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Research on the Current Situation Analysis of Modern Sensing Technology Courses and Curriculum Design Exploration in Traditional Chinese Medicine Universities

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Abstract: It is of great significance for traditional Chinese medicine (TCM) universities to offer modern sensing technology (MST) related courses to train students' cross-disciplinary ability of TCM engineering. This paper makes a full investigation and analysis on the situation of TCM universities offering relevant courses. We put forward the central idea that it is necessary to combine the discipline characteristics of TCM universities with the practical application scenarios and cases of TCM to increase the practical links of the course, and enhance students' understanding of theoretical knowledge and application ability. Based on the principle of combining problem-oriented and case-driven teaching methods, the course should achieve the purpose of combining teaching with fun, consolidating the foundation, integrating practical applications, improving scientific research ability, and improving both students' professional skills and teaching satisfaction. Taking medical information engineering major as an example, the MST course is designed, and the course object, content and course requirements are elaborated in detail, so as to provide reference for TCM universities to carry out relevant courses.

1. Introduction

The main ideas of curriculum design in traditional Chinese medicine (TCM) universities mainly revolve around inheriting TCM theoretical knowledge, cultivating TCM practical skills, integrating modern scientific knowledge and research methods, and promoting TCM culture and professional ethics education [1]. In curriculum design, it is necessary to comprehensively consider the combination of specialized courses with future employment and scientific research requirements [2]. Furthermore, it is essential to further cultivate students' subjective initiative [3, 4]. The teaching goal is to make learning enjoyable, consolidate the foundation, integrate practical applications, improve scientific research capabilities, and achieve the dual improvement of students' professional skills and teaching satisfaction.

With the development of science and technology, the research and application of Intelligent

Medicine in TCM diagnosis and treatment have attracted increasing attention from practitioners [5]. And sensors are devices that can sense the specified measured quantity (such as physical quantities, chemical quantities, biological quantities, etc.) and convert it into an available output signal (usually an electrical signal, such as voltage, current, frequency, etc.) according to certain rules. Sensors play crucial roles in physiological parameter detection such as electrocardiogram (ECG), electroencephalogram (EEG), electromyogram (EMG); medical imaging such as ultrasound, X - ray detectors, computed tomography (CT) for surgical navigation; and laser treatment. In the field of TCM, both intelligent medicine and sensors have important applications, bringing new opportunities and transformations to the development of TCM. In TCM diagnosis [6], by using instruments for the four - diagnostic information (tongue diagnosis, face diagnosis, pulse diagnosis, and interrogation), for example, tongue appearance and facial complexion can be obtained through image recognition technology. This enables more accurate and comprehensive collection and analysis of the four - diagnostic information in TCM, as well as quantitative analysis, providing an objective basis for TCM diagnosis. It can simulate the thinking process of TCM experts, offer diagnostic references and suggestions to doctors, and improve the accuracy and efficiency of diagnosis.

In treatment, sensing technologies such as bio - electricity, temperature, and infrared are used to detect the changes in the biophysical properties at acupoints, thereby determining the location and state of acupoints. In treatments such as acupuncture [7] and Tuina, they can assist doctors in accurately locating acupoints and improves the precision of treatment. At the same time, by monitoring the dynamic changes of acupoints, the operation of qi and blood in the human meridian system can be understood, providing a basis for syndrome differentiation and treatment in TCM.

In the quality inspection of TCM [8], sensing technologies based on spectroscopy, chromatography, electrochemistry, etc., are used to quickly detect and analyze the chemical components, contents, and impurities of TCM. In the production, processing, and quality control of TCM, it realizes real - time monitoring and ensuring the quality and safety of TCM.

Therefore, the design and implementation of modern sensing technology (MST) courses in TCM universities are of great significance. This paper will analyze and discuss the MST courses in TCM universities from the following aspects. The specific research content of this article is shown in Figure 1.

