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Application of Water Surface Cleaning Robot and Shore Station in Teaching

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Abstract: *With the acceleration of urbanization and the increasing deterioration of the aquatic environment, the challenge of water surface sanitation work is facing tremendous challenges. traditional way of water surface sanitation often relies on a large amount of manual operation, which is inefficient and costly. This paper investigates the recovery and treatment device of the shore-processing station of the water surface cleaning robot, and designs a set of efficient, intelligent and environmental friendly garbage recovery and treatment system. At the same time, the equipment integrates a variety function modules, which can not only recover efficiently, but also classify, compress and preliminarily process garbage, achieving an integrated solution from salvage to processing. The promotion and application this product will significantly improve the efficiency and quality of water surface sanitation work, and reduce the labor intensity and safety risks of manual operation.*

Keywords: *Environmental Protection; Base Station; Processing Device; Recycling*

1. Introduction

1.1 Research Background

Traditional manual salvage methods are inefficient, costly, and pose safety risks, necessitating the of intelligent technology achieve efficient and sustainable water surface cleaning. However, current products on the market face issues such as short battery life, high prices, and limited functionality. Moreover, these devices are limited waste salvage and lack subsequent environmental treatment solutions, resulting in incomplete cleaning. In terms of urban scenic waters, rivers, lakes, and artificial landscape water bodies within cities are not only components of the urban ecology but entertainment. However, these waters often face problems such as floating garbage and algal bloom, affecting ecological balance. There is an urgent need for cleaning and maintenance of such waters, and manual cleaning methods are inefficient, costly, and pose certain safety risks, while water surface cleaning can efficiently and sustainably perform tasks such as waste collection and algal control, the needs of urban scenic water management. With the deployment of corresponding policies and guidelines by various national departments, the development of underwater work robots has a good policy environment.

1.2 Significance of the Research

The research and application of water surface cleaning robots andside processing base stations can traced back to the early days of automation technology. However, in today's intelligent era, water pollution poses significant environmental demands. With the acceleration ofization and the of industrialization, the problem of water pollution is becoming increasingly serious, posing higher requirements for the governance of urban water systems and environmental protection. The research of water surface cleaning robots and shoreside processing base stations can clear water surface debris pollutants automatically and efficiently, effectively improve water quality, and protect the aquatic ecological environment. This is of great significance for improving the quality of life of urban residents and maintaining ecological balance. It can also process some degradable waste into fertilizer for continued use.

The traditional manual of cleaning the water surface has problems such as low efficiency and high cost. There are two existing ways of salvaging: manual salvage and machine salvage. Manual salvage not only has great difficulty, low efficiency, and poor effect but also has a high risk of operation safety

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for the salvage personnel. Existing machines find it difficult to have both good and cleaning ability. Water surface cleaning robots can automatically identify and clean up water surface garbage, greatly improving the cleaning efficiency. At the same time, robots can work continuously without being limited weather, time, and other factors, further reducing cleaning costs. The shoreside processing base station is responsible for collecting and processing the garbage cleaned up by the robot, realizing the harmless resource-based utilization of garbage. The research on water surface cleaning robots and shoreside processing base stations involves mechanical design, automation control, artificial intelligence, and other fields, and is important direction for promoting related technological innovation and industrial upgrading. In order to meet the needs of daily cleaning in small water areas, reduce operation costs and difficulty, this paper designs a and flexible water surface cruise cleaning robot, and studies its motion control and visual recognition and the way of garbage capture. Through the research topic, we can explore new technological paths and solutions and improve our country's independent innovation capability in the field of environmental protection equipment.

As an important part of the water surface cleaning robot system, the shoreside processing base station far-reaching significance, especially in the classification and resource utilization of garbage, it shows significant advantages. Through the automated process of garbage collection and processing, this base station can efficiently the various types of garbage collected from the water surface. This process not only lightens the burden of manual sorting but also improves the accuracy and efficiency of sorting, laying a solid foundation the subsequent garbage treatment and resource utilization[1].

During the sorting process of garbage, the shoreside processing base station can identify and separate different types of waste such as recyclables, hazardous, wet waste (kitchen waste), and dry waste. This kind of refined classification processing not only helps to reduce the environmental pollution caused by landfill and incineration of but also promotes the effective recycling and reuse of resources[2].

More importantly, the shoreside processing base station, through its garbage processing flow, shows the public the potential of turning waste treasure. It allows people to see intuitively that garbage, which is originally regarded as waste, can be converted into valuable resources after appropriate processing and processing. For example, recycle such as plastics, metals, and paper can be recycled, reducing the need for new materials and conserving natural resources[3].

