多模态知识图谱与体感交互驱动的高校太极拳教学资源库的构建研究

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摘要：研究目的：2020 年，"太极拳"列入了联合国教科文组织人类非物质文化遗产名录，国家对传统文化保护力度在持续加强。教育部数据显示，截止 2025 年全国已有一半以上的高校开设太极拳课程，但多以 24 式简化太极拳为主，缺乏攻防原理和中医经络理论，导致大多学生出现厌学等情况。《教育信息化 2.0 行动计划》提出"发展智能化教育生态"，在非物质文化遗产数字化传承背景下，太极拳教学还处于传统师徒制效率底、教学资源分散与文化内涵解构断层的双重困境，而智能化技术应用多集中于单一动作识别而缺乏知识体系构建。本文旨在探索多模态知识图谱与体感交互技术在高校太极拳教学资源库构建中的应用，以期实现太极拳教学资源的系统化、智能化和个性化，提高太极拳教学的质量和效率。研究期望达到以下几个目的：一是构建一个涵盖太极拳理论知识、技术动作和文化内涵等方面的多模态知识图谱；二是通过体感交互技术，实现学生与太极拳教学资源的互动，提升学生学习兴趣和参与度；三是利用智能化算法，根据学生的学习情况和需求，提供个性化的学习路径资源推荐，促进太极拳教学的个性化发展。**研究方法：**通过中国知网，以"多模态知识图谱"、"体感交互""太极拳教学"为主题词分别进行高级检索，时间跨度为 2020 年 6 月到 2025 年 6 月五年时间，选择 SCI、EI、北大核心等核心期刊论文，通过高级检索得到相关的学术期刊论文共 145 篇，经过筛选后最终得到有效文献共 86 篇。运用文献资料法、逻辑分析法、案例研究法等，系统梳理国内外现有研究成果，为本研究提供理论支撑和方法借鉴。利用专家访谈法，邀请太极拳教学领域的专家、学者及有丰富教学经验的一线教师共 6 人，就太极拳教学资源库构建的需求、内容、技术实现等方面进行深入访谈。通过专家的视**研究结果：**多模态知识图谱是一种融合文本、图像、视频、动作捕捉数据等多种信息形式的智能化知识组织工具。它以本体模型为核心，通过实体、属性、关系三元组整合太极拳的理论知识、技术动作及文化内涵，实现多模态数据的语义关联与统一存储，为智能化教学提供动态可扩展的知识底座。而体感交互技术作为人机交互的第三代革命性技术，其通过传感设备实时捕捉用户肢体动作、手势、姿态等生物力学信息，经计算机解析后与建立的多模态太极拳知识数据库进行双向信息传输与转换，自检查动作偏差，以可视化或

语音指导实现动态纠错。基于两者的创新性融合构建高校太极拳教学资源库，将分散资源整合化，提高学生学习效率。（1）构建多模态知识图谱。通过中国知网等学术数据库收集太极拳相关的理论、技术动作和文化内涵的文献资料，通过专家访谈获取专业领域知识和经验，整合文本、图像等多种信息形式，形成全面的太极拳知识库；根据太极拳的特点和知识结构设计太极拳本体模型，将抽象的理论、分散的技术动作与文化资源整合为可计算、可拓展的数字化框架，并利用语义关联技术，将不同模态的数据库进行关联，建立统一储存的多模态太极拳数据库。（2）体感交互系统的集成。在既能满足实验要求又能控制成本的情况下，部署奥比中光 Astra Pro 摄像头以 30fps 采集学生骨骼点坐标，捕获 RGB 图像和深度图，以六轴 IMU 传感器捕捉手腕脚踝旋转角度和速度并发送传感数据，使用 Kabschs 算法将捕捉的骨骼点等数据与太极拳本体模型中的数据库进行坐标系对齐，并进行双向信息传输与转换，实时动作纠错，提高学习效率。（3）教学资源库的应用与优化。利用智能化算法，分析学生的学习情况和需求，提供个性化的学习路径资源推荐；结合体感交互技术，设计互动式教学环节，增强学生的参与度和学习兴趣；定期收集学生的反馈意见和专家意见，对教学资源库进行更新和优化，并不断引入新的技术成果和教学理念，保持数据库的先进性和实用性。

研究结论： 在多模态知识图谱与体感交互驱动的高校太极拳教学资源库构建的研究中，将多模态知识图谱与体感交互技术融合应用于太极拳教学资源的整合与优化，实现了太极拳教学资源的系统化、智能化和个性化。通过构建涵盖太极拳理论知识、技术动作和文化内涵的多模态知识图谱，以及集成体感交互系统，不仅可以提升学生学习太极拳的兴趣和参与度，还能有效提高太极拳教学的质量和效率。这一创新性融合为高校太极拳教学提供了新的路径和方法，具有实际可行性，也为其他传统体育项目的数字化传承提供了有益的借鉴。

关键词： 多模态知识图谱；体感交互；太极拳教学；资源构建

Research on the construction of Tai Chi teaching resource library in colleges and universities driven by multimodal knowledge graph and somatosensory interaction

