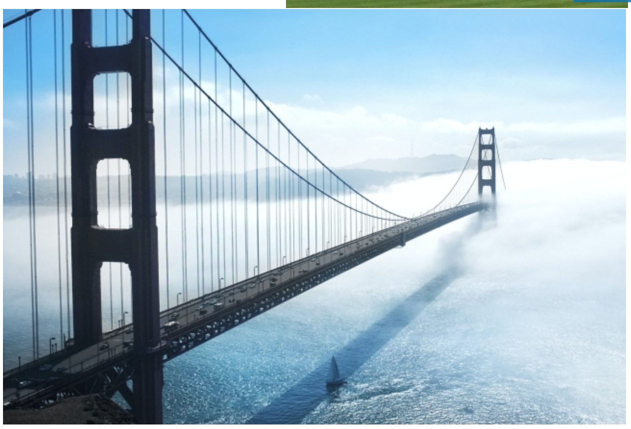



Industrial Grade Inertia Sensor Application Scenarios & Solutions



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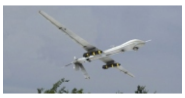	Military and aerospace articles Page 108	T, I,U Series Sensors
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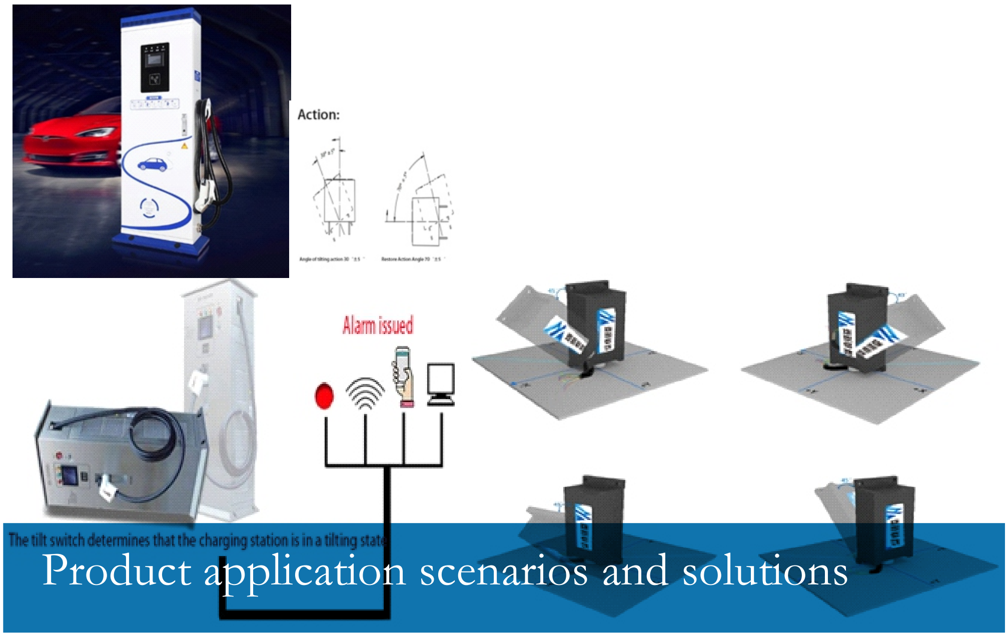
Product application scenarios and solutions

The intelligent online monitoring system for tower tilt can effectively monitor the tower during operation of high-voltage transmission lines 24/7 online and in real-time.

Energy and Electricity

Case1： Tilt switch charging pile anti tilt safety monitoring



Product application scenarios and solutions

The working principle of the tilt switch anti tipping'： When the host tilts or falls, the ball inside the tilt switch undergoes displacement under its gravity. Due to the detachment of the ball, the tablet returns to its original position, and the switch instantly disconnects and stops working. When the host is lifted, the ball returns to its original position and the host continues to operate normally.

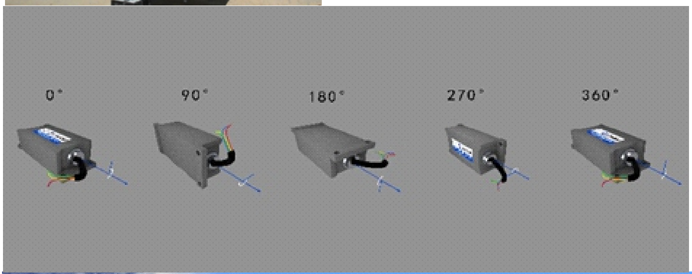
Charging Station Dumping Power Failure: When the charging station is connected to the vehicle and powered on, it should be ensured to tilt the charging station in any direction, and all charging stations cannot be powered off. The charging station should have the function of tipping, stopping, and powering off to avoid accidental collision accidents that may cause secondary electric shock injuries to personnel.

A tilt switch is installed on the charging pile body to detect whether the charging pile body is in a normal or tilting state. When the charging station is in a tipping state, the tipping switch sends a signal, and the charging station controller receives the signal to control the power outage. At the same time, the signal will be transmitted to the cloud system, and maintenance personnel can check which area's charging station is in a tipping state based on the information of the cloud system, so as to carry out maintenance and care.

T70-C is a high-performance 1-channel switch output model launched by BREEZE CO.,LTD, which measures the tilt angle in any direction of the horizontal 360° vertical attitude. When the tilt angle value is greater than the preset tilt threshold, it will output a switch signal to drive the solenoid valve. The alarm threshold is calibrated at the factory, with built-in relays and voltage signals (output voltage=supply voltage). Users can also set the alarm angle threshold themselves.

Energy and Electricity

Case 2: Inclination sensor for solar photovoltaic power generation tracking system



Product application scenarios and solutions

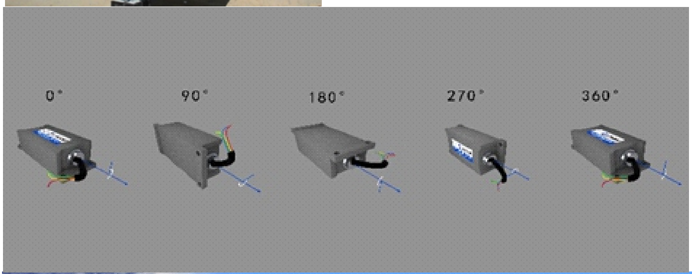
Solar power generation is divided into two types: solar photovoltaic power generation and solar photothermal power generation. At present, the development of solar photovoltaic power generation is faster and faster, making it a rapidly developing field. Currently, countries such as China, the United States, Europe, Japan, India, and Australia are developing rapidly. Mai Xinmin Micro has developed over ten different models of tilt sensors for photovoltaic tracking systems to meet customers from different countries.

Composition of solar photovoltaic tracking system:

1. Solar photovoltaic tracking systems generally consist of inclination sensors, motors, worm gears, and controllers.Solar photovoltaic tracking systems are divided into three types based on specific applications: horizontal single axis photovoltaic tracking systems, oblique single axis photovoltaic tracking systems, and dual axis photovoltaic tracking systems. Not only can it comprehensively increase the power generation of the power station, but it can also adapt to various complex terrains and application scenarios according to local conditions.
2. The solar photovoltaic tracking system needs to adjust the tilt angle of the solar photovoltaic panel, so that the solar photovoltaic panel can make timely adjustments according to the movement of the sun, in order to achieve the maximum solar radiation by always allowing the sunlight to shine vertically on the solar photovoltaic panel.
3. Although the angle of the sun varies widely throughout the day, the angle of sunlight remains almost constant for a certain period of time. The system can calculate the direction and angle information of the local sun for each day of the year based on the local longitude and latitude, and store the information in the controller software. This allows the angle information of the photovoltaic panel measured by the tilt sensor to be compared with the angle information of the sun stored by the controller, and then controls the motor to adjust the optimal position of the photovoltaic panel at that time.
4. The inclination sensor, as the eye for real-time measurement in solar photovoltaic tracking systems, is one of the key equipment for optimizing solar energy reception rate. There are certain requirements for the accuracy of tilt angle sensors, and the tilt angle sensor independently developed by BREEZE CO.,LTDis currently a mature application and multiple solar photovoltaic projects in the market.

Energy and Electricity

Case 2: Inclination sensor for solar photovoltaic power generation tracking system



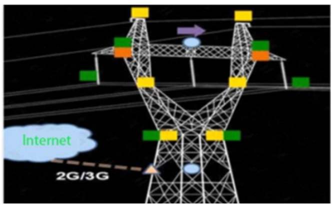
Product application scenarios and solutions

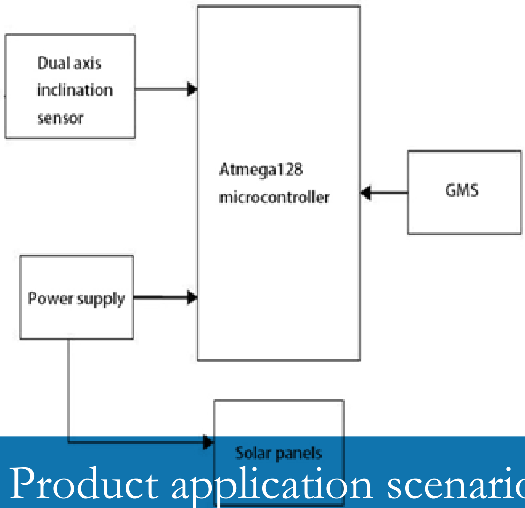
BREEZE CO.,LTD recommended tilt sensor model for single axis photovoltaic tracking systems and oblique singl axis photovoltaic tracking systems is T7-B. Its maximum measurement angle range is 360 ° , with RS485 output. It adopts industrial devices with stable performance and high reliability, and has protection functions against touch and misconnection. It is wind and sand resistant, salt spray resistant, and UV resistant, fully considering the complex application scenarios of solar photovoltaic.

BREEZE CO.,LTD recommended tilt angle sensor model for the dual axis photovoltaic tracking system by Mai Xinminwei is T70-A (RS485), with a dual axis structure and horizontal installation. It measures the tilt angle in the X and Y axis directions, with a measurement range of ± 90 degrees, and simulates voltage output. All products are made of industrial devices with stable performance and high reliability, and have protection functions against touch and wrong connection.

Energy and Electricity

Case 3: Tilt angle sensor for power tower and communication tower tilt safety monitoring



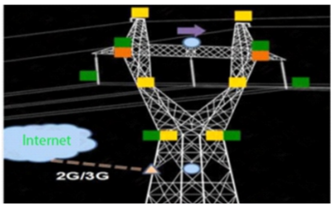


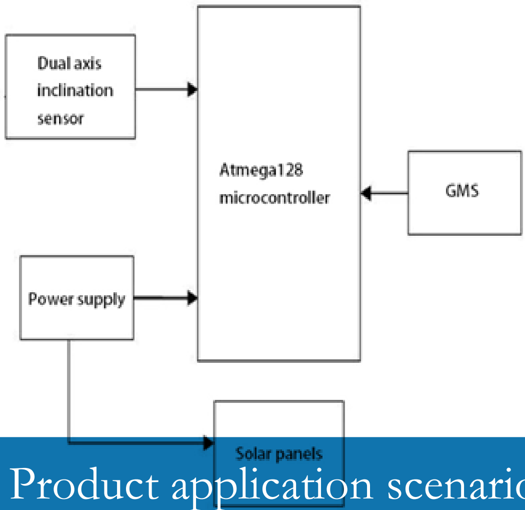
Product application scenarios and solutions

Due to reasons such as coal mining, engineering construction, and external damage, tilting accidents of transmission line towers often occur, posing a great threat to the safe operation of the power grid. Due to the large number of iron towers on transmission lines, the factors causing tower tilting, and the wide range, it is difficult to detect tower tilting faults in a timely and accurate manner solely through the daily inspection of transmission line inspectors. Therefore, developing an economical, practical, and timely and accurate system for monitoring the working status of power line towers is of great significance. The intelligent monitoring system for tower tilt of transmission lines is developed based on technologies such as universal wireless business communication and tower displacement monitoring. It plays an important role in timely grasping the operation status of the tower for line operators and ensuring the safe operation of the power grid.

Energy and Electricity

Case 3: Tilt angle sensor for power tower and communication tower tilt safety monitoring



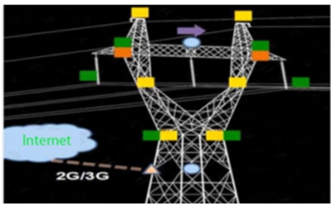


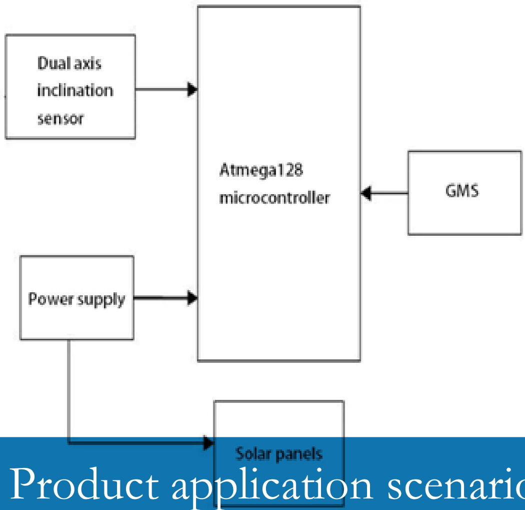
Product application scenarios and solutions

1.System design philosophy

The intelligent monitoring system for the tilt of transmission line towers consists of a front-end monitoring device and a back-end monitoring center. The front-end monitoring device is designed using high-precision dual axis inclination sensors and microelectronic control technology. The dual axis tilt sensor can measure the tilt angle of the tower in real-time along and across the line direction. The microprocessor sets its working mode and transmission method through program instructions, including zero point setting, transmission baud rate setting, and data encoding method. The tilt data monitored by the dual axis tilt sensor adopts a transparent transmission method, communicates with the microprocessor through RS232 serial port, and transmits the measured data to the non volatile data storage area of the microprocessor. The microprocessor processes the measured values through software. Analyze and calculate, and then compare with the set threshold. If the limit is exceeded, the microprocessor will initiate a review, measurement, and confirmation process for the dual axis tilt sensor to prevent misoperation. After confirming that the measurement results have indeed exceeded the limit, the microprocessor sends information such as the line tower number, tower tilt angle and direction, and device power voltage to the monitoring center and relevant staff's mobile phones in a short message (currently only supported in Chinese) mode through the GSM short message module, reminding staff to pay attention to and check the operation status of the tower in a timely manner. In daily operation, the backend monitoring center can set the parameters of the monitoring device through SMS commands as needed, such as setting the monitoring time interval, zero adjustment, threshold crossing, and reporting time for the dual axis angle sensor.

Case 3: Tilt angle sensor for power tower and communication tower tilt safety monitoring





Product application scenarios and solutions

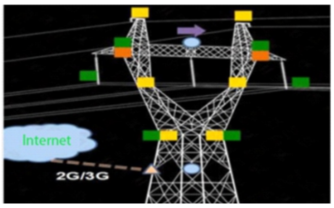
2. Characteristics and Functions of System Software and Hardware
2.1 ATmega128 microprocessor: The ATmega128 microprocessor is used, and its functional characteristics are as follows.
1) Adopting a 232 bus structure, the internal data bus and instruction bus of the chip are separated, and different widths are adopted to accelerate the execution speed of instructions.
2) Adopting a streamlined instruction set has improved the compression rate of the code.
3) Very strong anti-interference ability, suitable for stable operation in complex electromagnetic environments and independent power supply situations.

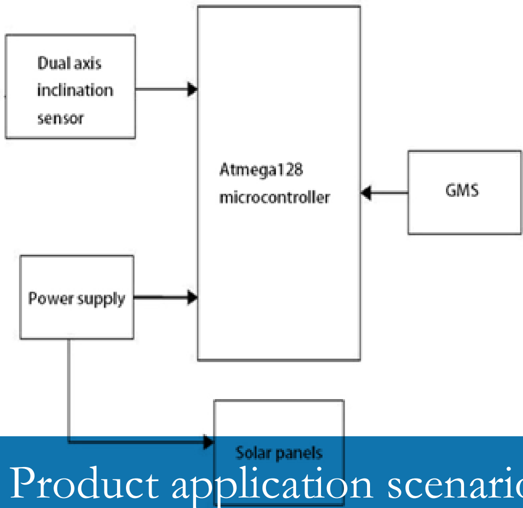
2.2 Solar photovoltaic power supply system
The power supply system consists of monocrystalline silicon solar cells, solar controllers, and lithium batteries. It is based on the float charging and lithium battery supply methods of monocrystalline silicon solar cells. The main parameters of solar panels are no-load open circuit voltage of 7.5v and short circuit current of 240MA, which are used to control the working status of the entire system and provide overcharging and discharging protection for lithium batteries. The device battery adopts a lithium battery pack, which makes the entire power supply system small in size and ensures reliable operation of the device in the absence of sunlight

2.3 Hardware circuit composition of front-end monitoring device The front-end monitoring device mainly consists of a dual axis inclination sensor, AVR microprocessor, GSM communication module, and solar photovoltaic power supply system. The device principle is shown in the following figure
2.4 Dual axis inclination sensor High precision dual axis inclination sensor has the characteristics of small volume, waterproof, dustproof, easy installation, low working voltage, small temperature drift, and wide measurement range.

Energy and Electricity

Case 3: Tilt angle sensor for power tower and communication tower tilt safety monitoring





Product application scenarios and solutions

The main functions of the 2.5 monitoring center system software include front-end monitoring device parameter setting, receiving data display and storage, query and printing.

1) Monitoring device parameter settings: Set the monitoring time interval for the dual axis tilt sensor, zero point adjustment for the tilt sensor, and device threshold parameters through SMS.

2) Display: It can be displayed according to pre-set line classification, tower number classification, and historical value curve.

3) Storage content: real-time data, historical data, operation records, and current status.

4) Historical data organization: Organize historical data files, delete selected historical data files, and delete previous historical data.

3 Main technical challenges to be solved

3.1 Power saving mode design: The power supply of the monitoring device is based on the floating charging of monocrystalline silicon solar cells and the supply point of lithium batteries. To ensure long-term stable and reliable operation of the device, low-power design has been carried out in terms of power supply and device operation.

1) The GSM short message module operates in an alarm state for a long time, and is only activated when reporting or exceeding the limit every day. The module consumes a constant current during normal times.

2) The atmega128 adopts a timed sleep and start mode, with a static working current of less than 0.1MA

3) The inclination sensor is designed as a timed (every n minutes or adjustable) measurement on mode, which is immediately turned off after measurement to reduce current consumption.Through the above measures, the current consumption of the monitoring device is constant during static operation, and the working current during inclination measurement is constant. The average working current of the entire device is very small.

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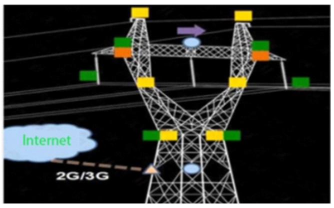
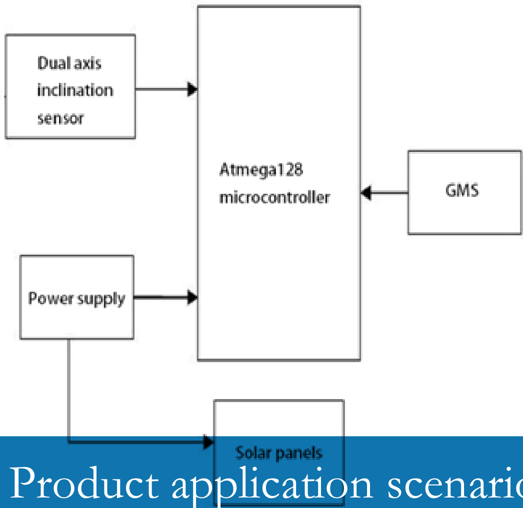
Case 3: Tilt angle sensor for power tower and communication tower tilt safety monitoring





Product application scenarios and solutions

Through the above measures, the current consumption of the monitoring device is constant during static operation,and the working current during inclination measurement is constant. The average working current of the entire device is very small.

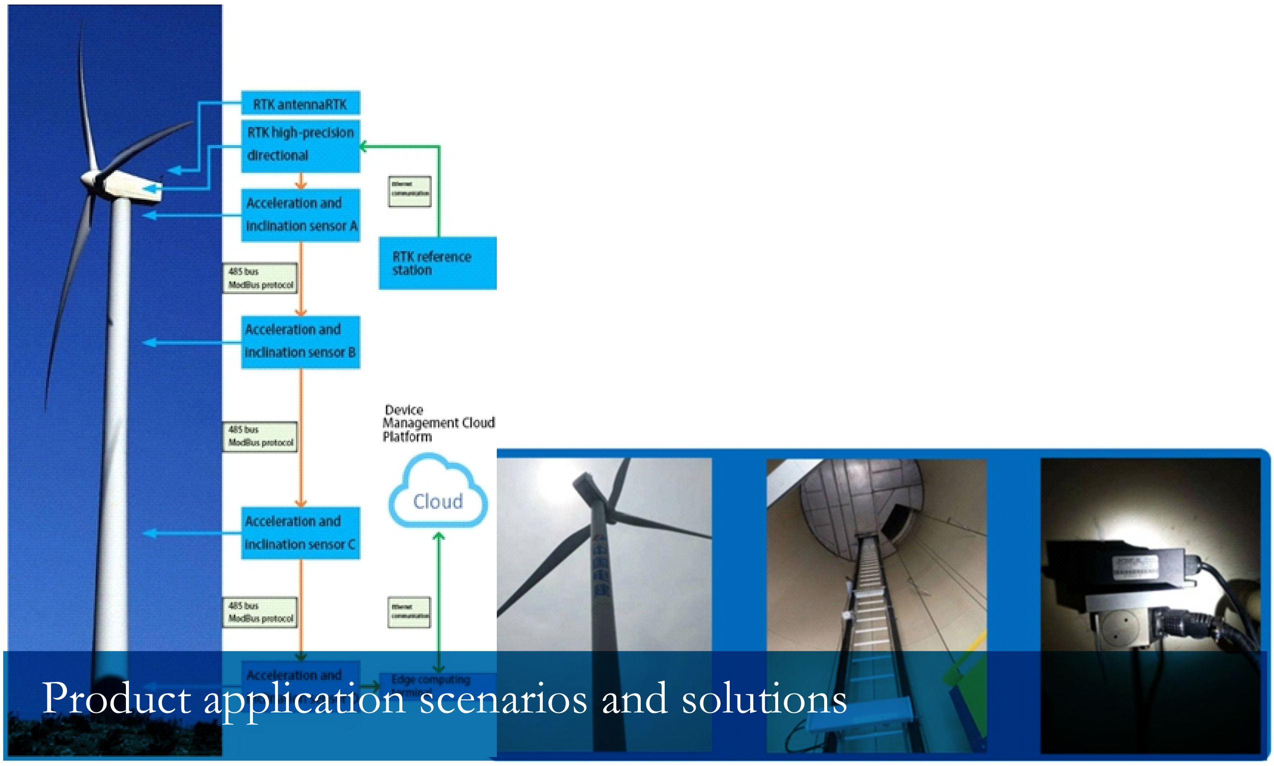
3.2 Anti interference design: The monitoring device operates on the line tower for a long time, and electromagnetic interference is relatively serious. Therefore, reliable anti-interference measures must be taken. The specific design measure is to use shielded wire protection for the inclination sensor; The control core, namely the ATMega128 low-power microcontroller with embedded control technology, has strong anti-interference performance. At the same time, the software adopts sleep and self recovery design to further enhance the stability and reliability of the monitoring device, ensuring long-term reliable operation.

The intelligent monitoring system for tower tilt of transmission lines has high measurement accuracy, low power consumption, strong anti-interference ability, simple installation, and maintenance free. The design fully considers the operating environment of the device and the requirements for reliable and stable operation. At the same time, adopting a monitoring center and monitoring terminal point-to-point mode facilitates centralized management.

Through on-site operation on 220 kV transmission towers, it has been found that the operation is stable and reliable, and can also be widely used.The product is used for horizontal status monitoring of communication towers, buildings, bridges and other equipment, and has good application performance and market prospects.

Energy and Electricity

Case 4: Wind turbine tower oscillation attitude monitoring



1. Overall architecture design

1.1. Overview of Architecture Design

This plan aims to achieve real-time monitoring of wind turbine tower oscillation, cabin heading, and other data by deploying attitude sensors on each layer of the wind turbine and RTK monitoring terminals in the wind turbine cabin, in order to restore the real-time attitude of the wind turbine tower.

1.2Description of each part of the architecture

The architecture design of this project includes the following parts:

1) Device Management Cloud Platform: refers to the cloud platform system used to uniformly manage the status of various wind turbines and their supporting facilities. It is also a centralized cloud platform for the storage, supervision, and analysis of data collected by various sensors in this project.

2) Edge computing terminal: refers to the computing platform used for data pre-processing of on-site acquisition, which can integrate and pre-process the data of multiple local systems, improve the monitoring efficiency, improve the real-time performance of the system, and reduce the pressure of cloud platform on data access management, storage management, etc.