1.3 Research Content

The main research involves the robot structure that adapts to different aquatic environments, ensuring its stability, flexibility, and. Efficient power systems, such as brushless motor thrusters, are developed to ensure the robot can operate under different aquatic conditions. Deep learning algorithms are utilized for garbage identification classification, enhancing the robot's accuracy in identifying floating debris. Efficient garbage collection devices, such as conveyor belts and robotic arms, are developed to ensure the robot can collect different types of waste. A base station is designed to receive the garbage collected by the robot and perform preliminary classification, compression, and storage[4].

The overall structure of the robot completed based on the research of different water conditions, the salvage structure of the robot, the obstacle avoidance function, the recovery device, and the assembly and adjustment of the power device The construction of the surface robot is completed, and the shoreside processing base station is unmanned and sorted by mechanical arm. The visual sensor identifies biodegradable garbage and processes for recycling. Garbage that can be used is crushed by a mixer for processing. Turned into organic fertilizer and discharged back into the water, a closed loop of energy saving and emission reduction.

2. System Overall Design Analysis

2.1 Control Scheme Analysis and Design

The automatic control system is constructed by using three-phase asynchronous, brushless motor, PLC, robotic arm, vision camera and sensor. This combination of control methods has the characteristics of flexibility and simplicity. PLC has excellent communication interface which can quickly exchange data with other systems. It can construct control systems of various sizes. In hardware design, the required hardware configuration and I/O interface can be quickly adjusted through control program memory. This method of field commissioning is very convenient. In addition, PLC has

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strong anti-interference ability and high reliability, which greatly improves the reliability of system.

The robotic arm is a programmable multi-joint automation device used to perform precise, repetitive, or dangerous tasks. The teaching pendant is used to manually control,, and debug the robotic arm device. The robotic arm has high flexibility, high precision, and the error can be controlled within ±0.1mm, which is suitable for precisionping, detection, and other tasks. The teaching pendant simplifies programming, no complex code is required to be written, and the motion can be recorded by guiding the robotic arm manually which reduces the technical threshold.

In this design, the main work is to recycle, return, identify, process, process, and discharge the water surface cleaning robot after work is. Thus, an automated recovery and discharge production line is realized. As shown in Figure 1.

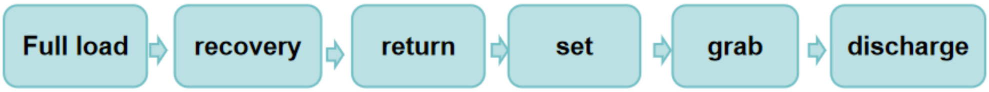

Figure 1: The overall structure diagram of the water surface cleaning robot and the shoreside processing base station system.

2.2 Design and Implementation of Intelligent Waste Classification and Recycling System

2.2.1 Recycling Part

Considering during long-term navigation, the recycling belt works continuously in the water, which not only accelerates its wear and tear, shortening its service life, but also increases the ships energy consumption due to the water flow resistance, we innovatively developed a smart lifting control system. This device adopts a design scheme combining a three-phase asynchronous motor with a cable, achieving precise lifting control of the salvage mechanism through the needs of the recycling operation. On the one hand, various complex factors in the water accelerate the wear and tear the recycling belt, causing its surface material to wear and its structural strength to decrease, which in turn greatly shortens its service life and increases the cost of equipment replacement. On the hand, the recycling belt is subjected to water flow resistance in the water, and with the extension of navigation time, the resistance accumulates continuously, resulting in the need for more energy overcome the resistance during ship navigation, causing energy waste and increasing operating costs. By precisely sensing the needs of the recycling operation, the system can intelligently control the operation of the motor drive the steel cable to be wound and unwound, and thus achieve precise lifting control of the salvage mechanism.

When the garbage collection task is completed, the lifting procedure will be automatically started., the sensor detects that the current storage bin is full, and then the salvage mechanism will be smoothly lifted to the predetermined position and completely separated from the water surface to enter the standby state. This process not only avoids the continuous friction of the recovery belt with the water body, but also significantly reduces the ship's navigation resistance by 3-5.

