system, PLC master program design, network building and program implementation of industrial Ethernet and testing and maintenance of overall system operation, and finally, this project is extended to the programming and testing of other brands of industrial robot and vision systems. The teaching resource presents a new solution to the "teaching" and "learning" of the technologies for the industrial robots and intelligent vision systems.

The teaching resource not only applies to the teachings in comprehensive trainings and engineering practice innovations in the electro-mechanical specialty of higher vocational colleges, but also to the activities by the students' organizations, engineering innovation practices and skills competitions in different colleges, and may be used as the training instruction manual for enterprise engineering technicians.

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# Brief Introduction to Authors and Translators

## Chief Editor

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**Lü Jingquan**, professor, senior engineer, vice president of Tianjin Sino-German Vocational Technical College. He has obtained more than 20 vocational qualifications and certificates. He studied, further studied and researched at over 20 vocational education institutes and enterprises training centers in Germany, Singapore, Spain, Canada, Australia and so on. He has published over 30 academic papers and 30 vocational educational research papers. Being a chief editor, he has compiled and published 10 electro-mechanical quality textbooks and planned textbooks of the “National Tenth Five-Year Plan” and the National “Eleventh Five-Year Plan”. He has been in charge of 6 national educational scientific research projects, and has got 3 National Teaching Achievements, and organized and accomplished 15 National Excellent Curriculums. He has been in charge of project of regional integrated training base construction supported by the Ministry of Education and the Ministry of Finance. He has also been in charge of the key research program of the Ministry of Education on “Research on Specialty Construction and Practice of High-demand Skilled Talents for Manufacturing Industry” and research program on “Teachers’ Training Standard in Manufacturing” supported by the Ministry of Education and UNESCO.



### Main Titles and Honors:

- National outstanding teacher, leader of national-level electro-mechanical specialty teaching team.
- The chairman of Teaching Research Association of China Vocational Education Automation Technology Specialty.
- The vice chairman of Automation Technology Specialty Teaching Instruction Committee of National Mechanical Industry Instruction Committee.
- The vice chairman of Automation Technology Specialty Teaching Instruction Committee of National Industry & Information Instruction Committee.
- Program leader of National Excellent Curriculum of “Installation and Testing of Automatic Production Line” and “PLC Control Technology”.
- Program leader of National Teaching Achievements of “Construction Mode of Core Technology Integration of Higher Vocational Electro-mechanical Specialty”.
- Member of Expert Database of Higher Vocational Talents Training Standard Evaluation Committee of the Ministry of Education.
- Executive member of the Council of Vocational Education Equipment Committee of China Vocational Technical Education Association.
- State council special allowance expert.

## Chief Translator

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**Wang Jinfeng**, professor, senior interpreter, director of Applied Foreign Languages College of Tianjin Sino-German Vocational Technical College. She has 16 years’ working experience in enterprise and has been an interpreter for technology and equipment imported projects and technical renovated projects involving electro-mechanical, iron and steel making, steel rolling and metal products. She has been engaged in vocational education for 14 years and published 6 academic papers. From the year 2005 to 2012 she has been an interpreter in vocational education delegations to Germany and America. She has been in charge of 4 science research programs and has been involved in the study and research on the theory & practice of modern vocational education.



### Main Achievements:

- Program leader of Tianjin Excellent Curriculum, “Practical English”.
- Program leader of Tianjin Education Science “Eleventh Five-Year Plan” Program, “Research on Realization

System of Vocational Education Modernization in China ”.

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## Deputy Chief Editor

**Jiang Zhengyan**, assistant professor and deputy director of Electronic & Electric Engineering Department, Changzhou Light Industry Vocational Technical College, Member of the 6th Youth Association for Science and Technology in Jiangsu Province; Member of the 10th Youth Association in Changzhou; One of the young key teachers to be developed in the “QingLan Project”, Jiangsu Province.

He participated in the program of the National Excellent Curriculum “Testing and Maintenance of Light Industry Automation Electric and Mechanical System”; The first class winner (the first place) of the 2nd “YaLong Cup Competition in the Auto-Line Assembling and Testing”; The first class winner (the second place) of the 3rd “YaLong Cup Competition in Auto-Line Assembling and Testing”; The first class winner in one event and second class winner in 4 events of “National Mitsubishi Electric Cup Students’ Automation Innovation and Application Competition”; Deputy chief editor of one textbook for “Eleventh Five-Year Plan” organized by the Ministry of Education; Deputy chief editor of one quality textbook of Jiangsu Province.



