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Design of Amphibious Cleaning Machine

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Abstract: With the progress of science and technology and the continuous improvement of people 's requirements for natural environmental protection, the research of an automatic identification and tracking, automatic obstacle avoidance, safe and stable, high efficiency, suitable for a variety of working environment of amphibious garbage cleaning machine has become a hot spot, the team for a variety of lakes, narrow rivers, beaches and scenic ponds of solid waste, duckweed pollution research and design a amphibious cleaning machine. At present, many small rivers have a series of problems such as long-term disrepair, serious siltation, sediment pollution and various domestic garbage filling. Small amphibious cleaning equipment is one of the most effective equipment that can operate freely in small rivers. Based on the research of existing amphibious equipment, this project designs an amphibious cleaning ship suitable for efficient cleaning of small river garbage to solve various cleaning and treatment problems such as river water garbage, aquatic corrupt plants and duckweed.

Keywords: Waterway Amphibious Cleaning Machine; Visual Control; Image Processing; Program Block Diagram

1 INTRODUCTION

With the further development of China 's economy, more and more attention has been paid to environmental protection. The types of mechanized water surface cleaners are increasing day by day. The attention of human beings to their own health has also accelerated the demand for water cleaning ships, and has shown a rapid growth trend. At present, the water surface garbage cleaning is mainly carried out by a single person on a small wooden boat using fishing nets or manual driving salvage boats. This cleaning method is relatively primitive, not only inefficient, but also likely to cause damage to water plants. [1] According to different water environment and different garbage types, the overall size, power size and salvage structure of the garbage cleaning boat required are different. Therefore, it is urgent to design a surface garbage cleaning ship that can realize personalized customization according to the requirements of surface garbage cleaning [2]. From the perspective of industry data, the application of amphibious cleaners is closer to people 's daily life, and its social role is more obvious. At this stage, the small surface garbage cleaning work urgently needs a new garbage cleaning mode to solve and improve the disadvantages of the traditional salvage cleaning mode. [3] With the advent of the intelligent era, it is the general trend for convenient and safe robots to replace human physical labor [4]. The demand for surface garbage salvage and treatment has increased dramatically, while the traditional salvage method has high cost, low efficiency and low safety performance. The market urgently needs a water surface garbage disposal equipment with high cleaning efficiency, easy maintenance and intelligence [5]. The design of amphibious cleaning machine can effectively clean up the garbage of small rivers and tidal flats, reduce garbage disposal and improve people 's quality of life.

2 MAIN STRUCTURE DESIGN

2.1 FRAME DESIGN

Fig.1 is the three-dimensional model of the frame. Four substrates are spliced into the floor of the frame. In the middle of the frame, there is a gear transmission mechanism base connecting the driving power part and a garbage frame storing garbage. On both sides, there are supports to support the ship propeller and the support rods to support the solar power plate on the top of the machine. In front of the frame, there is a mechanical arm mechanism, a base and a fixed rod connecting the arm rod and the fixed pulley.

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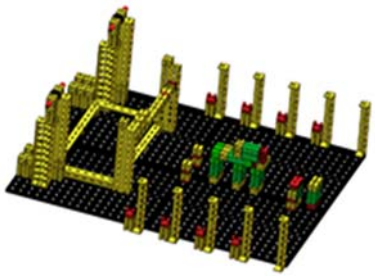
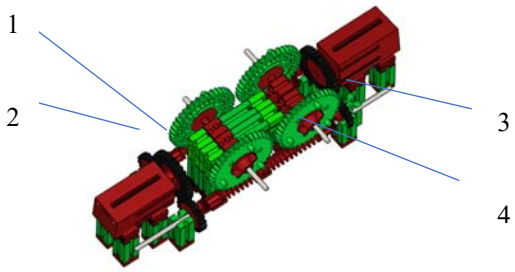


FIG. 1 RACK

2.2 GEAR TRANSMISSION MECHANISM

Figure 2 shows that the gear transmission mechanism is mainly composed of ' gear 1, gear 2, turbine 3, worm 4 ' and so on. The gear transmission mechanism is symmetrical and installed behind the frame. The gear 1 is connected with the motor prime mover to obtain power. The gear 2 is engaged with the gear 1 and fixed on the same shaft with the worm. The turbine is welded with a connecting seat and cooperates with the worm to transmit power. A double motor is used to provide enough power. One active gear 1 is engaged with two driven gears 2 at the same time, so as to provide the same size and direction torque for the two worms at the same time, so that the left and right sides of the ship propeller move synchronously. The design of worm gear and worm greatly increases the torque of the device.