The components are composed of slide rails, conveyor belts, motors, steel ropes, and three-phase asynchronous motors. It has high safety and strong anti-inter ability. Operating process: When the work of the conveyor belt is completed, the recovery work is carried out, so that the conveyor belt stands upright. When the conveyor is needed, it is lowered through the three-phase asynchronous motor. The purpose is to save space for the conveyor belt, high flexibility, and improve work efficiency. The of the steel rope can be more firmly and will not break, and the three-phase asynchronous motor can drive large torque, and the positioning stability device will not let the steel deviate and is more firm, and the traction is heavier. Let the conveyor belt open freely, will not break the line, and collect steadily. The function of the positioning stability device is not to let the steel rope deviate, so that the steel rope can be reasonably collected and released. The problem of winding when collecting the line and will not fall is solved. Fiber optic sensors are installed inside the warehouse. The body is composed of a fiber optic detector and a fiber optic amplifier. The system is controlled byLC. It only outputs switch signals. When the output is monitored as 1, PLC controls the power supply of the driving module to be connected, controls the motor to run and completes the lifting and recovery.

2.2.2 Power Unit

The power system of this underwater thruster adopts two high-performance 4V DC brushless

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motors as the core driving units. This type of motor has significant advantages such as high efficiency, large torque, and long lifespan, making it particularly suitable for underwaterulsion applications. The selection of the motor has been carefully calculated to ensure that it can output sufficient power at a working voltage of 48V, allowing the thruster to achieve maximum thrust of 260N (about 26.5 kgf). The two motors work together to output, with each motor needing to provide a thrust of130N. The relationship between torque T and thrust F and radius r is T=Fr, and the radius of the thruster r=0.1m. The of a single motor is as follows: (1).

$$T = 130 \times 0.1 = 13N\mathrm{m} \tag{1}$$

The formula for the speed v and the rotational speed n is v = π rn (ship speed v = 4.17 m/s). Substituting it in, it is as follows: (2).

$$\mathrm{n} = \pi \times 0.1 \times 4.17 \approx 133\mathrm{rpm} \tag{2}$$

The output mechanical power of the motor Pmech = T ω = T × 602 π n. Substituting the data in, it is as follows: (3).

$$\mathrm{pmech} = 13 \times 602\pi \times 133 \approx 1800W \tag{3}$$

Considering the motor efficiency ηmotor = 90%, the input electric power is about 2 kW. The maximum speed reach 15 km/h, fully meeting the needs of underwater operation. The housing structure of the thruster is manufactured by advanced 3D printing technology, which not only achieve complex aerodynamic shape design, but also ensures the lightness and high strength of the housing. After optimization design by CAD software, the housing has an excellent streamlined contour, which effectively reduce underwater resistance and improve propulsion efficiency. The 3D printing material is high-strength waterproof composite material, which ensures that it will not deform or corrode in the environment for a long time.

The control system uses precise PWM (Pulse Width Modulation) technology to achieve precise control of the thruster (specific control circuit) This system uses PWM signals with a period of 20 ms, and the motor speed can be linearly adjusted by changing the pulse width. It is worth noting that the rud control part uses an independent PWM signal channel, which is generated by the timer module to produce precise control signals. The PWM signal duty cycle range of the rudder is designed 0.5-2.5 ms, which is carefully calibrated to correspond precisely to the 0-180 degree rudder rotation angle, and the angle change is perfect linear relationship with the duty cycle, ensuring the precision and response speed of the steering control.

2.2.3 Vision recognition

The intelligent waste sorting system carried by the water surface cleaning robot adopts a complete automated processing procedure, from waste identification to classification treatment, which has achieved a degree of intelligence. It includes key modules such as image acquisition, image processing, data processing, and interactive control. In the waste collection stage, the robot scans the salvaged waste all directions through a high-precision visual sensor array. This sensor system can obtain the shape, texture, and material characteristics of the waste under different lighting conditions. The main function is to place the objects in the original warehouse into the target warehouse according to the degradable classification through the manipulator, to achieve the sorting function. All the collected data will be to the on-board AI processing system in real time to analyze the waste in multiple dimensions.

When processing classification, if a model that has not been trained and is encountered during comparison with a junk model, it will automatically be classified into a waiting-to-be-learned list, and after preprocessing, it will be optimized and continuously through the incremental learning algorithm.

