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Plan Design of Application of Unmanned Handling Chassis Robot in Intelligent Ship Object Operation

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Abstract

As the ships develop towards larger and more intelligent, traditional ship handling equipment and processes consume a lot of manpower and material resources. The application of ship LAN technology, information integration technology, and electronic identification technology have become more extensive, make various intelligent equipment can be used and implemented in ships. By comprehensively analyzing and comparing the current ship processes and possible automation equipment, existing technologies are integrated and designed.

Keywords

Unmanned Handling Chassis Robot; Automation; Intelligent Ship.

1. Introduction

While ships are developing towards large scale, the number of crew is also decreasing with technological advancements. If the ship automation equipment does not become the effective means to assist the crew in time, the work intensity of the crew will increase day by day. The longitudinal handling of light cargo (cargo weight is less than 150 kg) is one of the tasks that occupy a lot of physical strength of crew. Such work contents include but are not limited to:

(1) Handling of paint

(2) Handling of oxygen supply equipment during cargo hold detection

(3) Handling of material in the forepeak tank

(4) Cabin lock, floor lock, floor drain plug

(5) Other longitudinal handling of possible emergencies

At present, there are two mainstream handling methods.

(1) Flatcar and human pulling, this method is simple and easy to operate, inexpensive, but cost too much manpower.

(2) Longitudinal automatic figure elevator of extended hull, this method saves labor, but the construction and maintenance costs are high, may affect other ship operations, so few ships are equipped.

(3) Electric walker, the cost of this method is relatively low, but it needs manual drive and is affected by the terrain. It is not conducive to shuttle among the large cabin hatches of the ship.

In the past voyage seamanship, due to the limitations of various factors, unmanned handling equipment could not be realized. With the development of local area network technology, the maturity of electronic identification system, and the continuous upgrading of unmanned handling equipment itself, the possibility of applying unmanned handling chassis robot in the ship is increasingly significant.

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2. Technology of Unmanned Handling Chassis Robot

The unmanned handling robot and its chassis. The chassis includes a base plate, a follower unit and a drive unit; the follower unit is used to bear the load of the chassis and the load bearing, and includes many follower parts, many follower parts are arranged on the base board, so that the base board can move smoothly (namely no tilting, vibration, etc.); the drive unit includes the first drive parts and the second drive parts, the first drive parts and the second drive parts are symmetrically located at the two ends of the baseboard. The chassis of the unmanned handling robot has the advantages of compact structure, small size and strong load-bearing capacity.

Replacing manual handling with machine liberates the labor force in the whole transportation link of the ship and greatly reduces the labor cost for the ship.

3. Design of Ship Unmanned Handling Chassis Robot

3.1 Parameter design of this application robot

On the basis ofthe existing technology and within the achievable range, the design of the robot parameters includes

Integrated equipment size: LxWxH: 800mmx560mmx220mm (chassis)

Size after form extension: LxWxH: 800mmx560mmx520mm (top connect peripheral equipment)

Six wheels, front and rear four-wheel orient, the middle two wheels bear load.

Weight: less than 70KG.

Interface: Power&DO (four-way, total load capacity 24V/2A)

DI (eight-way NPN type)

Network interface: wired network interface, three-way gigabit network

Wireless network: mainstream wireless network card

Battery: 48v35AH lithium battery, 16 hours of endurance or 25KM no load

Charge 0-80% within 2h, charging and discharging times > 1500 times

Operation panel: 8.0" touchscreen display (wake up with n consecutive taps), equipped with 70° angle to the ground on the front face of the robot

Buzzer, speaker, or one out of two.

Maximum load capacity: 150KG, maximum traction force: 150N.

Passability: slope <5° step <0.5cm gap <4cm.

Positioning accuracy: ±1cm.

Functions also need to be equipped, including automatic charging function, 3D obstacle avoidance function, identification information reading function within 5m, reflector navigation function, etc.

3.2 Control system design

1) Other departments operate the robot on site, the robot feeds such instructions to the bridge, and it can only be executed after authorized by bridge. This design make the bridge to be immediately grasp the robot's movements and the work robot is doing. It also prevents unrelated instructions given to the robot by outside personnel.

2) Other departments contact the bridge via high frequency, and the bridge sends relevant instructions to the robot to meet the needs of other departments. This design can make the crew to summon the robot anytime and anywhere, but requires VHF or other communication devices to cooperate.

3) The robot updates all the electronic identification information (including fixed and mobile electronic identification) encountered on the path to the bridge. Update the load/power information to the bridge. This design can make the robot to complete automatic patrol work. It make the bridge to keep track of the location of visitors to the ship and assists the pilot in determining whether a crime

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has occurred. Control the sudden and abnormal gathering of people in some areas, or the situation where visitors are found to enter the restricted area.