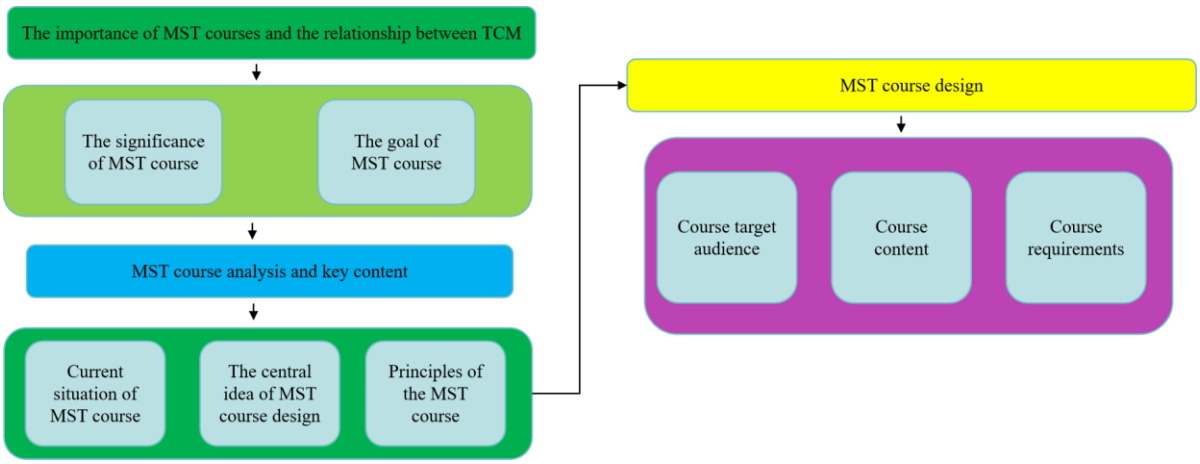

Figure 1: Structural Flowchart of this paper.

2. Current Situation Analysis and Key Contents of MST Courses

2.1. Current Situation of MST Courses in TCM Universities

MST is playing an increasingly important role in various industries. Relevant colleges and majors in engineering institutions, such as those in instrument science, electromechanical engineering, information, and electronics, all offer MST - related courses, which are important core specialized courses for the corresponding majors. The content of MST courses includes basic sensor theories, the principles and applications of various types of sensors, and the processing of sensor signals. The key part of these courses is the explanation of sensor principles, including related principles and formula derivations. However, this course model lacks practical components, making it difficult for students to truly understand the practical applications of sensor theoretical knowledge. Therefore, it is necessary to redesign the course content and add practical sessions. By combining theory with practice, students can enhance their understanding and mastery of theoretical knowledge, and finally apply it to practice.

TCM is a treasure of Chinese culture. The modernization strategy of TCM has promoted the intersection and integration of TCM and modern science and technology. This not only enriches and reveals the scientific connotation of TCM but also drives the rapid development of the TCM industry. However, the modernization of TCM in China is still in its initial stage. To promote the overall development of the TCM industry, relying on scientific and technological innovation is essential.

MST plays a crucial role in fields such as intelligent manufacturing and smart healthcare. A sensor serves as an "interface" for information exchange between systems. It provides the object information necessary for systems to carry out processing and decision - making. And it is an indispensable key component of highly automated systems and even modern cutting - edge technologies.

MST plays more and more important role in the intelligent manufacturing of TCM. For instance, by taking advantage of the sum-frequency and second-harmonic absorption characteristics of hydrogen-containing groups in the near-infrared spectral band of the components in Chinese medicinal materials, photoelectric sensors can be used for qualitative and quantitative detection of raw medicinal materials. This can achieve detection of the origin, harvest time, quality, and authenticity of raw medicinal materials. Some scholars have applied electrochemical sensors to the rapid detection of microbial and heavy metal contents in Chinese medicinal materials. The application of these sensing technologies effectively guarantees the quality of Chinese medicinal materials. Moreover, the detection in the pharmaceutical manufacturing process also relies heavily on the full application of MST. For instance, in the manufacturing process of TCM, real - time detection of process parameters can effectively ensure the safety and stability of the drug production process and the quality of the final product.