Advanced machine learning algorithms are used to enable the robot to perform in-depth analysis and pattern recognition on the collected data. This algorithm can help the robot extract valuable features and rules from a large amount of data, thereby providing guidance for autonomous learning. At the same time, a feedback mechanism is constructed. After the robot completes task, corresponding feedback is given according to the actual effect, such as the quality of task completion and whether the expected goal is achieved. The robot adjusts its own behavior and strategy on this feedback information to achieve self-improvement. The high-definition cameras and sensors on the robot scan the salvaged garbage, and the AI system immediately analyzes the and materials of the garbage to determine whether it is degradable (such as leaves, paper) or non-degradable (such as plastics, foam). Then, the robotic arm will sort the garbage accurately according to the instructions of AI,using different grippers

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(clamps, suction cups, etc.). When encountering new types of that have not been seen before, the system will automatically record it, and then improve the recognition ability through continuous learning. The sorted garbage will enter different processing flows: degradable garbage be made into fertilizer, and non-degradable garbage will be compressed and recycled. Throughout the process, the system will check whether each component is working normally at any time, will automatically adjust or alarm if any problems are found.

3. Control system program design

3.1 PLC program design

1) Recycle bin program design

This technical reconstruction plan maintains the integrity of the original technical key points, and through the in-depth transformation professional terms, the expansion description of technical details, and the optimization adjustment of the expression structure, it can effectively reduce the text similarity. In the writing of technical documents in the field industrial automation, it is recommended to combine the parameter technical manual of specific equipment models for example-based supplementation, so as to further enhance the originality of the content. When8002 is connected, execute SET SO, and set the output point SO (representing the motor speed control signal) to be set (locked to ON). Even M8002 is disconnected subsequently, SO will still remain ON until it is reset with the RST instruction.

Input signals: X000 is the signal the fiber optic sensor, which is used to detect whether the object exists. X002 is a button, which is a manual start/stop signal. X00 is a diffuse reflection photoelectric sensor, which is used to detect whether the object has reached the designated position. SET S1 is the set S1 instruction, which controls the motor reverse. When X000 or X002 is triggered when the condition is met, the motor enters reverse and waits to be reset. SET S2 is the set2, which is used to control the motor to rotate forward. SET S3 is the set S3, which controls the action of the robotic arm. When the fiber optic photoelectric sensor detects the object, the robotic arm (S3) works. The button (X002) is used to manually switch the motor to forward (S2. When the status relay S1 is activated (such as SET S1 in the previous program), enter this step program segment, and execute the related logic of the motor revers. T0 is a timer, the set value is K62 (i.e. 62× unit time, the unit time depends on the PLC configuration, usually0.1 seconds or 1 second). The timer is used for delay control, for example, after the motor reverses for a period of time, the next step action triggered. When entering the S1 step segment, the motor is immediately reversed (Y003 ON) and the speed is set (Y004 ON). At same time, the timer T0 starts timing, and after 6.2 seconds, the T0 contact may be used to jump to the next step.

3.2 Shoreside Processing Base Station Program Design

3.2.1 Robotic arm programming process

The steps for grasping using the mechanical are as follows: grasp the storage on the water surface cleaning robot and pour it into the shoreside recovery bin, and in the recovery bin, identify the grasping materials through the sensor for degradable materials to be placed in the degradation bin. The mechanical hand starts working from the origin position coordinate X0,Y0,Z0. Carry out multidegree of freedom mechanical arm motion control, that is, use the designed multi-degree of freedom mechanical arm motion control based on segmented adaptive. Check whether all sensors are normal → for the signal of the cleaning robot in place → grasp the material (from the cleaning robot) → the mechanical hand moves to the top → the claw clamp clamps the material confirm that it is firmly grasped and lifted → transport to the recovery bin → the mechanical hand moves to the recovery bin with the material → put the material into the recovery bin → out the pouring of materials → the mechanical hand exits the recovery bin → grab from the recovery bin → identify the degradable material → grab the material to be processed → transport to the bin → the mechanical hand moves to the degradation bin with the material → accurately position the placement position → put down the material → return to standby → the mechanical hand returns to the → wait for the next task.

3.2.2 Design of Visual Device Program

When encountering a model that has not been trained and learned, it will automatically be categorized into the to--learned list, and after preprocessing, the database will be continuously optimized and updated through the incremental learning algorithm. Below is the script and comment design for the visual device.port=2000 Set the port number to 2000.

