

# Research on the Combination of Experimental Equipment Improvement and Student Innovation Training

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**Abstract**—This paper introduces the specific measures of the combination of experimental equipment improvement and student innovation practice in the process of student innovation training. The measures include the selection of innovative projects, the use of modular design ideas to improve and upgrade existing experimental equipment, and the development and application of the experimental system. The practice has proved that the combination of equipment improvement and student innovation training has a significant effect, which not only saves the experimental cost, but also exercises the students' project development ability.

**Keywords**—experimental equipment improvement; innovation training; modular design; project development

## I. INTRODUCTION

Experimental teaching is an indispensable part of innovation ability training in the universities and higher vocational colleges [1, 2]. Due to the factors such as cost, the experimental equipment in the universities and higher vocational colleges has the problems such as single equipment type, limited number of sets, and slower update, which cannot adapt well to the rapid development of industrial technology [3]. Therefore, it is a feasible way to make full use of the scientific research and innovation ability of teachers and students in the universities and higher vocational colleges and to carry out the reconstruction and improvement of the experimental equipment. Especially with the increasing investment in student innovation projects in the universities and higher vocational colleges, it is of great significance to increase the improvement of experimental equipment in the training of students' innovative ability [4].

This article focuses that how to effectively combine the experimental equipment improvement and innovative projects training. For example, when designing the student innovation projects, the teachers should consciously use new components and new technologies which closely related to production and life. In addition, the students should be guided to master the modular design idea. And the students can apply this idea to independently complete the software and hardware design of

innovative projects. Due to the modular form of innovative projects, basically, most of the hardware units can be regrouped and reused in other practical teaching sessions. In this way, while improving students' innovative ability, both the improvement of experimental equipment and the diversification of equipment types is realized. Besides the benefit of transformation cost are maximized.

## II. THE APPROACHES OF COMBINATION OF EXPERIMENTAL EQUIPMENT IMPROVEMENT AND INNOVATION TRAINING

### A. Selecting the Topics of Innovation Projects Based on the Content of the Equipment Improvement

Teachers can directly develop innovative topics based on the needs of experimental equipment improvement [5], such as "Development of a comprehensive experimental system for a four-degree-of-freedom rotorcraft", "Sensor static calibration system based on virtual instrument", and "Design and implementation of positioning system based on semi-active RFID technology".

Teachers can also develop application-oriented innovation topics related to production and life according to the characteristics of their own university major [6]. Through the development of these projects, the hardware units in these projects can be reused in the project for experimental teaching and laboratory construction. For example, "Design of home security wireless monitoring system", "Design of wireless monitoring system for automobile tire temperature", "Research and application of fuzzy control in water-saving irrigation control system", "Design of residential heating performance monitoring system based on RS485", "Design and implementation of earthquake ruins search and rescue robot", and so on.

### B. Module-based Project Development

For these application-oriented innovation projects, the modular design idea is adopted. Firstly, the task is decomposed. A project is divided into several modules, each module is relatively independent and responsible for a specific function. Secondly, each module is assigned a student to complete.

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Finally, all the modules are combined and joint debug to realize the project requirements.

There are two reasons for adopting this approach. First, modular development is benefit for team division and collaboration. Second, the disassembled modules can be reused for experimental teaching and laboratory construction. The specific usage can be subdivided into three types:

- For temperature monitoring projects, due to different monitoring objects, the temperature sensors used in different objects are not the same, but the main control core of the system is basically the same. Therefore, in the development process, limited funds can be used to purchase diversified temperature sensors, such as SP12, DHT11 and NTC thermistor. SP12 is a sensor for integrated temperature and pressure acquisition, mainly used for tire monitoring. DHT11 sensor is mainly used in environments requiring integrated temperature and humidity monitoring. NTC thermistor is mainly used in medical application. These diversified temperature sensors not only change the current status of the laboratory with only the traditional analog temperature sensor and the DS18B20 digital temperature sensor, but also give students the opportunity to access many types of sensor detection component.
- For robotic innovation projects [7, 8], the students can assemble various sensing and control modules on robot with different mechanical structures. The assembled robots can be used as a carrier for senior students in practical teaching and scientific research, and can also

be directly to participate in various student competitions.