In the diagnosis and treatment of clinical diseases in TCM, MST also plays an important role. An increasing number of TCM four - diagnosis instruments have been developed for TCM clinical diagnosis. The detection of patients' vital signs and physiological states by these instruments depends on the full application of MST. For example, the pulse wave parameters of patients can be detected with the help of pressure pulse wave sensors in TCM clinic to provide objective reference for TCM clinical disease diagnosis. Some researchers have also developed TCM tongue and face diagnosis detection instruments by combining photoelectric sensors. These instruments extract TCM - related characteristic indicators of tongue and face appearances by obtaining different colors of the tongue and face through optical information, thereby assisting in the diagnosis of clinical diseases and the evaluation of treatment efficacy. In terms of clinical treatment in TCM, more and

more clinical treatment and rehabilitation devices in TCM have been developed. For example, treatment devices such as TCM fumigation and moxibustion devices combined with temperature sensors and position sensors can monitor skin temperature in real - time to avoid burns. At the same time, according to temperature changes and patients' feedback, parameters such as the duration and distance of fumigation or moxibustion can be adjusted, thus improving the treatment effect.

In summary, MST is playing an increasingly important role in the field of TCM. Enterprises also have an increasing demand for "medical - engineering integration" talents. Therefore, the cultivation of interdisciplinary talents with medical and engineering knowledge has become increasingly urgent. Under the background of the emerging engineering education concept, TCM institutions are paying more attention to the cultivation of interdisciplinary talents with medical and engineering knowledge and have opened relevant medical engineering majors. Taking TCM institutions as an example, this study makes a preliminary exploration of the construction of MST courses by applying medical practice platforms and centering around the "medical - engineering integration" education model.

Under the background of the emerging engineering education concept, TCM institutions are also paying more and more attention to the cultivation of interdisciplinary talents with medical and engineering knowledge and have opened relevant medical engineering majors, such as the medical information engineering major and the intelligent medical engineering major. Courses related to information technology, data mining, image processing, and electronic circuit design are offered for these majors. These majors have the potential and ability to offer MST courses.

For example: Medical Information Engineering Major at Henan University of TCM: The core courses include Advanced Mathematics, Linear Algebra, Probability Theory and Mathematical Statistics, Introduction to TCM, Introduction to Basic Medicine, Biomedical Informatics, Biomedical Signal Processing, Medical Image Analysis, Hospital Information System, C Programming Language, Python Programming Language, Data Structure, Database Principles, and Principles of Computer Networks.

Intelligent Medical Engineering Major at Henan University of TCM: The core courses include Introduction to Intelligent Medicine, Basic Theories of TCM, Formulae and Pharmacology of TCM, Information Science of TCM, Basic Theories of Western Medicine, Pharmacology, Anatomy, Medical Imaging, Cloud Computing and Big Data Technology, Medical Statistical Analysis, Medical Software Development, Neural Networks and Deep Learning.

Medical Information Engineering Major at Hubei University of TCM: The main courses include Introduction to Medical Information, Analysis and Design of Hospital Information System, Database Principles, VFP Programming, Network Database, Delphi Programming, Medical Record Management, Object - Oriented Programming, Principles of Computer Composition, Structured Programming, Algorithm Design, Principles of Operating System, Software Testing, Compilation Principles, and Software Engineering.

Medical Information Engineering Major at Changchun University of TCM: The main courses include Advanced Language Programming, Analog Electronic Circuits, Data Structure, Computer Network, and JAVA Object - Oriented Programming.

Medical Information Engineering Major at Guangzhou University of TCM: The main professional courses include Introduction to TCM, Medical Statistics, Medical Informatics, Medical E - commerce, Medical Data Mining and Decision Support, Medical Image Processing, Hospital Information System, Physiology, Human Anatomy, Artificial Intelligence and Machine Learning, and Principles and Design of Database Systems. At the same time, by integrating the online course resources of "Sensor Technology" from Wuhan University, the university offers the "Biomedical Sensing and Detection" course for undergraduates. Through the study of this course, students can better master the basic theories of sensors.