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Abstract: Purpose of the study: In 2020, "Tai Chi" was included in the UNESCO Intangible Cultural Heritage List, and the country's efforts to protect traditional culture are continuously strengthening. Data from the Ministry of Education show that by 2025, more than half of the country's colleges and universities

will have opened Tai Chi courses, but most of them are based on the 24-style simplified Tai Chi, lacking the principles of attack and defense and the theory of Chinese medicine meridians, which has led to most students becoming tired of learning. The "Action Plan for Education Informatization 2.0" proposes to "develop an intelligent education ecology." In the context of digital inheritance of intangible cultural heritage, Tai Chi teaching is still in the dual dilemma of low efficiency of the traditional apprenticeship system, scattered teaching resources, and faults in the deconstruction of cultural connotations. The application of intelligent technology is mostly concentrated on single action recognition and lacks knowledge system construction. This paper aims to explore the application of multimodal knowledge graphs and somatosensory interaction technology in the construction of Tai Chi teaching resource libraries in colleges and universities. The goal is to achieve the systematization, intelligence, and personalization of Tai Chi teaching resources, thereby improving the quality and efficiency of Tai Chi teaching. The research aims to achieve the following objectives: first, to construct a multimodal knowledge graph covering Tai Chi theoretical knowledge, technical movements, and cultural connotations; second, to enable students to interact with Tai Chi teaching resources through somatosensory interaction technology, thereby enhancing their learning interest and participation; and third, to utilize intelligent algorithms to provide personalized learning path resource recommendations based on students' learning situations and needs, thereby promoting the personalized development of Tai Chi teaching. **Research Methods:** Using CNKI, we conducted advanced searches for the keywords "multimodal knowledge graph," "body interaction," and "Tai Chi teaching" over a five-year period, from June 2020 to June 2025. We selected papers from core journals, including those from SCI , EI , and Peking University Core. We identified 145 relevant academic journal articles through advanced searches, and ultimately, 86 valid references were identified after screening. Using literature review, logical analysis, and case study methods, we systematically reviewed existing research findings both domestically and internationally, providing theoretical support and methodological reference for this study. Using the expert interview method, we invited 6 experts, scholars and front-line teachers with rich teaching experience in the field of Tai Chi to conduct in-depth interviews on the needs, content, and technical implementation of the construction of Tai Chi teaching resource library. **Research results:** Multimodal knowledge graph is an intelligent knowledge organization tool that integrates multiple information forms such as text, images, videos, and motion capture data. It takes the ontology model as its core and integrates the theoretical knowledge, technical movements, and cultural

connotations of Tai Chi through entity, attribute, and relationship triples to achieve semantic association and unified storage of multimodal data, providing a dynamic and expandable knowledge base for intelligent teaching. As the third generation of revolutionary technology for human-computer interaction, somatosensory interaction technology uses sensor equipment to capture biomechanical information such as user body movements, gestures, and postures in real time. After computer analysis, it conducts two-way information transmission and conversion with the established multimodal Tai Chi knowledge database, self-checks movement deviations, and realizes dynamic error correction through visualization or voice guidance. Based on the innovative integration of the two, a university Tai Chi teaching resource library is constructed to integrate scattered resources and improve student learning efficiency. (1) Construct a multimodal knowledge graph. Through academic databases such as China National Knowledge Infrastructure (CNKI), we collected literature on Tai Chi's theories, technical movements, and cultural connotations. We obtained professional knowledge and experience through expert interviews and integrated various information forms such as text and images to form a comprehensive Tai Chi knowledge base. Based on the characteristics and knowledge structure of Tai Chi, we designed a Tai Chi ontology model, integrating abstract theories, scattered technical movements, and cultural resources into a computable and scalable digital framework. We also used semantic association technology to associate databases of different modalities and establish a unified multimodal Tai Chi database. (2) Integration of the somatosensory interaction system. In order to meet the experimental requirements and control costs, we deployed an Orbbec Astra Pro camera to collect the coordinates of students' skeletal points at 30 fps, capture RGB images and depth maps, and use a six-axis IMU sensor to capture the rotation angle and speed of the wrist and ankle and send sensor data. We used the Kabsch algorithm to align the captured skeletal points and other data with the database in the Tai Chi ontology model, and perform two-way information transmission and conversion, real-time action error correction, and improve learning efficiency. (3) Application and optimization of the teaching resource library. Utilize intelligent algorithms to analyze students' learning situations and needs, and provide personalized learning path resource recommendations; combine somatosensory interaction technology to design interactive teaching sessions to enhance student participation and learning interest; regularly collect student feedback and expert opinions, update and optimize the teaching resource library, and continuously introduce new technological achievements and teaching concepts to maintain the advancement and practicality of the database. **Research Conclusions:** In

this study of constructing a university Tai Chi teaching resource library driven by multimodal knowledge graphs and somatosensory interaction, the fusion of multimodal knowledge graphs and somatosensory interaction technology was applied to the integration and optimization of Tai Chi teaching resources, achieving the systematization, intelligence, and personalization of Tai Chi teaching resources. By constructing a multimodal knowledge graph covering Tai Chi theoretical knowledge, technical movements, and cultural connotations, and integrating a somatosensory interaction system, it can not only enhance students' interest and participation in learning Tai Chi, but also effectively improve the quality and efficiency of Tai Chi teaching. This innovative integration provides new paths and methods for Tai Chi teaching in universities, is practical and feasible, and also provides a useful reference for the digital inheritance of other traditional sports.

Keywords: multimodal knowledge graph; somatosensory interaction; Tai Chi teaching; resource construction