Garbage Cleaning Ship Based on Image Processing Technology

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Abstract: With the acceleration of China's modernization process and the increase in the amount of garbage generated, the number of floating garbage on the water is also increasing. The water shortage and accidents caused by pollution continue to occur, which not only causes the plant to stop production, agricultural production or even harvest, but also caused bad social influences and large economic losses, which has seriously threatened the sustainable development of society and threatened the survival of mankind. The existing manual cleaning methods are not only inefficient, but also have certain risks. In view of this, we designed this multi-purpose garbage cleaning ship to achieve environmentally friendly and efficient collection of floating garbage. This paper first introduces the research status of surface garbage cleaning vessels at home and abroad, and then analyzes the main problems in the current treatment of water surface waste in China. Finally, the design contents of the multi-functional garbage cleaning ship are introduced in detail, including the applicable objects and the structure of the hull design, material selection of the hull, design of the garbage storage device, etc. The design and implementation of the multi-functional garbage cleaning ship plays an important role in improving the current situation of river management in China and reducing the pollution status of rivers.

1. Introduction

At present, there are many types of surface garbage cleaning robots at home and abroad, but most of them use the wireless remote control technology for human manipulation, or use the GPS module to locate the location of the garbage clearing ship, and set the fixed route through specific algorithms, and cruise in a fixed area according to the prescribed route, and clean up the rubbish encountered during the cruise [1]. Although the above two methods can realize the separation of people and ships, realize remote control and save certain human and material costs. To alleviate the problem of cleaning up the garbage on the water, but in this mode, the degree of automation is not high, still rely on manpower control, and can not accurately identify and locate the garbage. It has a certain blindness, low cleaning efficiency, and the function of most of the existing garbage cleaning ship is relatively simple [2].

2. Research status at home and abroad

Regarding the automatic salvage of surface garbage, there are mature commodities and deep research foundations abroad.

The Ministry of Marine and Fisheries of Korea invested 2.35 billion won in 2000 and commissioned the South Korean Institute of Marine Research to develop a garbage salvage vessel capable of carrying out garbage removal operations in shoals and ports [3]. At present, this marine garbage salvage ship has been built and passed the performance test. The ship, named "Ocean Cleaning No.", is 30m long, 10m wide and 2.3m high. It can remove floating garbage only in shoals and ports with a depth of only 2 meters. The ship is equipped with a "multi-joint" shovel with a length of 20 meters, which can be used to salvage the bottom of the beach at a depth of 15 meters. The hook-shaped collector on board can be used to collect fishing nets and fishing gear in the water. The cabin can also hold 40 tons of garbage, which can be cut and broken by the ship's wide-body cutting machine [4].

The a series 1010 cleaning ship developed by Pelican Company of Canada adopts a single ship type, which has the functions of cleaning surface water, oil sewage treatment, aeration and fire protection. The main working tools include dump bucket, garbage bin, oil-water separation equipment, fuel tank, Jet aerator, fire water gun.

The series of cleaning ships developed by United International Shipping Company (umi) adopts a catamaran type with two sets of z-type propulsion devices. The main function is to clean the surface garbage. The main working tools include diversion gate, bow conveyor, garbage bin and stern conveyor. The stern conveyor belt is used to transport garbage to the shore.

In recent years, the country has gradually developed its own high-efficiency surface salvage automatic salvage ship. The water cleaning ship "Fangtong" built by Tianjin Xingang Shipyard was launched in Tianjin Haihe River at the end of 2001 [5]. The ship is characterized by high efficiency, energy saving and environmental protection. It is powered by electricity and is powered by electric full swing. It not only has no pollution to the water body, but also has very flexible action. After approaching the garbage, the precision hydraulic spray automatic swing arm on the ship, the garbage collection basket lifting and lowering device and other equipment work together to clean up the surface garbage. The ship has realized automatic cleaning, collection and storage of surface garbage, and the hydraulic water spray automatic swing arm can also flush the embankment garbage and water the river bank green space.