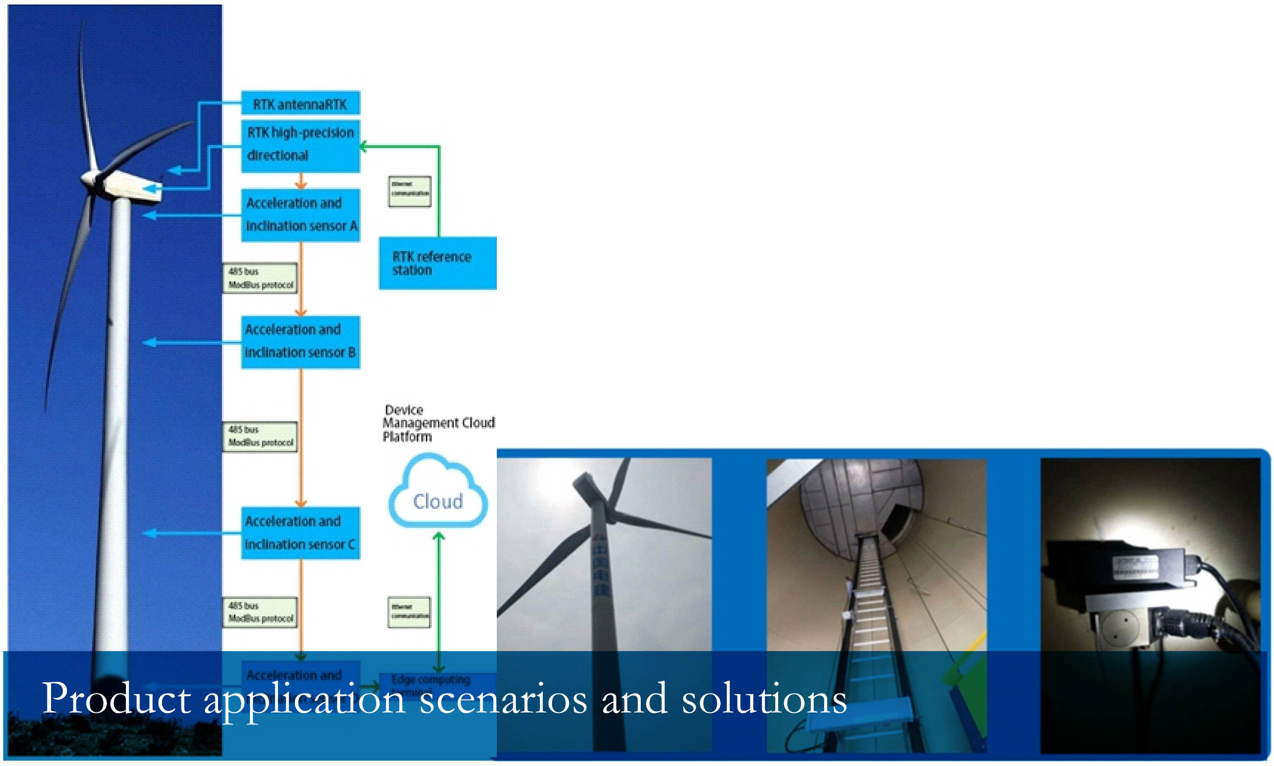
3) Attitude sensors: acceleration and inclination sensors, deployed on various maintenance platforms of the wind turbine tower. By monitoring the three-dimensional acceleration, angle, and other data of the wind turbine tower, the attitude monitoring of the wind turbine tower is achieved.

4) Self differential RTK terminal: Two antennas are fixed 1 meter apart and installed outside the fan compartment,providing high-precision real-time longitude and latitude position information.

5) RTK reference station: An RTK reference station is set up in the wind farm booster station, and differential communication between the reference station and each wind turbine RTK terminal is achieved through the existing wind turbine ring network, with an interface method of RJ45 (Ethernet).

Energy and Electricity

Case 4: Wind turbine tower oscillation attitude monitoring



2. Hardware requirements

→2.1. Self differential RTK terminal

→positioning accuracy

■Static ⩽ 1cm

■Dynamic ⩽ 2-3cm

→Sampling frequency: 10Hz (not less than 5Hz)

→Function: positioning+orientation

→Communication interface and protocol

■Directional positioning data transmission: 485 bus ModBus protocol

■Differential data: Ethernet communication

→2.2. Attitude sensor

→Output data: 3D acceleration and angle;

→Angle range: X, Z axis ± 180 ° , Y axis ± 90 °

→Angle accuracy

X. Y-axis static: 0.05 °

Dynamic state of X and Y axes: 0.1 °

Z axis: 1 °

→Sampling rate: ⩾ 100Hz

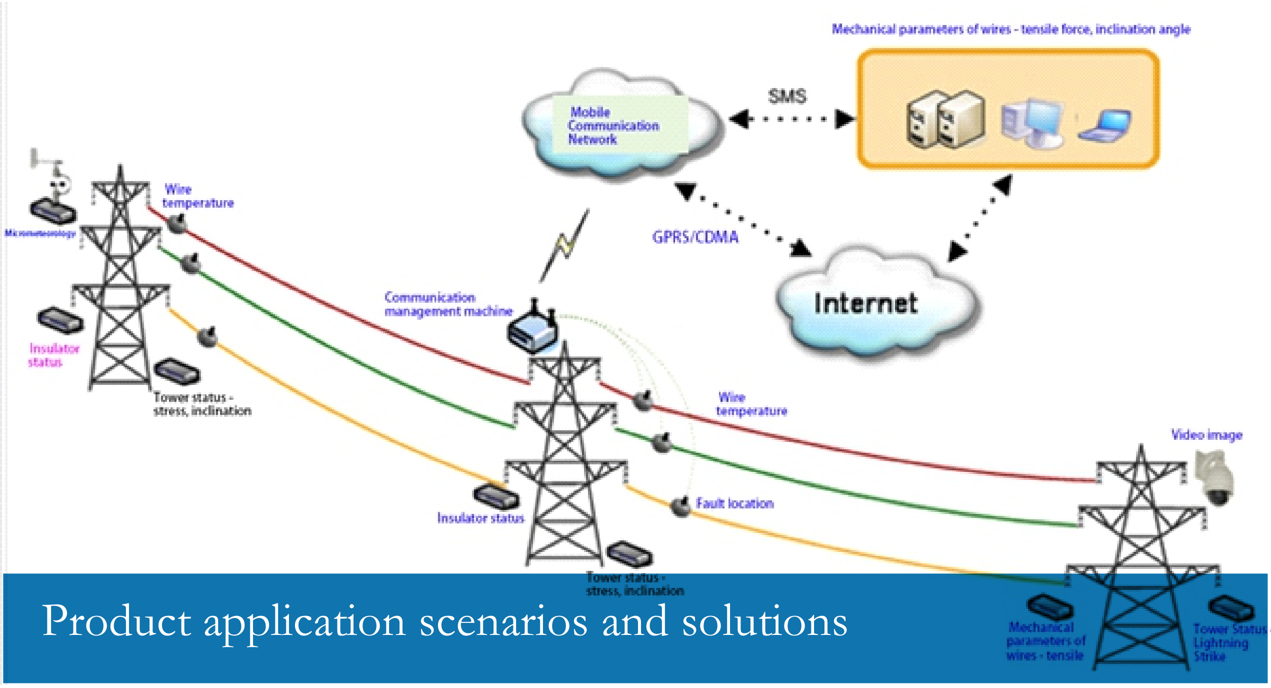
→Speed range: ± 5g

→Communication method: 485 bus ModBus protocol

→Strong magnetic field environment: need to resist magnetic field interference

Energy and Electricity

Case 5: Remote transmission tower inclination measurement online monitoring system solution



Product application scenarios and solutions

1.Necessity of the project

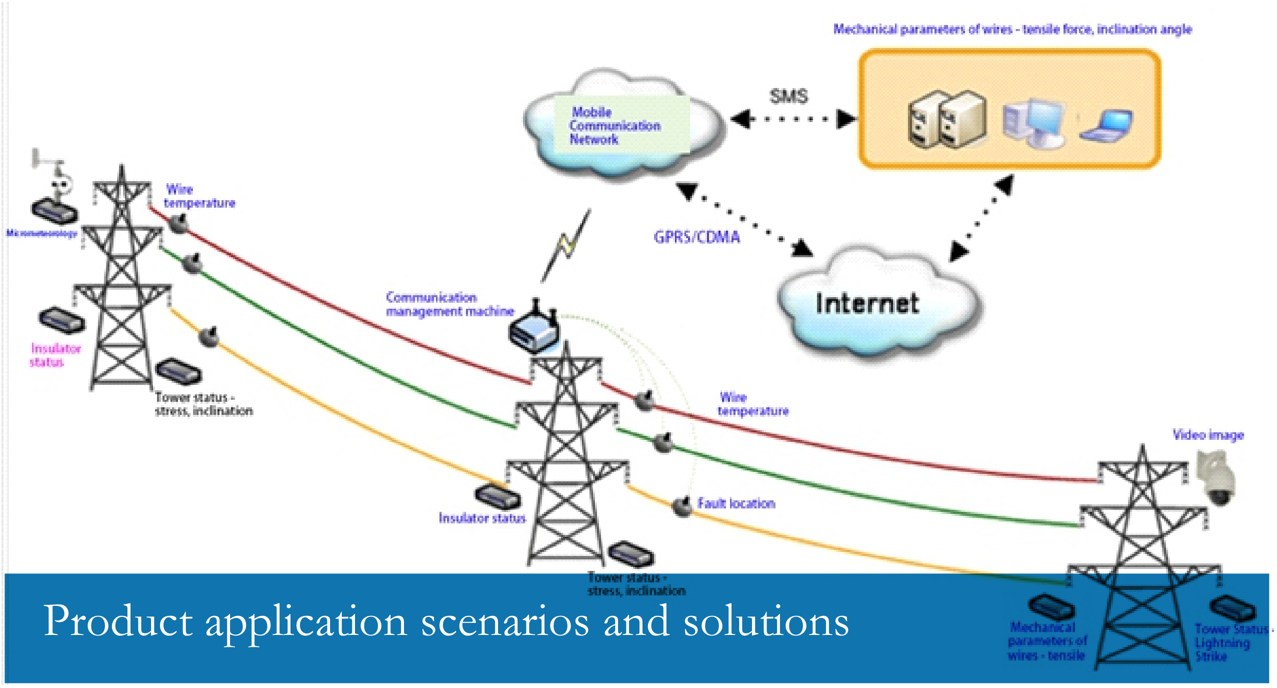
The transmission lines are basically overhead lines. Since the lines are erected in the air, they need to bear the effects of mechanical forces such as dead weight, wind, rainstorm, ice and snow, and the erosion of harmful gases such as wind and sand. The operating conditions are very bad. When the transmission line passes through unfavorable geological areas such as desert areas, high salt soil areas, goaf areas, and mountainous landslide areas, under the influence of natural environment and external conditions, the foundation of the tower is prone to sliding, tilting, cracking, and other phenomena, leading to tower deformation, tilting, and even tower breakage.

The inclination of the tower causes an unbalanced force on the grounding wire of the tower, resulting in changes in the force on the tower, insufficient electrical safety distance, and affecting the normal operation of the line. Tower collapse and disconnection will paralyze the power supply line, seriously affecting people's production and life, and causing huge losses.

In the early stages of the development of tower tilt phenomenon, it was difficult for line patrol personnel to observe small changes with the naked eye. At present, there is an urgent need to use intelligent data monitoring devices for online monitoring and fault analysis diagnosis of the tilt of transmission line towers, in order to detect hidden dangers, eliminate them in a timely manner, and improve the reliability of transmission line operation.

Tower tilt monitoring can monitor the tilt of the tower in real-time, and timely understand the safety and reliability of the operating tower. Based on the development trend of tilt monitoring data, various ways of timely warning and guidance for excessive tower tilt conditions are provided to guide maintenance and repair, remind operation and maintenance personnel to reinforce the foundation and prevent tower collapse accidents.

Case 5: Remote transmission tower inclination measurement online monitoring system solution



Product application scenarios and solutions

The online monitoring system for tower tilt can effectively monitor the tower during operation of high-voltage transmission lines 24/7 online and in real-time. It mainly includes two parts: a tower tilt monitoring device and a background comprehensive analysis software. The system measures and reports various state variables of the tower tilt transmission line, and transmits the data to the background comprehensive analysis software system for analysis and decision-making through communication methods such as 3G/4G/GPRS/CDMA. This accurately reflects the current various states of the transmission line, enabling power system operation and management personnel to grasp the actual situation of the line operation, Helping them make decisions and conduct safety assessments is of great significance in preventing power grid accidents.

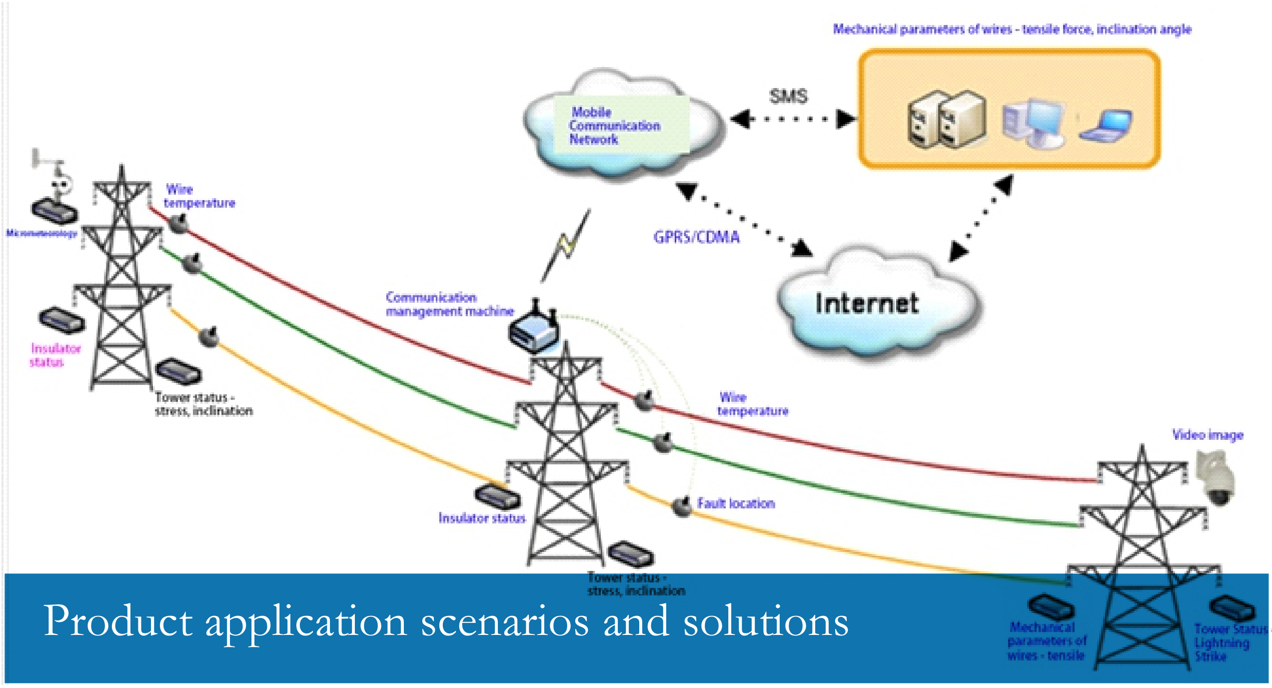
2. Main content

2.1 Monitoring methods and content

2.1.1 Monitoring method: By installing dual axis angle sensors and tower tilt devices on the tower, real-time online monitoring, early warning, and analysis decision-making of the operation status of the line tower can be achieved.

2.1.2 Monitoring content: Real time monitoring of bidirectional tilt angle (along and perpendicular to the line direction) and micro meteorological conditions (temperature and humidity, wind speed and direction, etc.).

Case 5: Remote transmission tower inclination measurement online monitoring system solution



Product application scenarios and solutions

2.2 Installation location of monitoring devices

2.2.1 Installation principles

1) According to the General Technical Conditions for Online Monitoring System of Overhead Transmission Lines (Q/GDW 245-2008).

2) The selected installation location and appearance structure of the device should not affect normal transmission line maintenance and repair work.

3) The installation of the device should be neat and firm, with necessary protective measures and rust prevention treatment.

4) Sensors and data concentrator devices are connected with dedicated cables to avoid electromagnetic interference.

5) The installation point on the tower facilitates the fixation of the monitoring unit and overall angle adjustment.

6) During installation, use standard angle measuring tools to pre adjust the installation angle of the device.

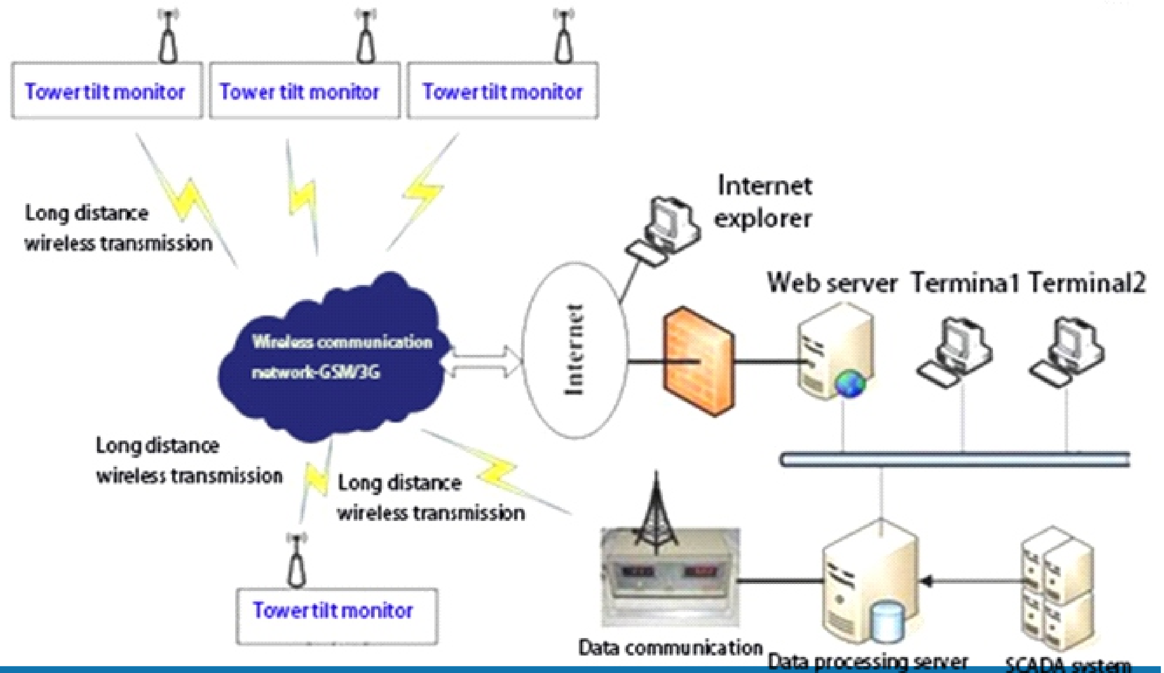
7) For lightning protection, waterproofing, and convenient installation and maintenance, the cable of the inclination sensor should be threaded into the cable duct.

8) The sensor is within the effective protection range of lightning protection facilities.

9) The casing of the device is grounded through a tower.

Energy and Electricity

Case 5: Remote transmission tower inclination measurement online monitoring system solution



Product application scenarios and solutions

2.2.2 Installation position

1) The installation position is generally selected at the tower position in the coal mine goaf and settlement area; Adverse geological sections, such as muddy areas, mountainous areas prone to landslides and weathered rocks, or hills.

2) The tower tilt monitoring device is installed on the cross arm of the tower, and the cable ducts are routed along the tower components at fixed intervals of 0.5m; Cables cannot be erected overhead.

3. Technical Proposal

3.1 System Structure Schematic Diagram: The entire system consists of a tower tilt monitor and a background comprehensive analysis software system. The system structure diagram is shown in the following figure:

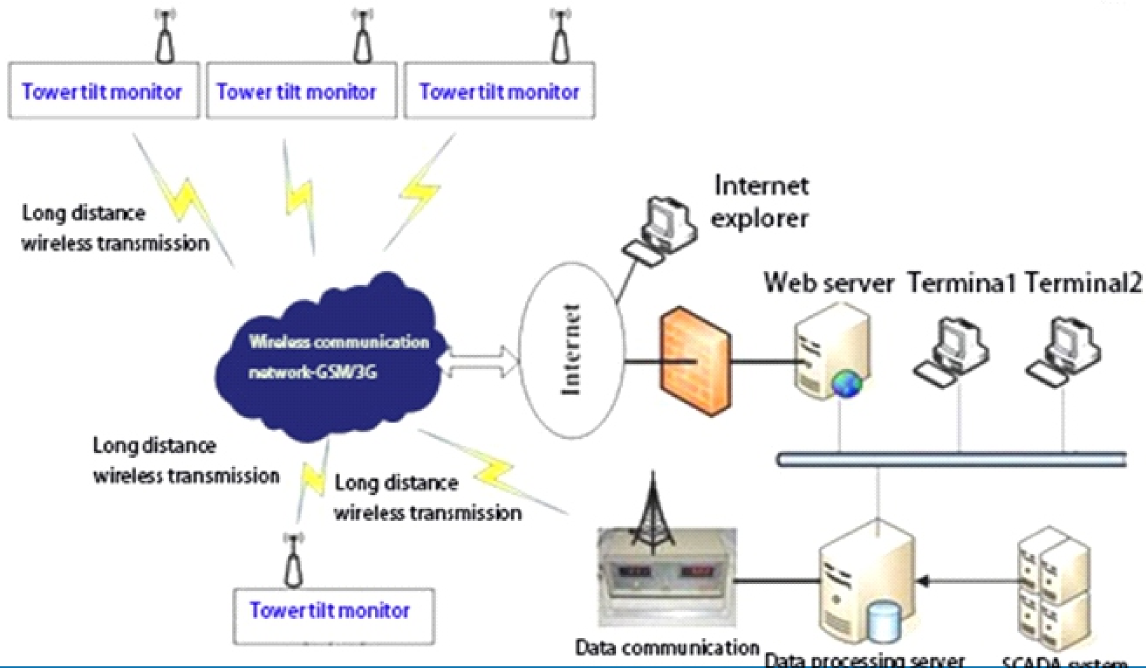
1) Tower tilt monitor: The tower tilt monitor is installed on the cross arm of the tower, and has a remote wireless communication interface for data communication with the comprehensive analysis software system. The monitor can self check, collect, measure, and transmit the measurement results to the comprehensive analysis software system.

2) Background analysis software system: The comprehensive analysis software system consists of a data communication module, a data processing server, a client, an uninterruptible power supply, and a comprehensive analysis software.

The comprehensive analysis software can uniformly receive data from the tower tilt monitoring instrument, display, analyze, and manage it, query and statistics historical data, generate reports, and make decision support analysis. The system can interface with other MIS systems and share data.

Energy and Electricity

Case 5: Remote transmission tower inclination measurement online monitoring system solution

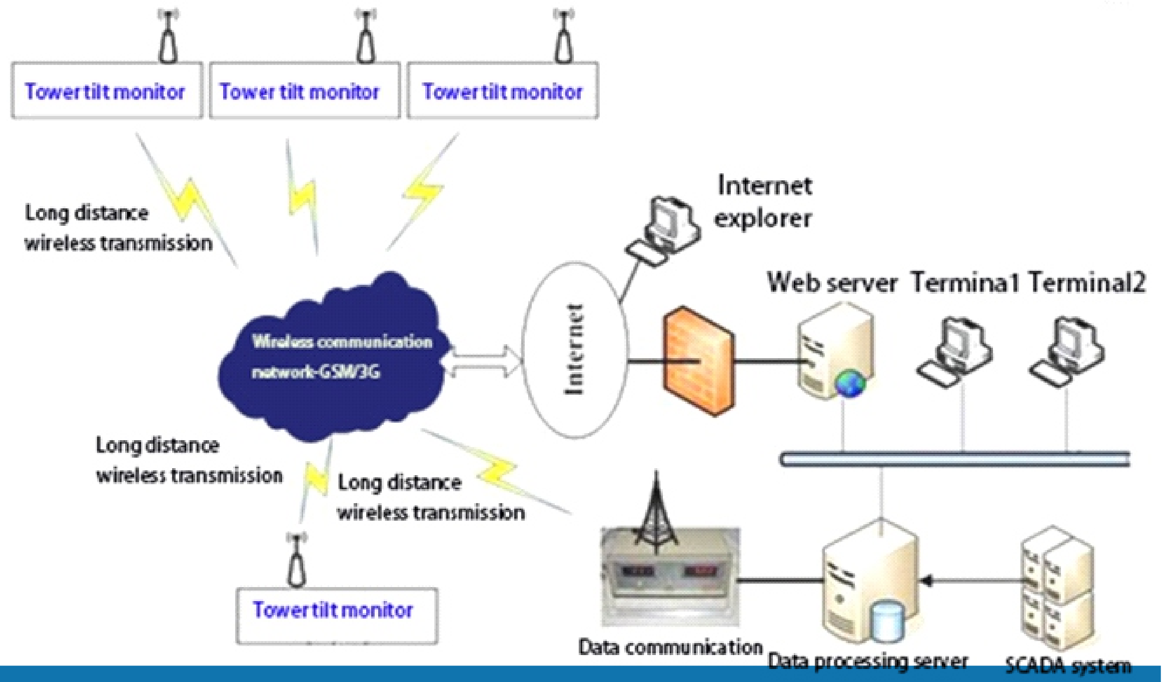


Product application scenarios and solutions

3.2 Monitoring System Composition and Operating Environment
→3.2.1 Monitoring device
Hardware composition
■Dual axis angle monitoring sensor: one set
■Data conversion module: one set
■Power system: solar panels, charging controllers, batteries
■Sub station communication system: GSM wireless data transmission module and mobile phone card
■Main chassis
■Installation and fixing fixtures for front-end equipment
Operating environment
■Environmental temperature: -25 ° C~+45 ° C
■Operating temperature: -40 ° C~+85 ° C
■Relative humidity: 5% RH~100% RH
■Atmospheric pressure: 550hPa~1060hPa
→3.2.2 System software
→Hardware configuration: server (host can store monitoring data for more than 10 years), data communication module, client, uninterrupted power supply
→Software configuration
■Server operating system Windows Server 2000
■Database Management System SQL Server 2000
■Client operating system Windows XP/Windows 2005, etc., IE browser
■Comprehensive analysis software

Energy and Electricity

Case 5: Remote transmission tower inclination measurement online monitoring system solution