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## Deputy Chief Editor

**Chen Yongping**, associate professor, Shanghai Electronic Information Vocational Technical College, outstanding teacher of talents training of national mechanical vocational colleges.

He is the chief editor of excellent textbooks, which won the first prize in National Mechanical Vocational Education Textbooks. He was the first prize winner of National Vocational College Teacher’s Competition of Automation Technology & Modern Manufacturing in 2011. He is the deputy chief editor of planned textbook “A Course in Engineering Practice and Innovation” by Automation Teaching Instruction Committee of Ministry of Education, PRC. He is the program leader of Excellent Curriculum “Installation and Testing of Automatic Production Line” in Shanghai, main member of Shanghai municipal teaching team and INESA Holding Group Excellent Youth Expert.



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## Deputy Chief Editor

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### Main Titles and Honors:

- The vice chairman of Teaching Research Association of China Vocational Education Automation Technology.
- The secretary of Teaching Instruction Committee National of Power Industry Vocational Education.
- Hubei Excellent Youth Expert.
- The 4th Technical Expert of Power Company in Hubei Province.
- Leader of National Excellent Curriculum “Automatic Operation and Monitoring of Generating Set in Hydropower Station”.
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### Deputy Chief Editor

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### Deputy Chief Editor

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**Huang Huasheng**, one of the founders of Zhejiang Tianhuang Science & Technology Industrial Co., Ltd, member of Hangzhou PCC, part time professor of National Education & Administration Institute, vice chairman of China Education Equipment Industry Association, managing director of China Vocational Education Association, managing director of China Adult Education Association, vice chairman of Science Research Working Committee of China Vocational Education Association, deputy director of School-enterprise Cooperation Committee, deputy director of Vocational Education Quality Assurance & Assessment Association, member Expert Committee of Zhonghua Vocational Education, managing director of Production-teaching Cooperation Council of UNESCO, member of National Mechanical Industry Vocational Education & Teaching Instruction Committee, deputy director of magazine “China Vocational Technical Education” and deputy director of journal “Electrical & Electronics Teaching”.



# Translators

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The textbook is translated mainly by the English teachers from Tianjin Sino-German Vocational Technical College. The translation tasks for Chapters are as following;

Chapter Zero		Wang Jinfeng
Chapter One		Wang Jinfeng
Chapter Two		Wang Jinfeng
Chapter Three	Task One	Ren Huifang
	Task Two and Task Three	Jin Jie
	Task Four	Xiang Dan
Chapter Four	Task One	Wang Jinfeng
	Task Two, Task Three and Task Four	Wang Yonggang
	Task Five and Task Six	Zhang Zhenda
Chapter Five		Wang Jinfeng

This book is one of the teaching resources planned, guided and developed by Automation Technology Specialty Teaching Research Association of China Vocational Technology Education Association. It is 3D teaching resources focusing on National Vocational Students' Skills Competitions, serving electro-mechanical majors and training students' comprehensive practical ability and innovation ability. It is also the ninth shared teaching resources which regard National Vocational Students' Skills Competitions as a carrier, serving the teaching for vocational teachers and students, involving wisdom and experience of national curriculum development team and technical personnel from enterprises. It focuses on vocational education and teaching reform, specialty and curriculum development guided by vocational competitions, which play model role in training technical talents.

National Vocational Students' Skills Competition 2013 is jointly sponsored by Ministry of Education with 31 authorities, departments and enterprises involving Tianjin Municipal Government, Industry and Information Ministry, Ministry of Finance and China Labor & Social Security Ministry. It is so far the biggest national vocational competition regarding the scale of vocational education, standard, specialty coverage and category. So it has developed the case that general education is with college entrance examination while vocational education is with skills competition. It is one key system design and innovation and also a promoter of vocational education reform and development in the new period.