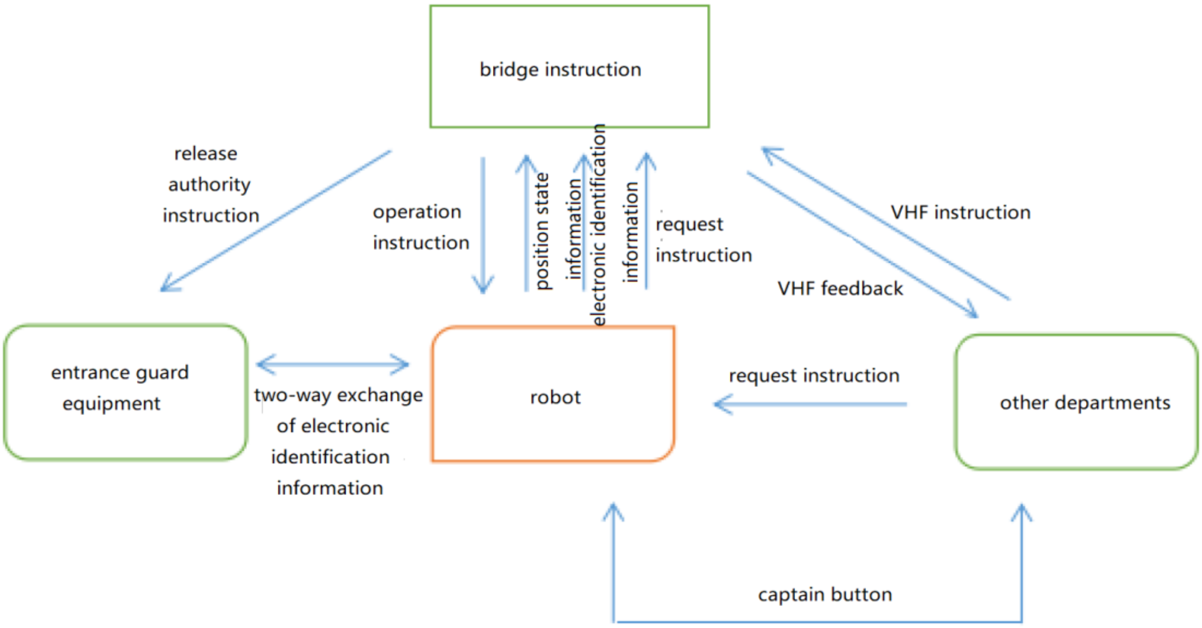

Fig. 1 Control system

4) The robot and the entrance guard equipment (elevator, etc.) exchange electronic identification information in both directions, and both sides feed back to the bridge, bridge sends release instructions to the entrance guard equipment manually/automatically, so that the robot can pass through and continue its operation.

(5) Set the captain button in the robot panel. Realize the absolute control of the robot by the staff on site. Staff can get absolute control of the robot on site via this design, which is convenient for maintenance and emergency operation. By triggering multiple CBs, the secret agreement alarm signal can be conveyed to the bridge. The absolute control of the robots also make 3-4 robots to be combined on site and work together and realize the handling of large items.

3.3 Key technologies of application system design

3.3.1 Ship electronic label and identification system

The essence of electronic identification is passive ceramic-based electronic label, it is based on ultrahigh frequency identification chip and stores unit identity data information. The working frequency band is: ultrahigh frequency 920~925 MHz, mainly composed of 3 parts: storage unit, antenna part and control unit, of which the control unit is composed of baseband part and radio frequency part. The information data contained in the electronic identification is unique, and the CID is written in the ROM of the identification chip during the production of the electronic identification, instead of being assigned by the central station, namely, each electronic identification has its own unique ID number, it cannot be changed since its birth [2].

The electronic identification has the function of permanent and fixed "ID card" and long-term and signable "residence certificate", and is a "black box" of information, according to the needs of intelligenct ship management, "electronic identification" or "electronic certificate" required for authorization or supervision of crew and ship visitors include: "ship identification tag (ship electronic ID card)", "ship card (ship/bridge electronic identification)", "equipment electronic tag (equipment electronic'identity card' and'residence certificate')", and "crew card (crew electronic Identification)" etc., "equipment electronic tag" can also include: "elevator electronic tag", "radar electronic tag", "liferaft electronic tag", etc. [4].

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The unmanned handling chassis robot is assembled with electronic tag similar to the crew. And additional reading device, anytime and anywhere record the electronic identification information within 15 meters. When outputing its own electronic identification, it also reads the nearby electronic identification.

3.3.2 Local area network (LAN)

Due to the limitation of maritime geographical terrain, the maritime digital communication mode usually adopts wireless local area network (WLAN), RF transmitter receiver is used to transmit and receive signals through the maritime air as a medium. According to the different transmission medium and frequency band of wireless LAN, there are three types as follows): infrared wireless LAN, its advantage is that it is not regulated by any country's frequency, but the disadvantage is that the transmission range is narrow and easy to be interfered. 2) Microwave wireless local area network. Use microwave as the baseband signal transmission carrier, including a central station, and at most 36 peripheral stations and several transponders leased. 3) Spread spectrum wireless local area network. Spread the baseband signal spectrum, and then use the radio frequency transmitter for transmission, this mode can support long-distance transmission, the signal transmission rate is high, its security is good. Thispaper uses this approach [3].