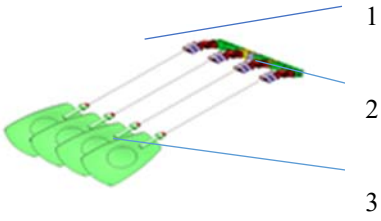


1, GEAR 1; 2, GEAR 2; 3, TURBINE; 4. WORM

FIG. 2 GEAR TRANSMISSION MECHANISM

2.3 CONNECTING ROD SHIP PROPELLER ACTUATOR

Fig. 3 shows that the connecting rod ship propeller actuator is mainly composed of ' straight rod, universal joint, ship propeller ' and so on. The shaft is connected with the connecting seat on the turbine to form a connecting rod mechanism, and then the universal joint on the connecting rod and the interaction between the ship 's propeller rod and the rod support point on the frame contact the high pair, so that the propeller can move forward.

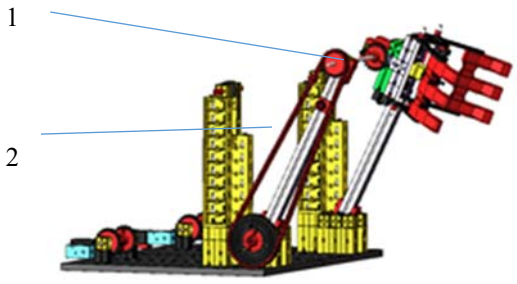


1, STRAIGHT ROD; 2, UNIVERSAL JOINT; 3. BOAT OAR

FIG. 3 ROD PROPELLER ACTUATOR

2.4 PICK-UP MECHANISM

Fig.4 shows part of the three-dimensional model of the grasping mechanism. The mechanism is mainly composed of a manipulator and a mechanical arm. The manipulator controls the positive and negative rotation of the motor through the program to make the screw positive and negative, so that the nut moves forward and backward. The forward and backward movement of the nut drives the linkage mechanism composed of the grab rod, the straight rod and the support seat to move, and finally realizes the grasping and releasing movement of the manipulator mechanism. The mechanical arm claw automatically moves to the same angle as the direction of the mechanical arm movement, so as to realize the fixed-point grasping and placing of the garbage.



1, MANIPULATOR; 2, MECHANICAL ARM

FIG. 4 GRABBING MECHANISM

2.5 AMPHIBIOUS STEERING MECHANISM

Figure 5 shows that the steering propeller mechanism is mainly composed of ' amphibious wheel, wheel shell, deflector, water outlet ' and so on. The robot adopts the wheel deformation structure. When running in water, the rotating wheel blade is unfolded, and the central gear continues to rotate to achieve the effect of the open wheel drive. When running on land, the blade is closed to act as a wheel. [6] The design of the amphibious wheel is to change the traditional wheel hub into a propeller impeller, so that the amphibious wheel can be used as a surface

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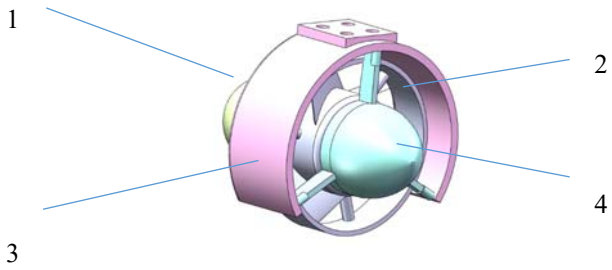
steering propeller or a land steering mechanism. The wheel shell is installed at the bottom of the left and right sides of the front end of the frame to protect the amphibious wheels inside, and can be used as a wheel when driving on land to simplify the design. The diversion and water outlet are installed before and after it to guide the water flow, and the open MV is used to control the left and right motors to work or stop to realize the water and land steering function of the whole machine.

