Research on the Reform of Medical Sensor and Detection Technology Based on Project Teaching Method

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Keywords: Medical sensor, Project teaching method, Curriculum reform.

Abstract. Medical sensor and detection technology is the backbone courses of biomedical engineering, the foundation of biomedical signal detection and analysis, with features of a wide range of knowledge, strong practical and so on. The traditional teaching method emphasizes the theory of the explanation and with the disadvantage of lack of integrated design application experiments. In order to change this situation, according to the personnel training objectives of biomedical engineering and course characteristics of medical sensor, we try to cultivate the practical hands-on ability of students, and also improve their ability of solve practical problems. In this paper, we analyze the present situation of medical sensor teaching first, and then discuss the teaching content and experimental design based on project teaching method.

Introduction

Medical sensor and detection technology is a core part of biomedical engineering teaching system. It is a highly interdisciplinary course which includes physics, chemistry, medicine, machinery, electronics and so on. It has characteristics of high knowledge intensity and the strong applicability. Medical sensor is similar to the doctor's facial features, which is the key device of medical equipment. It can access vital signs information more accurate and extensive. With the development of modern medical technology and clinical needs, the employer needs students with the strong comprehensive application ability of sensor increasingly. But in the past, our curriculum is more emphasis on the basic principles. The experimental teaching is also in the experimental box and only for the basic verification operation. The students are lack of comprehensive application ability training. Therefore, in order to train students with strong comprehensive application ability and meet the needs of enterprises, the course is in urgent need of reform.

Analysis on the Present Situation of the Course

1) Teaching content is refer from automation subject mostly, and the lack of appropriate teaching materials

Course content itself has characteristics of a theoretical abstraction, complex formula, the physical meaning of obscure and so on. Thus students are prone to get bored and do not know how to start. However, at present, the teaching content of this course is mainly introduce the basic principles and measurement circuit for the traditional physical sensors such as strain, inductive, capacitive, magnetic, photoelectric, etc. Those contents are refer from automation subject and be short of new medical sensor content such as biosensor and other relative content. The traditional textbook arrangement mode adopts the parallel knowledge structure, each chapter has independent exercises and experiments, each part of the experiment are separated, it does not involve the comprehensive application in the medical field.

2) Old teaching mode and teaching ideas
For a long time, teachers generally use the theory-based teaching methods to focus on the definition of the sensor [1], the formula derivation, the principle of analysis and so on. It makes the sensor formula and schematics more boring which has a bad effect on learning enthusiasm. Although some students have better knowledge of sensor-related theory, there is little knowledge of the application method of sensor in practical engineering, and still cannot understand the practical application value of sensor even when learning the sensor course. Practice has proved that it is difficult to master the sensor-related knowledge if only rely on the classroom to explain and the simple experimental curriculum [2]. In addition, this traditional teacher-centered and full-time inculcation of teaching methods, to a large extent, depressed the students’ divergent thinking, innovation and personality development.

3) Less comprehensive experimental teaching content
At present, the medical sensor experimental teaching is basically a basic sensor module can only verify the working principle of the common experimental platform, such as strain gauge, capacitive, inductive sensor etc., it cannot carry out demonstration and verification of physiological parameter measurement. Thus, the traditional experimental teaching is not conducive to students to consolidate the medical signal detection knowledge. In addition, the experimental content cannot reflect the characteristics of biomedical engineering which affecting the teaching effect of this course.

In order to change the teaching situation, the project teaching method is used in the course of sensor course teaching. It can extend the content of the textbook through the project practice content, make up the defects without proper teaching material. As well, it change the teaching mode centered on "teacher", stimulate students’ initiative and Creativity. Thus, students can master the comprehensive application of sensors in medicine and improve their engineering practice ability.

**Project Teaching Method**

Project teaching method is an effective teaching method that the teacher designs the teaching content into several relatively independent, complete "project", and with the guidance of the teacher, student study autonomy through group, independent organization and implementation of the project work in a certain time. It mainly including the selection of projects, assigns tasks, student grouping, plan designation and implementation, results demonstrate[3].

Project teaching method originated from European labor education thought, is the earliest prototype of work-and-study education in the 18th century Europe and cooperative education in the 19th century America, gradually perfect through the development to the middle of the 20th century, and become an important theoretical trend. Education project is a form of modern education which is established in the industrial society and the basis of information society. The content is the unity of the mass production and the social, which can socialize the educated. The purpose is that educated people to adapt to the unity of modern productive forces and production relations. It is a talent training mode that cultivates the practical talent as the direct purpose for the community[4,5].

"The project as the main line, teacher as guide and students as the main body" is the most distinguishing feature of the project teaching method. It change the traditional passive teaching way of "teacher speaks, students listen to" and is very suitable for sensor engineering course which can cultivate the students' practical ability, team cooperation ability and the comprehensive innovation ability effectively[5,6].