National Vocational Students' Skills Competition 2014 is coming. It seems that the competition 2013 has just ended, Professor Lü Jingquan, being the head, set up the development team consisting of referees, vocational college teachers and enterprises staffs and had much profound communications, "collision" of ideas, much sleepless thinking in Tianjin Haihe Education Park. So a 3D, task-oriented, practice-carrier selected by system and well-designed teaching resource has come out.



### Design Principles

It is on the basis of "three integrations" orientation of National Vocational Students' Skills Competition, which is the combination of competition events and specialty teaching, the combination of competition organization and industry and enterprises, the combination of the competition individual ability-orientation and team cooperation. The project development team plans and designs the book focusing on the professional skills of the electromechanical specialty and the comprehensive skills' steps application so as to implement "well planned event" "good organization and implementation" "achievements



popularization” “good teaching service” “events improvement”. The teaching resource is characterized by the following points:

(1) Conforming to the training objectives of higher vocational electro-mechanical majors listed in specialty guidance catalogue of Ministry of Education, it integrates the core technologies and skills of the specialty. It provides a new choice for the construction of productive practice training base on the campus for higher vocational colleges, a platform for training students’ comprehensive professional skills ability for teaching teams. It is possible of finding a new carrier for the implementation of action-oriented teaching and work process-oriented curriculum development.

(2) Selecting “THMSRB-3 training device of industrial robot and intelligent vision system application” which is the exclusive device for 2013 National Vocational Students’ Competition of Industrial Robot and Intelligent Vision System Application as the platform, the development team has jointly developed training program and teaching resources, in which the training for engineering implementation capability and professional quality are much more focused on.

(3) The development of teaching resources is focused on higher vocational students’ team cooperation ability, planning and organizing ability, the ability of installation and testing of industrial robot and intelligent vision system, communications ability, awareness of efficiency, cost and safety. It also involves team learning, team training and team spirit as well.



### Teaching Material Characteristics

It follows the principle of “accuracy, practicability, advancement and readability”. The integrated use of witty languages, beautiful pictures, cartoon characters and process simulation involves the learning and work in the relaxed atmosphere so as to improve students’ learning interest and efficiency in order to realize the goals for students easy to learn, easy to understand and easy to get started.

The book’s arrangement is from easy to difficult, from the perceptual to the rational through “Project Guidance” “Project Start” “Project Preparation” “Project Practice” “Project Implementation” “Project Development” in order to let the teachers and learners get to know teaching methods and way of learning for industrial robot and intelligent vision system. It also provides learners the engineering practice knowledge and experience, improves the technical application and innovation abilities, expands the professional knowledge, internalizes and forms a good professional behavior for different learners.

The teaching resources has strengthened the “authenticity” of the engineering practice cases, the “deepness” of the electro-mechanical application, the “broadness” of the innovative practice, the “richness” of the teaching resources, the “closeness” between hard and soft systems combination, the “effectiveness” of the virtual simulation, the “happiness”

of the teaching and learning process and the “moderation” of talents training goal. It makes the tentative exploration for new teaching and learning modes.



## Basic Content

The textbook (teaching resources) is composed of three parts involving paper textbook, multimedia disk and teaching resources ( [www.gzhgzh.net](http://www.gzhgzh.net)). In order to effectively promote work process-oriented teaching concept in higher vocational colleges, the use of textbook not being neglected in teaching, the textbook makes a good try in how to compile 3D and work engineering-oriented textbook. It will play a leading role in textbook writing style, content and so on in the future.

The paper textbook has six parts. To facilitate vocational teachers to use the textbook, “Project Guidance” is put in the front of the textbook, which is written by professor Lǚ Jingquan, “Project Start” by associate professor Tang Xiaohua, “Project Preparation” by associate professor Jiang Zhengyan, “Project Practice” by associate professor Chen Yongping, “Project Implementation” being jointly written by associate professor Qu Caiping, associate professor Wang Yifan, senior engineer Huang Huasheng, Jiang Zhengyan and Chen Yongping, while the “Project Development” is by associate professor Jiang Zhengyan.

The development of the teaching resource is also the R&D achievement of the Center of National Vocational Education Curriculum Resource Development and Quality Assessment. In addition, Management Committee of Tianjin Haihe Education Park has also given comprehensive guidance and support to the textbook development.