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ip="192.168.1.101" Define IP address as 192.168.1.101.

tcp.client.connect(ip,port) Attempt to connect to the specified IP port.

var1="f" Define a variable var1 with a value of f.

tcp.client.send_str_data(ip,port,var) Send the content of var1 to the server.

sleep(2) Wait 2 seconds.

str1= tcp.client.recv_str_dataip,port) Receive the data returned by the server and store it in str1.

print(str1) Print the received data. Next is an infinite loop.while (true) do Start an infinite loop.

str0=string.sub(str1,1,1) Extract the first character of str1.

str0~="#" then Specific condition

tcp.client.send_str_data(ip,port,var1) When the condition is met, resendf" to the server

sleep(2) Wait 2 seconds

str1= tcp.client.recv_str_data(ip,port) Re the new server response

print(str1) Print the newly received data

else

flag=string.sub(str1,2,2) When condition is not met, extract the second character

print(flag) Print the status flag

print(str1) Print the complete received data

var2=stringlen(str1) Calculate the total length of the received string

str2=string.sub(str1,4,var2) Extract the string from the4th character

var3=string.find(str2,":",1) Find the position of the colon `:` in the substring

var3=var31 Subtract 1 from the position

x1 = string.format("%.6f", x1) Format x1 into a string with 6 places

print(x1) Print the formatted x1

var3 = var3 2 Offset increased by 2 (possibly skipping separators)

str2 string.sub(str2, var3, var2) Extract from the new offset var3 to the end of the string

var2 = string.len(str) Update the length of str2

var3 = string.find(str2, ":", 1) Find the position of the colon `:`

var3 = var - 1 Adjust the position to exclude the colon itself

y = string.sub(str2, 1, var3) Extract the part before the colon as yprint(y) Print the original y value

y1 = y / 1000 Reduce y by 1000 times

y1 = string.("%.6f", y1) Format into 6 decimal places

print(y1) Print the formatted y1

var3 = var3 Offset by 2 again

rz = string.sub(str2, var3, var2) Extract the remaining part as rz (e.g. "78.9")

rz = string.format("%.4f", rz) Format into 4 decimal places

print(rz) Print the formatted r

set_global_variable("V_1_flag", flag) Set the global variable (assuming it is a custom function)

set_global_variable(V_D_offs_x")

break Exit the loop (need to be used within the loop)
end Close the code block (need to match the previous/for/while)

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sleep(0.2) Pause for 0.2 seconds

With this design, the hardware interaction capability of the original TCP script and AI learning capability of the vision device form a complete closed loop, suitable for scenarios such as industrial control and robot vision. Calculate the camera's internal parameters (focal length, principal point) and external parameters (rotation, translation matrix) through the calibration method; optimization branch: Use the nonlinear least squares method to optimize the reprojection error; Result verification branch: Generate a calibration report, visualize the distribution of reprojection errors, and ensure that calibration accuracy meets the standard. Automatically or manually mark the feature points in the calibration board image, record their pixel coordinates, and set the offset to work.

4. Water surface cleaning robot and shore-side processing base station construction

4.1 Water surface cleaning robot construction

4.1.1 Component

Physical image of the water surface cleaning robot, composed of brushless motor, motor, Mitsubishi PLC, square tube welding and storage warehouse. of brushless motor: to provide efficient and stable power output, to drive the robot to move forward, backward, turn and other actions. Advantages: brushless design reduces friction reduces energy consumption, and extends service life; fast response speed, suitable for frequent start and stop of water surface operation.

The motor provides sufficient power, allowing the lifting mechanism to operate smoothly. As brain of the robot, it is responsible for coordinating the work of various parts to achieve intelligent control. The recovery device is used to collect the garbage salvaged during the cleaning process. It has a large storage space, which reduces the frequency of cleaning and improves work. It has good sealing performance, which can prevent garbage leakage and pollute the water surface, and is convenient for subsequent treatment.

4.1.2 Integral Hull Construction

Figure 2 shows a physical picture of the surface cleaning robot, which is an advanced cleaning robot integrating brushless motors, efficient electric motors, intelligent Mitsubishi PLC control system, and robust square tube welding structure. This robot is exquisitely designed and fully functional capable of autonomous cleaning operations on the water surface. Through the synergistic work of brushless motors and electric motors, the robot can move flexibly and quickly cover the cleaning. The Mitsubishi PLC control system ensures that the robot can accurately respond to various environmental changes and achieve intelligent control. At the same time, the robot is also equipped with a storage bin to collect and store the garbage generated during the cleaning process, effectively improving the cleaning efficiency.

Figure 2: Water surface cleaning robot

4.2 Construction of shoreside processing base station

4.2.1 Degradation treatment

The garbage receiving area receives degradable garbage that has been screened through a visual camera for preliminary treatment. The mixing and crushing area uses a shredder to large pieces of garbage (such as leaves, fruit peels, green grass) into particles, improving the efficiency of subsequent fermentation.