IEEE 802.11 is a standard examined and approved by many LAN and computer experts in 1997. IEEE 802.11 specifies the operation of wireless LAN in the 2.4 GHz band, this band is defined by the global radio regulatory entity as a spread spectrum use band. The wireless LAN configuration of the unmanned chassis robot is also based on the 802.11b standard [1].

The network structure of the robot adopts the base station access type, i.e., the wireless LAN is formed by using the mobile cellular communication network access method, and the bridge is the base station, and the communication among the stations (robots/other units with electronic identification tags) is realized through the bridge access and data exchange method. On this basis, each chassis robot can not only form network by itself through the switching center (bridge), but also form its own working network with the WAN and other nearby equipment with electronic identification tags by relying on remote sites, thus realizing multiple robots work together, and complete the single operation.

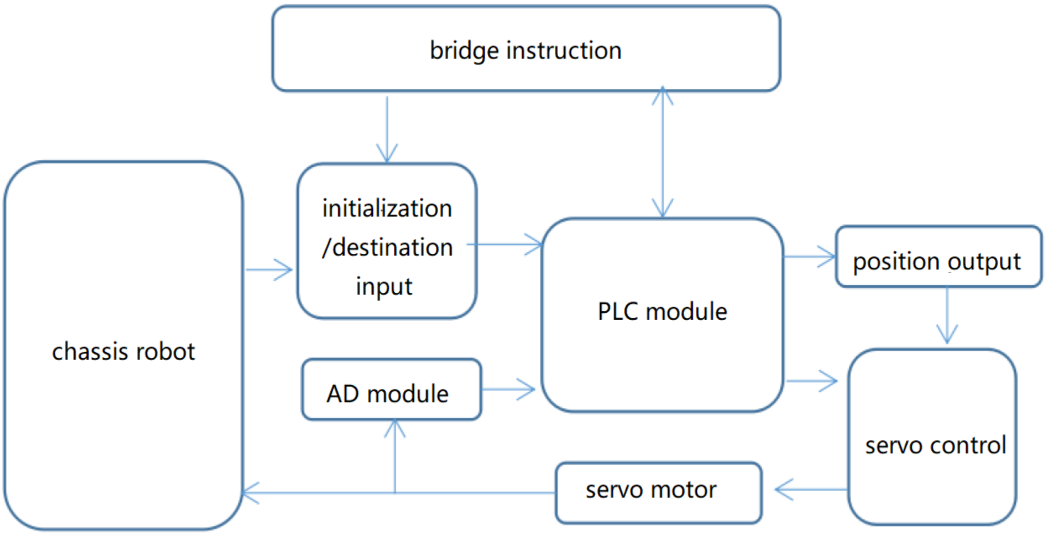

Fig. 2 Servo motor and PLC processing unit

3.3.3 Servo motor and PLC processing unit design

The PLC processing unit is connected to the bridge, servo controller and AD module, after getting the first control instruction signal, The PLC module will use high-speed pulse signals to distribute speed and direction commands to the servo controller, and passes the execution of the servo motor, and realizes the initial movement of the chassis robot. The output high-speed pulse is used to control

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the operation speed and angle of the servo motor; after passing the delay T, the pulse signal is transmitted from the servo motor to the AD module, the AD module collects the high-speed pulse signal input by the encoder to calculate the angle of motor rotation, thus obtaining the new position and movement state of the chassis robot, if the calculated position is consistent with the positioning location, this movement is continued, and if a deviation occurs, the PLC module is used to correct it. [5].

3.4 Limitations

The limitations of ship unmanned chassis robot are reflected in.

(1) It is not suitable for high wind and wave weather.

(2) Maintenance is relatively tedious, and it is difficult to achieve self-maintenance by ship personnel.

(3) It is influenced by the layout of the ship ground equipment. For example, threshold, pipeline, watertight door, etc.

(4) The installation and adjustment period is long. If the ship is not equipped with this system at the time of leaving the factory, later retrofitting require long installation time.

4. Conclusion

In the R&D process of intelligent ships, the unmanned chassis robot is by no means the end and purpose, but just a transition. But this transitional stage is of great significance and challenging for the realization of automated ships.

This exploration of unmanned chassis robots provides realistic possibilities for realizing automatic hull handling functions, automatic sorting functions and even automatic repair functions in the future. Unmanned chassis robots, most likely, can be applied to only ship hulls. On the basis of the above analysis of the control system design and application prospect of ship unmanned chassis robot, we hope to further strengthen ship automation.

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