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Design of Intelligent Inspection System for Unmanned Underwater Pipelines

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Abstract: This paper mainly introduces an underwater intelligent pipeline inspection system, which mainly introduces the design of mechanical part, control part and sensing part of underwater system. The underwater system uses the STM32f100c8T6B integrated chip as the core controller, and this device can quickly and thoroughly clean the pipe dirt, so it is designed to follow traces, pattern recognition, manipulator grasping and other modules. The device has low cost, accurate and efficient work, saves a lot of manpower, and has a good promotion and application.

Keywords: Underwater Pipelines; Inspection; STM32f100c8T6B

1 INTRODUCTION

In recent years, with the development of society, the pipeline network has become an indispensable part of people's lives, but the consequent pipeline cleaning has become a serious problem. This problem is mainly caused by the limited capacity of urban pipeline sewage discharge, complicated pipeline layout, rapid urban development and slow development of infrastructure construction, in order to fundamentally solve this problem, the state has begun to start the pilot work of drainage pipeline rectification project [1]. In order to solve this problem, the fundamental measure taken by China is to transform urban drainage pipes, but the per capita length of drainage pipes in China's cities is about 0.55m, while the average person in developed countries is 4m In this way, it seems to be much lower than that of developing countries, and taking such measures not only requires a lot of money in economic terms, but also has a relatively long construction period in terms of time In order to quickly alleviate the severe situation of a large number of urban pipeline sewage discharge[2]-[5]. Therefore, the cleaning of drainage pipes has become an urgent problem to solve the current situation.

Moreover, the cleaning of pipelines is still a more traditional manual cleaning method. The distribution of urban pipelines is relatively complex, and in terms of quantity, it is also a relatively large number for manual cleaning. The equipment used to manually clean the pipes is bulky and unsafe, and it is less convenient to carry. When manually cleaning urban pipelines, the odor will also have an impact on people's lives and harm to the health of construction personnel, and the efficiency of manual cleaning of pipelines is also low. At present, the research on pipeline intelligent inspection system has attracted more and more attention, including relevant institutions and some universities [6].

2 OVERALL PROTOCOL OF EXPERIMENTAL SETUP

In order to realize the tracking and cleaning of the pipeline, the system is mainly composed of a control part, a mechanical design part, and a sensor part. The mechanical part includes the floating-down diving mechanism and the cleaning mechanism. The control part includes the drive module, power supply. The sensor part includes a camera recognition part and an infrared tracking sensor, an ultrasonic sensor [7]-[9]. Through the cooperative control between various parts, the patrol and cleaning function of the underwater pipeline is jointly completed. The design diagram is shown in Figure 1

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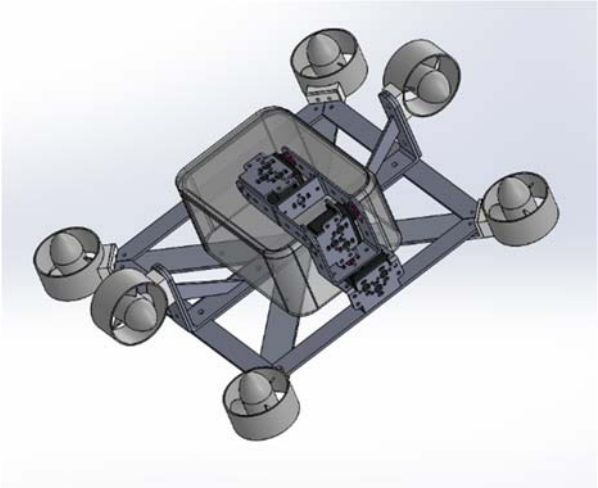

FIGURE 1 SCHEMATIC DIAGRAM OF THE COMPONENTS OF THE INSPECTION SYSTEM

3 HARDWARE DESIGN OF TRANSISTOR AMPLIFICATION MODULE OF EXPERIMENTAL DEVICE

The mechanical part is the basic part of the system, which is mainly composed of a motion mechanism and a cleaning mechanism, which is designed as shown in Figure 1 so that the inspection system is more stable when moving [10]. The kinematic mechanism includes propellers and brushless motors. The brushless motor has the advantages of high reliability, wide speed regulation range, large starting torque and high efficiency, and realizes movement on the surface and underwater through the cooperation with the propeller; The cleaning part of the pipeline inspection system adopts a mechanical gripper, as shown in Figure 2, because the mechanical gripper has greater flexibility and strong grasping force. The principle of the cleaning mechanism is mainly to identify and process the pipeline according to the information obtained by the camera, and send data to the control chip through the serial port program written in the camera, and the control chip controls the mechanical claw to accurately grasp the area that needs to be cleaned on the pipeline [11]-[13]. The mechanical part is also designed with camera protective housing, motor housing, etc., mainly to protect the camera and motor from erosion by water and pollutants.

