Inland water green smart power pusher

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Abstract: At present, the auxiliary ships for inland waterway operations mainly use diesel as fuel, and a large amount of polluting gas is emitted in the inland waterway, which seriously affects the air quality of cities along the waterway. In order to solve the impact of the current inland waterway auxiliary ships on the environment, this work has designed a new energy intelligent pusher for inland rivers and lakes. The pusher uses electric energy as an energy source. This work is mainly composed of power supply system, container battery rapid replacement system, ship slow contact system, ship positioning and anti-collision system. Under the joint cooperation of all systems, the intelligent jacking of inland rivers and lakes and the rapid battery replacement are completed, and finally it is green, Intelligent and efficient operation effect.

1. Introduction
The continuous development of the inland shipping industry has injected strong impetus into the economic development of china, but the resulting pollution has become increasingly serious. At present, the auxiliary operation ships of inland waterways mainly use diesel as the energy source, and the operation sites are usually concentrated in the port areas of coastal cities. Therefore, the emissions of various auxiliary operation ships pose a huge threat to the environmental protection situation of coastal cities; the current Chinese government Relevant international organizations have successively promulgated laws and regulations restricting ship emissions, and at the same time proposed the development goal of green and intelligent ships. Therefore, it is urgent to solve the pollution problem of auxiliary ships in inland waterways.

At present, there are auxiliary ships such as tugboats that use electric propulsion at home and abroad, but they need to be charged after a certain period of operation. Although the current fast charging technology develops rapidly and gradually matures, the charging process still costs A longer time, therefore reducing the work efficiency. In addition, there is still a lot of room for improvement in the intelligentization of auxiliary navigation ships. Therefore, this project proposes a green intelligent auxiliary ship suitable for inland waterway push operations. It is used in ship power supply systems, container battery quick replacement systems, slow contact systems, Under the coordination of positioning and anti-collision systems and other systems, the green, intelligent and efficient inland waterway pushing operations are realized.

2. Design of Green Electricity Pushing Ship
The main function of the green power pusher is to ensure the safe, green and efficient completion of work tasks for inland watercraft.
2.1. Working process of green power pusher ship

The ship dispatch center will first match each cargo ship in the waiting area with the pusher ship and enter the system. The pusher ship will gradually approach the pushed cargo ship in the cargo ship waiting area, and it will be quickly assisted by the millimeter wave radar installed in the pusher rack. When the two ships contact, the staff on the pusher ship will moor the two ships at the bow of the pusher ship. Then the cargo ship will complete the task under the action of pusher. In this process, the ship positioning and collision avoidance system monitors the real-time position of the pusher ship and the distance between the two sides of the channel, and the intelligent control system will control the pusher ship and the channel boundary to maintain stability Safe distance. The GPS positioning module and the image fusion monitoring system will monitor the navigation position of the pusher ship in real time, and upload it to the dispatch center to share with other pusher ships to avoid too close distances between ships and ensure navigation safety. After navigating several times, the pusher ship will be quickly moored in the cargo ship waiting area through a vacuum mooring system that can adapt to changes in ship's draft, and the battery will be replaced by a crane with the assistance of the laser automatic docking system. The pushing ship will continue to push the operation.

2.2. The composition of the green power pusher

The entire system consists of a hull and a quick battery replacement system. The hull consists of a push frame, battery compartment, control room, positioning system, radar system and propulsion device. The battery quick replacement system consists of an adaptive vacuum adsorption device and a lifting frame. The schematic diagram of the ship structure is shown in Figure 1.

![Figure 1: Schematic diagram of the ship structure of the green power pusher ship](image)

3. Ship power supply system

3.1. Battery capacity of pusher ship battery compartment and container

As shown in Figure 2, the battery compartment is located in the middle of the push ship, on both sides of the console. The size of the battery compartment is 2960 mm (length) * 2340 mm (width) * 2350 mm (height), which can accommodate a 10-foot container battery.

![Figure 2: Push ship cabin layout plan](image)
In order to improve the endurance and ensure safety, this push boat uses 10-foot container batteries as the power source. The container batteries are located in the middle of the push boat and on both sides of the console. Each container battery is composed of 12 26.8 kW·h battery packs (EVE-83-1P30S-11), which can provide 348.4 kW·h of electricity. Two container batteries can provide 696.8 kW·h of power, which can meet the power required by the booster ship for 8 hours and leave a margin of about 23%.