In the process of textbook development, great support has been got from leaders and colleagues from Zhejiang Tianhuang Science and Technology Industrial Co., Ltd., Mitsubishi Electric [Automation (China) Co., Ltd.], Tianjin Sino-German Vocational Technical College, Shanghai Electronic Information Vocational Technical College, Changzhou Light Industry Vocational Technical College, Changzhou Textile and Garment Vocational College and Guangdong Shunde Vocational Technical College. Thanks are also given to the experts group of national vocational competition, relevant industry and enterprises and vocational colleges for their great support and cooperation.

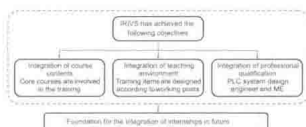
Due to the limited experience, knowledge and time of the development team, there are some shortcomings and deficiencies in the textbook. The advices from readers are warmly welcome.

Editor  
Oct, 2014

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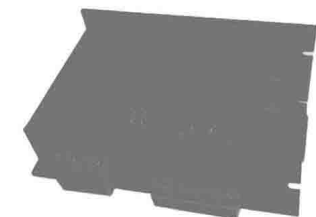
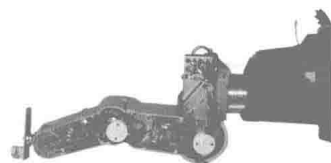
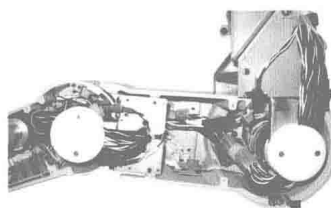
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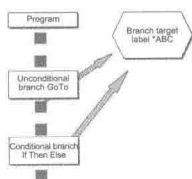
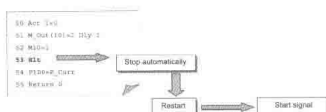
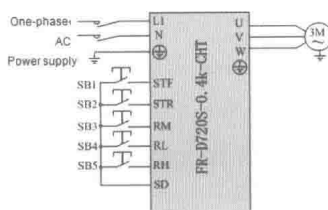
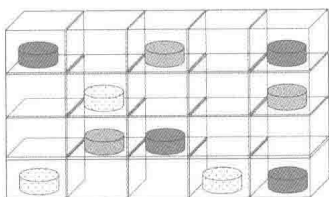
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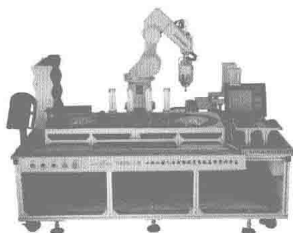
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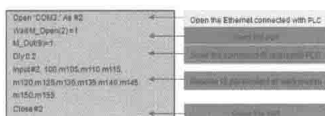
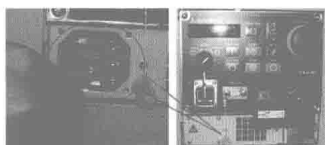
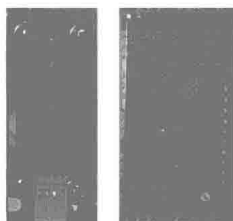
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## Chapter Zero

### Project Guidance —Teaching Design

Comprehensive practice-oriented teaching is considered as one of the most important ways and means for higher vocational students to obtain practical skills and multi-vocational abilities. How to design skills training practicum, comprehensive skills training practicum and how to stimulate the students' self-learning interest and how to train students to apply their acquired knowledge in production practice are the qualifications required in working post and also the prerequisite of obtaining ability for sustainable development.

#### I . Guiding Ideology

To incorporate integration of program core technologies into the curriculum development and teaching practice. To establish four integrations of core technology of professional courses on core knowledge and skills of the curriculum (see Fig. 0-1) in order to adapt to action-oriented teaching requirements, improve the students' comprehensive adaptabilities to working posts and to train highly skilled personnel who need “short transitional period” or “no transitional period” as well.

This project has won  
a second prize of  
national teaching  
achievement in 2009.