The surface floating fishing boat developed by the Shanghai Waste Disposal Company aims to achieve continuous operation of diversion, salvage, compression, storage and transshipment. It adopts a catamaran type, and the salvage device adopts a conveyor belt form to overcome the previous manual salvage and grab. The shortcomings of the gap salvage, the salvage speed is fast, the labor intensity is low, and the continuous operation can be realized for a long time, and the loss of the operation process is reduced. Independent work ability, single-ship operation can complete all work from salvage to transshipment [6]. From salvage to transshipment, all mechanized operations are carried out, which greatly improves work efficiency and reduces the labor intensity of workers. It is especially suitable for large-area aquatic plant pollution control. The operation device is mainly composed of water jet diversion, solid-liquid separator and screw press. The intercepting and salvaging device has high working efficiency and strong adaptability. The use of a mechanical solid-liquid separation device to salvage water hyacinth greatly reduces the labor intensity of workers.

With the increasingly prominent environmental problems, water environmental protection has also received more and more attention. The pollution of floating garbage on the surface has gradually threatened the public's drinking water, sanitation and city appearance. Therefore, mechanized cleaning of surface waste has become an important water environmental protection measure [7]. At present, the cleaning of surface waste at home and abroad generally uses manual salvage methods and mechanical salvage methods. Manually salvaging surface waste is a half-cabin or deck-powered barge. The sanitation worker holds a net bag and other tools to stand on the side of the deck and directly pick up the garbage. This type of operation is labor intensive, the working environment is poor, and the efficiency is very low. The mechanical method mostly uses the dumping type and the guide door type design of the surface garbage cleaning ship. The hull is generally several tens of meters long and the draft water tonnage is large, and the hydraulic device is used to salvage the garbage. The surface garbage cleaning ship generally consists of a single hull, a collecting device, a storage device. The collection device mainly has several forms such as conveyor belt, tipping bucket and flow collection. Its function is to guide the floating garbage in front, and collect it and then lift it in a dedicated garbage storage box [8]. These surface garbage clearing vessels are suitable for large rivers, lakes and offshore. Due to the inconvenient movement of the hull, the narrow working width of the collecting mechanism, the excessive power consumption and the cost of use, and the inability to adapt to the cleansing of small rivers, lakes and water playgrounds, work efficiency is low [9]. According to market research, data retrieval and patent search, there are no small-scale rivers, lakes and water playgrounds at home and abroad. The use of water-based garbage cleaning equipment for

contoured wing-off eccentric motion mechanisms is basically used in China to complete surface-level garbage by manual salvage [10].

3. Problems in the treatment of surface waste in china

1) Current status of China: The scope of cleaning is wide, and there are many sources of floating objects on the surface.

2) The salvage method and the ship equipment are backward, the efficiency is low, and there are certain safety hazards in the salvage personnel standing along the ship [11].

3) Insufficient funds for water cleaning.

4) There is a lack of uniform coordination between river management and water cleaning.

5) Waterborne garbage seriously affects the image of the city and causes economic losses.

6) Garbage is a breeding ground for virus pathogens, and water parks are public places. If garbage is not cleaned up in time, it is easy to cause public health accidents.

7) Garbage salvage work requires special personnel, which not only has hidden dangers, but also consumes manpower and material resources and increases unnecessary expenses.

8) Manual cleaning is inefficient and requires clean-up personnel to work hard and work long hours in a relatively harsh environment, which can easily cause discomfort and cause disease.

4. Design of multi-purpose garbage cleaning ship on water

4.1 Applicable objects

The surface salvage automatic salvage vessel is dedicated to the cleanup of solid waste in waters such as small and medium-sized lakes and rivers, such as plastic bags, beverage bottles, branches and leaves, and other easily cleaned surface waste. It floats the floating garbage (mainly branches, crop straw, white plastic, domestic garbage and aquatic plants, a small number of animal carcasses, etc.) from the surface of the water, directly shipped or compressed and shipped to the waste treatment plant for treatment.

The surface salvage automatic salvage vessel is mainly for the collection of surface garbage in rivers and lakes in urban and scenic areas. According to the survey and analysis, the surface garbage mainly includes straw, rotten vegetables, plastic bags, soft packaging, beverage boxes, plastic foam, melon skin and so on. Due to the surges and tidal waves formed by the passing ships in the river, the surface garbage is generally concentrated on the river banks, dams, lakes and corner recirculation areas on both sides, while there is almost no garbage in the center of the rivers and lakes. Therefore, the collection vessels are required to be small in size.

4.2 Structural design of the hull

The hull is the main part of the entire ship and does not include any hull structures of equipment, installations, systems, etc. and enclosed buildings above the upper deck. The structure, shape and size of the hulls play a crucial role in the design of the entire ship and in the design of the entire system.

First of all, the basic idea of hull structural design should be clear.