**Design Idea of Project-based "Medical Sensor” Course**

1) To determine the objectives of the reform
As an applied university, biomedical engineering professional training goal is cultivate high-quality applied talents with the strong social adaptability and competitiveness. Thus, this study aims to break the traditional model of sensor-based teaching and build a "student-centered, teacher-supplemented" of new teaching system. As a new model of sensor methodology, it emphasize on developing practical ability of student.
2) The selection of project content

Usually the design of teaching content and students need to meet the actual needs. Otherwise it will not give full play to the students' practical ability and cannot effectively complete the teaching task. At the same time, in the actual teaching, we need to pay attention to the interaction between teachers and students, and also between students and students. So that ensures the integrity of teaching activities. Moreover, we combined with the actual ability of students to customize the diversity of teaching content to achieve the individual development of students.

Therefore, it is necessary that the choice of the project must combine teaching tasks and practical needs. According to the characteristics of medical sensors and actual demand, we will introduce the basic physical sensor principle and measurement circuit firstly, and then design the project according to the measurement of physiological parameters: Respiratory signal detection, body temperature detection, heart rate detection, EMG signal detection, blood pressure signal detection.

In the implementation, we note that the same application can be achieved by choose the different types of sensors. In project teaching design, these factors should be fully considered. We need to direct students to choose different sensors to achieve, and then compare advantages and disadvantages of different choose. This approach is a great way to improve the comprehensive application of students, while to achieve a great degree of development of students learning interest and innovation.

Here, respiration signal detection is as an example to be illustrated, which is an important indicator of vital signs, and has great meanings on intensive care and sleep apnea syndrome. Strain sensors, temperature sensors, flow sensors, resistance sensors and capacitive sensors can be used for detection. Strain sensors detect period changes in the chest-abdomen respiration process. Resistive and capacitive sensors can detect the impedance and capacitive changes of human body, due to the movements of chest and abdomen. Flow sensors can detect the gas flow changes in the gas flow paths. And temperature sensors can measure the nasal temperature change. In these methods, the strain sensor is more sensitive to the position due to the mechanical movement of the abdomen; and the flow sensor, which is used in the medium and high grade ventilator, is more accurate but with high cost; and the resistance and capacitive sensors require the drive circuit, so the circuit structure is more complex. Based on the above analysis and comparison, students can select the cost-effective sensors in practical to achieve measurement. Here, respiration signal with low accuracy detection is enough, so that the temperature sensor with low cost and good reproducibility is preferable.

At this point, students can be further guided to analyze the actual temperature environment, select the appropriate temperature sensor. Respiration detection for the temperature sensors utilizes the periodic fluctuation principle of nasal temperature when gases exchange. The temperature change of the gas flow is not large. Therefore, the thermistor is enough to meet the requirements. The thermistor is divided into negative temperature coefficient, positive temperature coefficient and single crystal doped semiconductor type, so students need to further study the properties of different thermistors in the process of achieving the project. The project also needs to use the detection circuit (that is, Hui Tong bridges, amplifier, display instrument) for testing and display. Through this process of learning, thinking and operation, students not only consolidate the relevant theoretical knowledge, but also enhance the capacity of comprehensively using sensors.

3) The selection of teaching methods

The application of project teaching method in the sensor teaching should be based on projects and mixed usage of different teaching methods, thus can highlight the task-driven, and help students to understand the relevant knowledge, promote the improvement of students' awareness and solve the problems in the task effectively[6,7]. For example, the teacher may first combine with the traditional teaching method so that students have a certain grasp of the basic principles, and then use the situational approach and comprehensive task-driven method to further deepen their understanding of knowledge, to guide the students into the practical stage of the project, strengthen their interest in the specialized field, to promote the improvement of students' comprehensive ability. In addition, teachers can guide students to plan, design, implement and evaluate tasks, so that students are able to
use the knowledge and skills to complete the task, improving their ability of practical and innovation.

4) Implementation of the project

According to the selected project content, we should ensure that the content with the typical, comprehensive, interesting, feasibility, practicality and so on. In the process of project implementation, different levels of students will be grouped, so they can help each other and promotion together. Thus improve their teamwork ability.

As the project teaching method has a certain degree of flexibility, so in the evaluation of student achievement requires a flexible way, we should get a comprehensive study of student performance, performance and learning attitude [1,8].

Conclusion

According to the training objectives of the biomedical engineering and the requirements of students’ ability from the enterprise, we have reformed the teaching process of the medical sensor and detect technology which is a highly practical course. We discuss the application of project teaching method in the course of medical sensor. Practice shows that the course through the scene of the real physiological signal measurement, theory and practice integrates organically. This teaching mode stimulates the students interest in learning and deepens the students understanding of the content of the theory class, and obtains good teaching effect.

However, there are a wide variety of sensors involved in medical devices, how to design the contents of the project teaching with more useful sensors theory is a problem which needs to constantly think and improve in the future.

References