Medical Information Engineering Major at Tianjin University of TCM: The core courses include C Programming Language, Data Structure, Introduction to TCM, Introduction to Basic Medicine, Database Principles, Operating System, Algorithm Design and Analysis, Software Engineering, Computer Network, and Hospital Information System.

Shandong University of TCM has built a comprehensive science and engineering laboratory, which is equipped with sensor system experimental instruments, pulse and voice experimental instruments, embedded biomedical experimental boxes, etc., providing an experimental and practical platform for relevant medical information engineering majors.

Beijing University of TCM offers the course "Principles and Applications of Microfluidic Biosensors". This course integrates multiple disciplines such as analytical chemistry, electronic circuit design, life sciences, pharmacy, and information processing, enabling students to understand the applications of microfluidic biosensors in fields such as cell analysis and drug analysis and master the future development trends of microfluidic biosensors.

Although the opening of relevant MST courses in various TCM universities broadens students' horizons, a survey of these courses reveals that MST - related courses are mainly offered as undergraduate elective courses. The teaching mainly focuses on an overview of the development of sensors in a specific research field that the instructor is specialized in. The class hours are limited, and no practical class hours are set. This form can, to a certain extent, increase students' understanding of the application of sensors in a specific field. However, it does not enable students to truly understand and master the working principles of sensors and how to apply them in practice.

2.2. Central Idea and Principles of MST Course Design in TCM Universities

Based on the above - mentioned analysis, it is necessary to combine the disciplinary characteristics of TCM institutions. The central idea should be to increase the practical components of the courses and enhance students' understanding and application ability of theoretical knowledge. The teaching method should follow the principle of combining problem - orientation and case - driving, with the teaching goals of making learning enjoyable, consolidating the foundation, integrating practical applications, improving scientific research capabilities, and simultaneously enhancing students' professional skills and teaching satisfaction.

3. Overall Curriculum Design

3.1. Course Target Audience

The sensor courses in TCM universities are offered to undergraduates and postgraduates majoring in related medical engineering (such as TCM clinical practice or TCM pharmacy) within the university. It is preferable that these students have a foundation in courses such as college physics, electronic circuits, signals and systems, or computer - related courses. Therefore, the MST course can be offered to junior undergraduates or first - year postgraduates.

3.2. Course Content

Taking the medical information engineering major as an example, in line with the training objectives of students in this major and combined with the actual application scenarios and cases in TCM clinical practice, six course units are set up with a total of 36 class hours, focusing on commonly used sensors such as pressure sensors, temperature and humidity sensors, photoelectric sensors, and new - type intelligent sensors. The design of course units is shown in Table 1.

Table 1: Course content settings.

Teaching Unit	Teaching Content	Total Class Hours	Lecture Class Hours	Inquiry - based Teaching Class Hours
First Unit: Introduction	Understand the definition of sensors, the history of sensors, development trends, the types of commonly used sensors, and the composition of testing systems	3	3	0
Second Unit: Basic Characteristics of Sensors	Static characteristics	3	1.5	0
	Dynamic characteristics		1.5	0
Third Unit: Temperature and Humidity Sensors	Working principles and usage of temperature sensors	6	3	0
	Working principles and usage of humidity sensors		3	0
Fourth Unit: Pressure Sensors	Classification of pressure sensors	6	2	0
	Working principles of pressure sensors		2	0
	Usage of pressure sensors		2	0
Fifth Unit: Photoelectric Sensors	Working principles of photoelectric sensors	6	2	0
	Usage of photoelectric sensors		4	0
Sixth Unit: Other Types of Sensors	Classification, working principles, and usage methods of other types of sensors	4	4	0
Experimental Training	Set training projects guided by clinical problems	8	0	8
Total	Total	36	28	8
Grand Total	Grand Total	36	36	36

Unit 1: This unit provides an overview of the definition, history, development trends of sensors, the types of commonly used sensors, the composition of testing systems, and their applications in relevant professional fields.