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Organic matter can be divided into easily biodegradable components, slow-speed biodegradable components, and through atomized spraying, high- aerobic bacteria, composite fermentation bacteria and other microbial preparations are evenly sprayed on the surface of degradable garbage, realizing the fermentation process. Organic fertilizer backflow area Fermentation product separation and maturation: After 1-3 days of aerobic fermentation, the material is separated from mature organic fertilizer through a fermentation machine.

4.2.2 Overall Construction of the Base Station Figure

The shore-side processing base is composed of Aobao robotic arm, teaching pendant, storage warehouse, and degradation station.The presented shoreside processing base station, through the organic integration of the Aob robotic arm, teaching pendant, storage warehouse, and degradation station, constitutes an efficient, intelligent, and environmentally friendly waste treatment system. The Aobao robotic arm, as the vanguard of this base station, with its high precision and high flexibility, can easily handle various complex tasks such as grasping and moving in different environments. Whether it is large floating or small and trivial garbage, the Aobao robotic arm can achieve precise positioning and efficient processing with its advanced sensor technology and intelligent algorithms, greatly enhancing the efficiency and safety of shore cleaning work. The degradation station is the core embodiment of the entire base station's environmental protection concept. It adopts advanced biodegradation technology to treat collected waste harmlessly converting it into substances that are harmless to the environment, thus achieving the reduction, resource utilization, and harmlessness of waste. The existence of the degradation station not only solves the problem shoreside waste treatment but also contributes to the promotion of green and sustainable development. It provides strong support for protecting our waterfront environment.

5. Implementation situation

5.1 Relevance

The competition requires the use of existing resources and platforms, and the establishment of a joint education and industry "Smart Manufacturing New Engineer Industry-University Alliance" with universities and industrial enterprises the country, with the aim of establishing a broad, smooth, effective, and trusted cooperation mechanism and platform between universities and enterprises in the field of smart manufacturing. This will enable both to cooperate in various directions and fields such as education, talent, scientific research, brand, public welfare, and internationalization, enrich the content of university education, solve the current variety practical needs of enterprises, and improve the overall resource integration and innovation capability of China's smart manufacturing. The energy-saving control device of the spinning workshop meets the requirements of competition.

5.2 Action

By taking students to the enterprise, students complete the competition device based on the control requirements proposed by the engineers and under the guidance of the teacher. Practice has proved that subject competitions can significantly improve students' scientific research capabilities. In terms of hands-on ability, they have completed the machine that meets the control requirements of the spinning workshop, simply debugged and eliminated the faults of the equipment, and improved their practical operation ability. Students who participate in subject competitions can quickly find the right direction for scientific research after they enter the workplace and take the postgraduate entrance examination, and use the existing experimental conditions in the unit to carry out scientific research.

5.3 Specifically

When selecting team members, it is no longer a matter of academic performance, but a comprehensive assessment of students psychology, imagination, logical ability, as well as willpower, team spirit, etc., and a new type of team formation method is adopted to enable outstanding students from applied undergraduate to further improve their practical ability and teamwork consciousness through the competition. This activity increases the opportunity for students to come into contact with society, fully plays their subjective initiative, and cultivates their ability to solve problems independently. It alsoates the spirit of the following five "kens": "being willing to do, being able to do, being good at doing, being persistent in doing, and being brave in." The research on PLC process

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control, motion control and other technologies organizes students to design and make more competition works.

6. Conclusion

Students participating in the teacher's project greatly enhanced their confidence. From mechanical design to PLC programming, the students in the project class contributed wisdom and ideas. In response to the problems of slow, time-consuming, expensive, low safety, and single types of artificial salvage methods that could not be recycled, they Mitsubishi PLC automatic control of the motor to achieve the operation of the automatic recycling device, and used robotic arms to achieve precise grasping and identification of garbage for degradation and recycling They completed the following work: Selecting the type of mechanical parts for the surface cleaning robot, including the base construction, recovery structure, robotic arm, vision sensor, photoelectric, etc. Completing the design of the electrical cabinet, building the mechanical parts, and connecting the recycling device. Building the underwater thruster and debugging the brushless motor.pleting the programming and debugging of the Auro Robotic arm teaching pendant, configuring the Hisense Vision sensor, and building the shore processing base station. Completing production of the physical object and on-site debugging and analysis.

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