Integration of program core technologies: Focus on professional training and clearly define a number of core technologies and skills. Plan the system of professional courses as a whole according to core technologies and skills. Make clear the core knowledge and skills in each course and to establish a teaching context (module) guided by working process. Incorporate theory, experiment, training, internships and employment. To build up an integrated and



crossed teaching network of classroom, laboratory, attached workshop and production shop. Stressing theory and practice being paralleled, combined and cross-linked to each other longitudinally and transversely. The teaching process centers around core technologies and skills. Making the curriculum system and teaching contents serve the core technologies and skills and to enable the higher vocational graduates in this field to really acquire the ability to work. Aiming at training highly skilled personnel who need “short transitional period” or “no transitional period”.

—quoted from “Study and Practice of Construction Mode of ‘Integration of Core Technologies’ in Higher Vocational Electro-mechanics” by professor Lü Jingquan

This project has won a second class medal for national teaching achievement in 2005.

**Action Guided Teaching:** From the point of view of teaching professional knowledge and skills, generally increase the students’ comprehensive professional abilities. Enable them to systematically consider problems faced in their work, to understand the meaning of the work to be done, to be familiar with the work procedures and schedule, and to possess abilities to plan, perform and inspect on their own. As a prerequisite to be responsible for the society and to be able to effectively cooperate and communicate with other people. Work actively and carefully on their own initiative, with a high sense of responsibility and quality; possess a sustainable ability in the associated technical field to adapt to the requirement in the future.

—quoted from “Application and Research on Action Guided Teaching Method in Higher Vocational Teaching Practice” by professor Lü Jingquan

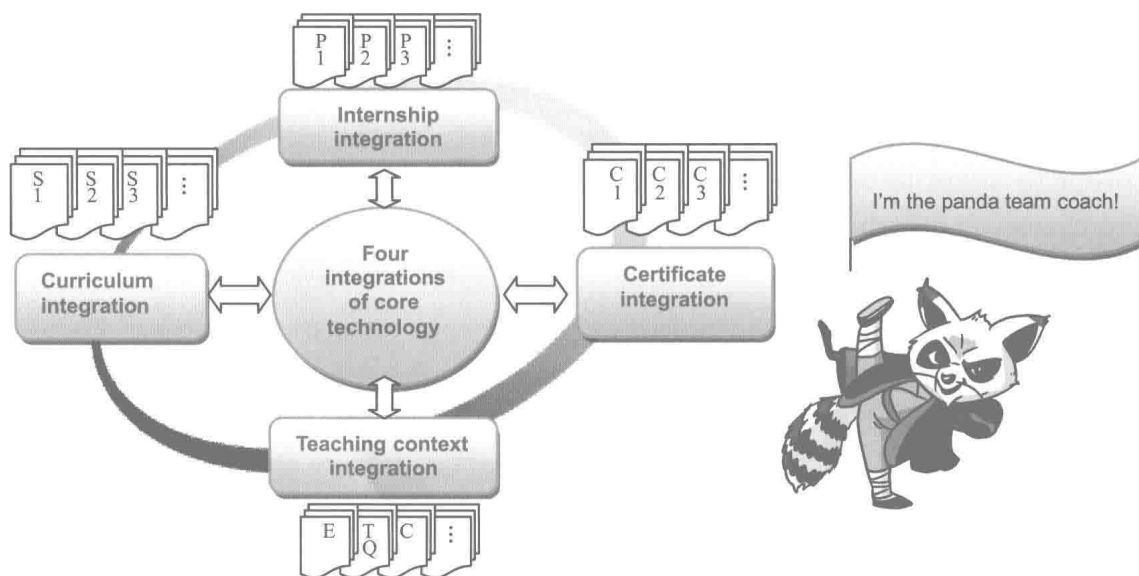


Fig. 0-1 Four integrations of core technologies



## II . Teaching Suggestions

Industrial robot and intelligent vision system (IRIVS) involves the core technology of automation field in high-end manufacturing industry. It integrates industrial robot, intelligent vision system, industry network technology and modern industrial production. It fully represents modern industrial production and management concept of optical electro-mechanical integration, management and control integration and two integrations, which offers a new carrier in training highly skilled talents for automation program. It also offers a new platform for integrated application of optical electro-mechanics in modern industrial production. The system involves a large quantity of core technologies in industry automation field, represents elements of industrial technology upgrading and actually displays the whole automation process in simulated industrial site.