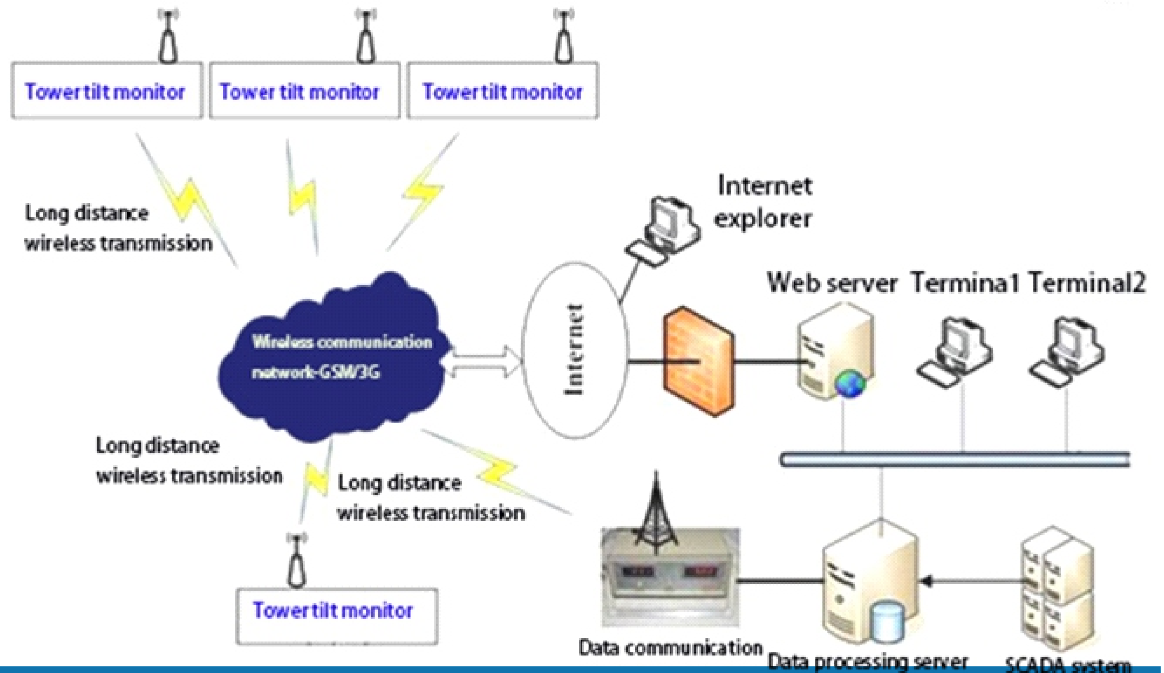


Product application scenarios and solutions

→3.3 Main technical parameters
→Scope of use
■Online Status Monitoring of Operating Poles and Towers in 66kV~500kV Transmission Lines
■Online Status Monitoring of Operating Poles and Towers in 66kV~500kV Substations
■Operating Voltage: DC12V
→Power supply method: solar energy+battery
→Communication method: 3G/4G/GSM/CDMA/GPRS
→Data channel: RS485/TCP/UDP transmission
→Working power consumption: ≤ 1W; Standby power consumption ≤ 0.1W
→Tilt detection unit
■Line direction angle range: -90° ~+90° ; Measurement accuracy: ± 0.01°
■Vertical angle range of the line: -90° ~+90° ; Measurement accuracy: ± 0.01° ;
→Temperature measurement range: -40 ℃~+95 ℃, measurement accuracy: 0.5 ℃
→Humidity measurement range: 0-100% RH, measurement accuracy: 2% RH
→Wind speed measurement range: 0-75m/s, accuracy: ± (0.5+0.03 V) m/s
→Wind direction measurement range: 0-360° , accuracy: ± 5°
→work environment
■Humidity: not greater than 98% RH
■Protection level: Ip65
→Software system: lifetime free upgrade;

3.4 Monitoring System Features
→Anti interference: anti electromagnetic, waterproof, lightning protection, ensuring stable and reliable system operation
→High measurement accuracy: high-precision, high-resolution, and highly reliable digital tilt sensors
→With data collection, measurement, and communication functions, the measurement results are transmitted to the backend comprehensive analysis software system through a communication network

Case 5: Remote transmission tower inclination measurement online monitoring system solution

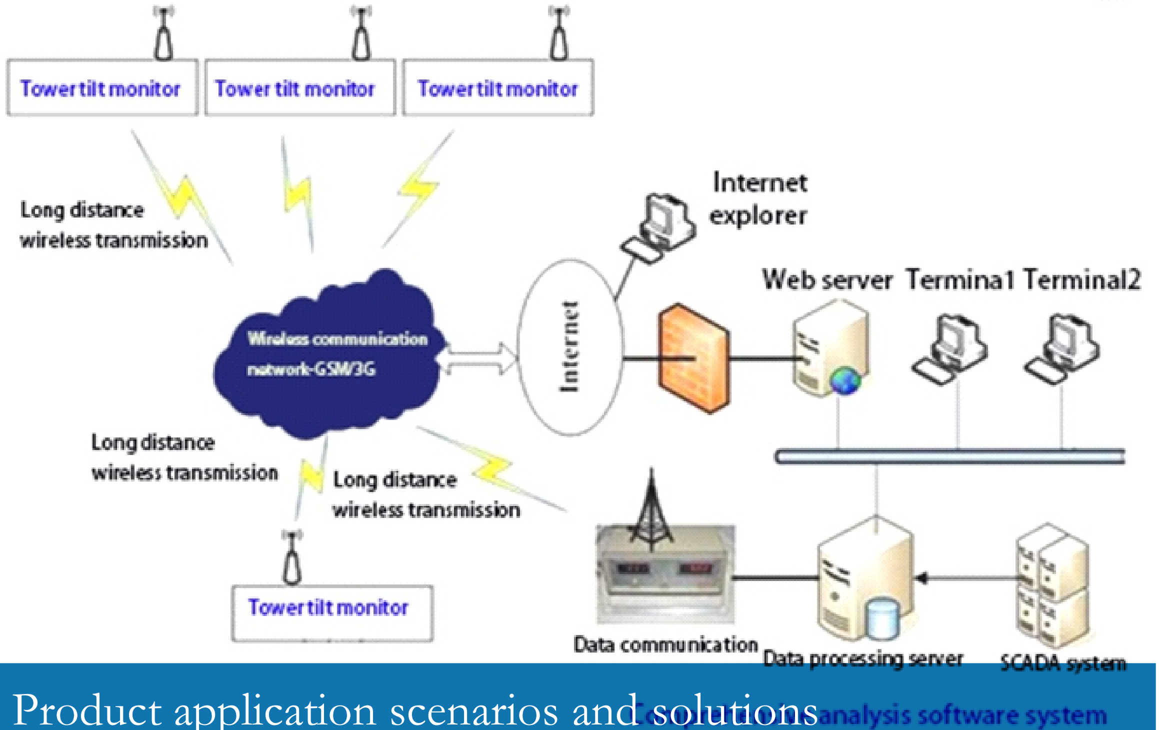


Product application scenarios and solutions

→Power on self start function
→With online self-diagnosis function
→Time synchronization function, capable of receiving time synchronization commands from the comprehensive analysis software system, once a day, with an error of no more than 5s
→The device is designed with small size, convenient installation, and can be installed with electricity without maintenance. After installation, it will not cause safety hazards to the structural characteristics of the line itself and subsequent operation and maintenance
→Having appropriate interfaces for local debugging
→Data temporary storage function, which can store data for more than 3 days in case of communication abnormalities
→The device host adopts solar energy+battery power supply mode, and the tower tilt angle acquisition unit adopts solar energy+lithium battery power supply mode. Under continuous rainy and rainy conditions, the device host can operate normally for at least 30 days, and the tower tilt angle acquisition unit can operate normally for at least 1 year
→In areas with frequent typhoons in coastal areas, wind speed sensors can be installed. Using wind speed as a parameter, draw a curve of wind speed over time and display it in the same coordinate system as the curve of inclination over time. It can be clearly seen that the wind speed has an impact on the inclination angle.
3.4.2 Characteristics of comprehensive analysis software system
→Capable of automatically receiving data from data collection units at a fixed time
→It has the function of remotely setting the collection method (automatic or controlled) and automatic collection time
→The backend software can set the data collection density according to user needs
→Can send timing commands to data acquisition units
→Can remotely modify the IP address and port number of the data collection unit
→Ability to query and analyze historical data, and automatically generate reports
→Equipped with alarm prompt function

Energy and Electricity

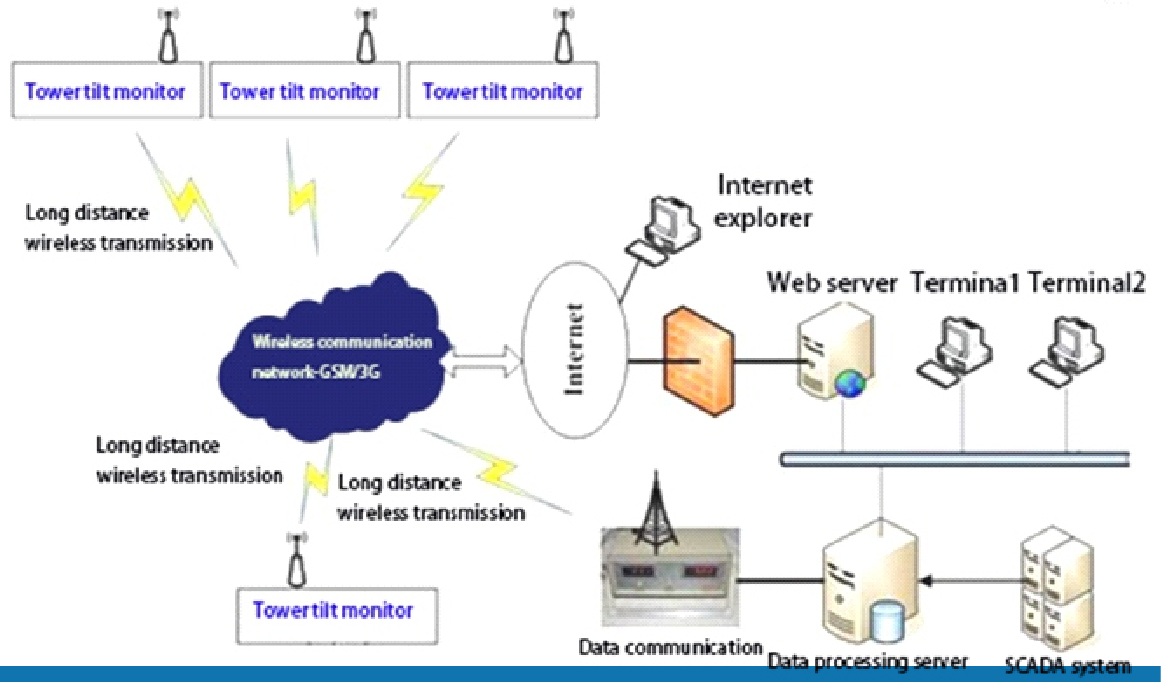
Case 5: Remote transmission tower inclination measurement online monitoring system solution



Product application scenarios and solutions

→Can interface from other MIS systems
→Lifetime free upgrade available
→Statistics, analysis, and output of monitored data, displaying relevant parameters in the form of digital lists, curves, and charts; And based on its historical and current data, a trend chart can be drawn to infer the development speed and trend of tower tilt, and determine the law of periodic changes in tower tilt
→On the trend chart, the corresponding date, time, and characteristic parameter values of any point can be quickly read out, which can reflect the change process of characteristic values and predict the occurrence of early tower tilt faults
3.5 Communication, power supply, and operation mode of monitoring system
3.5.1 Communication method: The tower tilt monitor adopts 3G/4G/GPRS/CDMA communication method to transmit data
3.5.2 Power supply method: The tower tilt monitor is powered by solar energy, and the power supply includes solar cell components, batteries, and charge discharge controllers. The power supply time of the battery without sunlight is more than 30 days, and the service life of the battery is more than 5 years.
3.5.3 Operation mode
→The tower tilt angle acquisition and monitoring terminal has two working modes, automatic acquisition and controlled acquisition. The automatic collection method is to collect on-site data according to the preset alarm working mode, and then automatically upload the collected data to the backend server. The client can connect to the server to download monitoring data
→Controlled collection method is a remote data collection terminal that waits for the client to send a command to collect monitoring data or other control commands. Only after receiving the control command, it will take corresponding actions. This mode can be used for customers to instantly obtain on-site monitoring data and set the working status in real time.

Case 5: Remote transmission tower inclination measurement online monitoring system solution



Product application scenarios and solutions

4. Project significance

The online monitoring system for tower tilt is a cutting-edge technology. After the implementation of the project, it can technically ensure the safe operation of the power grid and greatly improve the level of line operation management, opening up a new approach for line inspection and condition based maintenance, which has enormous economic and social benefits.

With the development of intelligent power grids and the vigorous promotion in the industry, the online monitoring system for transmission lines is in the stage of gradual development and heating up, and it is believed that it will soon reach the leading technical level in China.

4.1 Direct economic benefits

After the online monitoring system for tower tilt is put into operation, considerable economic and social benefits can be achieved. Due to improving the reliability of equipment operation, achieving fewer power outages and more power supply, facilitating condition based maintenance and reducing repetitive power outages caused by annual planned pre test minor repairs; Transmission line monitoring can be carried out without power outage.

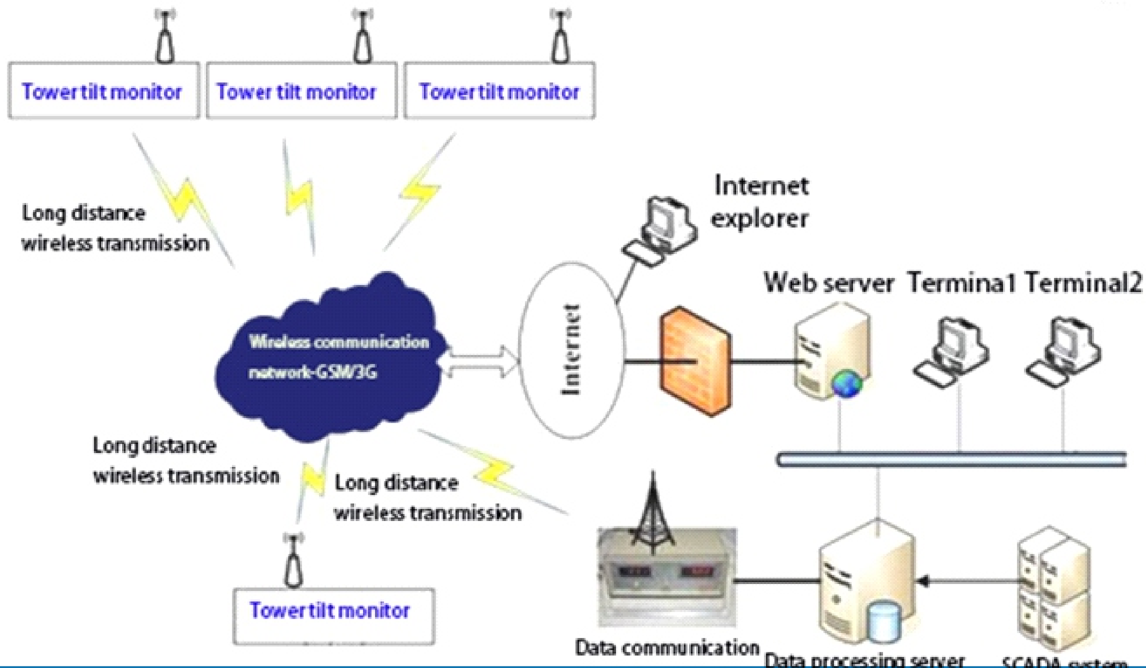
In general, each transmission line can provide an additional power supply of about tens of millions of kilowatt hours per year, saving travel and shift costs of several hundred thousand yuan. If fully promoted and used, the benefits are difficult to estimate.

4.2 Indirect Economic Benefits

4.2.1 Improving power supply reliability: By using online monitoring of tower tilt, it is possible to detect small changes in tower tilt that are difficult to observe with the naked eye, helping the operating department to detect hidden dangers and eliminate faults in a timely manner, thereby improving the reliability of transmission line operation.

Energy and Electricity

Case 5: Remote transmission tower inclination measurement online monitoring system solution



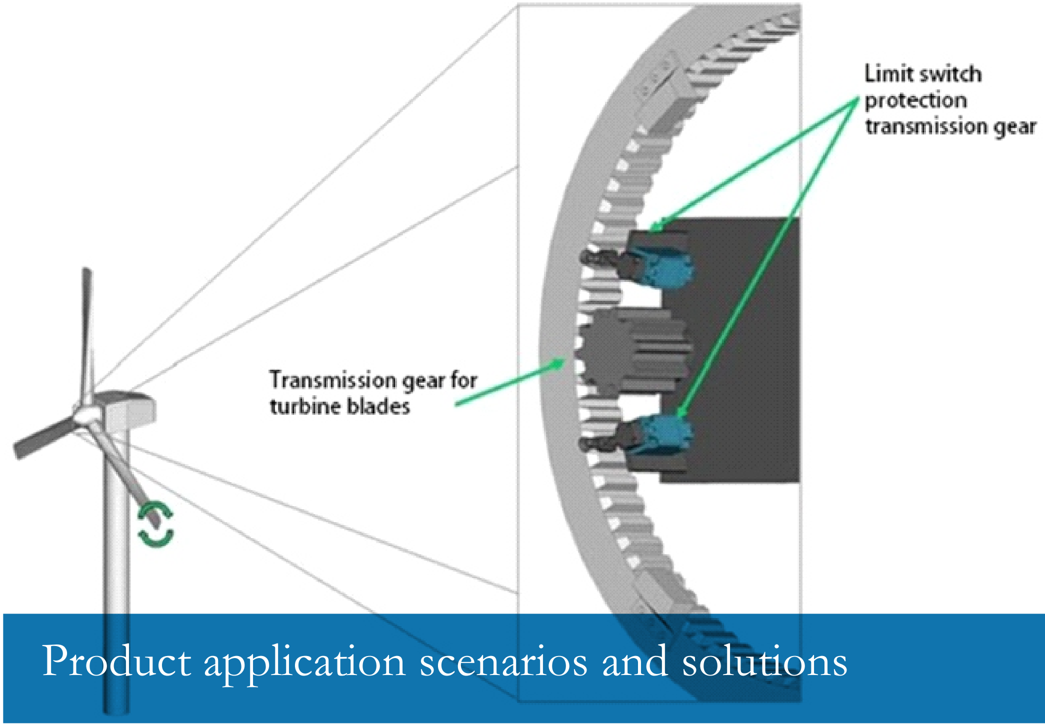
Product application scenarios and solutions

4.2.2 Improving personal and equipment safety: The implementation of online monitoring technology for transmission lines has reduced the workload of power outages and live maintenance, and reduced the probability of personal accidents. The original inspection required personnel to regularly visit the transmission lines, and the transmission lines were located in areas with poor geological conditions. In addition, in harsh weather conditions, workers were very tired, and in actual work, the risk of personal accidents occurred frequently within the system.

The use of online monitoring technology for transmission lines reduces the need for personnel to conduct regular inspections, which is very beneficial for ensuring personal and equipment safety.

Energy and Electricity

Case 6: Application of inclination sensor and acceleration sensor in offshore wind power generation equipment



Product application scenarios and solutions

The current energy issue has increasingly become a top priority that constrains the social development of various countries. Therefore, governments around the world are constantly trying to find new energy and develop renewable energy. Among them, wind power generation, especially offshore wind power generation, has become a hot topic for new energy investment and construction. In the construction of wind power generation equipment, there are many applications of safety monitoring technologies such as acceleration sensors, current sensors, and inclination sensors.

1. Acceleration sensor

Among various facilities used for wind power generation, wind turbines are crucial power generation equipment for converting wind energy into electrical energy. Simply put, the principle is that wind energy is converted into electrical energy through the impeller, spindle, gearbox, and generator. Among these components, wind turbine blades are highly susceptible to flutter under wind loads, which can lead to structural damage in severe cases. In addition, wind turbines may experience significant vibrations in the cabin in various directions due to various reasons during operation, which can pose a threat to the normal operation of the wind turbine. At this point, it is necessary to use acceleration sensors to monitor the vibration of components such as the gearbox, spindle, and motor stator of the wind turbine.

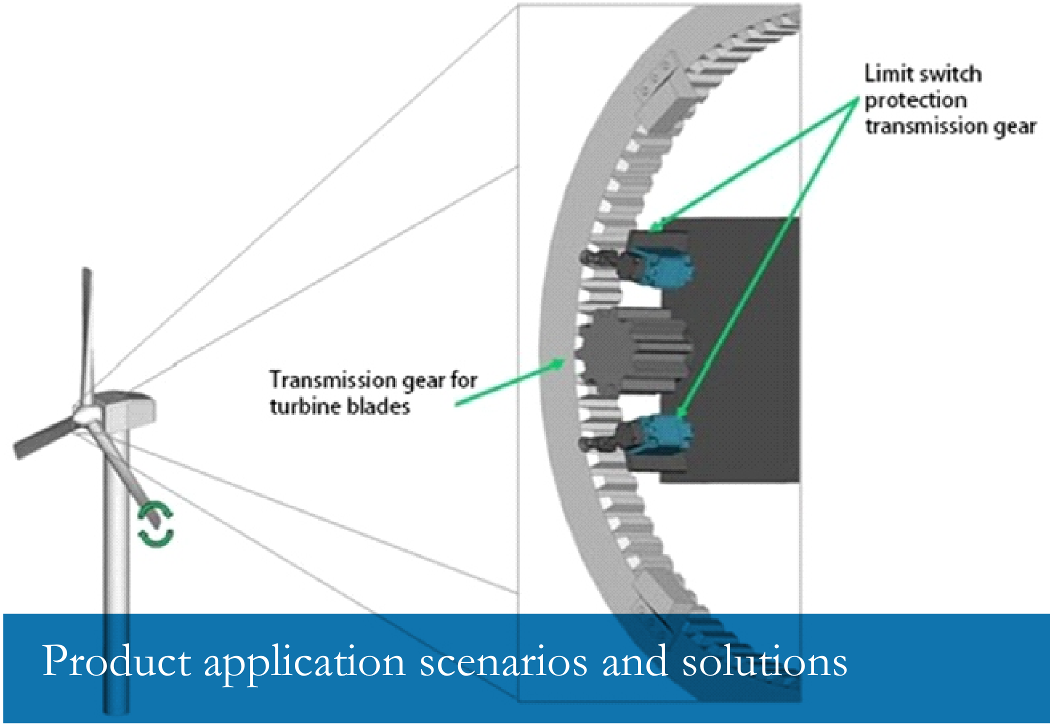
2. Tilt sensor

Mainly used for angle measurement work to monitor the level of wind turbines. When constructing offshore wind power towers, in order to avoid potential tilting of wind turbines at high altitudes, which threatens the normal operation and safety of the towers, it is necessary to use tilt sensors to monitor the verticality of the wind turbines for a long time. Once the tilting exceeds the safety value, timely warning can be given, and personnel can be notified to inspect and maintain, in order to ensure the stability of daily power generation work.

3. Limit switches and current sensors

In the process of wind power generation, due to the constantly changing size of the wind force, it is necessary to adjust the wind propeller of the generator to maintain a constant speed and ensure the stability of the power generation process. At this point, a limit switch device can be used to install it at both ends of the limited range of wind blade angle change to protect the relevant circuit from triggering the pitch operation when the pitch reaches the limit position, and avoid damage to internal electronic devices caused by this.

Case 6: Application of inclination sensor and acceleration sensor in offshore wind power generation equipment

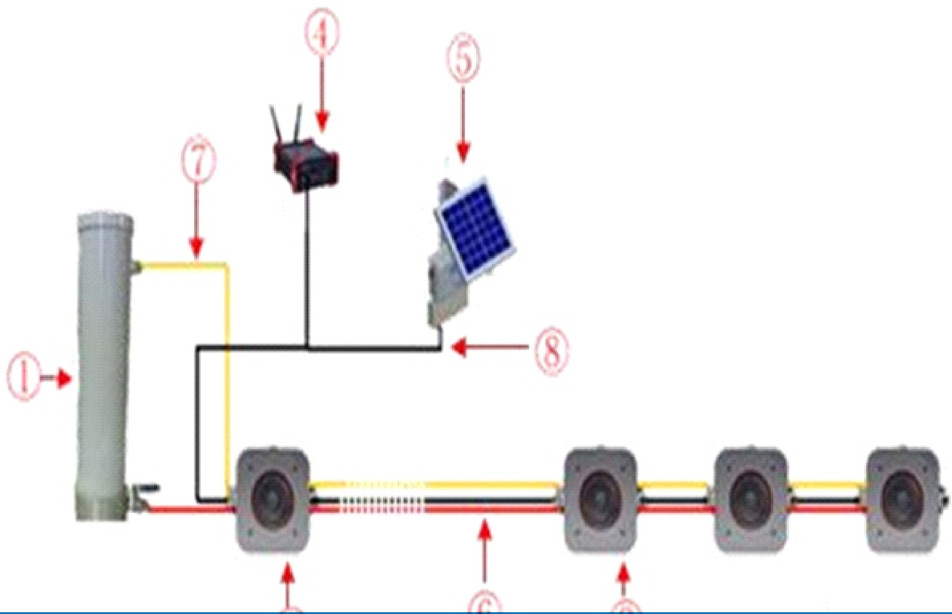


Product application scenarios and solutions

In addition, complex and ever-changing wind farms can also make the voltage of power generation very unstable. In order to process the generated electrical energy and ensure the optimal operation of the generator, it is necessary to use current sensors to accurately measure the current magnitude of wind turbines. Generally speaking, current sensors are responsible for measuring the current on the DC and AC sides to ensure the stable and normal operation of the inverter.

