

SOLUTION FOR INTEGRATED HIGH-ALTITUDE WORKING ROBOT OF WIND POWER

SOLUTION

SOLUTION INTRODUCTION

The Wind Power Integrated high-altitude working robot is an integrated operation device developed for high-altitude intelligent operations, equipped with functions such as cleaning, rust removal, flaw detection, and spraying. It can be used in conjunction with unmanned Aerial (UAV) to address the high risk, high cost, and low efficiency of traditional manual work at high altitudes in wind power scenarios. The robot adopts a universal walking chassis combined with multi-functional modules to achieve versatility, capable of replacing steeplejacks to complete operations. Users can replace different functional modules according to their needs and customize modules to achieve various operation functions for the tower.

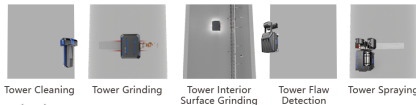
SYSTEM COMPOSITION

■ Comprehensive Land and Air Solution for Wind Power Scenarios

- ① Tower Cleaning
- ② Tower Grinding
- ③ Tower Flaw Detection
- ④ Tower Spraying

SYSTEM ADVANTAGES

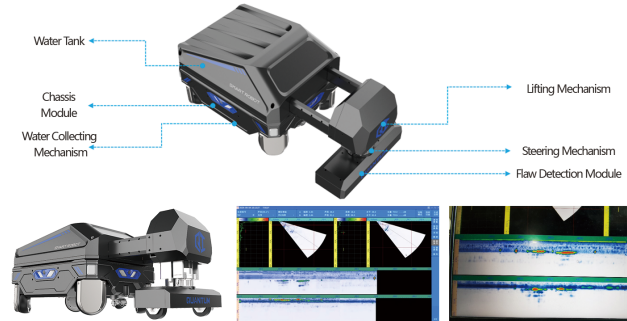
- Equipped with AI Algorithms
- Position Feedback
- Synthesized Corrosion Map
- Automatic Positioning
- System Path Planning
- Autonomous Control Platform
- Multi-Machine Collaborative Operation



TOWER NON-DESTRUCTIVE TESTING + CLEANING ROBOT

NON-DESTRUCTIVE TESTING

Non-destructive testing (NDT) system based on The Phased Array Ultrasonic Testing (PAUT) integrates surface cleaning, weld seam grinding, and subsequent corrosion protection treatment processes, collectively forming a comprehensive one-stop work solution. The multi-transducer dynamic focusing technology ensures high precision and provides a full-spectrum flaw analysis. Equipped with remote control operation and autonomous operation capabilities, it significantly revolutionizes the way personnel perform operations. The system is mounted with a high-capacity circulating water system to support prolonged operations and meet environmental protection requirements. The system allows for convenient switching between transverse and longitudinal inspection modes, enabling rapid transitions during the inspection of transverse and longitudinal weld seams.



CLEANING ROBOT

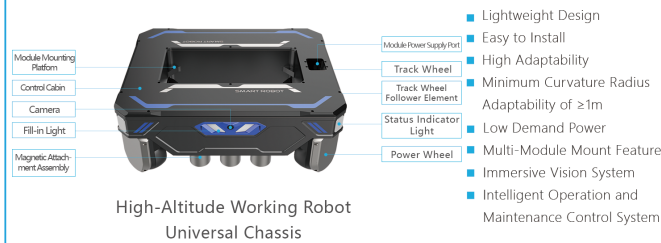
The cleaning robot is an intelligent operation robot developed specifically for the removal of oil stains on the surface of wind turbine towers and for maintenance refurbishment. It addresses the high risk, high pollution, and low efficiency associated with traditional manual work, as well as the inability to recycle cleaning water and the low level of intelligence in the operation process of other related equipment. The robot features a magnetic track chassis equipped with a cleaning operation module, ensuring stable and reliable adhesion to the tower surface. It provides smart, efficient, safe, and environmentally friendly cleaning services, extending the service life of the equipment.