**Basic requirement:** It is necessary to have IRIVS training equipment and typical IRIVS platform. Each mechanism has the comprehensive function of mechanical technology and electrical technology. The design concept of “integration of core technologies” will be represented to establish a platform to conduct action-guided teaching mode.

**Requirements for teachers:** They are supposed to have comprehensive knowledge of automation, electro-mechanical integration and industrial robot, be familiar with IRIVS technology, have strong ability of teaching and project development.

**Teaching carrier:** Taking the installation and testing of IRIVS training platform as an example. It is capable of accomplishing the design concept of curriculum development of core technology integration (Fig. 0-2). The tasks of unit testing and overall joint testing

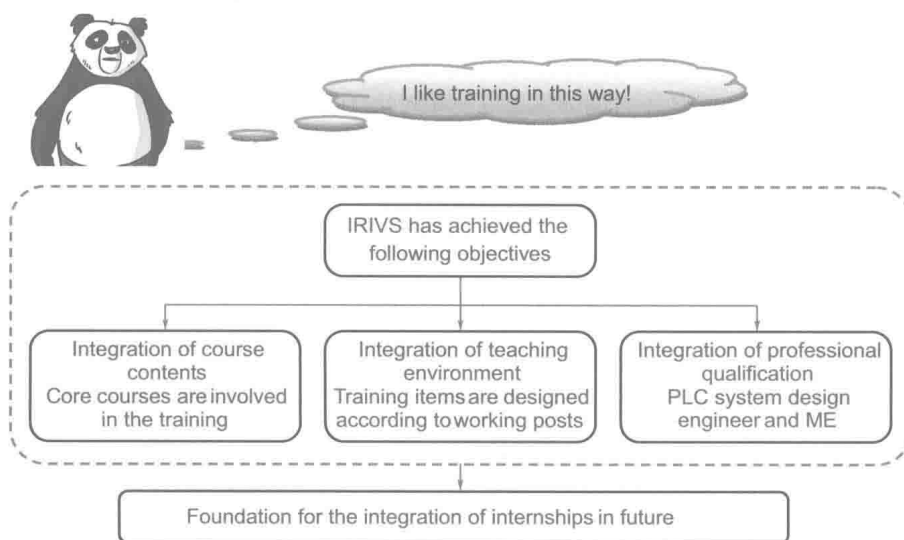


Fig. 0-2 Relationship between IRIVS and core technologies

involve mechanical and electrical core knowledge and technology and advanced IRIVS application. It is capable of training and assessing the students' ability of mastering core technology and comprehensive application ability. It's an effective way to develop students' ability in technical innovation.

**Training mode:** Three students, who are in one group, cooperate to accomplish tasks of installation and testing of the single and double elevator installation in IRIVS. Schools or colleges may make related choices according to its professional teaching requirements. Different job content may have different requirements for professional skills.

**Training contents:** The project tasks involve core technologies of mechanical engineering, electronic engineering and modern automation engineering. The platform mainly includes industrial robot system, intelligent vision system, PLC system, transformer, AC motor, servo driver, servo motor, industrial sensors and so on. Competitors are supposed to accomplish the testing and wiring of IRIVS, the programming and testing of industrial robot and PLC, process programming of intelligent vision system, setting of position point teaching-demonstration of industrial robot, parameter setting of servo driver and frequency converter. It also includes mechanical and electrical installation, connection, fault diagnosis and testing, etc.

**Get certificate:** The training contents include standard requirements for professional qualification certificates of "Maintenance Electricians" and "PLC System Designers" awarded by the Ministry of Labor and Social Security, PRC.

**Organizing the competition:** Depending on the national higher vocational students' skills competition, it is to create a situation of general education with college entrance examination and the vocational education with skills competition. The comprehensive practical ability and project practical innovation ability of electro-mechanics major students in higher vocational colleges will be improved through the competition of IRIVS installation and test.

### III. Five Key Points

Five key points involving "competition, teaching, virtual, simulation, practice" will be stressed in teaching with the teaching resources.

**Competition:** Competition contents will be introduced, applied and enriched in teaching by way of overall describing IRIVS competition items, video experiencing of competition site, scene atmosphere showing, robots performance, competition technology upgrading and industry standard integrating of National Vocational Students' IRIVS Competition.