Energy and Electricity

Case 7: Application of inclination sensor and static level for gate inclination settlement monitoring



Product application scenarios and solutions

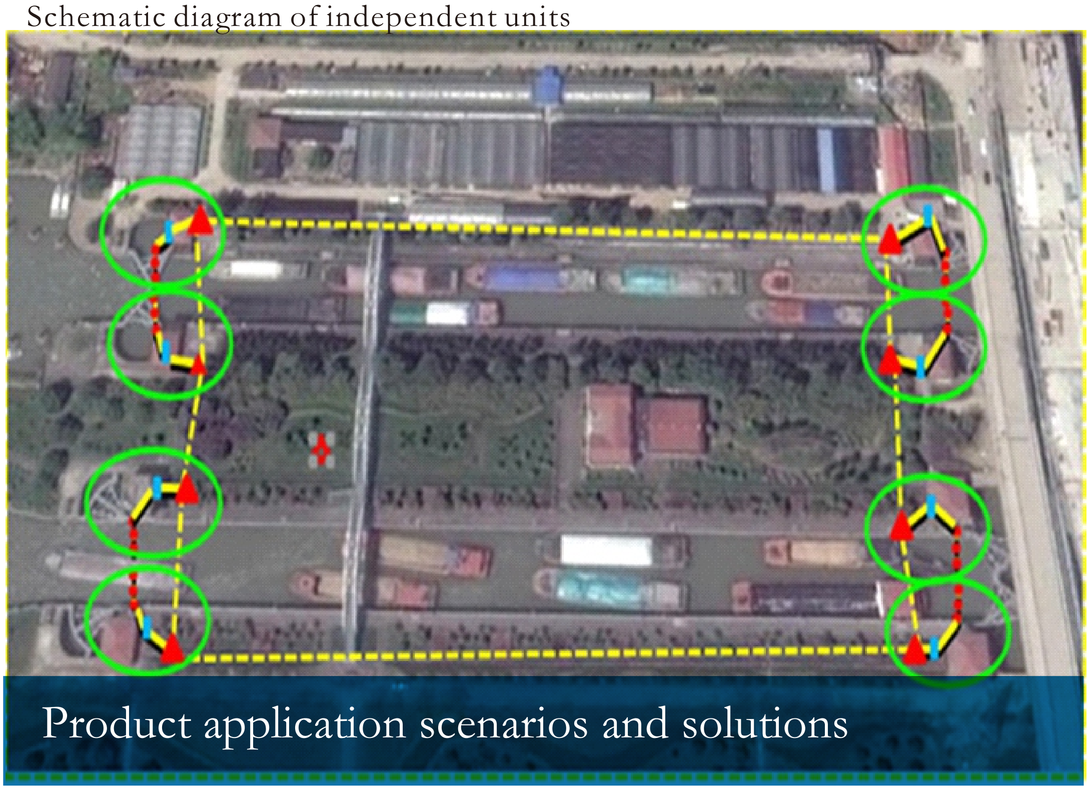
A certain company uses our company's tilt sensor and static level to observe the deformation of ship lock gates (mainly tilt and settlement observation). The system composition of the plan is as follows.
The automatic monitoring system for gate deformation mainly consists of a liquid storage tank, a connecting pipe, a static level, and a deformation monitoring background. The details are as follows:
① Liquid storage tank ② Reference point level ③ Monitoring point level ④ Wireless gateway
⑤ Solar panel ⑥ Liquid tube (red) ⑦ Ventilation tube (yellow) ⑧ Observation cable (black)
During the deformation observation process, a static level is uniformly arranged on the approximate contour line according to the direction of the gate. Monitoring nodes are mainly arranged on the gate, and settlement observation is carried out jointly by the storage tank, reference point, and testing point. This can achieve functions such as storage, preprocessing, management analysis, visual analysis, and limit warning of settlement monitoring data.
2. Scheme design
According to the specific situation of the company's ship lock, a total of 4 high-precision settlement monitoring gates (8 gates) need to be installed. According to the requirement of monitoring key parts at the head and tail of the gate, a plan is proposed: each gate forms an independent monitoring unit, which includes 1 liquid storage tank (blue rectangle), 1 benchmark equipment (red triangle), and 2 monitoring equipment (red dot), A total of 8 independent monitoring units (green circles) form a deformation monitoring system.

Energy and Electricity

Case 7: Application of inclination sensor and static level for gate inclination settlement monitoring

3. Overall layout diagram (based on actual situation)

Schematic diagram of independent units



Install two static level gauges on the gate, and install a benchmark static level gauge near the house.

Energy and Electricity

Case 8: Application of Automatic Control System for Water Conservancy Valves

Product application scenarios and solutions

The inclination sensor is widely used in the automatic control system of water conservancy valves. At present, the front-end equipment of the flip plate water valve control system is generally composed of the flip plate water valve, oil cylinder, and a steel cable valve opening meter fixed on the oil cylinder. The oil cylinder is connected to the upper end of the valve through a rotating shaft, and the expansion and contraction of the oil cylinder drives the opening and closing of the valve.

During the expansion and contraction process of the oil cylinder, the steel cable is driven to expand and contract, and there is a certain functional relationship between them. As long as the length of the steel cable is measured, the real-time angle of the gate can be calculated. However, due to the exposed external steel cables, they are easily corroded, causing instability in the opening meter. Therefore, in recent years, new non-contact control technologies have gradually been adopted, which use inclination sensors to measure the angle of the oil cylinder,which can effectively compensate for the shortcomings of the original system.

Construction machinery

The inclination sensor can measure the absolute inclination angle of the tunnel excavation body, and can also calculate the deviation distance and other data through the inclination angle, which plays an irreplaceable role in correcting the guidance. Ensure that it digs along a prescribed trajectory.

Construction machinery

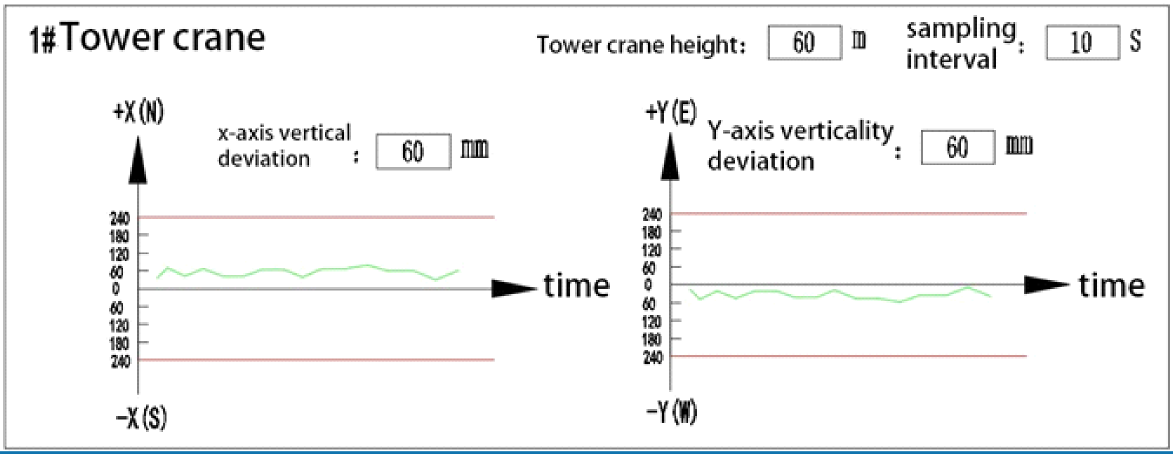
Case 1: T7000-I wireless tilt product is used to detect the vertical tilt offset of tower cranes

1. Hardware design requirements
→ Measuring range: ±15°
→ Signal output method: ZigBee wireless transmission (within 1.6km)
→ Accuracy 0.001° , resolution 0.0005°
→ Response frequency: 100HZ, 0.01 seconds
→ Power supply mode: Installed on the upper end of the tower crane, it is inconvenient to frequently disassemble and install the battery. It can be connected to an external power supply, with a built-in 6000mAH battery and an external solar panel.

2. Software design requirements
→ Corresponding modules can be added according to the number of tower cranes, and the modules can be named (such as: 1# tower crane, 2# tower crane, 3# tower crane...)
→ The height of the tower crane can be entered under each corresponding module (e.g.: tower crane height: 60m)
→ Assign a tolerance to all modules, that is, the verticality deviation limit of the tower crane: 4H/1000 (H is the height of the tower crane, in mm)
→ Generate a fluctuation line chart in the X and Y directions under each module. The sampling interval can be adjusted, and the red line of the limit value and the real-time X-axis and Y-axis verticality deviation values are displayed, as shown in the figure:

Construction machinery

Case 1: T7000-I wireless tilt product is used to detect the vertical tilt offset of tower cranes



Product application scenarios and solutions

→ For each module, if the deviation value exceeds the limit, set a buzzer alarm to remind
→ Set up the report generation function, which includes the tower crane number, tower crane height, X-axis and Y-axis verticality deviation values (differentiating between positive and negative directions). The report file format is mainly an EXCEL table.

Construction machinery

Case 2: Inclination sensor application for safe operation of coal washing and mining machinery

Product application scenarios and solutions

Surface coal mining machine, as the name implies, is a coal mining machine for mining open pit mines. In order to ensure the working safety of the coal washer, the chassis of the entire equipment needs to be leveled before work to ensure construction safety. By installing a T7000-K dynamic inclination sensor to measure the inclination angle of the chassis in all directions, the angle output signal is sent to the PLC to drive the hydraulic cylinder to achieve the leveling of the chassis. The angle measurement of the machine arm is used to calculate the lifting height and prevent the entire equipment from tipping due to excessive lifting, causing property damage and casualties.

Surface mining machines work in high temperature, high dust, and corrosive environments for a long time, and the sensors act as the senses of the mining machines. If there is a problem with the sensor, it will have a big impact on work efficiency and safety issues. T7000-K News Inclination sensor, suitable for water, oil, steam,

Construction machinery

Case 3: T7000-L Analysis of Accelerometers Used for Monitoring and Controlling Roller Rolling

Product application scenarios and solutions

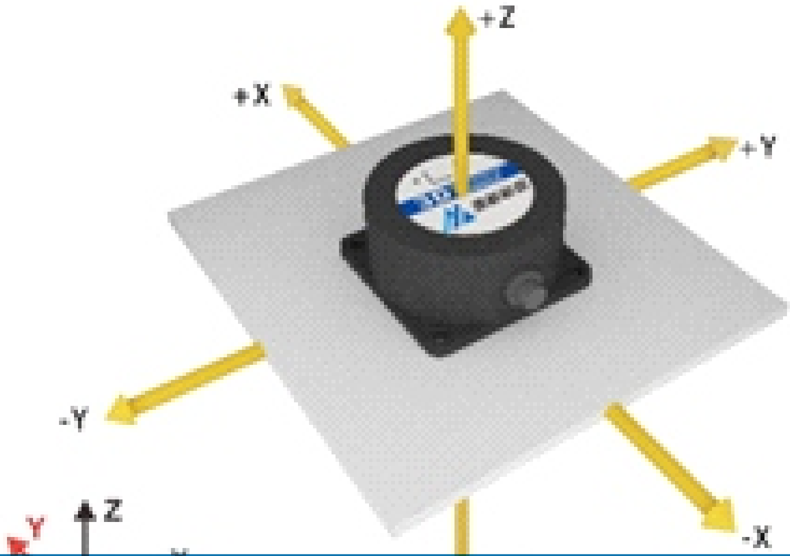
1. The importance of monitoring the rolling quality of road rollers

With the development of information technology, informatization and digitization have gradually penetrated the entire lifecycle of engineering construction and operation. In recent years, the rapid development of the Internet of Things and mobile technology has once again promoted the new application of high-precision measurement, positioning technology, and intelligent technology in construction process control. These innovative products provide scientific and effective means to control the quality of the construction process, improve work efficiency, and ensure construction safety.

Rolling compaction construction is one of the main construction measures commonly used in infrastructure projects such as hydropower stations, airports, high-speed railways, and transportation, including soil and stone compaction construction, concrete compaction construction, etc. Compaction is the core indicator for evaluating the quality and results of rolling construction, while the thickness of the rolling layer, the number of rolling passes, and the frequency of vibration are the key control indicators for the quality control of the rolling construction process. For a long time, traditional quality monitoring methods have adopted the method of "manually measuring the thickness of the rolling layer, recording the number of rolling passes, and organizing sampling testing for compaction degree after rolling is completed", which not only has low work efficiency but also cannot comprehensively evaluate the rolling quality. In recent years, digital products and solutions for rolling monitoring based on GPS and related sensing technology have gradually emerged, but the cost is high and Chinese enterprises do not have independent intellectual property rights in core technologies.

Construction machinery

Case 3: T7000-L Analysis of Accelerometers Used for Monitoring and Controlling Roller Rolling

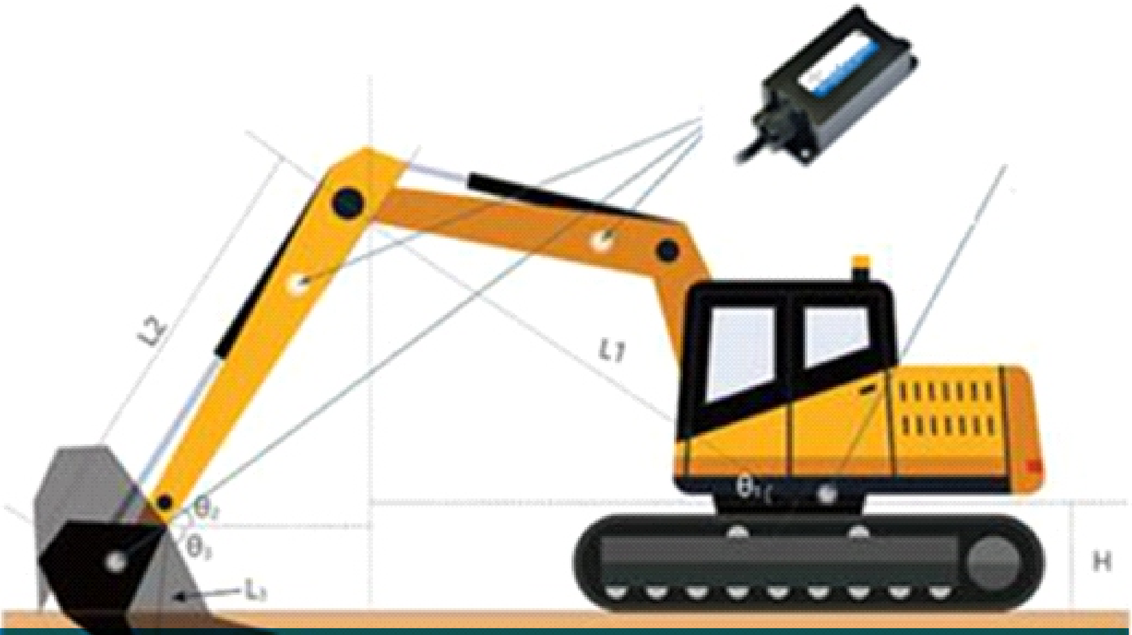


Product application scenarios and solutions

2. T7000-L Accelerometers Sensor Used in the Quality Monitoring and Analysis System of Roller Compaction

The T7000-L accelerometer sensor plays a role in monitoring the roller in the "Real time Monitoring and Analysis System for Rolling Quality". By using the vibration frequency and amplitude of the accelerometer, the roller's rolling construction speed, speed, excitation force, whether it vibrates according to requirements, whether the vibration meets the design requirements, and the excitation force of the roller at that time can be calculated through the amplitude and frequency. The vibration frequency is the number of vibrations within a period of time, and the vibration amplitude is the maximum acceleration per unit time. The sensor is installed on the roller of the press, uploading data in real-time, providing construction guidance and abnormal warning of rolling speed, layer thickness exceeding standards, and assisting the driver in driving and control.

Case 4: Shield Tunnel Boring Machine



Product application scenarios and solutions

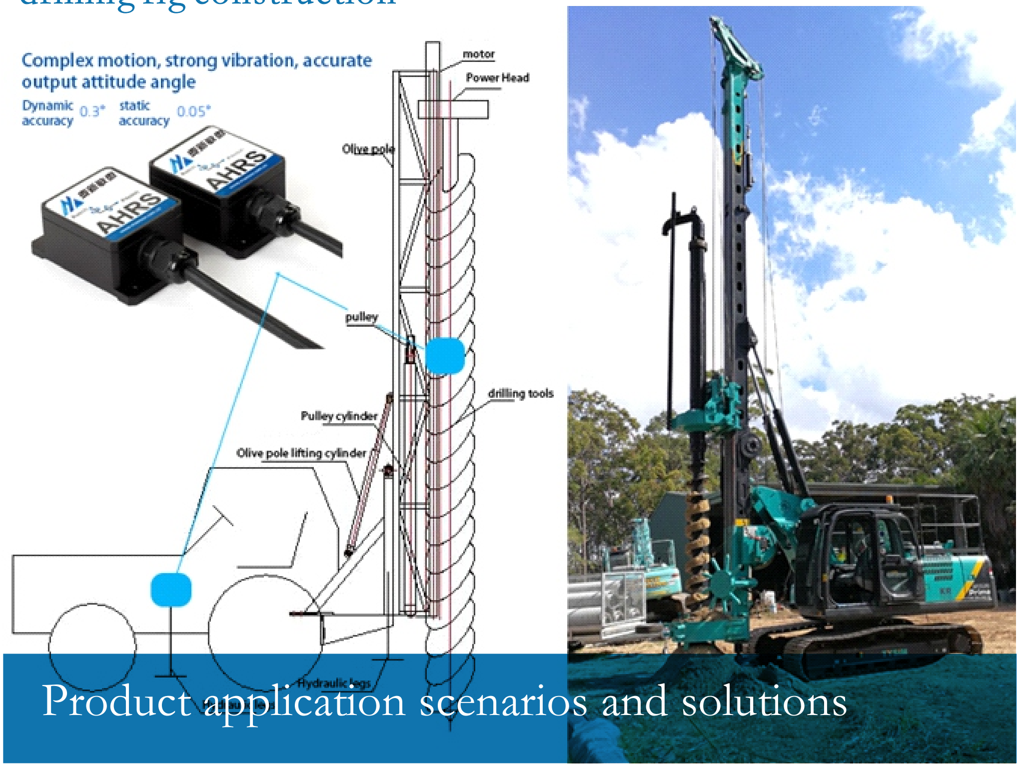
2. T7000-L Accelerometers Sensor Used in the Quality Monitoring and Analysis System of Roller Compaction

The shield tunneling machine, also known as the shield tunneling machine, is a specialized engineering machinery for tunnel excavation. The basic working principle of the shield tunneling machine is a cylindrical steel component that advances along the axis of the tunnel and excavates the soil during the process. The shell of this cylindrical component is commonly known as a shield, which serves as a temporary support for the excavated yet unlined tunnel section. It not only bears the pressure of the surrounding soil layer, but also bears the groundwater pressure and keeps the groundwater out. Excavation, soil dumping, lining and other operations are generally carried out under the cover of the shield of the shield machine. Widely used in tunnel engineering such as subways, railways, highways, municipal facilities, and hydropower.

However, in the process of shield tunneling machine operation, it is very difficult to ensure that it excavates along a designated trajectory. Its control system integrates optical, mechanical, electrical, hydraulic, sensing, and information technology, and has functions such as excavation and cutting soil, conveying soil debris, assembling tunnel lining, measuring and guiding deviation correction. It involves multiple disciplines and technologies such as geology, civil engineering, machinery, mechanics, hydraulic, electrical, control, and measurement, The inclination sensor is an important part of this control system. The inclination sensor can not only measure the absolute inclination angle of the shield tunneling machine body, but also calculate deviation distance and other data through the inclination angle, playing an irreplaceable role in correcting guidance. In addition, the control system composed of inclination sensors, other sensors, and motors makes the shield tunneling machine more automated,labor-saving, and faster in construction speed.

Construction machinery

Case 5: T7000-K Dynamic inclination sensor installation and posture control during rotary drilling rig construction



With the continuous heating up of the domestic construction machinery industry, rotary drilling machines can be seen everywhere in some building and road construction sites, and are widely used in various foundation construction projects such as cast-in-place piles, continuous walls, and foundation reinforcement. The rotary drilling rig is a pile construction machinery used for on-site grouting pile drilling construction in pile foundation engineering. By configuring different drilling tools and adopting corresponding drilling techniques, the drilling rig can be suitable for various complex formation drilling operations.

Rotary drilling rigs generally use hydraulic crawler type telescopic chassis, self lifting and foldable drilling mast, telescopic drilling rod, with automatic verticality detection and adjustment, digital display of hole depth, etc. The overall operation of the machine generally adopts hydraulic pilot control and load sensing, which can operate on large construction sites, improve work efficiency and project progress.

Application of inclination sensor in monitoring rotary drilling rigs

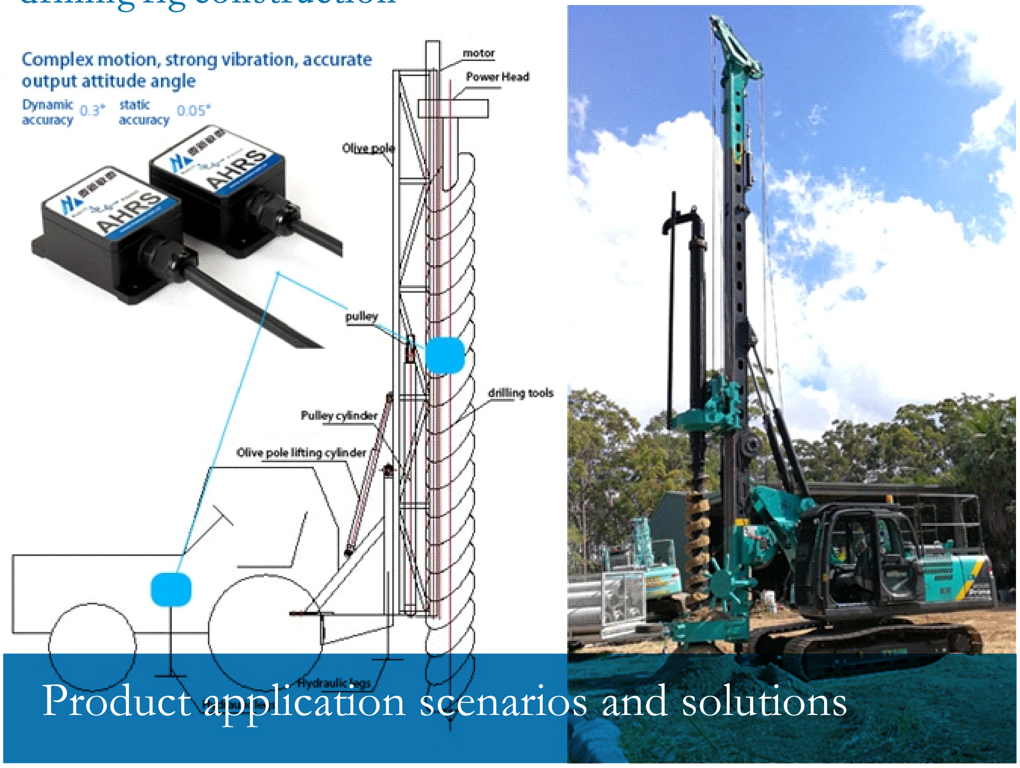
The center of gravity position of the rotary drilling rig is a key factor affecting its stability. There are many factors that affect the center of gravity position of the rotary drilling rig, including static factors such as the angle between the chassis and the horizontal plane, the position of the luffing mechanism, the inclination of the mast, and the weight of each component of the drilling rig; Dynamic factors include pressure, lifting force, rotational speed, etc.

When drilling with a rotary drilling rig, it is necessary to erect and adjust the mast of the rotary drilling rig, that is, first move the rotary drilling rig to the position where the drilling operation is located, and the display of the rotary drilling rig displays the working screen of the mast. The deviation of the X-axis and Y-axis directions of the mast can be observed in real-time from the working screen of the mast. By measuring the inclination of the corresponding components on the rotary drilling rig, the variable amplitude boom, and the mast through inclination sensors, the center of gravity position of each component can be calculated. Combined with the weight of each component, the static center of gravity coordinates of the rotary drilling rig can be determined.

Real time attitude angle control of rotary drilling rig using Mai Xinmin micro tilt sensor

Construction machinery

Case 5: T7000-K Dynamic inclination sensor installation and posture control during rotary drilling rig construction



The T7000-K dynamic high-performance inclination sensor is installed at the drill pipe end, which can achieve real-time dual axis attitude measurement under the motion conditions of the drill pipe structure. The T7000-K high-precision static inclination sensor is installed on the vehicle chassis, which can accurately measure the attitude of the vehicle relative to the horizontal plane. The measured posture, combined with the three-dimensional mechanical model of the rotary drilling rig, can calculate the spatial coordinates of the vehicle's center of gravity relative to the horizontal coordinate system in real-time. When the actual center of gravity exceeds the pre calculated safe space area of the vehicle's center of gravity, the system will give a safety alarm, the motion mechanism will pause execution, and the center of gravity will be automatically or manually adjusted to the safe area to avoid dangerous accidents.

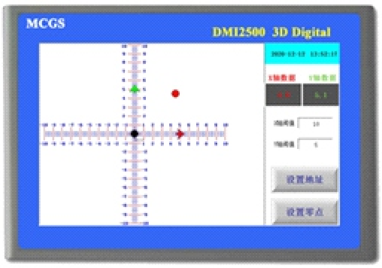
Construction machinery

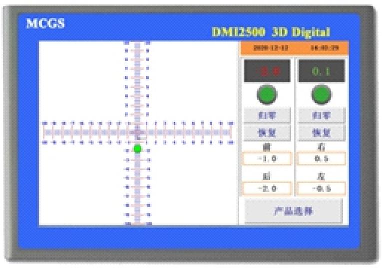
Case 6: Measurement and control of the verticality of the mast of rotary drilling rigs and pile drivers using dual axis inclination sensors

The verticality of the mast determines the qualification of the drilling hole, especially for pile drivers. Verticality is an important indicator of the reliability of buildings. Therefore, how to maintain good verticality or drill at a certain angle is a common problem encountered during the construction process. In an electro-hydraulic control
system, this function can be achieved by directly installing a dual axis inclination sensor on the mast. At the same time, operators can input tilt data through the PLC's human-machine interface device, and the drilling rig will automatically drill according to the set angle
Recommended pairing scheme: dual axis inclination sensor+inclination display instrument

Construction machinery

Case 6： Measurement and control of the verticality of the mast of rotary drilling rigs and pile drivers using dual axis inclination sensors





Product application scenarios and solutions

Select the T700-I dual axis digital inclination sensor to monitor the current angle value in real-time. This is a horizontal sensor for dual axis measurement, combined with the DD-100 inclination display instrument, which can visually see the vertical angle value on the screen.