TOWER CORROSION PROTECTION ROBOT

CORROSION PROTECTION ROBOT

Tower Corrosion Protection Robot is an intelligent maintenance machinery for high-altitude anticorrosion and touch-up painting, mounted with accessories and equipment for rust removal, spraying, and other maintenance operations, which is designed to address the pain points of the high risk, high cost, and low efficiency associated with traditional manual work. The robot features a universal walking chassis combined with a multi-functional operation mode, achieving multi-function in one machine, which can replace steeplejacks to complete the operation. Users can replace different functional modules as needed and customize modules to achieve other functions such as tower non-destructive testing.



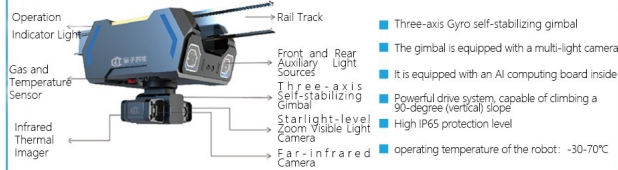
MODULE INTRODUCTION



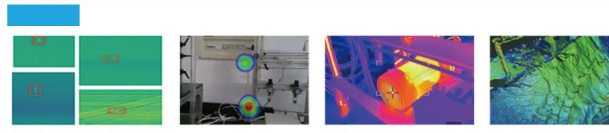
UNATTENDED INTELLIGENT OPERATION AND MAINTENANCE SOLUTION FOR BELT CORRIDOR

① Intelligent Inspection Operation Robot

The intelligent inspection operation robot can realize functions such as inspecting excessive temperature of material powder on the conveyor belt line, abnormally excessive dust concentration monitoring in the corridor, detection of spilled material powder, identification of foreign objects on the belt, belt misalignment detection, abnormal idler roller detection, intrusion detection in specified areas, support for tracking moving objects, detection of personnel without safety helmets and smoking, facial recognition support, supporting audio expulsion and sound-light alarm, temperature detection of bridge rack pipeline in the corridor, identification of open fire in the corridor, smoke warning, detection of abnormal gases such as hydrogen sulfide, carbon monoxide, methane, detection of abnormal heating of cables, reading of pointer instruments, reading of digital instruments, recognition of status indicator lights, recognition of switch states, LCD screen information recognition and etc.



Multi-dimensional Sensing+Operation Unit



- ⑥⑦⑧ Through multi-dimensional sensing means such as ultrasonic sensors, multispectral industrial cameras, and blockage sensors, real-time monitoring is carried out on positions prone to blockage such as silos and chutes.
- ⑨⑩⑪ Through multi-dimensional sensing means such as visible light, thermal infrared cameras, acoustic cameras, and vibration sensors, real-time monitoring is carried out on motors and reducers.

⑮ Operation Unit

- It has a long service life, the microcontroller unit (MCU) accurately controls with a control precision up to 1 centimeter.
- 2 Easy to install, support explosion-proof, and offer flexible configuration to meet on-site requirements.
- It has strong thrust, is suitable for different sites. The running speed can be customized according to the belt speed. It is highly targeted and has good effects.
- It has an alarm function to prevent the occurrence of deviation accidents.

Industrial Internet Platform Powerful AI Middleware

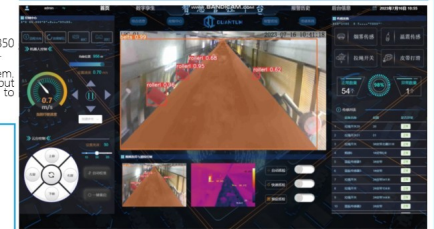
- Highly integrate the robot system, environmental monitoring system and operational status detection system to improve system interoperability.

- Integrate storage technology, database technology, analysis and recognition technology, big data mining technology, linkage technology, human-computer interaction technology and so on to improve operation and maintenance efficiency.