3.2. Vacuum mooring system capable of adapting to changes in ship draft

The vacuum mooring system that can adapt to changes in ship's draught is used to adsorb and fix ships whose batteries are to be replaced, and can adjust water level adaptively according to the ship's draught. The system includes a vacuum adsorption device, an adaptive water level adjustment system with a floating body, a tension sensor and a hoist. When a ship is replacing a container battery, the vacuum device in the vacuum suction cup is first activated to suck, so that negative air pressure is generated in the suction cup, thereby fixing the ship, which provides a prerequisite for the replacement of the container battery. As the water level floats up and down, the vacuum suction cup that fixes the ship and the vacuum suction device base that carries the vacuum suction cup will also go up and down. Floating, therefore, force is applied to the tension sensor, and the external force causes the change of the tension sensor to feel the force, and the electric signal is transmitted to the hoist, so as to control the hoist to retract the rope to make the vacuum suction device move up and down to keep the ship, achieving this set of container battery quick replacement system The purpose of adapting to changes in water level and draft.

3.3. Ship slow contact system

The slow contact system includes a laser radar device, a millimeter wave radar device, a high-definition camera, a solid rubber fender and a corresponding control system. The radar system is used to monitor the distance between the two ships, the high-definition camera is used to observe the contact situation, and the solid rubber fender can play a certain buffering role, effectively reducing the impact of ship collision on the hull. The composition of the ship's slow contact system is shown in Figure 6:
4. Ship positioning and anti-collision system

4.1. Composition of ship positioning and anti-collision system
The ship positioning and anti-collision system consists of GPS channel precision positioning system, radar detection system, panoramic image camera, ship-borne AIS device and ship positioning and anti-collision control system. The GPS system and radar system are used to accurately locate the position of the ship in the channel and the distance between the ship and the channel boundary. The panoramic camera is used to observe the surrounding conditions of the hull. The onboard AIS system is used for the information exchange between the ship and the ship, the ship and the control center, and the ship positioning and anti-collision control system is used for the comprehensive analysis of GPS channel precision positioning system, radar detection system, and panoramic camera. The information collected by the image camera and the onboard AIS device sends appropriate speed and steering control commands to the shaftless rim propulsion system.

4.2. Selection and design of ship positioning and anti-collision system
In order to meet the demand for high-precision positioning of ships in the waterway, the UBLOX 7020 chip is used in the ship positioning system, and a GPS-based precise positioning system for the ship's waterway is designed. Utilizing the characteristics of GPS anti-interference ability and wide effective distance, it can realize the collection and precise positioning of ship position information in the channel. Detection radar, ship panoramic image and ship-borne AIS technology are important technical means to ensure the safe operation of ships in the channel.

The radar detection system is composed of millimeter wave radar and lidar. Lidar is highly accurate and expensive, and is mainly used to detect the distance between the ship and the channel boundary. Millimeter-wave radar has relatively low accuracy and is mainly used to assist lidar measurement and range measurement during ship mooring. The radar detection system operating in the ship's navigation can effectively obtain information about the situation around the ship, which is convenient for judging the direction of the ship during navigation to effectively reduce the collision of the ship with the channel.

The panoramic image of the ship is composed of four 190° HD 1080P wide-angle fisheye cameras installed at the four corners of the ship. The four-direction video images collected at the same time are synthesized, and finally a 360° bird's-eye view without blind spots is displayed on the central control screen, allowing the staff to clearly grasp the situation around the ship, to a large extent avoid visual blind spots and reduce the difficulty of ship navigation. The installation of the panoramic image camera is shown in picture 6.

![Figure 6: Installation diagram of panoramic camera](image-url)
5. Innovation

① Designed a slow contact system for the pushing ship and the pushed ship: the slow contact during the lashing process is realized through the cooperation of the radar system and the ship's propeller to avoid ship damage caused by collision during the lashing process;

② Designed a rapid battery replacement system for containers: the combination of a vacuum adsorption device with a vertical slide and a dual-container synchronous loading and unloading device realizes the rapid mooring of ships and the safe and rapid replacement of batteries;

③ Designed a ship positioning and collision avoidance system based on inland waterways: through the combination of radar, depth vision and other technologies and control systems, accurate positioning, omnidirectional vision and collision avoidance of ships in the channel are realized.

6. Conclusion

This work is designed based on inland waterways. Compared with auxiliary ships on inland waterways at home and abroad, it is smarter, more environmentally friendly, and safer. It can better meet the navigation requirements of narrow and large water drop channels, and this work has a wider range of The scope of application is capable of satisfying ship's push sailing in various scenarios, and has good promotion and development prospects.

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