# Design and Realization of Orbital Inspection Robot Chassis

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**Abstract:** In order to ensure the real-time operation response of the inspection robot, a type of orbital inspection robot should be designed. Different forms of robots are used in different occasions. The chassis is very important in the movement of the orbital inspection robot. This paper will design a The chassis of the track-type inspection robot includes the main frame, the driving wheel suspension device, the positioning device, the curve suspension device, the pan-tilt bearing device, etc., which can use the reasonably arranged suspension structure to reduce the connection gap and curve speed changes. impact on operational stability.

Mobile robots contain a variety of advanced technologies, such as integrated navigation technology, automatic control technology, computer vision technology and artificial intelligence technology. It is also the product obtained after the rapid development of related technologies such as intelligent control technology and pattern recognition[1]. Now a relatively common mobile power inspection robot, the control system used is a system with industrial computer as the core content. This system can use remote control or autonomous mode to inspect the related equipment of high-voltage substations when there are no people or few people on duty. This article will combine the existing information technology to design an orbital inspection robot chassis system.

## 1. Design requirements

As a robot running on the track, the structural strength of the track inspection robot is the first parameter to be guaranteed. The structural strength not only affects the operation stability, but also poses a potential safety threat to the nearby personnel.[2] Track inspection robots usually appear as a monitoring machine, which is used to carry precision sensors to monitor the running status of equipment along the way. Therefore, the positioning accuracy and control stability of the robot are also important parameters that need to be guaranteed. The distribution of the track along the way is less likely to be a straight track, so the track inspection robot still needs to be able to smoothly pass through a given curve. Taking into account comprehensively, this research designs a track-type inspection robot that can smoothly pass through curves, has high positioning accuracy and high structural strength.

## 2. Robot structure design

### 2.1 Overall Design

In order to ensure that the robot has sufficient strength in orbit and reduce the influence of orbit errors on its motion, this paper proposes an integrated chassis driven by a suspension system. The inspection robot chassis also needs to ensure sufficient strength and rigidity while meeting the needs of quick release[3]. Therefore, it is considered to adopt a structural design similar to the integration of the frame between cars, combined with the hinge opening and the hasp fixed connection for quick disassembly and assembly. The number of hinges ensures the certainty of movement, thus ensuring the stability of the operation of the mechanism.

The parts included in the chassis and the specific specifications are as follows:

(1) The parts of the chassis include standard parts, self-designed and processed parts and

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aluminum alloy parts.

(2) The motion mechanism of the chassis includes 2 universal wheels and 2 parallel wheels (driven by electric motors).

(3) It is necessary to add a fixed encoder to the vicinity of the driving wheel. The operation of the encoder wheel needs to be driven by the driving wheel. The key point is that the driving wheel and the encoder wheel should be on the same axis. If the motor has its own associated encoder, there is no need to consider this factor.

(4) During the chassis design process, its maximum width needs to be less than 450mm.

(5) The position and number of sensors installed on the chassis need to be determined by the specific use environment and function. The chassis designed this time contains two ultrasonic sensors, one on each of the left and right ends, to measure the distance from the foreign object to the chassis, and then self-adjustment can be achieved. There are many infrared sensors installed, mainly used to avoid obstacles[4].

(6) There are many factors that need to be considered in the selection of specific parameters of the encoder and motor. From the design link to the use link, there are many factors that need to be considered, and will not be discussed in detail.

Table 1 Chassis design materials and quantities

| materials | brand | amount |
|---|---|---|
| Infrared module<br>Ultrasonic Module | E18-D80NK<br>TELESKY | 5<br>4 |
| motive and motor<br>DC planetary gear motor | Matsushita | 2<br>2 |
| PU wheel (6 inch)<br>Encoder | Omron | 2<br>2 |
| Battery (12V/12A) | ANJING | 2 |

**2.2 Material selection for chassis design**

When selecting materials in the chassis design process, there are not many principles that need to be followed. As long as some of the more critical items need to choose products produced by well-known companies, such as encoders and motors, these important items should be selected with better quality. Other materials can be determined according to the specific usage, and the price and related performance of the materials can be considered comprehensively. Material selection is the basis for building a 3D model. It is also necessary to record different material sizes, etc., which plays a very important role in the specific design link after the chassis[5].

Combined with the selected chassis design materials and specific parameter requirements, it is recorded in the model. There will be some deviations in some data, the schematic diagram of the designed 3D model of the chassis (Figure 1).

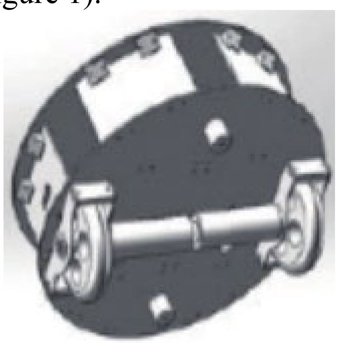

Figure 1 3D model of chassis design

**3. Design method and process of track inspection robot chassis**

The operating system of the power inspection robot is a system that needs to integrate behavior control, environmental perception, path planning and other functions. The entire robot system includes a mobile system and a base station system.

### 3.1 Chassis structure design

#### 3.1.1 Design of driving wheel suspension device

The robot designed in this design adopts a candle-type suspension structure. At the position where the height of the step surface changes, the driving wheel moves vertically up and down along the established track. The suspension only compensates for the change in the height of the step surface[6]. Therefore, there will be no additional impact on the operation of the robot. By fixing the slider on the main frame of the robot, the tension spring pulls the slide rail and drives the driving wheel to stick to the upper surface of the track downward, so as to ensure that the driving wheel does not detach from the upper surface of the track at any time and any position of the movement. The vertical motion of the suspension offsets the influence of the gap on the step surface, reducing the influence on the running stability of the robot.