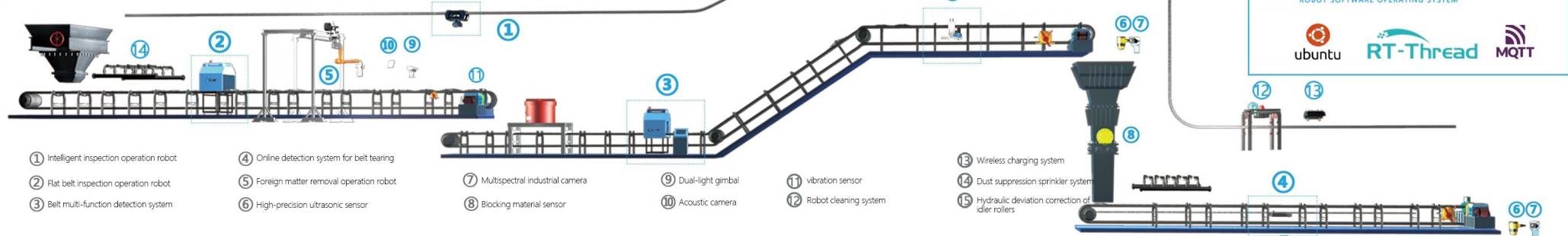
- Simultaneously detect the operational status across multiple scenarios

- The system supports the IEC61850 protocol and has strong scalability.

- Flexible reporting and alarm system, support alarm linkage, output function and can be linked to perform fire extinguishing tasks.

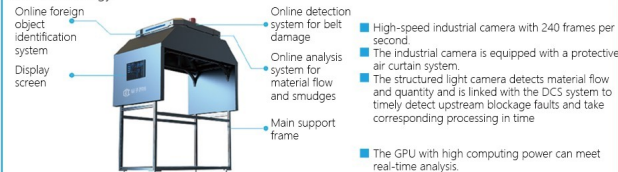


ROBOT SOFTWARE OPERATING SYSTEM



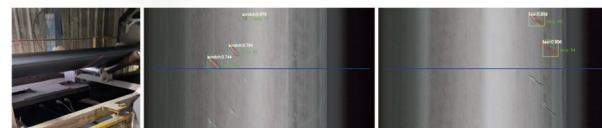
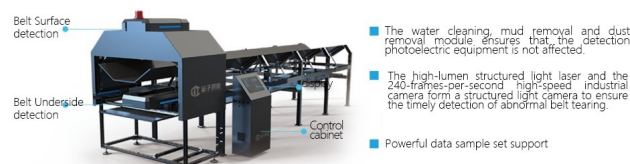
② Belt Multi-function Detection System

The belt multi-function detection system conducts foreign object detection and, in conjunction with the industrial robotic arm ⑤, carries out the removal of foreign objects. It detects edge damage of the belt; equipped with a structured light camera, it monitors the material flow and quantity on the belt, thereby determining whether there is blockage upstream, and is linked with the DCS system to make timely corresponding shutdown processing. In addition, the belt running speed can be adjusted according to the flow rate to improve the service life of the belt conveyor and save energy.



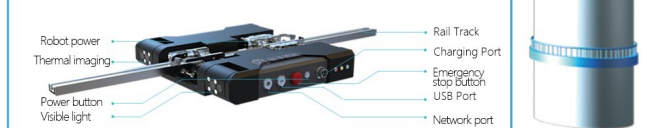
③ Online Belt Tear Detection System

The online belt tear detection system mainly detects whether there is longitudinal tearing of the belt, and is linked with the DCS system to effectively reduce the accident losses caused by belt tearing. The system is equipped with a water cleaning, mud removal and dust removal module to ensure that the detection photoelectric equipment is not affected. It also features a high-lumen structured light laser and a 240-frame high-speed industrial camera to form a structured light camera, which ensure that abnormal belt tearing is detected in time.



④ Pad Robot

The PAD intelligent inspection robot is a special robot designed for inspection work in narrow spaces. On the belt line, it can inspect whether there are abnormalities in the upper and lower idler rollers, including idler roller malfunctions, overtemperature of idler rollers, idler roller detachment, damage and deformation and corrosion of the belt idler frame.



- With a thickness of less than 85mm, it is the thinnest inspection robot in the industry and can solve the inspection problem inside narrow and flat spaces.

- Equipped with two sets of Dual-Light Gimbal.
- The robot is equipped with an AI computing board.
- The minimum turning radius is 400mm.



INTELLIGENT OPERATION AND MAINTENANCE SOLUTION FOR DANGEROUS ENVIRONMENTS

Explosion-proof Inspection Management System

Product Introduction

The rail-mounted explosion-proof intelligent inspection robot adopts intrinsically safe and explosion-isolation design, mainly comprising a mobile inspection platform, an intrinsically safe wireless communication system, a safe charging device, a three-axis self-stabilized explosion-proof gimbal, various signal acquisition equipment and tracks. It integrates multiple technological methods such as visual recognition, deep learning, edge computing, and big data analysis, and realizes the automatic or manual control operation of the robot on the track, and equipment monitoring within the entire trajectory, real-time collection, transmission, analysis and storage of parameters such as sound, image, gas and etc.