- For secure wireless monitoring projects, the underlying monitoring modules such as temperature and humidity, fire, flammable gas concentration measurement and prevention control are basically the same in the different monitoring places. Therefore, detection components and control components have little change. Only the wireless network transmission structure and communication module need be changed for different application objects and monitoring places, such as intelligent home safety monitoring, station safety monitoring, laboratory safety monitoring etc.

### III. THE INSTANCE OF COMBINATION OF EXPERIMENTAL EQUIPMENT IMPROVEMENT AND INNOVATION TRAINING

This article takes “Design of home security wireless monitoring system” as an example to introduce the improvement of experimental equipment. The home intelligent security protection system mainly includes three parts: Zigbee wireless sensor network, GSM network and remote monitoring. The overall structure is shown in Fig. 1. Similar the number of the laboratories in universities and higher vocational colleges of laboratory rooms is large and the rooms are scattered. Therefore, the home security wireless monitoring system can be modified for laboratory security monitoring system based on Zigbee wireless network.

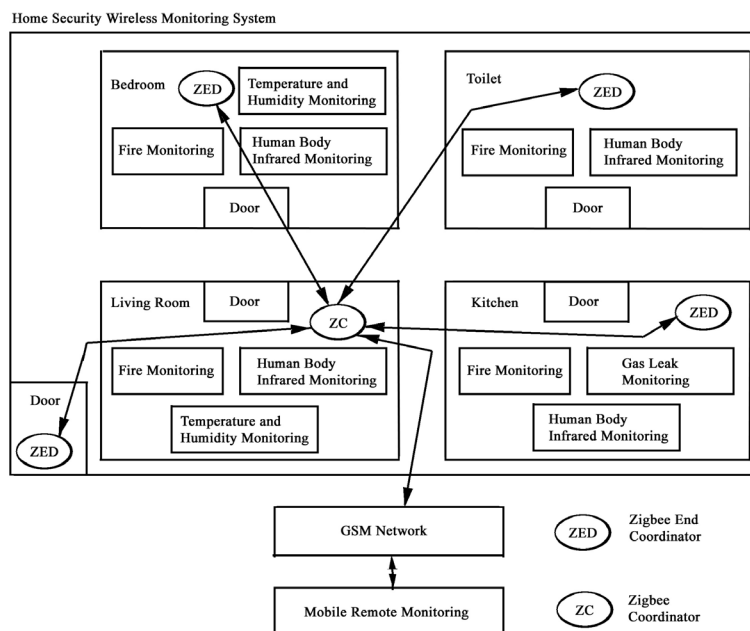


Fig. 1. Overall structure of home security wireless monitoring system

The laboratory terminal can directly use the end device in Fig.1, that is, each room in the family is regarded as a different laboratory, and each laboratory is equipped with infrared,

smoke, flame, temperature and humidity sensor nodes to collect laboratory environmental data.

The Zigbee coordinator is connected to the computer management system in the monitoring center and the GSM Module. The coordinator sends the received information to the computer management system through the serial port. The computer management system in the monitoring center uses LabVIEW 8.6 as the development environment. The functions of the monitoring system software are as follows: real-time monitoring data display, over-limit alarm, temperature, humidity and smoke concentration timing storage, historical curve and statistical information query of each laboratory, etc. A communication program is designed through the GSM

module. If an abnormal event occurs in a certain laboratory, the alarm is sent to the teacher or user by SMS (short message service) to take appropriate measures.

The overall structure of the modified laboratory safety monitoring system is shown in Fig. 2. After the system modification, the limited equipment can be reused. The benefits of the approach are as follows: First, the students exercise hands-on ability through practice. Second, the students have a perceptual understanding of the actual project. Third, the unity of production, study and research is realized.

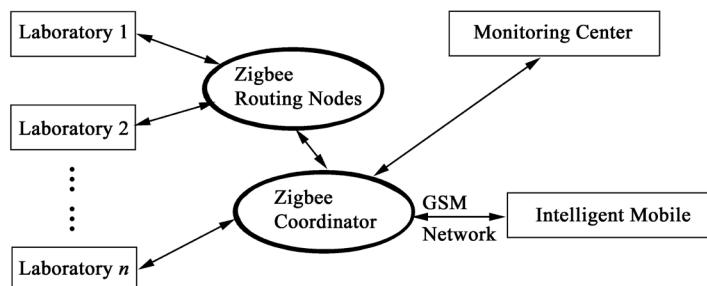


Fig. 2. Overall structure of laboratory safety monitoring system.

