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Research on the Construction and Management of University Robot Laboratory

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Abstract: The laboratory plays a crucial role in cultivating college students' practical and innovative abilities. Based on the teaching characteristics and advantages of the robotics major, this paper constructs a laboratory construction system covering robot structure and mechanism, drive, sensing and control, and comprehensive experiments. It also explores more scientific management strategies by optimizing the management team, innovating the management model, ensuring daily operation, and reconstructing the assessment mechanism. These efforts aim to create favorable conditions for promoting academic exchanges, enhancing students' practical and innovative abilities, and improving teachers' professional qualities. This research is of great significance for improving the teaching quality of robotics in universities and cultivating innovative talents, providing strong theoretical and practical support for the long-term development of university robot laboratories.

Keywords: University; Robots; Laboratory construction; Management

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1. Introduction

With the rapid development of science and technology, robot technology has been widely applied in numerous fields, and the demand for robotics professionals is increasing day by day. As an important base for knowledge innovation and talent cultivation, universities have far-reaching significance in constructing robot laboratories. From an educational perspective, robot laboratories provide students with a platform for integrating theory and practice, enabling them to deepen their understanding of professional knowledge through hands-on operations [1]. From a scientific research perspective, they can facilitate universities to conduct cutting-edge robot technology research and promote the development of disciplines. From the perspective of talent cultivation, they can enhance students' innovative and practical skills, and supply high-quality talents who meet the needs of the times to society. In view of this, it is urgent to deeply study the construction and management of university robot laboratories [2]. Through reasonable planning of construction content and optimization of the management model, the effectiveness of laboratories can be fully exerted, injecting new vitality into university education, scientific

research, and talent cultivation. The following will discuss this in detail [3].

2. Construction of university robot laboratories

2.1. Construction of the teaching area for the robot structure and mechanism

In the teaching area for robot structure and mechanism, to meet the teaching requirements of theoretical mechanics and mechanical design-related knowledge for the robotics major, dynamic modeling analysis and basic experiments are designed. The focus is on cultivating students' abilities in kinematic and dynamic analysis of mobile robots and interactive force analysis during robot operation, enabling students to master the functions of typical mechanical structures through practical operations and mechanism design [4]. In this experimental area, students can deeply understand the functions and roles of different structures in robot movement by building and debugging mechanical structures by themselves. For example, when building a four-bar mechanism, students can visually observe the movement relationship of each rod and how to achieve a specific movement trajectory by reasonably designing the rod length and connection method.

At the same time, this area also pays attention to the introduction of cutting-edge technologies. The dual-arm cooperation technology demonstrates how robots can complete complex tasks by coordinating the actions of two robotic arms, such as jointly carrying large objects or performing fine assembly work. The human-robot cooperation technology allows students to understand how humans and robots can work safely and efficiently in the same workspace. For example, on an industrial production line, workers and robots cooperate to complete product processing. The human-robot interaction technology focuses on the information transfer and communication methods between humans and robots, such as controlling robots through gestures and voices [5]. In addition, students are encouraged to design new experimental content, providing them with opportunities to apply theoretical knowledge from the classroom to practice.

2.2. Construction of the teaching area for robot drive, sensing, and control

In the teaching area for robot drive, sensing, and control, to meet the needs of robot experiment and practice courses, a variety of equipment is equipped. The aim is to enable students to explore and master drive technology by using motor, hydraulic, pneumatic drive mechanisms, as well as reducers, drivers, and other equipment, and to cultivate their mechatronic design and implementation capabilities [6]. In the experimental area, students can operate motors by themselves, experience the process of converting electrical energy into mechanical energy, and deeply understand the core role of motors in robot movement by controlling the start, stop, and rotation speed of motors.

At the same time, based on the practical requirements of analog circuit, digital circuit, and embedded system development, experimental equipment for circuit hardware design and embedded software program design is configured. This not only supports students in understanding relevant theoretical knowledge in practice but also lays a solid foundation for them to master basic hardware design and software development capabilities and to further study robot technology.