This solution is the most concise and cost-effective, and our company has provided this solution configuration to many enterprises.

The instrument panel can be placed in the driver's cab and can be installed with holes or directly fixed in a convenient location. The sensor is installed on the mast and connected to the instrument through a dedicated connecting wire. Simply connect the instrument to a 24V DC power supply. There are 2 meters, 5 meters, 10 meters, 12 meters, 15 meters and other specifications available for connecting cables.

Function description

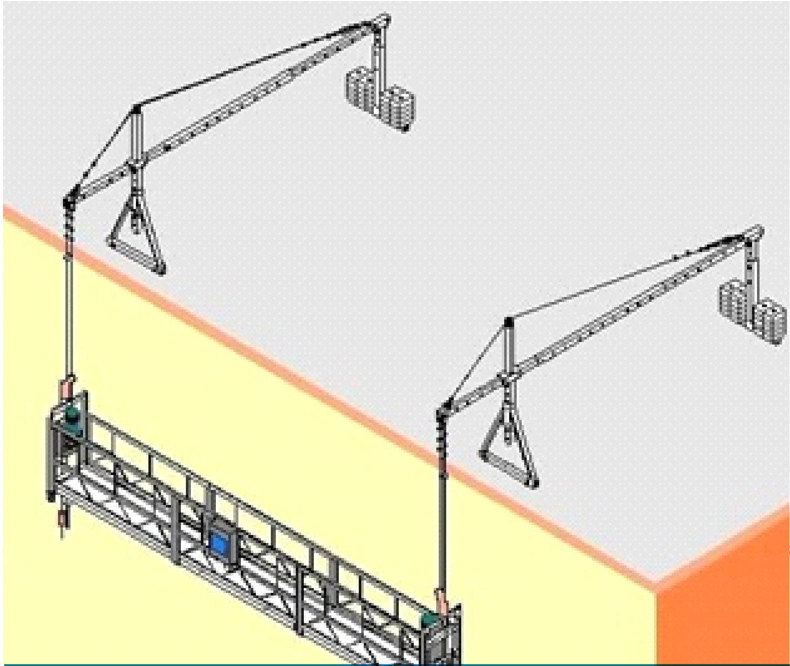
→Absolute angle display (default screen)

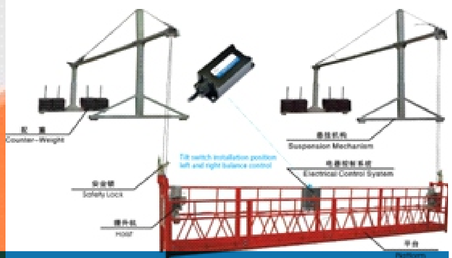
→Display of relative angle (press the up and down arrows to switch screens)

→Relative zero reset (6 9-digit keys set to zero)

→Alarm angle setting (switch to the alarm angle setting interface to set the alarm angle value)

Case 7: Inclination sensor, hanging basket balance control safety detection





Product application scenarios and solutions

Standard requirements for high-altitude hanging baskets:

1. Requirements for overload detection (protection) devices

→ The hanging basket should be equipped with an overload detection device to avoid personal danger and mechanical damage caused by overloading. This device can detect the load of personnel, equipment and materials on the platform

→ Overload detection device should be installed on each hoist

→ Overloading when the platform is rising, falling or stationary should be detectable during use.

→ The platform overload device should be triggered on or before reaching 1.25 times the ultimate working load of the hoist.

→ Once the overloading device is activated, it will stop all movements except descending until the overloading load is removed.

→ When the overload device is triggered, the overload indicator will continuously send out a visual or audible signal to alert the operator on the platform

→ Preset components of the overload device must be protected against unauthorized adjustment

→ The design of the overload device should enable it to carry out the static load and dynamic load tests required by this standard.

The overload device should work within the range of 1.6 times the ultimate working load of the hoist. The overload device should be able to withstand a static load of three times the ultimate working load of the hoist without being damaged.

2. Requirements for electronic anti-tilt (platform) devices

When triggered, the electronic anti-tilt device shall:

a) When rising, stop the action of the upper (high-end) hoist motor.

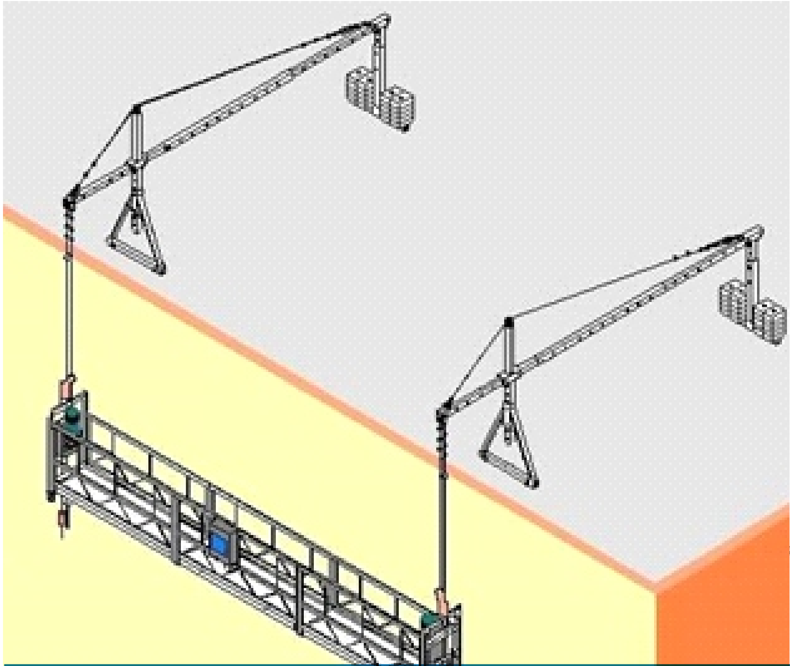
b) When descending, stop the lower (lower end) hoist motor.

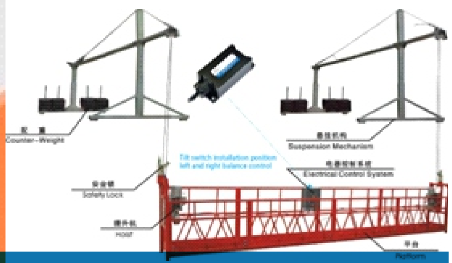
c) The tilt angle in the length direction of the platform reaches 1.5 degrees (the error is not greater than 0.3 degrees)

d) Anti-collision detection

Construction machinery

Case 7: Inclination sensor, hanging basket balance control safety detection





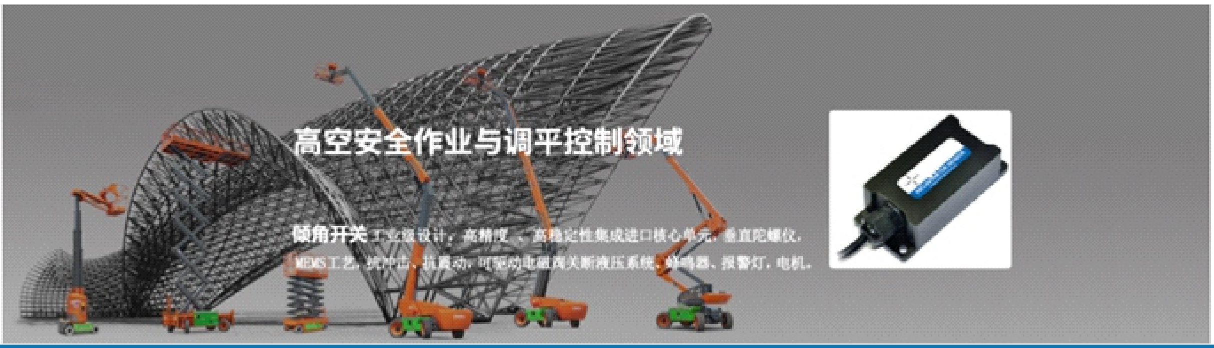
Product application scenarios and solutions

High-altitude operations are very dangerous. How to ensure the stability of the hanging basket and ensure the safety of construction workers is one of the issues that must be considered for high-altitude hanging baskets. You can choose the T70-D three-axis dual-way relay output tilt angle leveling control switch. , the measuring range is adjustable at ±90° , the resolution is 0.01 degrees, the accuracy is 0.1 degrees, with temperature compensation, industrial grade, the output mode is relay output, you can choose normally open or normally closed, die-cast aluminum shell, protection grade IP67, easy to install It is very simple. It is installed on the bucket of the crane machine to determine the inclination angle of the hanging basket to avoid operational errors caused

by the operator's lack of understanding of the high-altitude environment, such as the influence of high-altitude wind, the movement of high-altitude workers themselves, and the high-altitude distance. It is difficult to accurately judge the tilt and rollover accidents caused by various factors such as the distance.

Construction machinery

Case 8: Safe operation and leveling control of hydraulic lifts and aerial work vehicles



Product application scenarios and solutions

For high-travel lifts or lifting equipment, the angle measurement and control of the operating platform is related to the life safety of the operator. Therefore, it is necessary to measure, control and alarm the tilt angle of the operating platform and the base of the entire equipment. The omni-directional tilt switch T70-E is suitable for this function.

Both single-axis and dual-axis tilt switches are based on improved MEMS technology. The products have analog output and RS485, RS232, CAN digital output, etc., with high accuracy, vibration resistance and long-term stability. In the temperature range of -40-85° C, the zero point drift is less than 0.2° , the measurement range is 0-+180° , the nonlinearity is better than 0.05, and the repeatability is good. Since the sensing unit adopts anti-vibration technology, it solves the problem of large data changes of the tilt sensor in a vibration environment. The module is not sensitive to vibration and can withstand impacts higher than 1000g.

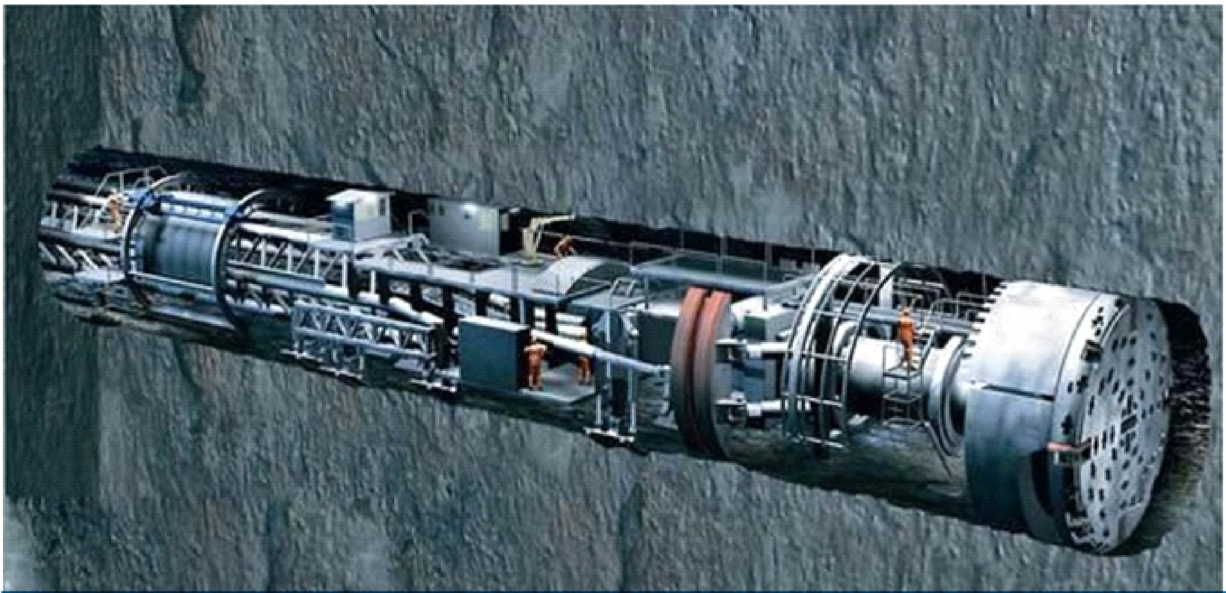
Petroleum Geology

Product application scenarios and solutions

The inclinometer plays an important role in geological exploration, and is applied in foundations, slopes, foundation pits, etc. to prevent geological disasters.

Petroleum Geology

Case 1: Application of inclination sensor in precise excavation of tunnel boring machine



Product application scenarios and solutions

In the past, the drilling and blasting method was widely used for hard rock excavation in mountain tunnels. However, under the same conditions, the excavation speed of the full face tunnel boring machine is about 8 times that of the drilling and blasting method, which has advantages such as efficiency, speed, quality, safety, economy, and environmental protection.

The excavation principle of a hard rock tunnel boring machine is to press the high pressure of the rolling cutter on the tunnel face through the rotation of the cutter head. The rolling knife rotates on the palm surface, loosening the surrounding rock. The excavated stone slag is collected by the edge scraper and enters the belt conveyor through the slag hopper. The belt conveyor then transports the stone slag along the excavation machine to the end, and finally the stone slag is loaded onto the slag truck and transported out.

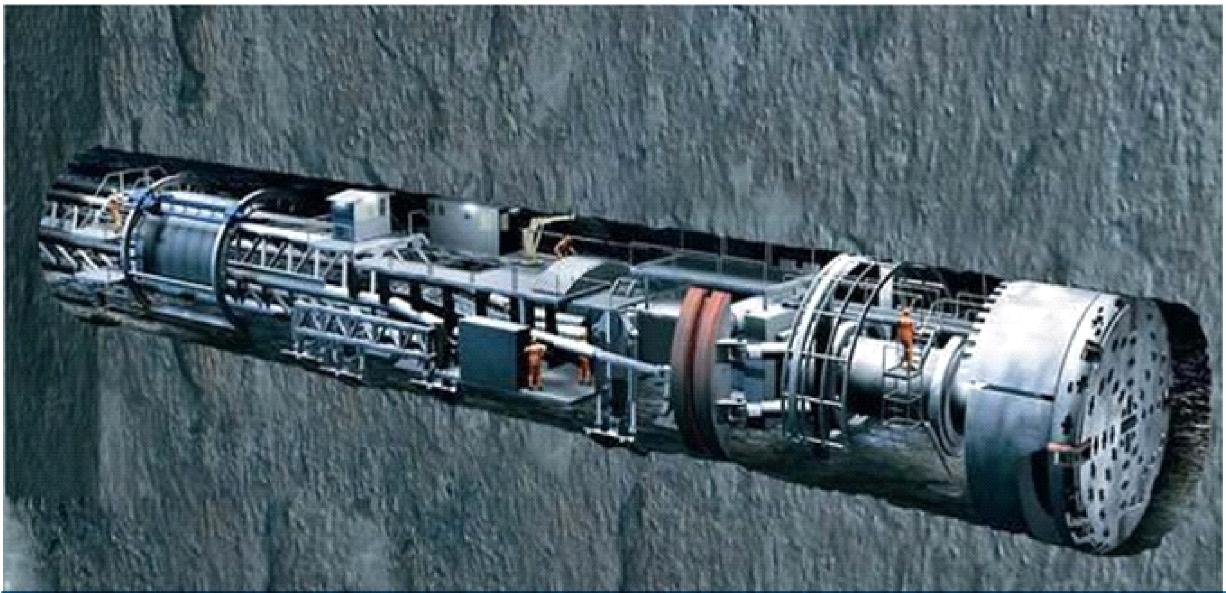
The inclination sensor is an important part of all components of a full face tunnel boring machine. It can measure the inclination angle of the shield machine body and also the inclination angle of the excavation chamber. Through a series of complex calculations, it calculates data such as the distance of the excavation deviation, which plays a very important role in correcting the guidance.

A tiny difference can lead to a thousand miles. Some tunnels are very long, and even small differences can cause trouble in the later stage. Therefore, tunnel boring machines require high accuracy of inclination sensors. Moreover, the tunnel environment is humid, with varying temperature differences, and the vibration of the tunnel boring machine is strong.

The T700-A tilt sensor produced by the company fully considers the above situations, especially optimizing circuit protection and program protection in terms of vibration resistance, so as not to cause the sensor to malfunction due to excessive vibration. After testing, the long-term stability reaches 0.05° and has a high resolution of 0.0025°. It has a waterproof grade of IP67 and can be used in underground humid environments. It can work at a wide temperature of -40~+85 ℃ and also meet most practical conditions. From this, it can be seen that the tilt sensor T700-A produced by Mai Xinmin Micro is competent for directional testing and control of tunneling machines, and its performance parameters are as follows:

Petroleum Geology

Case 1: Application of inclination sensor in precise excavation of tunnel boring machine



Product application scenarios and solutions

① Range ± 15°, ± 30°
② Wide voltage input 9-36V
③ Wide temperature operation -40~+85 ℃
④ High vibration resistance>20000g
⑤ High resolution 0.0025°
⑥ Waterproof grade IP67, strong resistance to external electromagnetic interference
⑦ Vibration suppression adjustment and setting can be carried out on-site

Case 2: Application of inclinometer in oil pipelines

Product application scenarios and solutions

Pipeline transportation is a long-distance transportation method that uses pipelines as transportation tools to transport liquid and gas materials. It is a specialized transportation method that transports petroleum, coal, and chemical products from the production site to the market. It is a special component of the trunk transportation in a unified transportation network. Most pipelines are used by their owners to transport their own products. Pipeline transportation not only has a large transportation volume, continuity, speed, economy, safety and stability, but also has the advantages of low investment, small land occupation, low cost, and can achieve automatic control.

In addition to being widely used for long-distance transportation of oil and natural gas, pipelines can also transport minerals, coal, building materials, chemicals, and grains. Pipeline transportation can save transit time for water or land transportation, shorten transportation cycles, reduce transportation costs, and improve trans portation efficiency. So in the construction of pipelines, there are very strict requirements, such as the need for leak detection and azimuth detection of pipeline laying, among which pipeline horizontal detection is a very important indicator.

Usually, a level meter is used to detect the level of pipelines, but the level meter can only know the level of pipeline laying and cannot quantitatively measure it. Therefore, there are significant defects. Therefore, pipeline construction personnel introduced inclination sensors to measure the level of pipelines through inclination sensors. It can not only qualitatively perceive the level of pipeline laying, but also quantitatively determine the current elevation angle of the pipeline, making detection more convenient.

Bridge construction

By placing static levels and inclination sensors on the entire bridge, the settlement and inclination of the main body of the bridge are monitored respectively, and the settlement and angle data are monitored in real time through the master control computer and mobile phone. Provide early warning of on-site construction conditions, and use intelligent monitoring of sensors to minimize safety risks and hidden dangers in bridge construction.

Bridge construction

Case 1: Dam tilt monitoring

The inclination monitoring of the dam uses fixed inclinometers with a range of ±30° and a sensitivity of ≤9″. The fixed inclinometers are arranged in the longitudinal direction of the dam in the concrete core wall and on the downstream side of the dam. A total of three sections are arranged, respectively. They are dam cross 0+021.00, dam cross 0+041.00, and dam cross 0+061.00. Fixed inclinometers are arranged at 5m intervals along the elevation direction of a section. All equipment installation elevations and pipe mouth elevations can be appropriately adjusted and made according to the site conditions. Accurate records. The dam body inclinometer tube and SC50 steel pipe work together as a signal cable protection tube. Each set of signal cables is combined with an SC50 protective steel pipe outside the dam body inclinometer tube. The number of signal cables and protective steel pipes can be determined according to actual occurrences. Adjust appropriately. Flat steel is used to reliably connect the protective steel pipe, data acquisition box shell and dam lightning protection grounding system.
Both the flat steel and the protective steel pipe need to be hot-dip galvanized.

Bridge construction

Case 2: Remote dynamic monitoring of tilt and settlement of urban and rural buildings using T7-C inclination angle

Product application scenarios and solutions

The houses built in China in the 1970s, 1980s and early 1990s have entered the middle and late stages of use. Increased safety hazards caused by aging components and inadequate maintenance, coupled with factors such as man-made demolition and modification during use and the natural environment, have increased the pressure on safe management of houses. At the same time, due to the influence of the "emphasis on construction and neglect of management" mentality, the management of in-use houses has been neglected for a long time. Information on the demolition and modification of the house, changes in use functions, disasters, and damage status are nowhere to be found, which brings troubles to the management of the house.

The existing Class C dilapidated buildings have certain utilization value, and most of them do not have the conditions to stop use or be completely demolished. Some Class C dilapidated buildings have complex usage environments and site conditions, making it difficult to implement reinforcement measures. Houses and residents' concern about the quality of their houses has always been a focus, especially during severe weather such as typhoons, strong winds, and heavy rains. The total number of Class C dilapidated buildings is large and scattered.

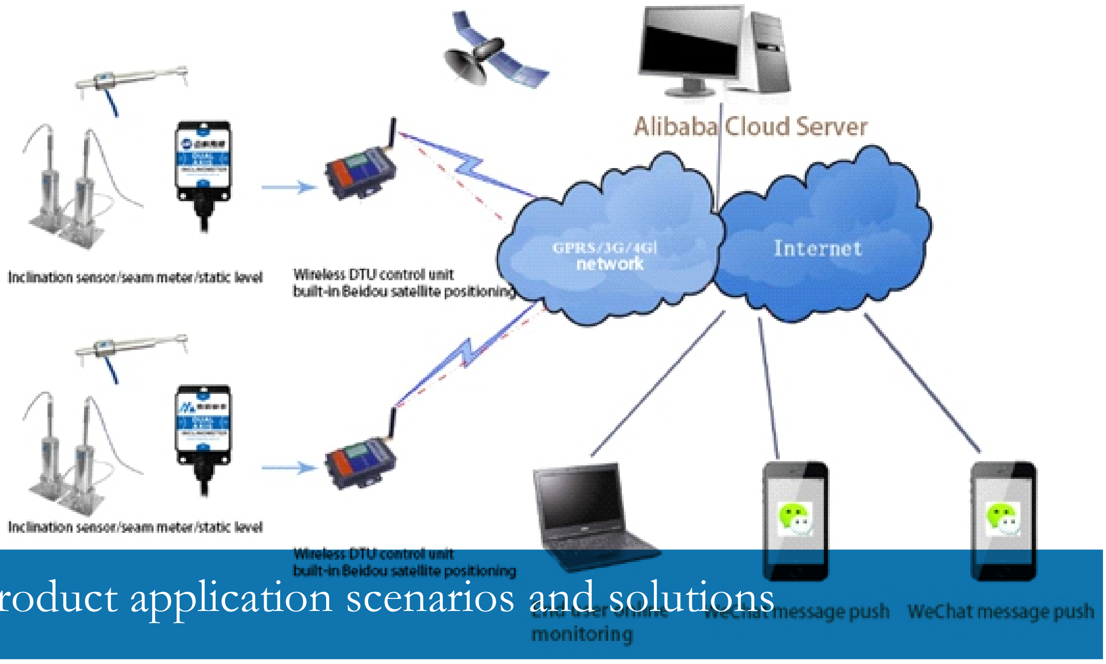
It is very difficult to rely on the competent authorities or communities for daily inspections. There is also a lack of relevant professional knowledge and comprehensive research and judgment capabilities. It is imperative to establish a dynamic remote automatic monitoring system for dangerous buildings.

To implement dynamic monitoring, daily, weekly, monthly and other systems can be selected according to actual needs, so that monitoring of real-time dynamics and risk avoidance measures (organizing personnel to evacuate in advance in times of crisis) are well-founded. Through the dynamic remote automatic monitoring system, managers can clearly see the basic information of the house, real-time on-site monitoring data (house settlement, tilt, cracks, etc.) and risk avoidance suggestions.

The company's system is a high-rise building monitoring solution based on Beidou high-precision positioning technology: it can dynamically monitor the tilt and settlement of high-rise buildings in real time, and is compatible with traditional sensors such as levels, acceleration sensors, and inclinometers.

Bridge construction

Case 2: Remote dynamic monitoring of tilt and settlement of urban and rural buildings using T7-C inclination angle



Product application scenarios and solutions

By installing inclination sensors on the four corners of hazardous houses (buildings), we can obtain the inclination data of the building; installing static levels at the foundation of the building to obtain the settlement data of the building; and installing seam meters at cracks in the wall. , obtain wall crack width data. All sensor data are regularly sent to the cloud server for storage through the GPRS wireless network of the wireless DTU control unit, and then the client summarizes and analyzes the data through remote monitoring software to obtain the changes in tilt, settlement, and defects of the building for dynamic identification.

1. Monitoring system module function: Authorized system users can provide online monitoring services 365*24 hours a year through the building tilt remote monitoring system center server and networking with the building's wireless terminal module.

→ Real-time monitoring: The computer in the remote monitoring center regularly inspects various sensors on each building, and remotely transmits the data collected by the sensors to the backend data center wirelessly to achieve the purpose of active monitoring and real-time monitoring.

→ Timely alarm: Once the data collected by each sensor of the building is greater than the safe value, the background system will actively send alarm information. The alarm method supports the following multiple methods: computer system alarm, WeChat public account alarm to the mobile phone of the designated person in charge, etc. to ensure that maintenance personnel receive the information and handle it in a timely manner.

Remote login: This system uses cloud platform data management technology. System maintenance personnel can log in to the monitoring system from any computer in China with Internet access to query the tilt indicators of the monitored building, and view equipment information anytime and anywhere.

Hierarchical management: The monitoring system supports hierarchical management of users. The system can set up multiple users and different levels of management permissions to support users with different permissions to view and maintain their own devices. That is, the general administrator can manage all devices, while the bottom-level administrator can only view the devices within their own management area, which is great.

Bridge construction

Case 2: Remote dynamic monitoring of tilt and settlement of urban and rural buildings using T7-C inclination angle

Product application scenarios and solutions

Convenient device management.