#### IV. EFFECTS OF EXPERIMENTAL EQUIPMENT IMPROVEMENT AND INNOVATION TRAINING

In the innovative training, students participate in the experimental equipment improvement and also participated in the management of laboratories. Taking School of Automation of Shenyang Aerospace University as an example, the effects are reflected in the following four aspects.

##### A. The Experimental Teaching Conditions are Improved

In recent years, through the efforts of both the teachers and students, the outcome of student innovation projects have been modified and improved, and most of them have been used in

experimental teaching. For example, as shown in Fig. 3, the home security wireless monitoring system has been modified for laboratory security monitoring, ensuring the security of the laboratory open 24/7. Another example, the earthquake ruin search and rescue robot takes the smart car as the carrier. Through the disassembly and assembly of the vehicle-mounted sensor module, the teachers can derive multiple topics related to smart cars and intelligent robots. These topics can be used for the exercise of curriculum design, graduation design, which greatly improving the usage rate of the experimental equipment, and effectively saving experiment funding.

#### Laboratory Safety Monitoring System of Shenyang Aerospace University

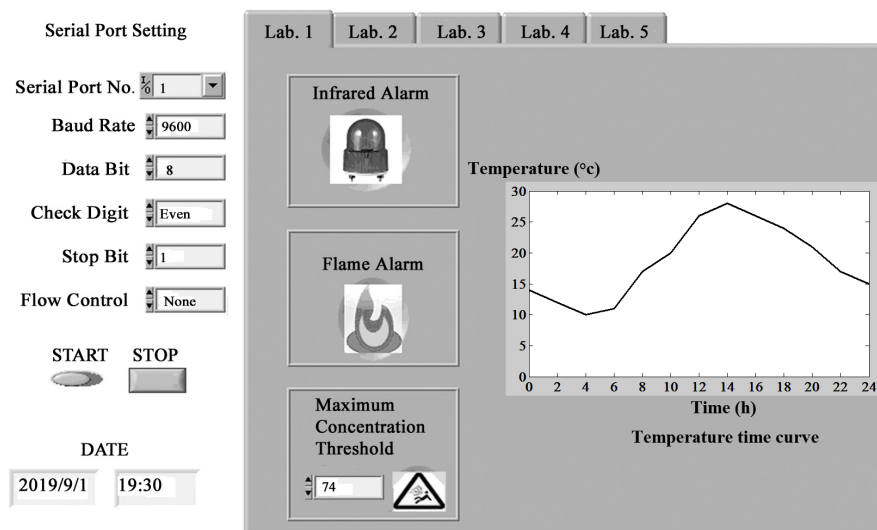


Fig. 3. Monitoring interface of laboratory safety monitoring system

### B. *The Student's Engineering Practice Ability Has Improved Significantly*

In the process of participating in the improvement of equipment, students have enhanced their perceptual knowledge of engineering practice. In turn the students' innovative thinking and hands-on ability are stimulated. Based on this, in the past two years, a total of more than 150 students have participated in national, provincial and school-level competitions. And among of them have won more than 50 awards. The number of awards has increased by 5%.

### C. *The Students Have been Good at Drawing Inferences about Other Cases from One Instance*

For instance, the students can actively find and discover the actual needs of production and life, propose innovative topics of interest to develop, and convert their finished products into patents or popularized applications. For instance, teacher and students cooperate to obtain utility model "wireless smart socket", obtain computer software copyright "laboratory safety monitoring system software v1.0", and so on. At present, the students have applied for the relevant software copyrights and started to set up their own entrepreneurial team.

### D. *The Students Establish Team Spirit in Cooperation*

Whether it is the improvement of experimental equipment or the completion of innovative projects, all of the tasks need a team to complete. Everyone needs to cooperate with each other in the team. Therefore, in the process, the spirit of team cooperation has been developed. In addition to this, professional technical ability and communication ability are developed. All the skills lay a good foundation for students to go to society in the future.

## V. SUMMARY

Students' innovation training based on the improvement of experimental equipment, takes into account both the students' innovative ability training and laboratory construction. In the process of innovation training, for the purpose of laboratory construction, teachers select or design the related innovation topics. Students can intuitively feel the application effect of the

completed works. Students can actively participate in laboratory construction and management. Not only engineering practice ability are effectively improved, but also the sense of ownership of students are enhanced. In summary, combination of experimental equipment improvement and innovation training has played a good role in promoting practical teaching in colleges and higher vocational colleges.

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