2.3. Construction of the robot comprehensive experimental area

In the robot comprehensive experimental area, a series of targeted experiments are set up to strengthen students' understanding of the overall closed-loop of robot perception-decision-motion [7]. By building simulation scenarios, students can observe how robots use various sensors to collect environmental information. For

example, a lidar can sense the distance and position of surrounding obstacles, and a camera can identify the shape and color of objects. The collected information is transmitted to the decision-making system, and students can see how algorithms analyze and process these data to make reasonable decisions, such as planning the best action path to avoid obstacles. Finally, the robot drives its movement according to the decision-making instructions to complete the task. At the same time, experiments on multi-sensor information fusion and artificial intelligence technology are actively carried out. Students can try to fuse data from different sensors to improve the accuracy and reliability of information and use artificial intelligence algorithms, such as machine learning and deep learning, to endow robots with more intelligent decision-making capabilities [8]. In addition, this area takes micro-nano robots, bionic robots, medical robots, and industrial robotic arms as practical objects and encourages students to carry out full-process research and development work in groups. Each group starts from requirements analysis and scheme design, goes through hardware construction, software development, system debugging, and other links until the overall research and development of the robot is completed. In this process, students can not only comprehensively master various knowledge but also exercise comprehensive abilities such as teamwork and problem-solving, truly achieving the integration of knowledge [9].

3. Management of university robot laboratories

3.1. Optimizing the management team and improving the intelligent management level

Building a professional and efficient management team is the key to the smooth operation of university robot laboratories. Firstly, universities should formulate strict and comprehensive talent selection criteria. Recruit personnel with a profound background in robotics, who are not only familiar with various technical principles of robots, such as mechanical structures, drive systems, sensing and control, but also have rich practical experience and can skillfully operate and maintain various equipment in the laboratory. At the same time, since laboratory management involves communication and cooperation with teachers and students of different professional backgrounds and external partners, pay attention to selecting personnel with good communication skills and team spirit.

Secondly, adopt diversified methods to carry out talent selection work, such as professional knowledge written tests, practical operation assessments, and case-based interview evaluations to comprehensively assess the abilities of candidates. Secondly, regularly organize internal training courses, invite industry experts and senior university teachers to give lectures, and the content covers the latest technological developments in the robotics field, laboratory safety management, and advanced educational concepts. Encourage managers to participate in domestic and international academic conferences and professional seminars, broaden their horizons, understand the forefront trends of the industry, and bring back the knowledge learned to share and communicate in the laboratory. In addition, integrate intelligent technology into the laboratory management system to improve the overall level of the management team. Introduce an intelligent management system to realize intelligent equipment management. Through the Internet of Things technology, real-time monitoring of the operating status, usage, and maintenance requirements of equipment. Managers can obtain equipment information at any time, arrange maintenance in advance, and improve the service life and utilization rate of equipment. Use an intelligent attendance system to accurately record the entry and exit times of students and teachers in the laboratory, which is convenient for management and statistics. At the same time, apply big data analysis technology to analyze laboratory usage data, student experiment data, etc., providing a scientific basis for management decisions, such as rationally arranging experimental courses and optimizing resource allocation [10].

3.2. Innovating the management model and adopting intelligent management means

The traditional laboratory management model is highly dependent on manual operations, which are prone to errors and have low efficiency. Universities should innovate the traditional management model and introduce intelligent management means to improve the accuracy and timeliness of management. Firstly, build an information platform. By constructing an exclusive information management system for the laboratory, realize the centralized integration and efficient circulation of various types of information. This platform has the function of displaying information about various experimental equipment, including equipment models, performance parameters, usage status, reservation status, etc. Teachers and students can reserve equipment online, and the system will automatically allocate it according to the equipment usage arrangement, avoiding equipment usage conflicts and improving equipment utilization [11]. At the same time, the declaration and approval processes of experimental projects can also be completed on the platform. Teachers submit project applications, and managers and experts review them online, shortening the project declaration cycle.

Secondly, vigorously apply intelligent management means. Install a face-recognition access control system at the laboratory entrance, and only authorized personnel can enter, effectively ensuring the safety of the laboratory. The intelligent lighting system can automatically adjust the brightness according to the indoor light intensity and personnel activities, which is not only energy-saving and environmentally friendly but also provides a comfortable experimental environment for teachers and students. Temperature and humidity sensors monitor the temperature and humidity data of the laboratory in real-time and transmit the data to the management system. Once the temperature and humidity exceed the appropriate range, the system will automatically issue an alarm to remind managers to take corresponding measures to ensure the safety of experimental equipment and samples. Intelligent management has significant advantages and improves management efficiency. Data that used to be manually recorded and counted one by one can now be automatically generated into reports by the system, saving a large amount of manpower and time costs. On the other hand, intelligent management also means providing more convenient services for teachers and students. They can query laboratory information and submit applications anytime and anywhere through mobile phones or computers, breaking the limitations of time and space [12].