1) The design of the hull is to find a balanced solution among several contradictory requirements such as structural function, component weight, space occupied and manufacturing process.

2) The overall structural design solution is also not unique.

3) Among all the considerations, safety is of the utmost importance to structural design.

Secondly, it analyzes and solves some problems in the design of hull structure.

1) The hull structure design should meet the reasonable requirements of the required functions as much as possible.

2) Some hull structural problems, their feasible solutions need to comply with other professional designs,

Active and reasonable cooperation should be provided.

Since the installation and welding of all parts of the ship are completed on the basis of the original hull, the structural design of the hull should take into account various factors. Such as:

The overall structural aspects of the hull, including single hull structure, double hull structure, and multi-hull structure;

3) In terms of the shape of the hull, since the wind direction and the water flow may hinder the travel of the hull, proper streamline type and bevel angle are essential in design.

4) Whether the size of each part of the hull structure is reasonable;

5) The material aspect (mechanical properties) of the hull, including whether the strength, hardness, plasticity and toughness of the materials used to manufacture the hull meet the requirements and the process performance such as fatigue resistance, corrosion resistance and weldability of the material can meet the demand;

6) Whether the weight of the ship and the depth of the draft meet the demand;

7) Whether the installation and mutual matching of the various components on the ship can meet the requirements, such as welding methods, cooperation methods, etc.;

8) The source of the ship's power and its transmission structure, etc.;

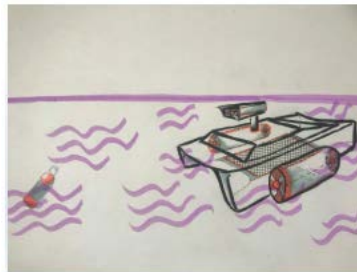9) Is the balance stability of the ship guaranteed?

Figure 1. Cleanup ship model

4.3 Hull material selection

The hull material is made of structural steel for hulls. It is mainly used to manufacture the hull structure of ships in the voyage, coastal and inland rivers. The strength grades are general strength steel and high strength steel according to their minimum yield point. Marine structural steel is the most important metal material used to make the hull and its ancillary structures. In order to make the hull structure successfully built under modern shipbuilding conditions, and to ensure the safe and reliable use of the ship, in addition to the reasonable design and correct construction process, the hull requires that the hull structural steel must have good technical performance, such as strength, hardness, plasticity, toughness, fatigue resistance, seawater corrosion resistance and some special properties, and must also have good process properties, such as hot and cold bending process performance and welding process performance.

The general strength structural steel of China Classification Society standard is divided into four quality grades: A, B, D, and E; the high-strength structural steel of China Classification Society standard is three strength grades and four quality grades: A32, A36, A40, D32, D36, D40, E32, E36, E40, F32, F36, F40.

The surface salvage automatic salvage vessel is mainly used for salvaging surface water in rivers and lakes in urban and scenic areas. In order to make the hull not too heavy, the thickness of the steel plate of the hull is set to 5mm. When the functional requirements of various aspects are met, the hull material is selected as A32 steel.

The chemical composition and mechanical properties of the material are: carbon content $\leq 0.18\%$, the manganese content is $0.9\% \sim 1.60\%$, and the silicon content is $\leq 0.5\%$, phosphorus content $\leq 0.035\%$, Sulfur content $\leq 0.035\%$. It does not contain bismuth or vanadium 2 elements. And the yield strength of the material $\geq 315MPa$, tensile strength $\geq 440 \sim 570MPa$, Elongation $\geq 22\%$.

4.4 Design of garbage storage device

In view of the design features of the transmission device, a garbage storage box is designed in the rear position in the middle of the hull.

The garbage storage device is used for temporarily storing the garbage transferred from the conveyor belt. The whole process is automatic and no human operation, and the garbage is transported from the conveyor belt and falls into the garbage storage box. At the same time, the left and right hull space is also used to store garbage, but taking into account the convenience of garbage transfer on board and after landing, make full use of the effective space, add two replaceable garbage storage boxes, and separate the other spaces with partitions .The total garbage storage box has a total length of 600mm, a box width of 800mm and a wall thickness of 2mm. The garbage collection device is separated from the hull. The whole garbage storage box is a rectangular outer frame (without the bottom plate) which is fastened in the middle of the hull by the buckles on both sides of the box. On the top, there is a space of 20mm between the two. In addition, since the garbage is transported together with the water in the process of transporting it from the water, the garbage transferred into it is somewhat water-poor, so the bottom of the tank is designed with a grid structure so that the water coming up with the garbage can be taken from the bottom of the garbage storage box. The holes are leaked out to reduce the resistance of the ship during driving, and garbage storage is more effective.