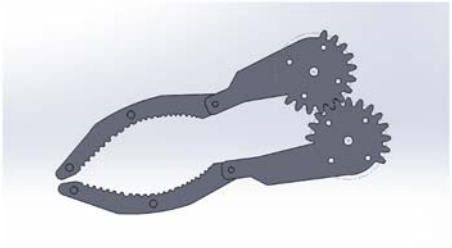

FIGURE 2 DESIGN OF THE GRIPPER

3.1 CONTROL SECTION

If the mechanical part is compared to the body, and the sensor part is compared to the sensory organs such as the eyes, then the control part is the human brain. The information of the individual modules is processed by the internal algorithms of the control system to jointly complete the task [14].

This system adopts STM32f100c8T6B chip as the control chip of the control system, the chip generates six PWM outputs, and controls the brushless motor in the four directions of up, down, left and right by outputting pulse electricity with a certain frequency and adjustable pulse width. The drive module of the brushless motor adopts TB6612, as shown in Figure 3, the module is dual-driven, can drive two motors at the same time, and the size is small, and the peripheral circuit is simple only need to connect the external power filter capacitor to directly drive the motor [15]. The control signal input is connected to the brushless motor, and the motor controls the left turn, right turn and forward and backward stop of the inspection system through the PWM wave output by the control chip, so as to control the movement of the system on the surface or under water. After the inspection system arrives at the operation position, the information collected by the sensor is sent to the control chip through the serial port, and the chip uses C language to write a program according to the needs and processes the collected information before controlling the mechanical part to operate, and the program flow chart is shown in Figure 4. When the brushless motor works underwater, it feedback its own motion status to the main control chip in real time. The main control chip PID adjusts the data collected by the infrared tracking sensor and the motor state parameters, and returns the adjustment results to the motor, so as to smoothly adjust the attitude of the underwater inspection system [16]-[18]. PID control can adjust the attitude of the underwater robot, effectively ensuring its operational stability. The above series constitutes a closed-loop feedback system. Each module that needs to be powered by the system is connected to the positive and negative poles of the rechargeable battery for energy supply, and the main

control chip of the control system, the camera, and the motor drive module TB6612FNG are powered by 5V.

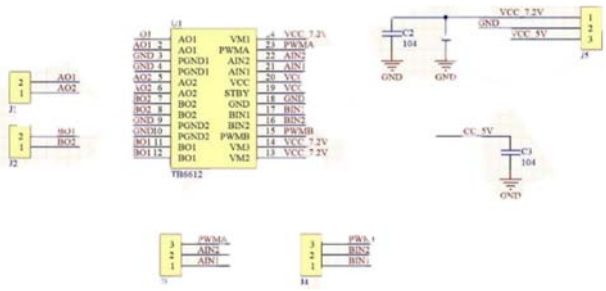

FIGURE 3 DESIGN OF THE CONTROL SYSTEM

3.2 SENSOR SECTION

The sensor part mainly includes camera, acceleration sensor, infrared tracking sensor, etc. The camera uses O PENMV, because the requirements for the camera in the inspection system are not high, and O PENMV is widely used, the technology is more mature, the use of the camera can fully meet the demand, O PENMV can directly write the download program, with Python language writing, first the camera first takes pictures of the pipeline, then saves the taken photos to the camera, and then through the python language programming to perform threshold processing on the acquired images, and compares the collected images with the saved pictures, and then Serial communication between the camera and the control system control chip [19]. After the camera master control chip converts the result into parallel data characters, it is converted into a continuous serial data stream through the serial interface and sent to the control system master control chip. The use of acceleration sensor is mainly to measure the distance of the inspection system from the pipeline, the collected data is transmitted to the control system main control chip, should be the collected data belongs to the physical quantity, send it to convert it into parallel data characters before it can be sent to the control chip of the control system through the export, and the control system controls the floating or diving of the inspection system according to the received data. The infrared tracking sensor is used to inspect the tracking of the pipeline by the inspection system, and the infrared tracking sensor can only follow the black and white trace. This tracking sensor is used because most pipes on the market are white, and the sensor is widely used and the technology is relatively mature. Although the camera can also be used as a tracking sensor, the installation design of the camera in the mechanical part is more troublesome, and the cost performance of the infrared tracking sensor is obviously better than the camera from the economic point of view, so the infrared tracking sensor is selected [20].

4 CONCLUSION

This design is an underwater pipeline inspection and cleaning system based on STM32f100c8T6B, which integrates inspection and cleaning. Through the coordination and adjustment of the control system and various parts, the inspection system can independently complete the task of underwater inspection and cleaning. The inspection system can help people greatly improve work efficiency and effectively ensure the safety of construction personnel in the work, and it is also more affordable in terms of economy, for which the research of the inspection system is also of great significance.

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