Unit 2: This unit covers knowledge related to the basic characteristics of sensors, including the static and dynamic characteristics of sensors.

Unit 3: Temperature and humidity sensors. Temperature and humidity sensors are widely used in fields related to TCM. And take tongue diagnosis in TCM clinical practice as examples. By introducing the examples in the course content, students can have a more specific understanding of the specific applications of this type of sensor in TCM diagnosis.

Unit 4: Pressure sensors. The teaching content includes the classification of pressure sensors, their working principles, and their usage. The teaching is carried out in a way that combines problem - orientation and case - driving.

Unit 5: Photoelectric sensors. The working principles and usage of photoelectric sensors.

Unit 6: New - type intelligent sensors. The classification, working principles, and usage methods of other types of sensors.

In addition to the content settings of each unit above, relevant experimental and training projects can be set up in combination with the school's relevant experimental and training platforms. Students will carry out project - based course practices in groups. Taking practical problems in TCM clinical practice as examples, experimental and training projects oriented to different actual clinical problems are set up. Students will formulate practical implementation plans for each group through group discussions, conduct experiments, process and analyze experimental data, and finally form practical reports and conduct classroom presentations and discussions.

3.3. Course Requirements

The purpose of this course is to enable students to comprehensively understand the development of sensing technology, the classification of commonly used sensors, and their application scenarios, master the basic working principles, and have preliminary analysis and data - processing capabilities. It aims to lay a solid knowledge foundation for students to solve practical problems in their subsequent studies and work. In terms of knowledge objectives, it is expected that through the study of this course, students can master the main types of commonly used sensors, their basic working principles, basic characteristics, and measurement methods; be able to correctly select appropriate sensors for the design of data acquisition systems; understand the current development status and trends of sensors; and enhance their love for TCM and their enthusiasm for the application and research of MST in the field of TCM engineering.

At the same time, from the perspective of ideological and political education, ideological and political elements are incorporated into the course. The course aims to cultivate students to establish a dialectical materialist world - view, develop good learning habits, a strong will, a spirit of exploration and innovation, and a good teamwork spirit. Students should be able to deeply think about the significance of applying MST in the field of TCM pharmaceutical engineering, strive to broaden their academic horizons, and build confidence in their future careers. They should also be cultivated to have a rigorous and meticulous learning attitude, and develop a research mindset of being diligent in thinking and not afraid of difficulties.

The final assessment method of the course can be combined with the content of experimental and training projects. Students are guided to think boldly and practice personally. Through literature retrieval, experimental design, implementation, data analysis, and discussion, they will finally form a short paper for presentation. The final course grade includes usual performance (40%) and final - exam performance (60%).

4. Conclusion

This paper takes the curriculum design of MST courses in TCM institutions as the research object. By investigating and analyzing the current situation of the opening of relevant MST courses in various TCM institutions, it is proposed that it is necessary to combine the disciplinary

characteristics of TCM institutions, integrate actual application scenarios and cases in TCM, adopt a teaching method that combines problem - orientation and case - driving, increase the practical part of the courses, and enhance students' understanding and application ability of theoretical knowledge. This enables students to master and use relevant sensors to solve practical problems in TCM. Through this research, it is determined that the target students for this course are preferably those who have a foundation in courses such as college physics, electronic circuits, signals and systems, or computer - related courses. Therefore, the MST course can be offered to junior undergraduates or first - year postgraduates. The course content design should be fully combined with the actual problems in the field of TCM to set up the content of each unit. Taking the medical information engineering major in TCM institutions as an example, and combining the characteristics of this major, six units can be set up. Combining theoretical explanations and experimental and training content, 36 class hours are set. Through experimental and training projects, students are guided to think actively and practice personally. Finally, they will form project reports, and the assessment will be conducted in the form of project reports. This research provides an effective reference for the curriculum design of MST - related courses in TCM institutions.

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