4.5 Introduction to the cleanup ship

The hull adopts the mode of GPS navigation system and object recognition technology to plan the cruising route of the hull, improve the automation degree of the garbage cleaning ship, save manpower and material resources, and at the same time use object detection and visual positioning technology to accurately implement the garbage positioning, reducing the blindness of the garbage cleaning ship and improving work efficiency. At the same time, the added photovoltaic power generation board improves the endurance of the garbage cleaning ship. The water quality detection device attached at the bottom is more perfect for the hull function, and the air quality detection is placed on the top equipment, anemometer, atmospheric pressure meter, and ultraviolet radiation detector, and transmitted to the electronic display on the shore of the lake through the wireless data transmission module to provide real-time weather conditions for tourists or passing pedestrians. The probability of hooking is related to the atmospheric pressure of the water surface. When the atmospheric pressure is high, the water has high oxygen content. The fish is active and has a strong appetite. It is easier to hook. When the atmospheric pressure is low, the water oxygen content is low, and the fish's appetite is reduced, resulting in more fish. It is not easy to hook, and the fishing index can be displayed in the scenic spots or lakes where fishing is allowed. When the atmospheric pressure is higher than 1006 Pa, the screen display "appropriate fishing", when atmospheric pressure is lower than 1006 Pa shore display shows "Fishing is not easy" to provide real-time information for the fishing enthusiasts.

4.6 The ship's clearing function

The cleaning ship is implanted with a GPS module, which can be used to determine the specific position information of the cleaning ship, and to specify the cruising route and range of the garbage cleaning ship through a specific algorithm. In addition, the project adds object detection and visual positioning technology. The camera detects the surface of the water, detects the presence of surface waste, and calculates the location of the target in real time. The positioning is accurate and reliable, and the garbage cleaning efficiency is improved. At the same time, the device is also equipped with a solar photovoltaic panel to solve the emergency situation that the water power cannot be recovered. To increase the cruising range of a single charge, the equipment also has a water quality detection function. At the same time as salvaging the garbage, the water quality testing equipment provided by the equipment will conduct water quality inspection on the nearby waters to determine the impact of the surface water on the water quality. Subsequent water quality management provides some help.