→ Information query: The monitoring system supports real-time monitoring information query and historical monitoring information query. Provide scientific basis for managers to conduct systematic analysis of building safety conditions.

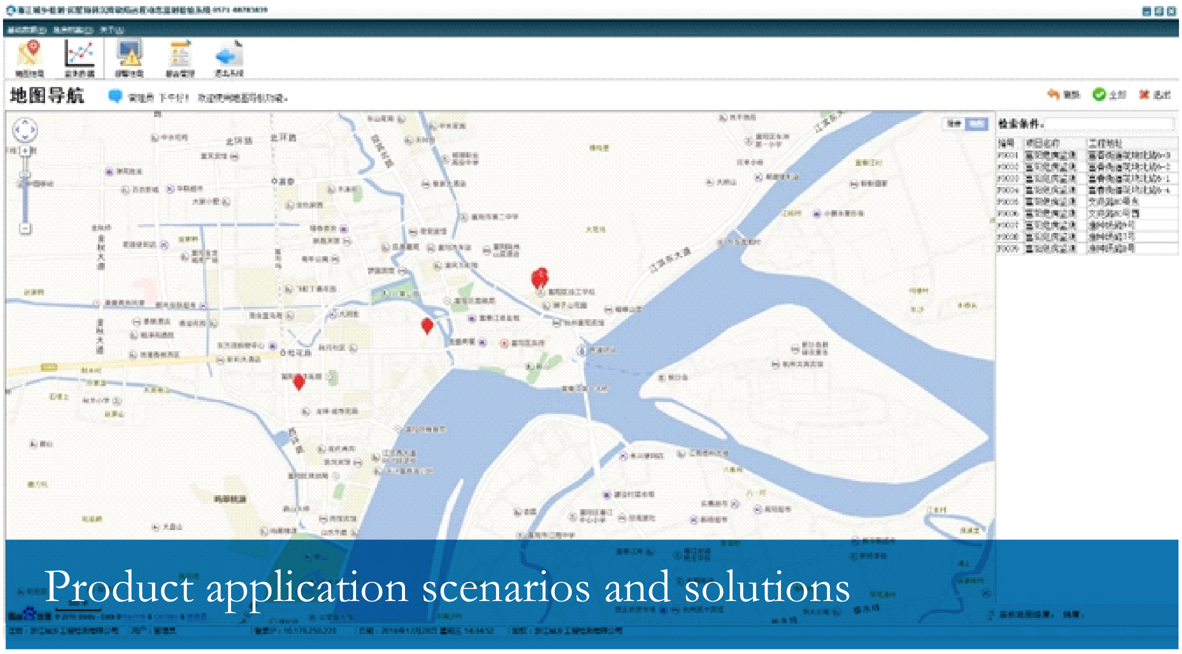
→ Remote management: Supports remote restart, remote upgrade, remote configuration and other functions of equipment, saving maintenance personnel time, reducing the workload of maintenance personnel repeatedly visiting the site, and also greatly saving maintenance costs.

→ Massive operation: This monitoring system supports thousands of sets of equipment running online at the same time. At the same time, system engineers will monitor the status of system operation in real time and make reasonable optimizations in a timely manner.

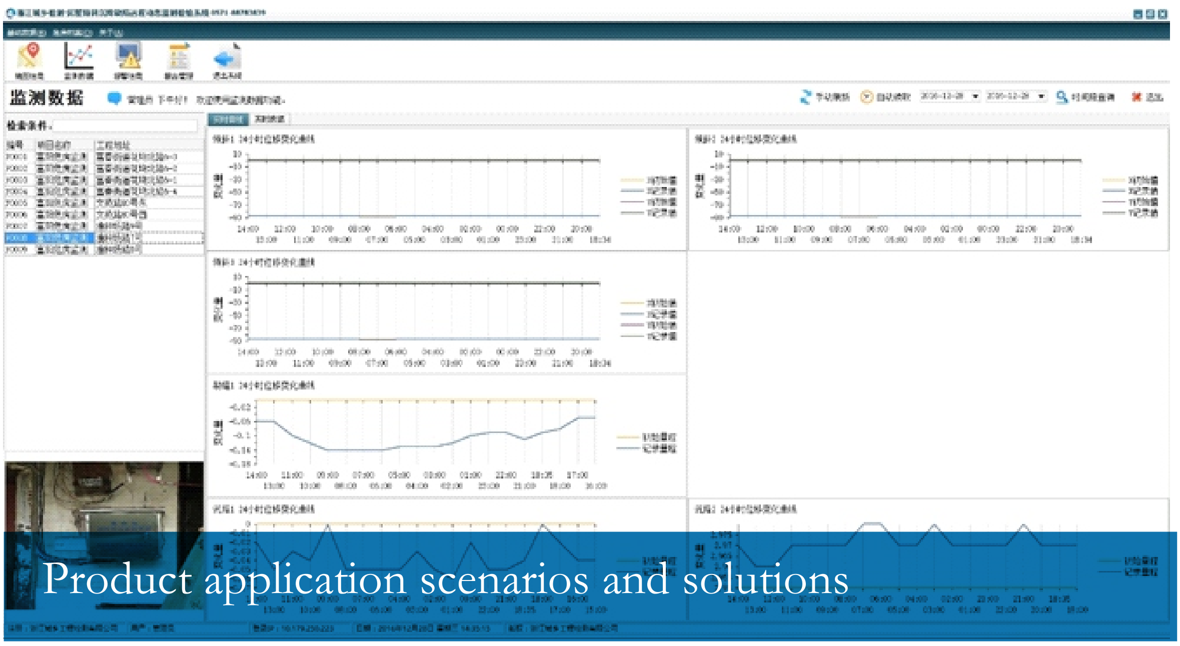
2. Monitoring system screen, sensor installation

Bridge construction

Case 2: Remote dynamic monitoring of tilt and settlement of urban and rural buildings using T7-C inclination angle

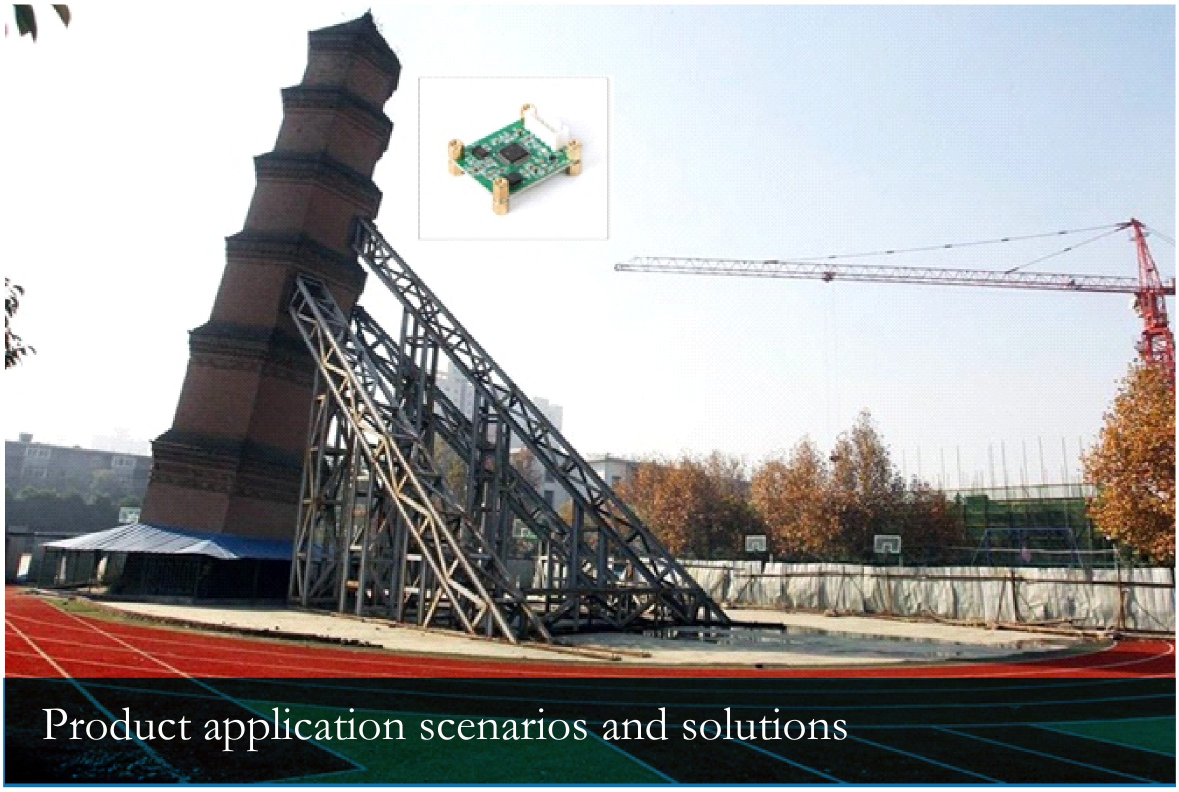


Using GPS and DTU automatic real-time monitoring equipment, inclinometers, crack meters and other special monitoring equipment and real-time dynamic monitoring and management platforms, the data of D-level and Class I dangerous buildings is monitored every hour; the data of C-level and Class II dangerous buildings is monitored every two hours, such as Due to typhoons and weather changes, as well as government requirements, data can be monitored every 2 to 5 minutes for Class I dangerous buildings and Class II dangerous buildings, and technicians can be on duty remotely at the same time.



Bridge construction

Case 3: Application of inclination sensor in inclination measurement of towers and buildings

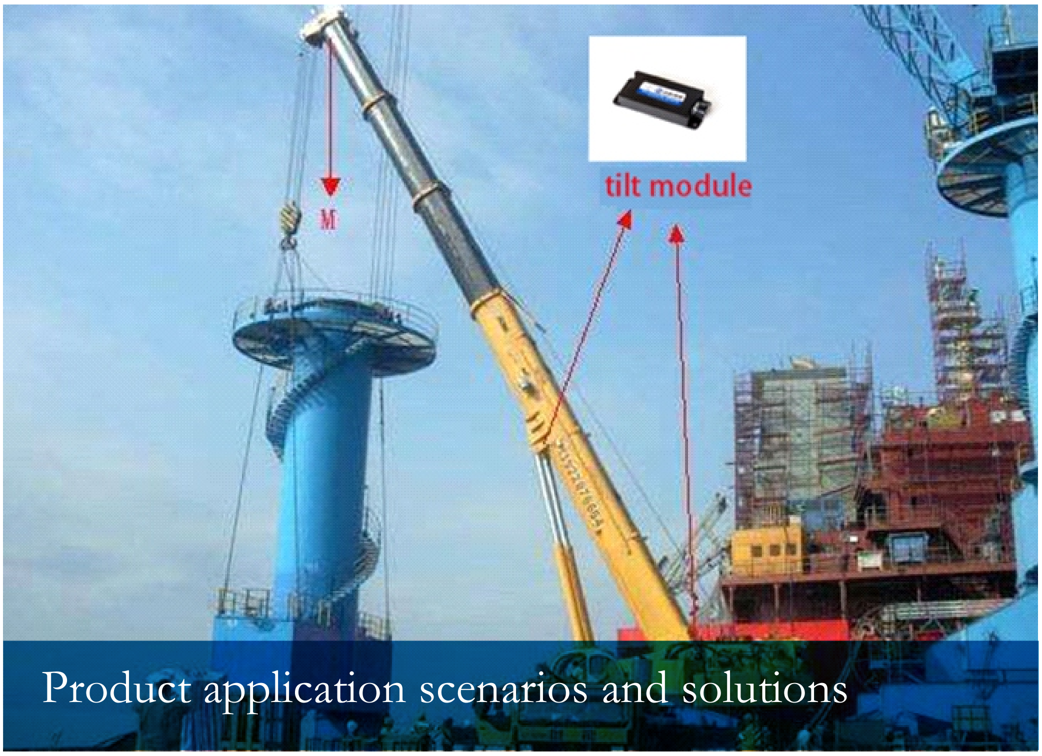


The story of two iron balls landing at the same time tells us about the famous Leaning Tower of Pisa. It is located in the small town of Pisa, Italy. It is an ancient tower built of white marble. It was built in 1173 and is 79 meters high.
The ruler has tilted many times since it was built, and ordinary people can detect it with just their eyes. We know that the tower body will tilt slightly when the tower or building is under construction or due to the influence of external factors for a long time. If the tilt is serious and reaches a certain angle, it will collapse.
To prevent and monitor the inclination of towers and buildings, we can install inclination sensors on the objects that need to be monitored. The 3D MEMS sensor technology of BREEZE CO.,LTD inclination sensor, biaxial measurement, can measure the inclination angle of the top plane. It can detect the tilt status of the tower in real time by converting it into the tilt orientation of the tower. It can also be output to the display instrument in real time, and can even be connected to the PLC control system and system computer to not only measure the tilt angle of the building, but also An indispensable equipment to implement the tower tilt measurement system.

BREEZE CO.,LTD sensors are produced using the original VTI production line in Finland. All products undergo strict zero point, sensitivity and temperature calibration, making them suitable for applications with relatively high accuracy requirements. All products are fully automatically produced in batches with good consistency. This product is a PCBA type inclination sensor that can be easily integrated into the customer's system.

Bridge construction

Case 4: Analysis of anti-overturning monitoring of bridge erecting machines based on inclination sensors



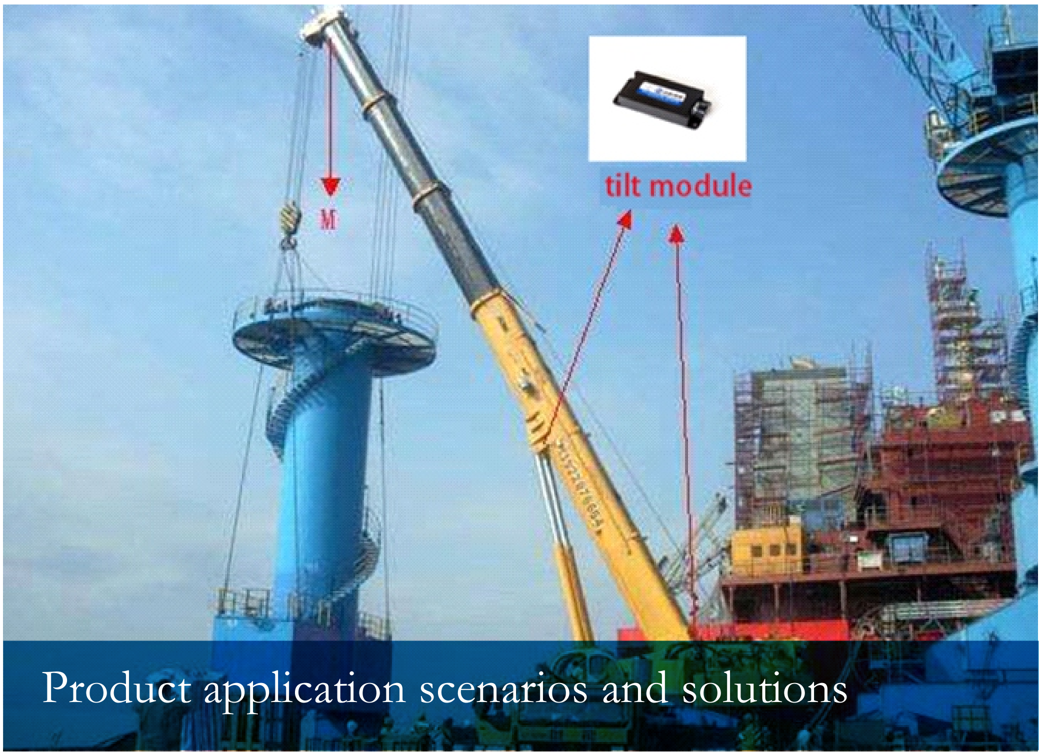
As bridge erecting machines are used more and more frequently in railway construction, overturning accidents of bridge erecting machines occur from time to time. The anti-overturning device of the bridge erecting machine came into being. The device consists of two parts: the pathfinder wheel loading system and the monitoring and control system, and is installed in front of the bridge erecting machine.

The inclination sensor can detect at any time the longitudinal and transverse inclination angles of the pathfinding wheelset and bridge erecting machine frame caused by the subsidence of the roadbed. Under the action of the pathfinding wheelset, if the subsidence of the roadbed exceeds the specified value, or the inclination of the left and right tracks exceeds the specified value, the monitoring and control system will alarm in time, cut off the power of the drive motor, and use the braking system to make the frame Emergency braking of the bridge machine ensures that the bridge erecting machine does not enter unfavorable areas and prevents the bridge erecting machine from overturning.

Sensor H1 detects the lateral inclination of the tie rod between the left and right pathfinding wheels, indicating the lateral inclination of the line caused by uneven subsidence of the roadbed; sensor H2 detects the actual lateral inclination of the vehicle body; sensor L1 detects the actual longitudinal inclination of the vehicle body; sensor L2 detects the actual longitudinal inclination of the vehicle body; The longitudinal inclination angle of the lower arm of the overturning device; the difference between the longitudinal inclination angles measured by sensor L2 and sensor L1 represents the subsidence amount of the roadbed under the vertical load exerted by the pathfinder wheel loading system (compared with the subsidence of the roadbed caused by the wheel set of the bridge erecting machine). Equivalent in quantity), used to measure the compactness of the roadbed. Compare each of the above measured quantities with their respective thresholds determined through research to determine whether the compactness of the roadbed meets the requirements, that is, whether the bridge erecting machine can pass safely.

Bridge construction

Case 4: Analysis of anti-overturning monitoring of bridge erecting machines based on inclination sensors



The T7000-A series dual-axis inclination sensors are based on MEMS technology. The products have analog output and digital output such as RS485, RS232, CAN, etc., and have high accuracy, vibration resistance and long-term stability. In the temperature range of -40 - 85° C, the zero point drift is less than 0.2° , the measurement range is 0 - ±90° , the nonlinearity is better than 0.01° , and the repeatability is excellent. Since the sensing unit adopts self-developed anti-vibration technology, it solves the problem of large data changes of the tilt sensor in a vibration environment. The module is not sensitive to vibration and can withstand impacts higher than 10,000g.

Case 5: Inclination sensor application in water conservancy and hydropower dam monitoring system

Product application scenarios and solutions

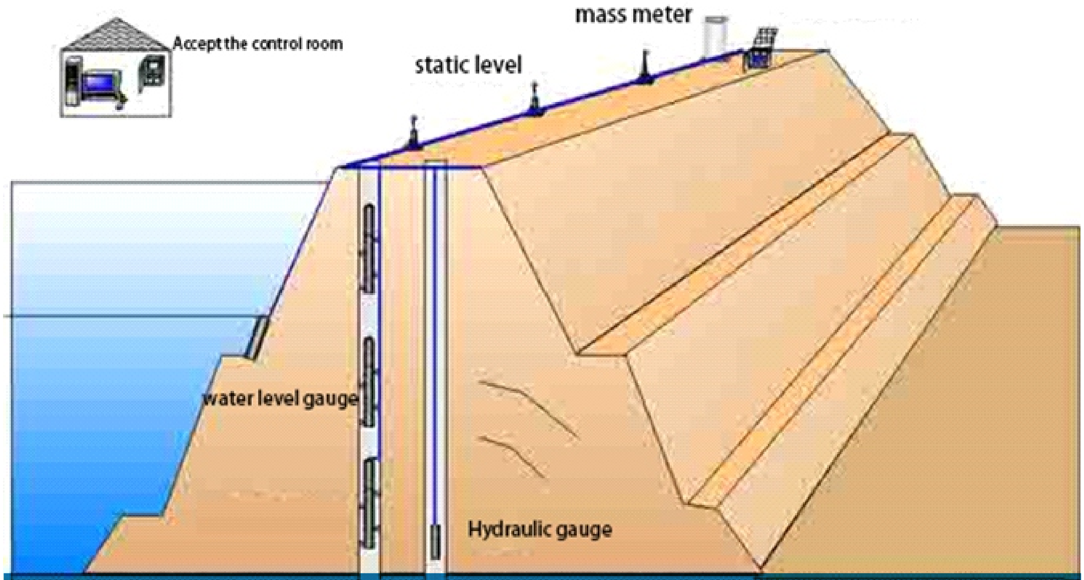
The safety of hydropower dams not only directly affects the efficiency of the power plant itself, but is also closely related to the lives and property of downstream people, national economic development and the ecological environment. With the development of electronic technology and the promotion and application of digital communication technology, monitoring automation has been provided. At present, the automation of dam monitoring in the national power system has been fully launched and is developing in the direction of networking and intelligence

Main monitoring items and equipment:.

m height (m	Monitoring project dam type	Horizontal displacement	vertical displacement	Drift amount	Yang pressure	dam body stress	Dam body temperature	Steel stress	Bedrock deformation	crack	seam	earth pressure	sediment pressure	Reservoir water temperature	water level
<70	dome	△	△	△	√	√	△		△	△	△		√	△	△
	gravity dam	△	△	△	△	√	√	√	√	△	△	√	√	△	△
	buttress dam	△	△	△	√	√	√	√	√	△	△	√	√	△	△
	lock	△	△	△	√	√	√	√	√	△	△	√		√	△
	sluice gate	△	△	△	△	√	△	√	√	△	△			√	△
>70	dome	△	△	△	√	△	△	√	△	△	△		△	△	△
	gravity dam	△	△	△	△	△	△		△	△	△	△	△	△	△
	buttress dam	△	△	△	√	△	△	√	△	△	△	△	△	△	△
	lock	△	△	△	△	√	△	△	△	△	△	△		△	△
	sluice gate	△	△	△	△	√	△	△	△	△	△			△	△

Note: "√" Indicates recommended observation items; "△" Indicates items that must be observed

Case 5: Inclination sensor application in water conservancy and hydropower dam monitoring system



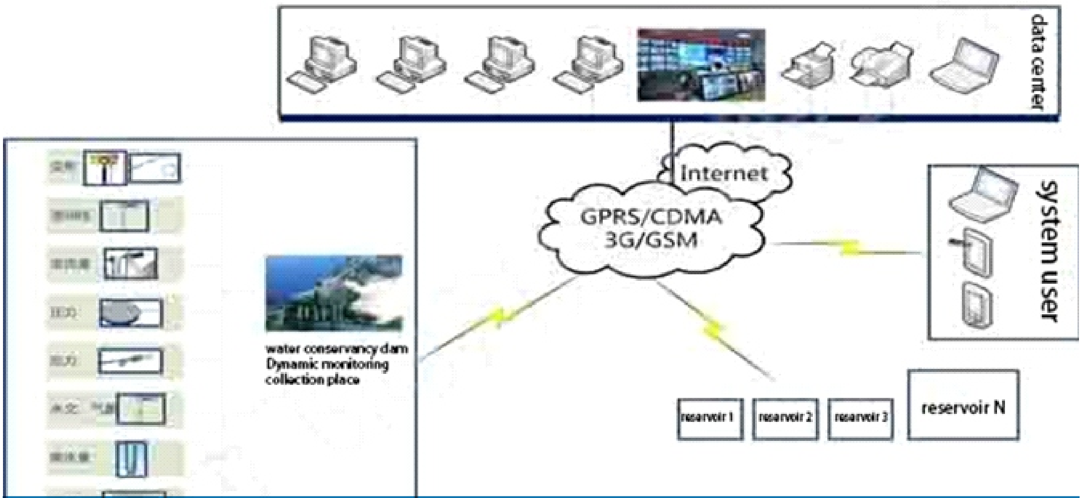
Product application scenarios and solutions

1. Deformation monitoring

Dam deformation is an important monitoring item for hydropower station dams. It can be divided into two sub-items: horizontal displacement and vertical displacement. Most dams are equipped with horizontal and vertical displacement observation on the dam top, and usually one pair of measuring points is set up in each dam section. In recent years, more attention has been paid to the horizontal displacement observation of typical dam sections, and more than three measuring points are generally arranged along the dam height.

Dam deformation monitoring equipment can choose tensile wires, GPS, fixed inclinometers, inclinometers, static levels, etc.

Case 5: Inclination sensor application in water conservancy and hydropower dam monitoring system



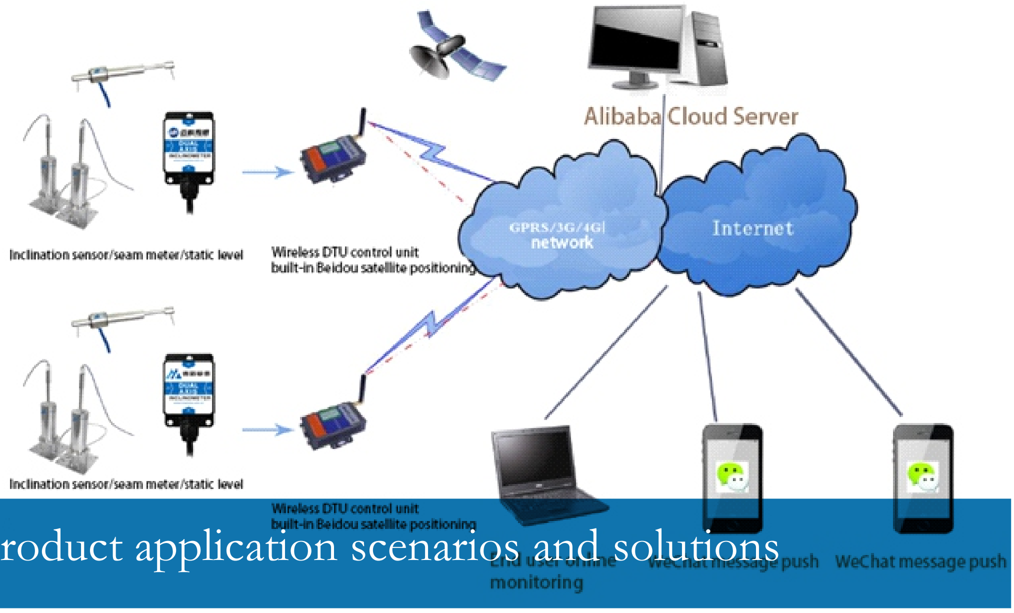
Product application scenarios and solutions

2. Seepage
Dam seepage is also one of the important monitoring projects of hydropower station dams. It can be divided into two sub-items: seepage pressure and seepage volume. The observation facilities of the concrete dam are located in the foundation corridor, with one measuring point for each dam section for uplift pressure; the seepage flow measuring points are determined based on the water collection conditions of the drainage ditch, and generally the regional flow rate and total volume can be measured. The seepage flow of earth-rock dams is observed at the seepage collection point at the dam toe, and the seepage pressure measuring points are arranged below the wettability line of the dam body or behind the toe plate according to the specific dam type. In addition, groundwater level observation projects are also set up on the slopes on the left and right sides of the dam to monitor seepage around the dam.
The main detection equipment for dam seepage monitoring is piezometer.