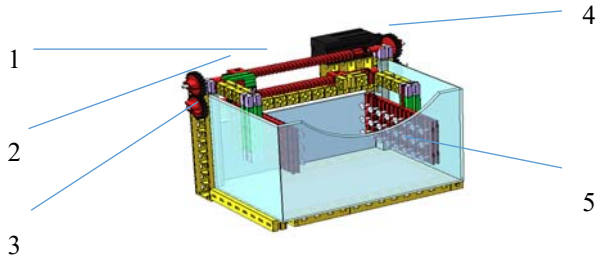


1. DEFLECTOR; 2, AMPHIBIOUS WHEEL; 3, WHEEL SHELL; 4. WATER

FIG. 5 STEERING THRUSTER MECHANISM

2.6 *WASTE LIQUID TREATMENT MECHANISM*

Figure 6 shows that the residual liquid treatment mechanism is mainly composed of ' screw, nut, gear 1, gear 2, spine plate ' and so on. In order to solve the problem of difficult garbage cleaning in rivers, lakes, ports and other waters, this paper proposes an optimized design scheme for the sorting of surface garbage cleaning ships [7]. The sorting mechanism is fixed on the garbage basket as a whole, and the screw and nut cooperate to form a screw mechanism. The screw mechanism provides a large clamping force for the spine plate, so that the spine plate can pierce the bottle garbage and collect the residual liquid inside it.



1, SCREW; 2, NUT; 3. GEAR 1; 4. GEAR 2; 5, THORN PLATE

FIG. 6 WASTE LIQUID TREATMENT MECHANISM

3 THREE-DIMENSIONAL EXPLOSION DIAGRAM AND ASSEMBLY DRAWING

The explosion diagram and assembly diagram of the three-dimensional model of the amphibious cleaning machine are as follows:

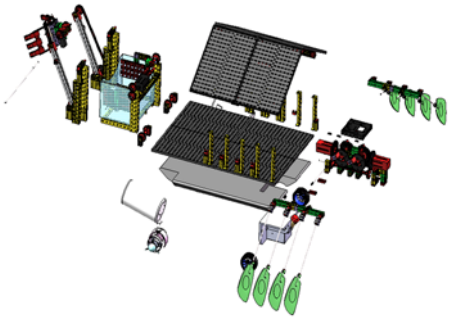


FIG. 7 EXPLOSIVE VIEW

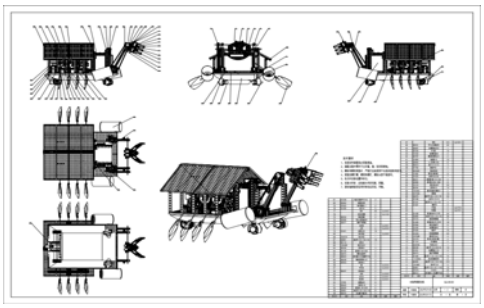


FIG. 8 ASSEMBLY DRAWING

FIGURE 3.1 THREE-DIMENSIONAL EXPLOSION DIAGRAM AND ASSEMBLY DIAGRAM

According to the three-dimensional assembly model, the physical model assembly of the amphibious cleaning machine is completed, as shown in Figure 9.

FIG. 9 PHYSICAL ASSEMBLY MODEL

4 VISUAL RECOGNITION PROGRAM DESIGN

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More and more researchers use deep learning-based methods to study water surface target detection, and have made good progress. However, interference such as water surface environment and water surface small target detection are still research difficulties [8]. Using the open MV visual recognition effect, different positions of the garbage are identified and different signals are transmitted to the left and right steering mechanism motors to control the motion state of the two steering motors to achieve the effect of steering and tracking the garbage.