When no hull is found in the hull, the hull's cruising route is controlled by the GPS navigation module and the specific route planning algorithm. In this case, the hull will be cruised according to the planned route in advance within the prescribed range, and cruised. During the period, through the object detection technology and the camera on the hull, the surface garbage is identified. Once the surface garbage is found, the hull will automatically detect and locate the garbage through the visual positioning and ranging algorithm. At this time, the GPS navigation module stops. For the drive of the turbine, the visual control module will drive the cleaning ship to the garbage and complete the garbage recycling work, thus realizing the automatic operation of the surface garbage cleaning. The object detection technology has a very wide application in real life. Compared with the infrared image recognition technology, the object detection technology has the advantages of high resolution, strong contrast, good visual effect, etc. In the object detection technology, background subtraction can be applied, that is, the difference between the current frame and the previous frame is recognized, and any moving object in the scene is created, in turn, identifies the surface waste. The visual positioning and ranging technique uses pinhole imaging. According to the similar triangle principle, the actual coordinates of the corresponding pixel points of the surface garbage are calculated, and then the propeller is driven close to the target and salvaged. The hull type used in the project is a small waterplane face catamaran type which is more advanced in the ship design field. It can obtain a larger upper space while providing the same buoyancy. At the same time, because its width is much larger than that of a single ship, its stability will be significantly better than that of a single ship. It has good maneuverability and the resistance peak is not obvious. In addition, the left and right sides of the hull are also equipped with propellers, which can not only drive the progress of the cleaning ship, but also adjust the forward direction by controlling the rotation speed of the propellers on the left and right sides. At the same time, the propeller can also form a water flow under the hull to make the floating. The garbage is more easily collected by the cleaning ship. In addition, the garbage cleaning ship is also equipped with water quality testing equipment to determine the impact of various garbage on the water quality. When the garbage cleaning ship approaches the surface garbage, the monitoring equipment above the hull will be captured by shooting. The main features of the surface waste, while the water quality testing equipment will obtain water pollution data near the garbage, and the relevant data and images of the garbage are matched to obtain the influence of different surface garbage on the water quality, which is beneficial to the analysis and treatment of the water source pollution. At the same time, there are air quality testing equipment, an air velocity measuring instrument, an atmospheric pressure measuring instrument, and an ultraviolet radiation detector, and it is transmitted to the electronic display on the shore of the lake through the wireless data transmission module to provide real-time weather conditions for tourists or passing pedestrians. Through investigation, it is found that the probability of fish hooking during fishing is related to the surface pressure of the water. When the atmospheric pressure is high, the water has high oxygen content. The fish is more active and appetizing, and it is easier to hook. When the atmospheric pressure is low, the water has low oxygen content, and the fish's appetite is reduced, which makes the fish more difficult to hook. In the scenic spots or lakes that allow fishing, the fishing index can also be displayed. When the atmospheric pressure is higher than 1006 Pa, the shore display shows "suitable for fishing". When the atmospheric pressure is lower than 1006 Pa, the shore display shows "not easy to fish". In the place where fishing is not allowed, "No fishing" is displayed as a fishing enthusiast. It provides real-time information.
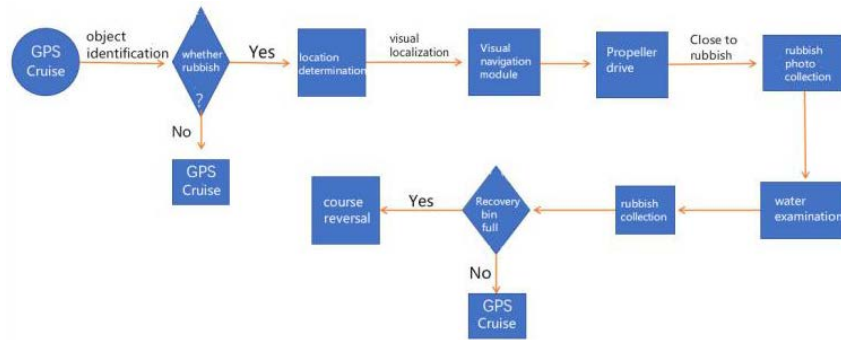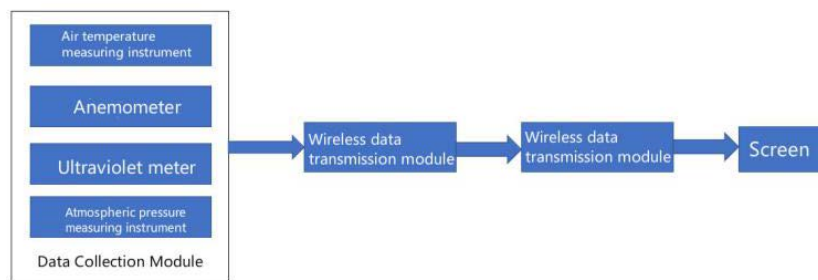
Figure 2. Technical solution

Figure 3. Module composition

4.7 The advantages of the cleaning ship

The clean-up vessel solves the problem of garbage disposal in small water areas of the scenic spot and water surface (such as small reservoirs, ponds, etc.) that are not suitable for the work of existing large-scale garbage collection vessels. It replaces the traditional manual salvage method and improves the efficiency and safety factor of garbage cleaning.

Compared with the existing automatic salvage equipment, the equipment can accurately identify and locate the surface waste, featuring high efficiency, high degree of automation and strong maneuverability. At the same time, the equipment has added photovoltaic power generation equipment, water quality detection and weather conditions. The monitoring device increases the endurance and working time of the hull, improves the function of the garbage cleaning ship, and realizes multi-purpose use of one ship.

4.8 Promotion value

With the acceleration of urbanization, the amount of garbage generated in China is growing rapidly. At present, China's annual garbage production has exceeded 140 million tons, with an average annual growth rate of about 8%. Among them, a large part of domestic garbage is discarded at will, seriously polluting the natural environment and destroying the ecological balance. China's urban canal network, floating water in Hanoi is mainly from 16 tributaries. The garbage is distributed throughout the voyage and is evenly distributed throughout the year. The main source is the surface floating objects of 16 tributaries along the canal. The multi-purpose garbage cleaning ship on the water is designed for the cleaning of floating garbage on the water, which can effectively utilize the existing ship resources and has a simple structure. If it is promoted on a large scale, it will not only have great benefits for the disposal of waste recycling in China, but also generate relatively large social and economic benefits.

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