3. Vipassana items such as stress and strain
Internal observation projects such as dam stress and strain are general observation projects for hydropower station dams. Only some important measurement points are included in automated monitoring. Many medium and low dams have stopped measuring or sealed such observation projects. Internal observation items such as stress and strain are commonly used in the dam construction stage. Commonly used monitoring equipment include embedded strain gauges, steel bar gauges, etc.

Bridge construction

Case 6: Rail transit subgrade settlement monitoring solution



Product application scenarios and solutions

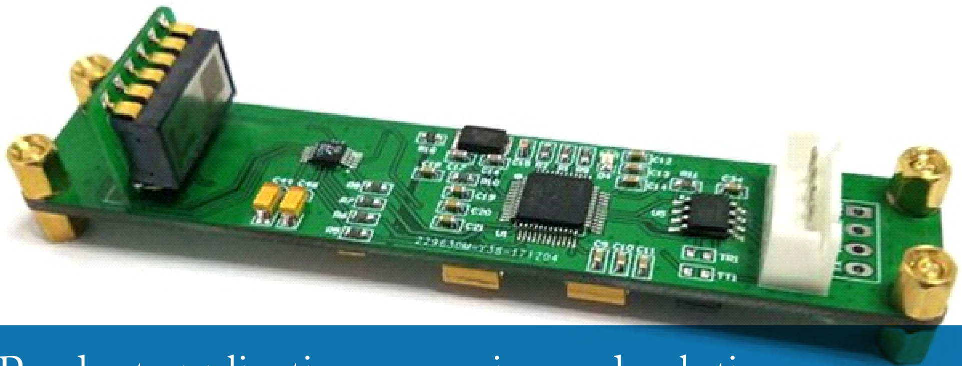
Solution applicable scenarios:
This solution mainly solves the problems of untimely collection of track environment monitoring data, lagging monitoring information, and difficulty in equipment management and line operation management.

This solution can be applied to:
1. Deformation monitoring and settlement monitoring of subway tunnel subgrade, railway subgrade and high-speed railway bridge subgrade during operation period
2. Deformation monitoring and settlement monitoring of railway subgrade when shield tunnels penetrate the surface
3. Deformation monitoring and settlement monitoring of high-speed railway bridge subgrade when shield tunnels penetrate the surface
4. Monitor deformation and settlement of surrounding large structures, highways/urban roads, bridges/ culverts and other roadbeds during construction
5. Real-time monitoring can be carried out not only during the construction of rail transit line projects, but also during the post-construction line operation stage.

The entire solution takes the monitoring and early warning cloud service platform as the core, and uses the mobile Internet as the information transmission carrier to connect the real-time interaction of information between sensor equipment and users. This solution realizes the long-term and continuous collection and transmission of information reflecting the geotechnical safety status, changing characteristics and development trends of rail transit lines, and carries out the entire workflow of statistical analysis, information feedback, and safety warnings.
Ensure that the technology is mature, the economy is reasonable, and the plan is reliable to ensure the safe operation of people, property, and transportation lines in the engineering structure and surrounding environment.Scheme diagram:
This solution is an overall monitoring information solution, consisting of three parts: monitoring equipment, communication network, and monitoring and early warning cloud service platform.

Case 6: Rail transit subgrade settlement monitoring solution

Introduction to core monitoring equipment: T700-A



Product application scenarios and solutions

Monitoring items and monitoring instruments:

Monitoring items	Monitoring instrument
Horizontal displacemen	convergence meter
vertical displacement	static level
Deep horizontal displacement	Fixed inclinometer
Soil layered vertical displacement	Electromagnetic sedimentation meter
tilt	Inclinometer
crack	seam gauge
pore water pressure	osmometer
groundwater level	water level gauge
rock pressure	earth pressure gauge
Anchor cable and soil na tension	Dynamometer
structural stress	Strain gauge, steel bar gauge

Bridge construction

Case 6: Rail transit subgrade settlement monitoring solution

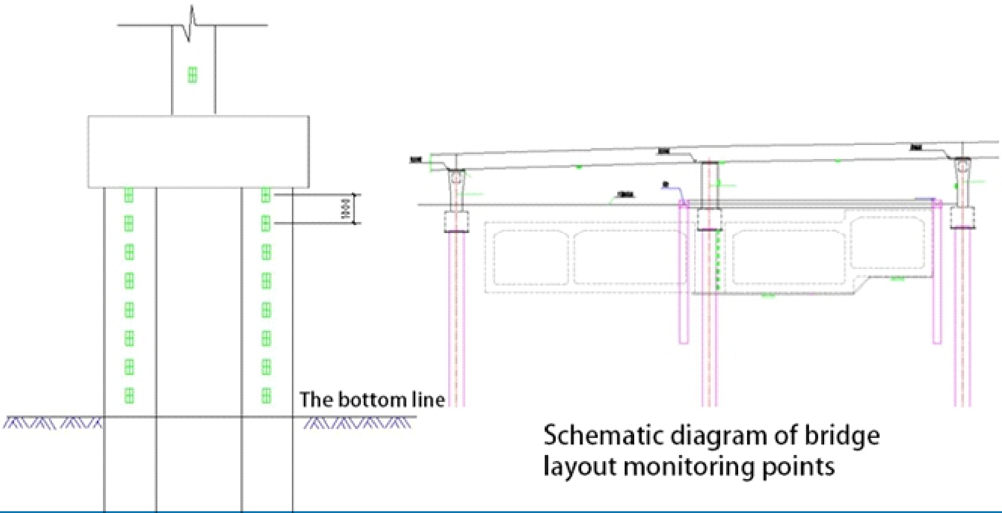
Railway line settlement observation

Implementation function:

1. 24-hour real-time monitoring: Through real-time online monitoring of supporting structures, surface settlement, inclination of retaining piles, etc., the structural changes of the building foundation pit can be grasped in real time.
2. Report push: Monitoring results are displayed and released in real time, and monitoring reports are pushed to users regularly.
3. Multiple graded early warning: Establish a three-level alarm mechanism. When abnormal data is detected, users will be notified immediately through SMS, fax, broadcast, etc., to achieve a comprehensive early warning function.
4. Emergency plan processing: directly extract corresponding processing methods from the expert system, and take timely measures such as personnel intervention and road blockade to eliminate potential safety hazards in the bud.
5. Structural trend analysis: Through monitoring data analysis and safety evaluation during the foundation pit construction period, structural stability trend analysis can be achieved.
6. Historical data storage: The storage of monitoring data provides an analogous basis for the design and construction of similar projects in the future.

Bridge construction

Case 7: Automated monitoring of settlement inclinometer to ensure construction and operation of bridge foundation pits



Schematic diagram of bridge layout monitoring points

Product application scenarios and solutions

solution

According to the conditions of the bridge and excavation of the foundation pit, we set up monitoring points on the bridge piers and beams. In order to ensure the smooth progress of the project construction, we communicated with the owner many times to design and optimize the construction plan, and independently developed an automated remote settlement system for tilt settlement of building structures. The monitoring system monitors the settlement and inclination of the main body of the bridge by installing static levels and inclination sensors on the entire bridge. It monitors settlement and angle data in real time through the main control computer and mobile phone, and provides early warning of on-site construction conditions. With the help of intelligent monitoring by sensors, Minimize safety risks and hidden dangers in bridge construction. There are two GNSS monitoring stations arranged on the bridge part, namely GNSSA1 and GNSSA1 monitoring points on the main span 1/2.

The specific layout location is shown in the picture on the right:

Bridge construction

Case 7: Automated monitoring of settlement inclinometer to ensure construction and operation of bridge foundation pits

Technical advantages
BREEZE CO.,LTD automated building structure tilt and settlement remote monitoring system can accurately disp the deformation of large bridges in real time. Over the years, we have gained market share and accumulated a lot of successful experience. This also promotes the scientific, informatization, standardization and visualization of large bridge structural health monitoring systems, effectively ensuring the safe operation of large bridges.

Tilt angle switch - hydraulic automatic horizontal control system for dragging agricultural machinery

By monitoring the current angle of the lifting tool through an inclination sensor, controlling the on-off of the solenoid valve through a relay, and adjusting the lifting tool to reach a horizontal posture through the hydraulic system, automatic horizontal adjustment is achieved, greatly improving the efficiency of farming.

Agricultural Equipment

Case 1: Application of Inertial Navigation System in Precision Agriculture and Autonomous Driving Agricultural Machinery Industry

Product application scenarios and solutions

At present, the research on autonomous navigation systems for agricultural machinery in China mainly focuses on satellite navigation systems and inertial navigation systems. The inertial navigation system is mainly used to assist in determining the walking direction of agricultural machinery. This system is composed of accelerometers, gyroscopes and microprocessors, navigation algorithms, power supply systems, etc. Its basic principle is to use inertial components such as gyroscopes and accelerometers to sense the acceleration of the moving object during the motion process, and calculate the position, velocity, and Navigation parameters such as orientation. Sensors in inertial navigation systems can detect the azimuth and attitude of agricultural machinery vehicles to assist in positioning information, which includes three parameters: azimuth, roll angle, and pitch angle.

Recommended products:I6000 MEMS-INS

Main features of the product

→Build high-precision real-time heading and attitude integrated navigation settlement output

→Fast directional speed and strong anti-interference ability

→Equipped with yaw angle output, especially capable of providing accurate heading and yaw angles for drones, aerostats, etc

Agricultural Equipment

Case 1: Hydraulic automatic leveling control system for agricultural machinery

The tilt switch developed by BREEZE CO.,LTD - the automatic control system for dragging agricultural machiner suspension level has achieved good market response since entering the market. The system detects the current angle of the lifting tool through a tilt sensor, controls the on-off of the solenoid valve through a relay, and then adjusts the lifting tool to reach the horizontal state through a hydraulic system.

The main characteristics of the electronic control system of this system are:

1. There are two modes available: manual mode and automatic mode
2. Sensitivity of reactions can be set
3. It is possible to set the horizontal range size
4. You can choose whether it is an internal angle sensor or an external sensor based on the specific status
5. Wide voltage DC9-36V input, effectively eliminating the impact of power supply voltage changes on the circuit
6. High waterproof level, able to effectively adapt to various harsh environments
7. Has strong seismic performance

After the tractor is installed with the automatic leveling system produced by our company, the position of the agricultural tools can be automatically adjusted horizontally, even in a tilted state, which greatly improves the efficiency of plowing. Practice is the only standard for testing products. Since its use, products have maintained good stability and surface products can withstand market inspections. Our company will strive to innovate and develop more comprehensive products to repay customers based on our existing achievements.

Subsidence and tilt monitoring

The inclinometer and settlement sensor integrates a dynamic remote automated incline and settlement monitoring system, which can monitor the settlement, tilt, cracks and other data of buildings in real time and provide hazard avoidance suggestions, reducing manual measurement errors.

Subsidence and tilt monitoring

Case 1: Hydraulic automatic leveling control system for agricultural machinery

1. Project Overview

The total length of the underground comprehensive pipe gallery project of a certain avenue and Tongjiang Avenue in China is 6,400 meters (of which the avenue comprehensive pipe gallery is 4,635 meters long and the Tongjiang Avenue comprehensive pipe gallery is 1,765 meters long), with a double-cabin structure, the cabin is 3.1 meters high, the comprehensive cabin and the power cabin The width is 2.6 meters; there are four pipelines entering the corridor: electricity, water supply, reclaimed water, and communication; the project consists of standard sections, ventilation openings, feeding openings, pipeline leads, introductions, substations, inverted rainbow sections and other nodes. The main construction contents include overall engineering, structural engineering, fire protection system, drainage system, ventilation system, monitoring and alarm system, power supply and distribution system, etc.

This plan intends to carry out automated monitoring of the settlement, tilt and vibration of the comprehensive pipe corridors of Jiangzhou Avenue and Tongjiang Avenue.

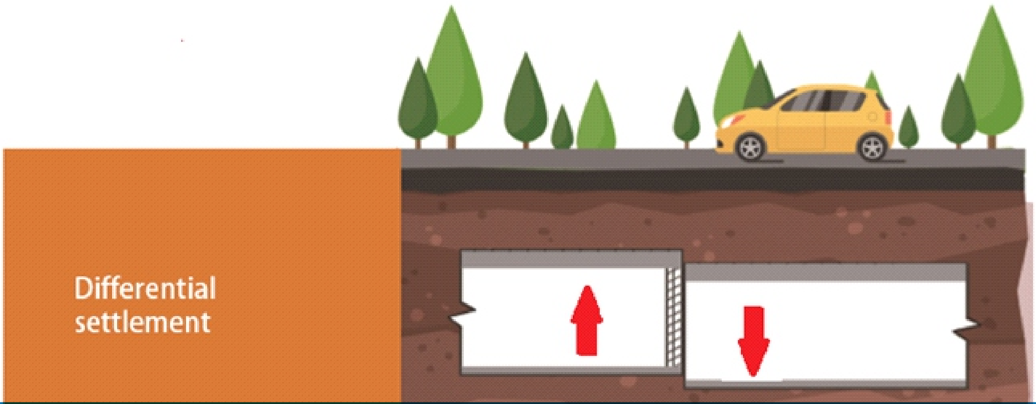
2 Monitoring purpose and basis

2.1 Monitoring purpose

The underground comprehensive pipe corridor is a structure that is shallowly buried underground. It is easily affected by the artificial environment and the natural environment, causing uneven settlement, tilt or vibration damage, resulting in structural fatigue damage, cracking, water seepage and other problems. Therefore, it is necessary to repair the pipe corridor The settlement, inclination angle and vibration are monitored. Automated monitoring has the advantages of high frequency, saving time and effort, and is an important measure to ensure the structural safety of pipe corridors.

Subsidence and tilt monitoring

Case 1: Hydraulic automatic leveling control system for agricultural machinery



Product application scenarios and solutions

The municipal comprehensive pipe gallery is a long strip frame structure, so uneven settlement will have an extremely important impact on the pipe gallery:

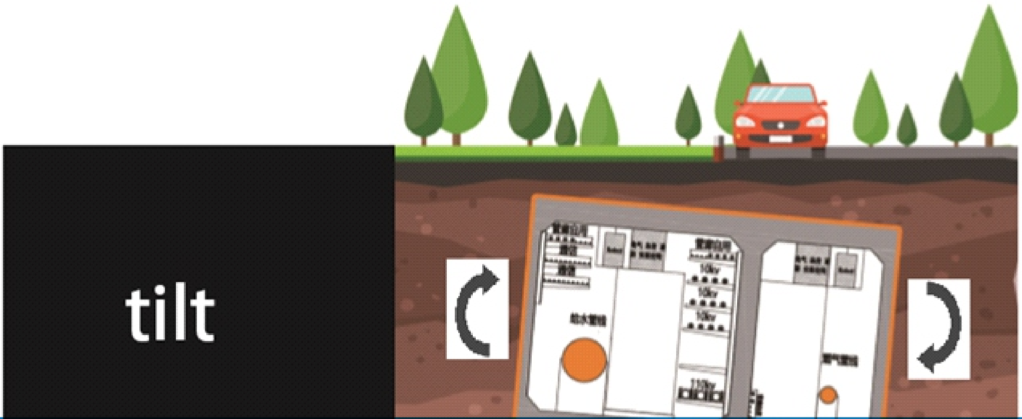
1. Comprehensive pipe corridors are usually equipped with expansion joints at regular intervals. If uneven settlement occurs, the expansion joints will easily be dislocated and deformed. In severe cases, the waterstops will be pulled apart and cause leakage.
2. Cast-in-place pipe galleries are prone to construction cracks (side wall cracks, etc.). If uneven settlement occurs, it will affect the bearing capacity and durability of the structure and shorten the service life of the structure.
3. If the uneven settlement is too large or subjected to external loads, longitudinal fracture may occur in serious cases.
4. Uneven settlement will cause bending and deformation of rigid pipes (such as gas, water supply, and heating pipes) in the pipe gallery. Once the allowable deformation value is exceeded, it may cause leakage of the pipeline transportation medium or even an accident.

Automated settlement monitoring can observe settlement changes in real time. When shearing occurs on the pipe wall, vertical displacement changes are bound to occur. The amount of change can be monitored in a timely manner, and improvement measures can be taken in advance based on the changes.

Inclination monitoring reflects the rotation amplitude of the pipe gallery. Excessive changes in the inclination angle indicate that the pipeline has generated a large torque force, causing torsional shear damage to the pipe gallery. Therefore, it is necessary to monitor the inclination angle of the pipe gallery. The inclination meter can monitor changes in the inclination angle in real time. Reflect the health status of the pipe gallery in real time.

Subsidence and tilt monitoring

Case 1: Hydraulic automatic leveling control system for agricultural machinery



Product application scenarios and solutions

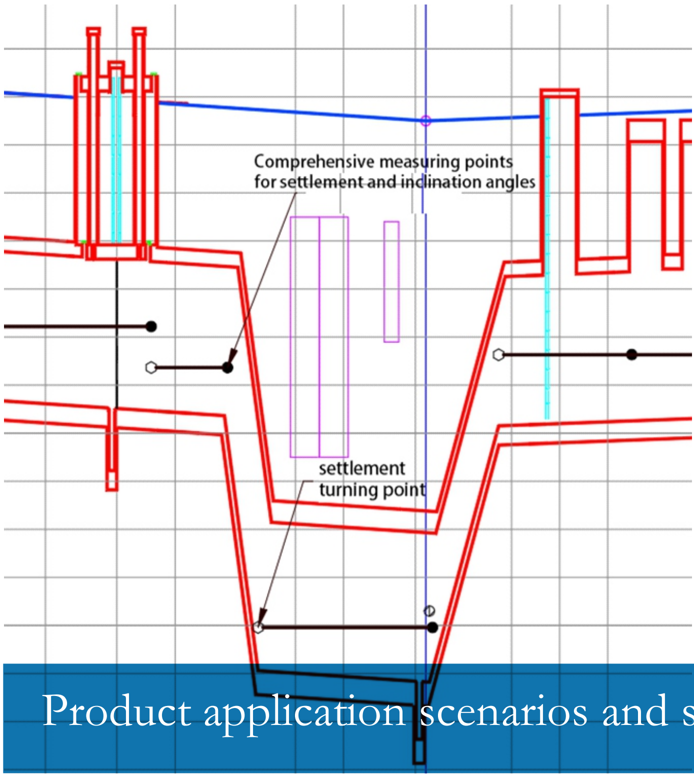
Comprehensive pipe galleries are generally buried shallowly. Strong excitation forces will be generated around the pipe gallery during vehicle operation or engineering construction. The excitation force will propagate through the surrounding soil and affect the pipe gallery, causing the pipe gallery itself to Produces fatigue and wear, shortening service life. Therefore, vibration monitoring is an important measurement item for pipe gallery structural monitoring.

Vibration monitoring reflects the impact of vibrations around the pipe gallery on the damage to the pipe gallery. The three-axis vibrometer can monitor the amplitude and frequency of the pipe gallery vibration, and set an internal alarm value to determine the magnitude of the vibration excitation to the pipe gallery. Observe the deformation of the pipe gallery in real time through automated monitoring to ensure the healthy operation of the pipe gallery structure.

The underground pipe gallery is equipped with various signal lines, heating pipes, gas pipes, telecommunications pipes, water supply pipes, electric power pipes, etc. It is a place where various signals and transmission objects meet. In order to fully ensure the safety of the environment in the pipe gallery, it is necessary to The internal environment is monitored to achieve real-time and automatic monitoring of deformation in the underground pipe gallery.

Subsidence and tilt monitoring

Case 1: Hydraulic automatic leveling control system for agricultural machinery

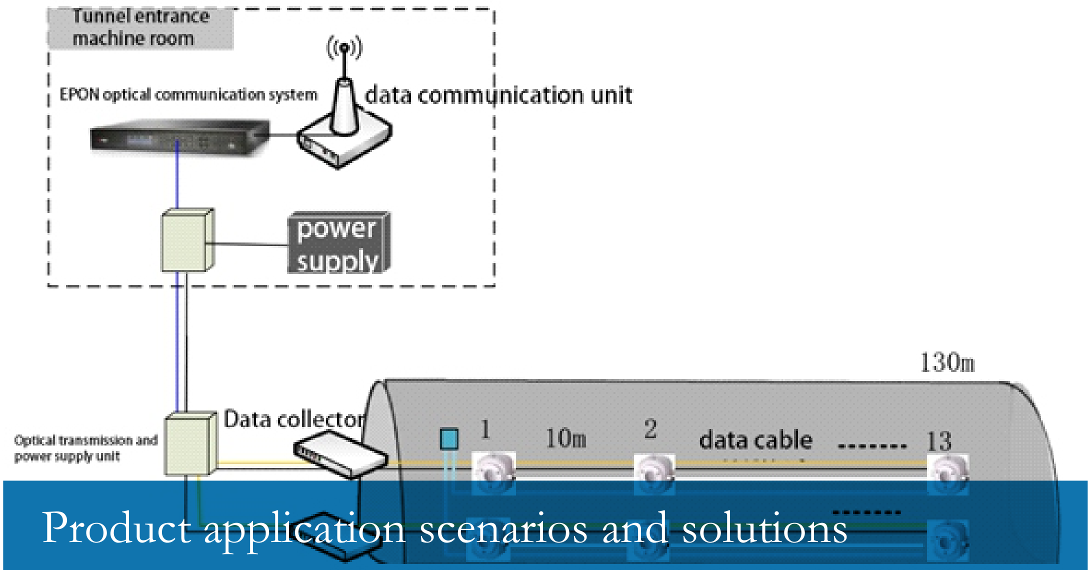


2.2 Monitoring content

Settlement monitoring uses a differential pressure settlement meter, which is installed on the side wall of the pipe gallery. One set is installed every 50 meters in the pipe gallery. Inclination monitoring uses inclination sensors, which are installed on the side walls of the pipe gallery. One set is installed approximately every 50 meters in the pipe gallery. Vibration monitoring uses a three-axis acceleration sensor, which is installed on the side wall of the pipe gallery. One set is installed approximately every 200 meters in the pipe gallery. In this plan, the differential pressure settlement meter and the inclinometer can be built into the same instrument to form a comprehensive settlement and inclination angle. Measuring instrument. The three-axis vibration meter and the comprehensive settlement and tilt angle measuring instrument should be installed at the same section. These three sensors all have RS485 bus interfaces and are connected to the RTU in the pipe gallery through the RS485 bus. The RTU is connected to the monitoring switch. Each PLC station generally has a UPS. The UPS can supply power to the RTU, and the data collected by the RTU passes through Optical cables and switches are transmitted to the control center. The Tongsen Cloud health monitoring system is installed on the computer in the control center, and a health monitoring management workstation is established. The unified management platform workstation then captures data from the health monitoring workstation, and then displays the data of each workstation in the control center. on the big screen.

Subsidence and tilt monitoring

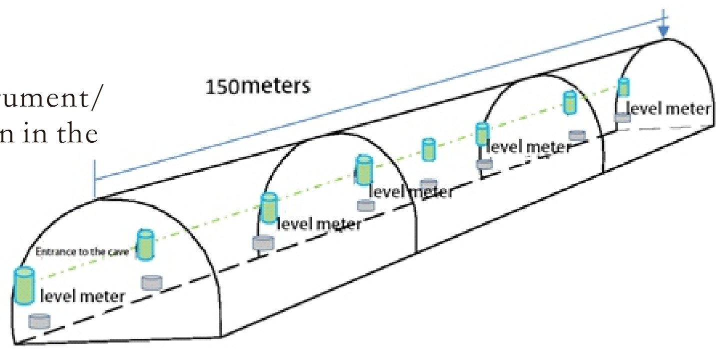
Case 2: Static level for monitoring tunnel bottom settlement and deformation



Product application scenarios and solutions

[Summary description] Within a range of 150 meters from the left and right tunnel entrances to the tunnel, static levels are evenly distributed at 10m intervals on the tunnel bottom and tunnel side lining walls to monitor tunnel settlement and vertical deformation. As shown below:

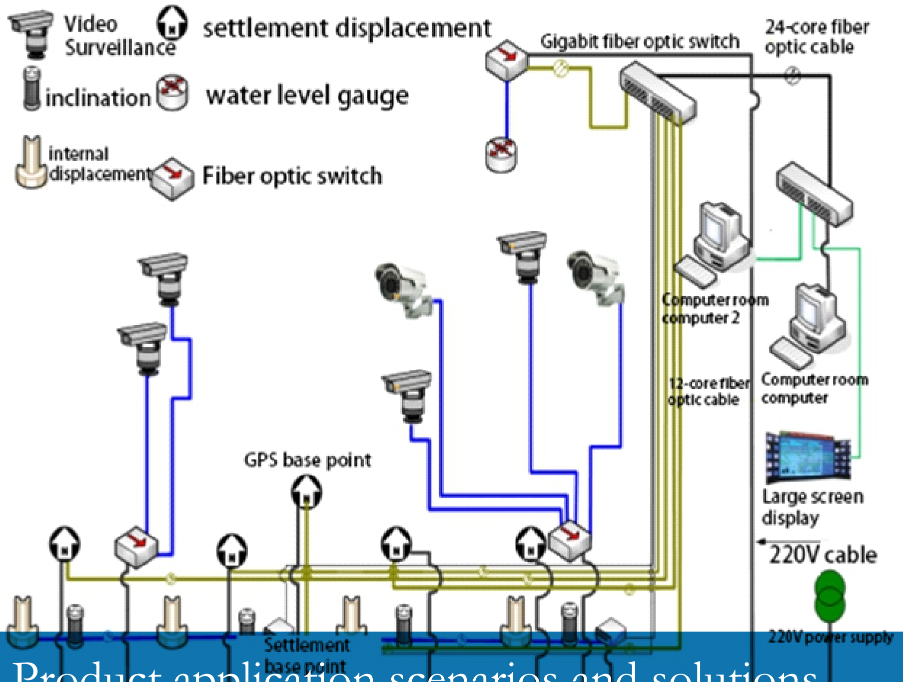
1. System composition
The longitudinal deformation monitoring of the tunnel entrance consists of a static level, a data acquisition instrument/ photoelectric transmission unit and other parts, as shown in the figure below.