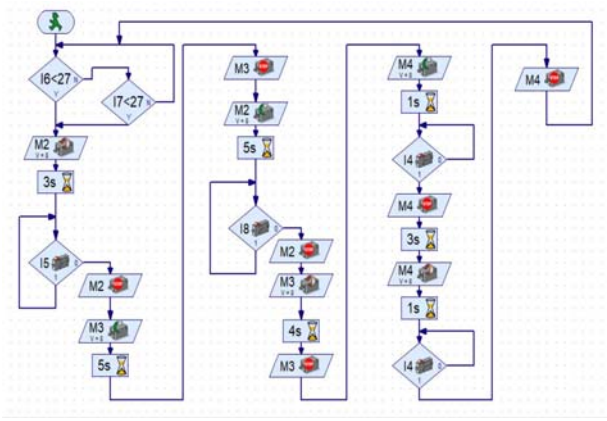

FIG. 10 ACTUATOR PROGRAM

The working process and sensor layout: two ultrasonic sensors are installed in the front end of the machine. After pressing the start button, when any of the two ultrasonic sensors sense that the distance between the garbage and the garbage is less than 250 mm, the control signal is transmitted to the control board. The control board supplies power to the motor M2 to make it counter-transfer the mechanical arm downward, disconnect the switch 1 to make the drive motor stop working, and the mechanical arm downward until it touches the switch 2 to make it jump out of the cycle. At this time, the control board controls the M2 to stop and supplies power to the motor M3 to make it reverse, so as to realize the grasping action of the manipulator. After 6 seconds, the motor M3 stops. And the motor M2 starts the forward rotation to pull the mechanical arm up until it reaches the vertical touch to the switch 1 and stops after jumping out of the cycle. At this time, the motor M3 starts the forward rotation and closes the drive motor to start the work. After the garbage is put into the garbage basket, the motor M4 that pierces the bottles and cans of garbage in the garbage basket starts working to pierce the garbage, so that the residual liquid in the garbage can be processed. At this time, a workflow is completed and the next cycle is started.

5 STATIC ANALYSIS

Through the simplification of the model, the performance analysis of the amphibious cleaning machine floor is convenient, the finite element model is established, the material properties are defined, the mesh is divided, the constraints and loads are applied, and the analysis is carried out. The full load state deformation cloud diagram of the amphibious cleaning machine floor. It can be seen from the figure that the maximum deformation of the bottom plate appears at the installation position of the solar roof support rod on both sides, and different degrees of small deformation also appear in other parts. However, in general, the deformation of the picking machine is very small, and the stiffness of the equipment meets the design requirements.

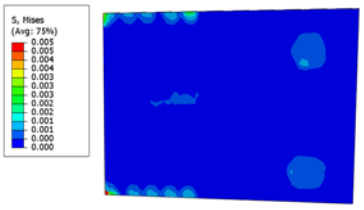

FIG. 11 WHOLE MACHINE MODEL

Fig.12 shows the stress cloud diagram of the floor of the amphibious cleaning machine under full load. It can be seen from the figure that the maximum stress of the bottom plate appears at the installation position of the solar roof support rod on both sides, and a certain amount of stress also appears in other parts. However, in general, the stress of the amphibious garbage ' cleaner ' floor is small, and the strength meets the design requirements.

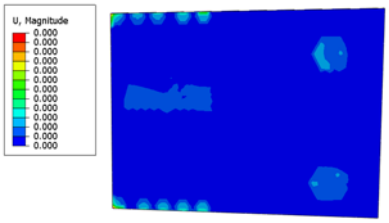

FIG. 12 FLOOR STRESS CLOUD DIAGRAM

6 CONCLUSION

In this paper, according to the narrow river surface and road garbage, the functional requirements of garbage collection and treatment device are analyzed. Therefore, this paper designs an amphibious cleaning machine. The device is mainly composed of four parts: transmission mechanism, grasping mechanism, steering mechanism and residual liquid treatment mechanism. The steering mechanism has amphibious function, which can realize waste treatment in both land and water. SolidWorks is used to design the three-dimensional modeling of the amphibious cleaning machine, and then the equipment is manufactured. After functional testing, the designed amphibious cleaning machine meets the design and use requirements. The design can effectively reduce the labor intensity of the staff and

improve the efficiency. In the future, solar panels can be used instead of power supply to provide power, increase the detection of water quality, salvage sediment operations and other functions, save time and reduce costs. The design of the cleaning machine broadens the cleaning range of existing equipment and has broad application prospects.

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