- The explosion-proof rail-mounted intelligent inspection robot has an explosion-proof rating of Ex db IIC T4 Gb.
- Composed mainly of mobile inspection platform, wireless communication system, safety charging device, three-axis self-stabilized explosion-proof gimbal, various signal acquisition equipment and rail system.

Application Scenarios



Chemical Factory



Smelter



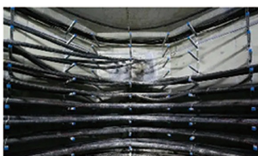
Dangerous Goods Storage



Coke oven Chamber



Oil-gas Field



Thermal Chamber

Wheeled Explosion-proof Inspection Robot

Product Introduction

- The wheeled explosion-proof inspection robot system is composed of the robot body, the intrinsically safe communication system, and the digital intelligent management and control platform. It can realize functions such as uninterrupted monitoring, early warning, and handling for the on-site environment and equipment.
- Adopting an integrated structural design, it features waterproof and dustproof capabilities with the entire machine meeting the IP65 protection level, enabling stable operation for a long time in humid environments such as rain, snow, and thunderstorms.



Explosion-proof Qualification

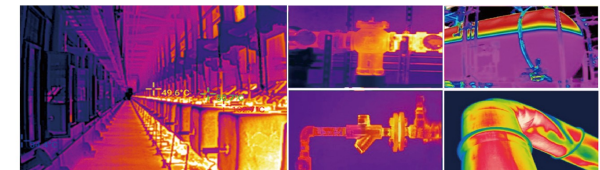


Application Scenario

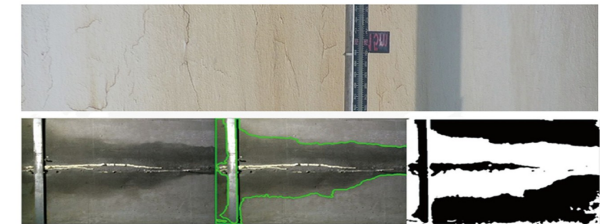
- First floor: Detect the opening and closing position of the waste gas tray cover, whether there is flame escape when the waste gas tray cover is open, and detect the opening and closing state and temperature of the waste gas tray cover.
- Basement: Detect instruments and meters, the position of the exchange cock, and whether the concentration of CO gas exceeds the standard, etc.
- Second basement: Detect whether the concentration of CO gas exceeds the standard.



Thermal Infrared



Level Gauge, Liquid Leakage



INTELLIGENT OPERATION AND MAINTENANCE SOLUTION FOR NEW ENERGY SCENARIOS

Nacelle Operation and Maintenance

Product Introduction

- The wind turbine nacelle inspection robot is equipped with a dual-light gimbal, as well as the digital twin platform software for the self-developed wind turbine nacelle inspection robot, while conducting in-depth research on AI technology and edge computing for wind turbine nacelles.



Product Function

- Capable of performing inspection tasks in narrow spaces, relying on modules such as visible light cameras, infrared thermal imagers, and environmental monitoring sensors and others carried by the robot, to accurately collect, detect, and monitor the status of on-site equipment and environmental information. Achieving rapid data collection around the clock, real-time information transmission, and intelligent analysis and early warning.



ROBOT DETECTION MODE

Inspection part	Detection method
Control cabinet	Visible light recognition Infrared thermal imager
Hydraulic system	Visible light recognition
Converter	Infrared thermal imager
Generator	Microphone array, Infrared thermal imager, Visible light recognition
Coupling	Microphone array, Infrared thermal imager, Vibration sensor, Visible light recognition
Yaw system	Microphone array, Vibration sensor, Infrared thermal imager, Visible light recognition
Mechanical brake	Visible light recognition
Gearbox	Infrared thermal imager, Visible light recognition
Spindle	Infrared thermal imager, Microphone array, Vibration sensor, Visible light recognition

Operation and Maintenance of Booster Station

Product Introduction

- The composite inspection robot, equipped with a 6-Degree-of-Freedom (6-DOF) collaborative robotic arm, visible light camera and 3D vision camera, is capable of performing inspection work at various angles and distances in the booster station. It can improve operation safety, equipment reliability and work efficiency. It can provide support for data collection, analysis and fault diagnostics, aiding management personnel in making more scientific and effective decisions.