3.3. Ensuring daily operation and meeting the needs of intelligent talent cultivation

To meet the needs of intelligent talent cultivation, it is necessary to ensure the daily operation of robot laboratories. Firstly, do a good job in equipment maintenance. Establish a perfect equipment maintenance system and regularly conduct comprehensive inspections and maintenance of various types of equipment. For key equipment such as motors, hydraulic, pneumatic drive mechanisms, and reducers, drivers, etc., formulate detailed maintenance plans, including cleaning, lubrication, calibration, etc., to ensure that the equipment is always in good operating condition. At the same time, reserve sufficient common spare parts so that they can be replaced promptly when equipment fails, reducing equipment downtime. Arrange professional technicians to be responsible for equipment maintenance to quickly and accurately diagnose and solve equipment failures.

Secondly, rationally plan resources such as experimental equipment, venues, and time. According to the curriculum arrangement and students' experimental needs, develop a scientific resource allocation plan [13]. Give priority to ensuring the resource needs of teaching experiments, to ensure that students can make full use of laboratory resources for practical operations. At the same time, take into account the development of scientific research projects and provide necessary support for teachers' and students' scientific research work. Establish a resource sharing mechanism to promote resource exchange and cooperation between different disciplines

and projects, and improve the overall utilization efficiency of resources. In addition, creating a good academic atmosphere is also an important factor in cultivating intelligent talent. Organize various academic lectures, seminars, and competition activities, invite industry experts and outstanding students to share experiences and achievements, and stimulate students' learning enthusiasm and innovation awareness. Design challenging and innovative experimental projects, encourage students to explore independently and collaborate in teams, and cultivate students' ability to solve practical problems. For example, in the robot comprehensive experimental area, add open-ended experimental topics, allowing students to choose different research directions according to their interests and specialties and conduct in-depth experimental research. Encourage students to participate in scientific research projects and innovation and entrepreneurship activities, providing them with broad development space and platforms.

3.4. Reconstructing the assessment mechanism and infiltrating 5S management literacy

Reconstructing the assessment mechanism of university robot laboratories is an important measure to improve the laboratory management level and students' comprehensive quality. Firstly, to ensure the scientificity and effectiveness of the assessment, it is necessary to consider multiple dimensions. In the assessment of experimental operations, not only should students' proficiency in basic operations of robot equipment be examined, such as whether they can correctly start and debug motors, hydraulic, and pneumatic drive mechanisms, etc., but also their ability to set and adjust various parameters during the experiment should be evaluated. They should be able to rationally use reducers, drivers, and other equipment according to the experimental objectives to achieve precise control. In the assessment of experimental reports, the reports are required to be accurate and complete, with the ability to analyze data and draw conclusions, and clearly explain the problems and solutions in the experimental process.

Secondly, integrate the 5S management concept into the assessment mechanism to further improve the management efficiency of the laboratory and students' literacy [14]. In the "seiri" aspect, assess whether students can classify and organize experimental equipment and materials, distinguish between commonly used and spare items, and clean up useless sundries to keep the experimental area clean and orderly. In the "seiton" link, examine whether students can place equipment, tools, and other items in the designated positions and make markings for easy and quick access, improving experimental efficiency. The "seiso" requires students to regularly clean the experimental equipment and venue to ensure that the equipment is free of dust and stains and the venue is clean and hygienic, creating a good environment for experiments. "seiketsu" is the continuous maintenance of seiri, seiton, and seiso. By formulating cleaning standards and inspection systems, students are urged to develop good hygiene habits. "shitsuke" is the core of 5S management. Assess whether students have good experimental habits, teamwork spirit, and safety awareness, whether they abide by laboratory rules and regulations, cherish experimental equipment, and respect the labor achievements of others. Integrating the 5S management concept into the assessment mechanism helps to cultivate students' rigorous scientific attitude, making them pay more attention to the environment and order of the laboratory and laying a foundation for adapting to high-standard work requirements in the future [15].

4. Conclusion

In conclusion, the construction and management of university robot laboratories is a systematic project that is related to the running level of universities, the construction of robotics majors, and talent cultivation. By

rationally planning laboratory construction, universities can build a teaching and research platform with complete functions and advanced facilities, providing students with rich practical opportunities and enhancing their professional skills and innovative abilities. At the same time, scientific management measures, from optimizing the management team to innovating the management model, from ensuring daily operation to reconstructing the assessment mechanism, can ensure the efficient, safe, and orderly operation of laboratories. In the future, with the continuous progress of robot technology, university robot laboratories should continuously innovate construction and management models to contribute to the cultivation of more high-quality robotics professionals who meet the needs of the era.

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