#### 3.1.2 Design of side suspension device

The side suspension is mainly composed of springs, bushings and bearings. The frictional energy loss caused by the contact between the robot and the track is reduced by the rotation of the bearing. The graphite bushing has its own lubrication function, and the side suspension device composed of the shaft and the spring can reduce the sudden change in the speed of the robot caused by the sudden change of the curve, thereby reducing the energy loss, passing the curve smoothly, and reducing the stable operation of the robot caused by the curve. Sexual changes.

### 3.2 Mechanical system design

#### 3.2.1 Choose the right motor

The working path of the mobile robot is uncertain and requires a battery to provide power. Because traditional motors have a short lifespan and are subject to relatively large radio interference, DC brushless motors can be used. The starting torque is relatively large, the response speed is fast, the time it takes to transfer from zero speed to the rated speed is relatively short, and the overload capacity is relatively strong. After multiple comparisons, choose the DC planetary gear motor produced by Panasonic.

#### 3.2.2 Design of drive components

Both the reducer and the motor need to be fixed on the rear suspension swing arm with the help of screws, which are somewhat similar to car tires. After they are fixed, they are tightened with bolts. Because the output shaft has a relatively large torque, it can be fixed by the flange[7].

### 3.3 General performance design of chassis

#### 3.3.1 Modular Design Method

Analyze the product function, and then select specific elements to form a subsystem with some specific functions, and then combine this subsystem with other subsystems to generate a new system. The design of the robot chassis system is actually a sub-module in the robot design process, including the body frame, suspension and drive modules. The battery and various control boards are placed in the body frame module to ensure the realization of this function.

#### 3.3.2 Serialization Design Method

Standardize processing for different groups of products in the same product to ensure better matching in the process of module interface processing, so that the modules of components can achieve the goals of combination, generalization and serialization. In the process of designing the chassis of the mobile robot, the modular design is carried out for the omnidirectional wheel, thus forming three sets of series products that match each other. Each omnidirectional wheel has a DC motor for independent driving. Under the action, the related goals of straight walking, in-situ rotation and chassis translation can be achieved[8].

### 3.3.3 Hardware Platform Design

The sensor wiring usually contains 3 wires, among which the signal line corresponds to the IO signal, and then make the relevant signal table, which is convenient for later programming. The motor drive is connected to the output port of PWM, which contains 4 channels in total. The encoder is connected to the IO port, mainly to read the pulse number of the encoder. Dupont wire can be used to connect the 5V low voltage; 0.5 size wire is used as the 24V power supply wire. In order to avoid the fire phenomenon caused by the overload of the line, it is strictly forbidden to violate the conventional electrical principles during the wiring process.

### 3.3.4 Design of the lower computer system

In the process of designing the control system of the lower computer, it is necessary to write the relevant program design, and then store it in the control panel. The program design is divided into driver program and logic cycle program. In the process of specific design, motor driver, infrared driver and ranging driver need to be designed respectively[9].

### 3.3.5 Interface Design of Host Computer

First, perform serial communication between the upper computer and the lower computer; secondly, complete the hardware matching initialization of the serial port and serial port number connected to the lower computer; thirdly, the user needs to input the relevant coordinates, indication purpose and other positions; from the second, the command of the upper computer Pause and start; finally, check whether infrared and ultrasonic are in normal operation interface.

## 4. Conclusion

By designing a chassis structure of a track-type inspection robot, the proposed rectangular track-type inspection robot chassis carrying the main frame and the suspension system has a reasonable form, and the combination of the suspension, the driving wheel, the side wheel and the positioning device can eliminate the error caused by the connection of the track. The impact of the resulting step gap on the operation of the orbital robot ensures that the driving wheel does not fail at any time of operation and passes through the curve safely and smoothly.


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## References


[1] Tao C , Yun L , Cheng H , et al. Design and realization of integrated patrol-robot system for underground pipe gallery[C]// IEEE International Conference on Electronic Measurement & Instruments. IEEE, 2017.

[2] Zhang S , Zhang Y , Liu J . Design and Realization of TCM Pulse Analysis and Management System[C]// International Conference on Intelligent Transportation. IEEE Computer Society, 2018.

[3] Chen Z , Gao W . Design and realization of agricultural intelligent inspection robot[J]. International Agricultural Engineering Journal, 2017, 26(3):320-326.

[4] Zhang Z , Fu B , Li L , et al. Design and Function Realization of Nuclear Power Inspection

Robot System[J]. Robotica, 2020:1-16.

[5] Zang S S , Jing-Ya M A , Wen-Tao L U , et al. Design and Realization of Control System of Mine-used Belt Conveyor Inspection Robot[J]. Coal Mine Machinery, 2015.

[6] Ping Y , Jie Y , Liu L . Design and realization of self-balancing control method for flight-sliding inspection robot on power lines[J]. Electrical Measurement & Instrumentation, 2015.

[7] Ge N , Qian R . Mechanism Design and Statics Analysis of Walking Module of Orbital Machine Room Inspection Robot[C]// 2021 International Conference on Computer, Control and Robotics (ICCCR). 2021.

[8] Tan Y . Design and Realization of a Special Robot Manipulator[J]. Journal of Physics Conference Series, 2020, 1637:012131.

[9] Can-Feng W U , Wang T M , Tian J W , et al. Design and Realization of an Unmanned Rescue Robot[J]. Machinery Design & Manufacture, 2018.