The robot is suitable for inspection and maintenance tasks on offshore operation platforms such as offshore oil fields and wind farms. It has good waterproof performance and a wheeled chassis, and can move freely in complex offshore environments. The robotic arm of the robot can perform various operations, such as inspecting wind turbine units and detecting equipment failures.

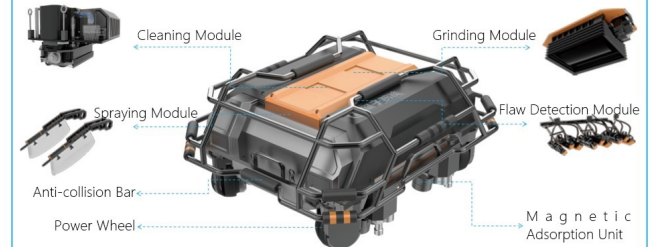
Product Function

- Safety inspection:** Reduce personnel entry into risk areas and improve work safety.
- Real-time monitoring:** Monitor temperature, humidity, smoke, gas leakage, etc. in real time.
- Equipment maintenance:** Perform equipment inspection and maintenance tasks such as electrical switches, cable connections, transformer and battery status, instruments and meters, etc., to ensure the normal operation of equipment.
- Data acquisition and analysis:** The data collected by the robot can be used for subsequent data analysis and processing to optimize operating efficiency, diagnose problems and propose improvement measures.
- Remote control and management:** Utilize the remote control and monitoring system for real-time operation and monitoring, quickly respond to abnormal situations and take measures.
- Autonomous navigation and path planning:** Autonomous navigation and path planning. Move according to preset inspection routes or real-time perception of the environment to fully cover the booster station area.
- Improvement of work efficiency:** Save time and labor costs, and be able to continuously and efficiently perform inspection tasks.

Operation and Maintenance of Wind Turbine Tower

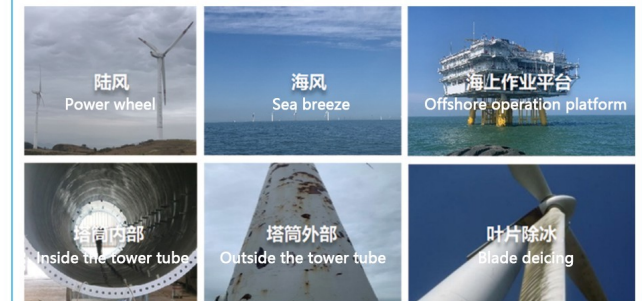
Product Introduction

- The high-altitude robot is an intelligent special robot that combines adsorption function, walking function and operation function. It expands the working scene of mobile robots from the traditional sea, land and air to the facade space. Industrial scenarios include wind power, ships, chemical industry, thermal power, bridges, etc. The main operation contents include roughening, rust removal, spraying, cleaning, detection, deicing, welding, etc.



Subdivision of Wind Power Application Scenarios

Anti-corrosion maintenance of wind power tower tubes, including cleaning, deicing and insulation detection.



Product Advantages

- Chassis patent technology:** Based on the four-link four-wheel drive chassis system, it is suitable for complex scenarios with large curvature and variable radius.
- The robot uses a large amount of carbon fiber material and is designed with lightweight.** The self-weight is less than 30 kg, and one person can carry and deploy it.
- Self-developed electric grinding system based on force feedback.** Customized composite grinding head with metal skeleton. No high-pressure water supply on the ground is required. It can be reached and deployed, suitable for temporary field operations and reducing the requirements for operation windows.
- Equipped with a self-developed high-efficiency metal dust recovery system,** there is no dust escape, meeting environmental protection requirements and suitable for use in scenarios such as the ocean.
- The measured rust removal speed reaches 30 square meters per hour.** The efficiency is much higher than that of manual work and is four times higher than the customer's expectation.