2. System technical requirements
a) System monitoring indicators
b) Measuring range: 0~1000mm
c) Measurement accuracy: 0.2mm
d) Display resolution: 0.01mm
e) Working temperature range: -30~+70° C
f) Output voltage: DC12V~36V
g) RS485 digital output
h) Protection level: Ip67

Subsidence and tilt monitoring

Case 3: Safe tilt settlement and automated monitoring plan for ancient building protection



Product application scenarios and solutions

1. Overview

1.1Project status

According to my country's existing conventions in the maintenance and management technology of ancient buildings, daily inspections and regular inspections are adopted for management and maintenance. Routine inspections are mainly based on manual visual inspection, which makes it difficult to measure the structural parameters of the building; regular inspections cannot collect data continuously due to limitations such as long cycles, poor effectiveness, and insufficient timeliness, and can only provide time and space for local structural conditions. information and cannot provide an overall comprehensive status assessment.

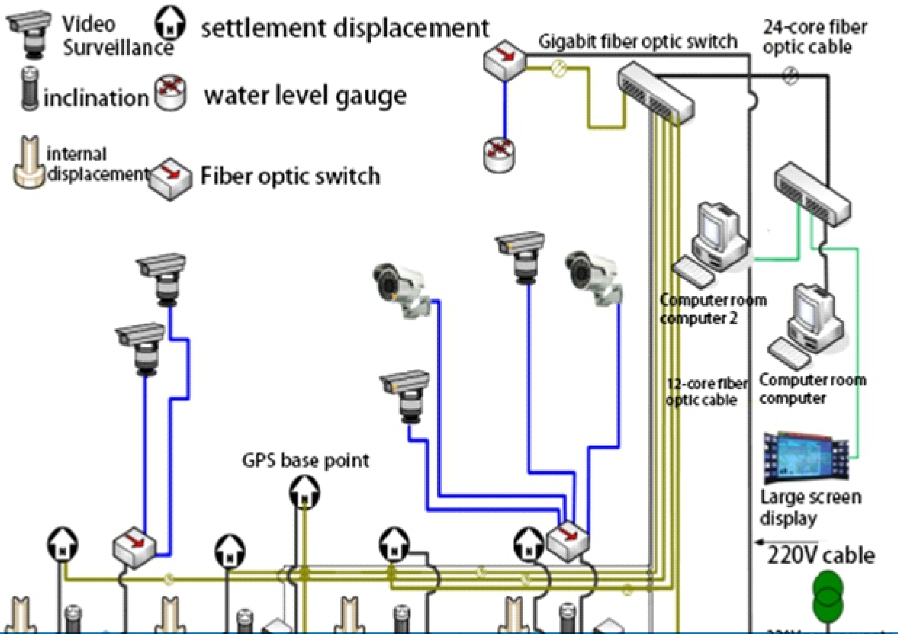
Therefore, in view of the key factors of safety hazards in ancient buildings due to their age, in order to prevent sudden structural damage and cumulative damage from endangering the safety of ancient building operations, in addition to establishing a complete daily management and maintenance system, it is also necessary to establish a long-term online A real-time safety monitoring system can collect comprehensive information reflecting the safety and health status of ancient building structures, assess the degree of structural damage and safety conditions in real time, and provide early warning before danger occurs, allowing managers to grasp the structure's operations in real time. conditions and make management decisions as soon as possible to ensure the normal operation and safety of ancient buildings.

1.2 Monitoring purpose

1.2.1 The ancient buildings are very old, and the impact of structural settlement is monitored and early-warned. Ancient buildings are old and their structures may change. Based on the long-term on-site survey results of ancient buildings, we can rationally select key equipment parameters, conduct real-time safety monitoring of its structural operating status, real-time assessment of its structural safety status, and conduct real-time identification and analysis of its service life. Early warning, and early warning for sudden and cumulative damage; long-term monitoring of its development and change trends can promptly assess the technical status of key structures, allowing managers to grasp the operating status of the structure in real time and make management decisions as soon as possible to avoid accidents occur.

Subsidence and tilt monitoring

Case 3: Safe tilt settlement and automated monitoring plan for ancient building protection



Product application scenarios and solutions

1.2.2 Modern management and monitoring system

Through in-depth research on the daily management and maintenance of ancient buildings, this system starts from building digital archives, developing digital full-platform inspection systems, digital inspection reports and safety assessment reports, and digital maintenance to unify dynamic monitoring data and manual maintenance data. Management, unified storage, and unified analysis and integration of data obtained from the two monitoring methods are a necessary complement and improvement to the automated sensing test and signal analysis remote control system.

1.3 Automated monitoring equipment

The system collects data through front-end hardware, transmits it from the front-end to the monitoring server with the help of wireless data transmission, and realizes data sharing and storage of the entire network through the server. Users can conveniently monitor in real time through the network, mobile phones and other terminal devices, thereby realizing the connection of things. safety monitoring system. The main monitoring object of ancient building structures is settlement. Parameter indicators need to collect on-site physical quantities through corresponding sensors and demodulators, and transmit the data to the remote monitoring center database through Ethernet or wireless networks. Through the structural safety of the host computer, Monitoring system software

performs data processing, analysis and risk assessment control.

1.4 System scheme design basis

a.<<Building Construction Safety Inspection Standard>>(JGJ59-2011 J1334-2011)

b.<<Basic specifications for railway bridge and culvert design>> (TB 10002-2005)

c.<<Technical requirements for dynamic environmental monitoring equipment (FSU)>> (Q/ZTT 1008-2014)

d.<<Regulations on Safety Production Management of Construction Projects>>(2008)111

Subsidence and tilt monitoring

Case 3: Safe tilt settlement and automated monitoring plan for ancient building protection

Product application scenarios and solutions

2. Delivery cycle and time arrangement

According to the influence of the weather and environment, reasonable working time arrangements require a minimum of 4-6 days of working time per week, and each working time is from 8:00 to 17:30 the next day, that is, the actual working time per day is 8 hours.

Based on the actual working time and on the premise of ensuring safe construction, a large amount of equipment and labor will be invested to ensure that the construction cycle is completed on time.

a) Automation equipment is ready for shipment: it takes about 3 days

b) The automation equipment was installed and tested successfully, and the planned construction period takes 4 days.

It will take 5 days to complete all automated monitoring installation and testing (single point).

3. Equipment and instrument parameters

3.1 Collection instrument

Central Collection System Technical Specifications

1. Transmission mode: wired/wireless	5. Working temperature range: -40~+85℃	9. Zero point temperature drift: ±0.002/℃
2. Baud rate: 9600	6. Body channel: dual channel	10. Smart Protection: Smart Watchdog
3. Standard bearing load: 40±2	7. Power-on startup time: 0.5s	11. Electrical appliance link: Waterproof four-core plug-in
4. Output signal: RS485	8. Supply voltage: 7-24v DC	12. Protection level: IP67

Subsidence and tilt monitoring

Case 3: Safe tilt settlement and automated monitoring plan for ancient building protection

Product application scenarios and solutions

3.2 Settling equipment
Static level technical specifications:

1. Measuring range：0-2500mmH2O	5. Supply voltage：9-24v DC	9. Electrical appliance link: Waterproof four-core plug-in
2. Comprehensive accuracy: 0.2mm	6. range of working temperature：-20~60℃	10. Protection level：IP67
3. resolution：0.01mm	7. Overload withstanding：150%	11. Installation process: small size and easy to install
4. output signal：RS485	8. Shell material: aviation aluminum surface anodized treatment	12. Smart Protection: Smart Watchdog

Subsidence and tilt monitoring

Case 3: Safe tilt settlement and automated monitoring plan for ancient building protection

Product application scenarios and solutions

3.3 Tilt equipment

T7000-H tilt sensor technical specifications:

1. Accuracy 0.001°	5. Output Interface RS485	9. Electrical appliance link: Waterproof four-core plug-in
2. Measuring range 0~±5/±15/±30° optional	6. Wide operating temperature -40~85℃	10. Installation process: small size and easy to install
3. Wide voltage input DC 11~35V	7. Protection level: IP67	11. Smart Protection: Smart Watchdog
4. Baud rate 2400~115200 (can be set)	8. Shell material: aviation aluminum surface anodized treatment	

Subsidence and tilt monitoring

Case 3: Safe tilt settlement and automated monitoring plan for ancient building protection

Product application scenarios and solutions

4. Equipment parameters and installation

4.1 Equipment details

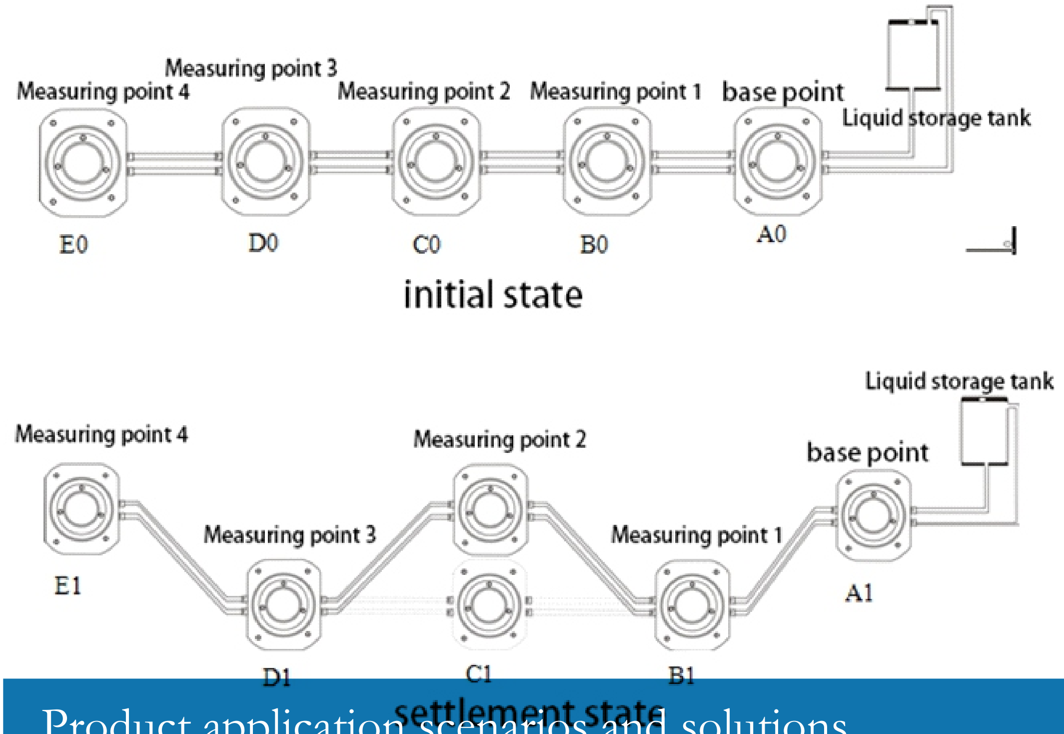
	Hardware device name	Specification	quantity	unit
1	Central collection system	Compatible with all company's digital signal equipment sensors	1	tower
2	Hydraulic static level	Measuring range 10 ~2500mm; resolution 0.1	5	set

4.2 construction tools

	Construction equipment and tools	Specification	quantity	unit
1	truck	2 tons	2	department
2	Portable demodulator	high speed	1	tower
3	laptop		1	tower
4	shovel	Effective and multifunctional	2	Bundle
5	Petrol Engine	5KW	2	tower

Subsidence and tilt monitoring

Case 3: Safe tilt settlement and automated monitoring plan for ancient building protection



4.3 Construction organization
4.3.1 Automatic monitoring system based on static level
The system mainly consists of a liquid storage tank, base points, measuring points, and collection equipment. The static level includes a main container, a connecting pipe, a sensor, and other components. The static level uses the principle of connected liquid to observe settlement. The liquid storage levels connected by multiple universal connecting pipes are always on the same level. By measuring the liquid level heights of different liquid storage tanks, each static level can be calculated through calculation. Relative differential settlement of force level.
4.3.2 Settlement calculation method:
Measuring point: current measurement value - initial measurement value = settlement change value
Base point: initial measurement value - current measurement value = base point change value
Calculation of settlement change: (Settlement change value － base point change value) X-1 = final settlement value

Subsidence and tilt monitoring

Case 3: Safe tilt settlement and automated monitoring plan for ancient building protection

Product application scenarios and solutions

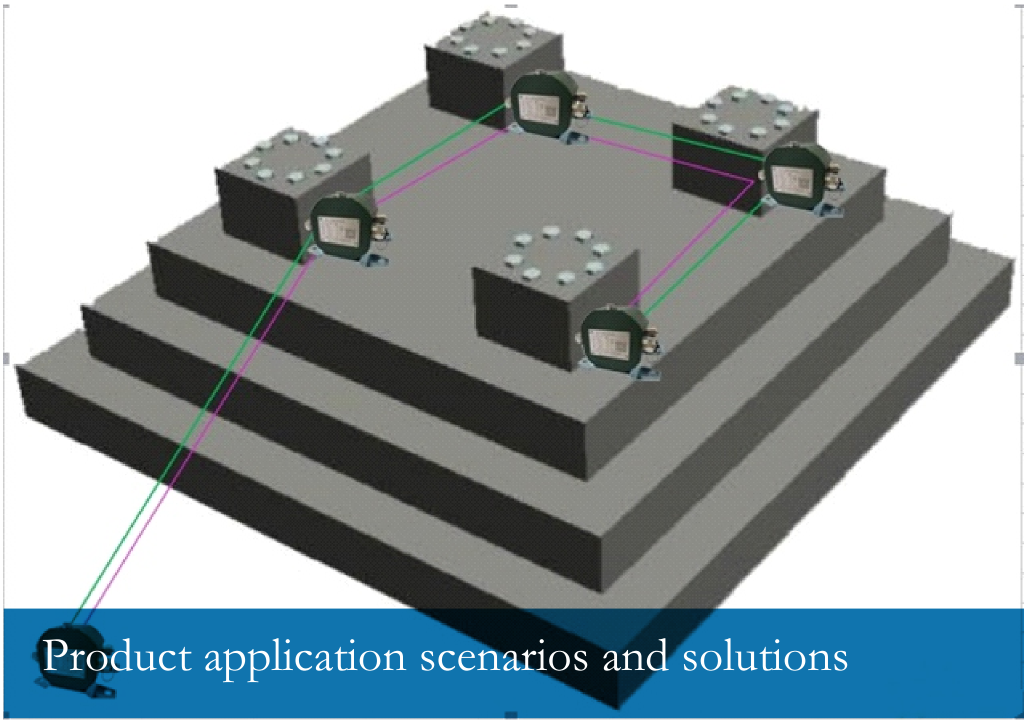
7. Quality assurance and safety assurance measures

7.1 Add security protection

Establish and improve the quality assurance system for safety monitoring projects, and formulate progress arrangements for each link of hole making, instrument and equipment procurement, burial installation, maintenance, observation and data collection based on the design documents approved by the supervision, and specify the quality assurance of each sub-item The person in charge regularly conducts safety production education for all employees and strengthens quality awareness to ensure that qualified safety monitoring projects and continuous and reliable observation data are provided to owners.

Subsidence and tilt monitoring

Case 3: Safe tilt settlement and automated monitoring plan for ancient building protection



Product application scenarios and solutions

7.2 Precautions

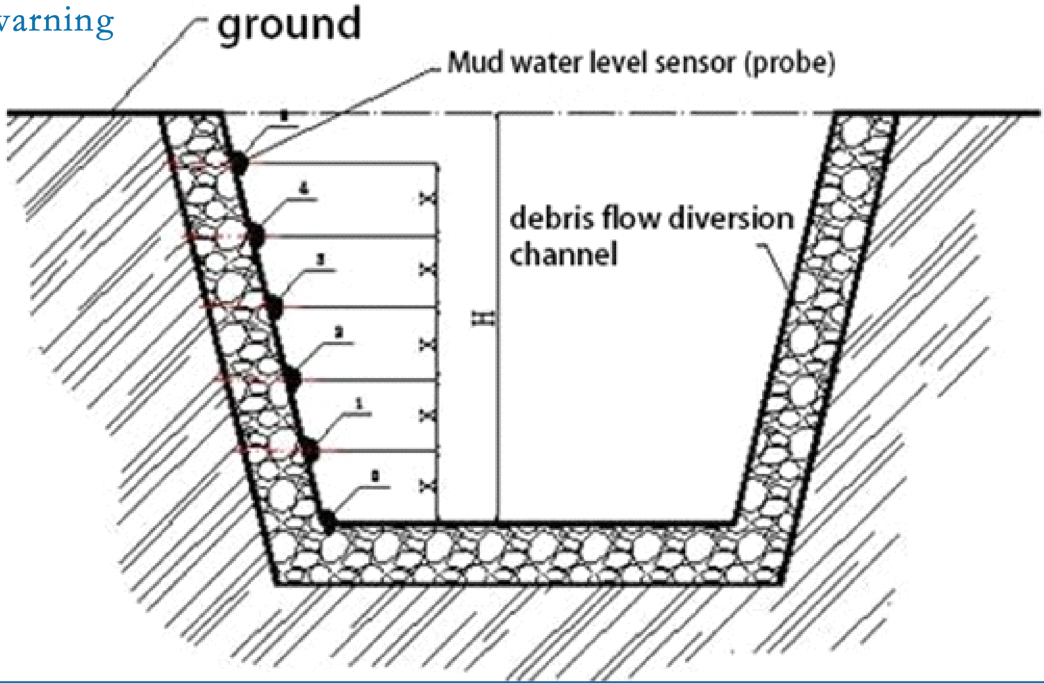
In addition to strictly complying with the relevant quality control provisions, special attention is also paid to:

a. The instruments and equipment used for inspection have been certified by the national standard unit of measurement and their parameters are within the valid period of use.

b. Secondary direct-reading instruments used for observation must be inspected (calibrated) once a month and meet the requirements stipulated in relevant technical specifications or factory instructions. Before replacing the instrument, check whether it is interchangeable.

c. All information provided to the supervisor, including drawings, reports, manuals and data, etc., shall be clear and legible copies and blueprints, or printouts, or disk files, in a format approved by the supervisor, and with a systematic and continuous index. serial number.

Case 4: Inclination sensor is used for debris flow and dam landslide monitoring and early warning



Distribution diagram of mud water level alarm probes

Product application scenarios and solutions

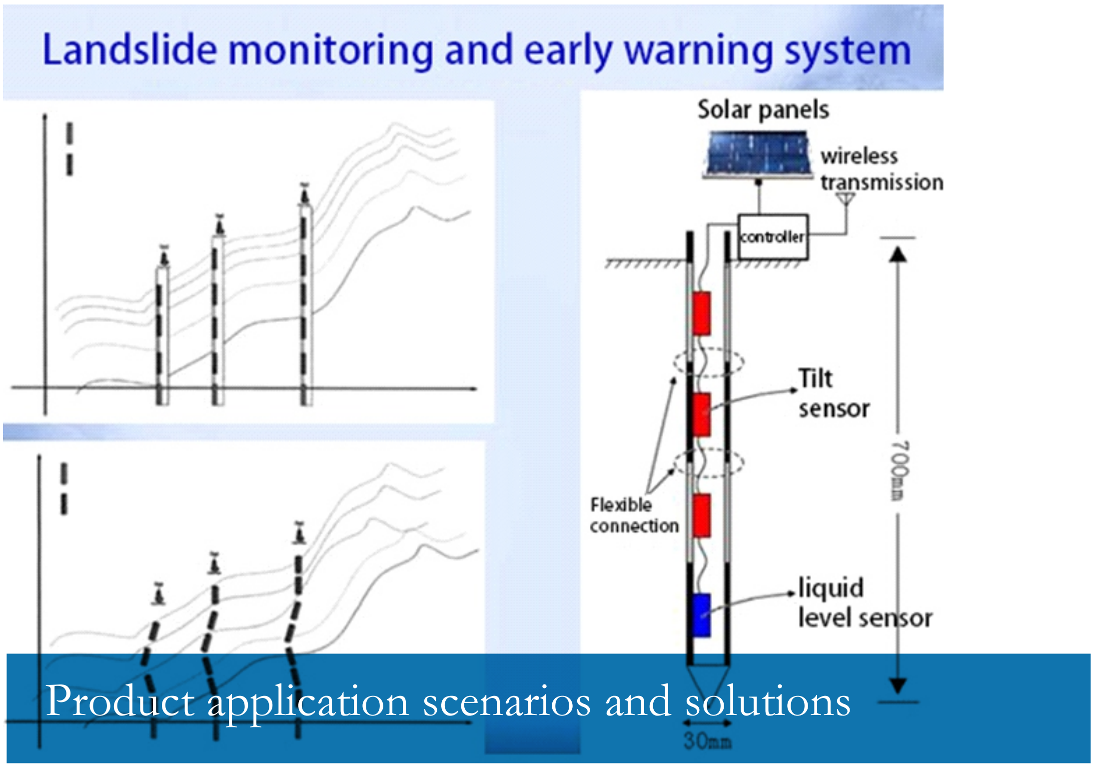
1 Overview
Collapses, landslides, and debris flows are the main types of geological disasters. The degree of harm is second only to earthquakes. They erupt frequently. They are widely distributed and the degree of harm is extremely serious.

According to incomplete statistics, from the founding of the People's Republic of China to the end of 2010, a large number of geological disasters occurred nationwide. There were more than 3,000 large-scale collapses, more than 2,000 landslides, and more than 2,000 debris flows, and there were hundreds of thousands of small and medium-sized collapses, landslides, and debris flows. Tens of thousands of villages, more than 100 large factories, 55 large mines, and more than 3,000 kilometers of railway lines in more than 350 counties across the country are seriously affected by collapses, landslides, and mudslides. Since the mid-1990s, it has caused more than 1,000 deaths every year and caused economic losses of more than 20 billion yuan. These data show that it is urgent to effectively reduce losses from geological disasters. Our inclination sensors are applied to landslide monitoring, transmitting the mountain status to the terminal in real time through wireless transmission, sending out early warning signals before landslides and collapses, and relocating people and important personnel. property, effectively reducing casualties and property losses. There are more than 8,000 ore bodies in the country alone, and their market prospects are broad.

2. Landslide and debris flow monitoring components
a) We designed the following pile. The lowest end is a liquid level sensor, and 3 inclination sensors are distributed upward. A control system is installed inside and connected to the control system through the RS485 bus; it mainly relies on the functions of two sensors: liquid level sensor and tilt sensor. In areas prone to danger on the mountain, multiple holes should be set up vertically along the direction of the mountain, as shown in the figure below:

Subsidence and tilt monitoring

Case 4: Inclination sensor is used for debris flow and dam landslide monitoring and early warning



b) Each hole will deploy a liquid level sensor at the bottom and several inclination sensors at different depths. Since landslides in this area are mainly caused by rain erosion, the depth of the groundwater table is the first indicator of landslide risk.
This data is collected by a liquid level sensor deployed at the bottom of the hole and sent by a wireless network. Inclination sensors can be used to monitor the movement of mountains. Mountains are often composed of multiple layers of soil or rock. Different layers move at different speeds due to different physical compositions and degrees of erosion. When this happens, tilt sensors deployed at different depths will return different tilt data, as shown in the figure below.
After the wireless network obtains the data from each tilt sensor, through data fusion processing, professionals can judge the trend and intensity of the landslide and determine its threat. Landslides can be seen everywhere in disaster areas after earthquakes, especially landslides on both sides of traffic arteries, which pose a huge threat to rescue progress.

3. Landslide and debris flow monitoring components
a) It can monitor mountain dynamics, including possible landslide areas, landslide scope, direction, predicted disaster occurrence time, etc.
b) Centralized control system, all sensors are a node, and the Internet of Things network is fully monitored.
c) The inclination sensor independently developed by our company has good reliability, full temperature compensation, dynamic compensation, etc., and is suitable for outdoor environments.
d) Easy and convenient installation, no wiring required, solar power supply, wireless transmission.
e) The address coding and terminal computer are equipped with a host computer control system, which can locate coordinates and comprehensively analyze data.
f) Able to send out early warning signals before landslides occur and effectively move property to reduce losses.

Product application scenarios and solutions

Gyroscopes are used in track detection vehicles to detect tracks, and their main functions include monitoring track gauge, height, direction, level, triangular pits, vibration acceleration, etc. The uneven state of the track is a key factor that directly restricts the improvement of train speed in terms of the line.

Railway Engineering

Case 1: Gyroscope Track Inspection Vehicle

Product application scenarios and solutions

Track inspection vehicle, also known as track inspection vehicle or track inspection instrument, is abbreviated as track inspection vehicle. The use of track inspection vehicles to check the geometric status of the track is an important link in ensuring the safety of railway operation. The main content of track deformation detection by track inspection vehicles includes track gauge, height, track orientation, level, triangular pits, vibration acceleration, etc. The uneven state of the track is a key factor that directly restricts the improvement of train speed in terms of the line. Track irregularity refers to the deviation of two steel rails from the ideal position geometric dimensions of the rails in the height, left and right directions.

There are four types of track irregularities:

1) The height of the track is uneven. It refers to the vertical geometric position deviation between the actual track centerline and the ideal track centerline along the length direction.

2) The track level is not smooth. It refers to the vertical height difference between the left and right rails along the length direction.

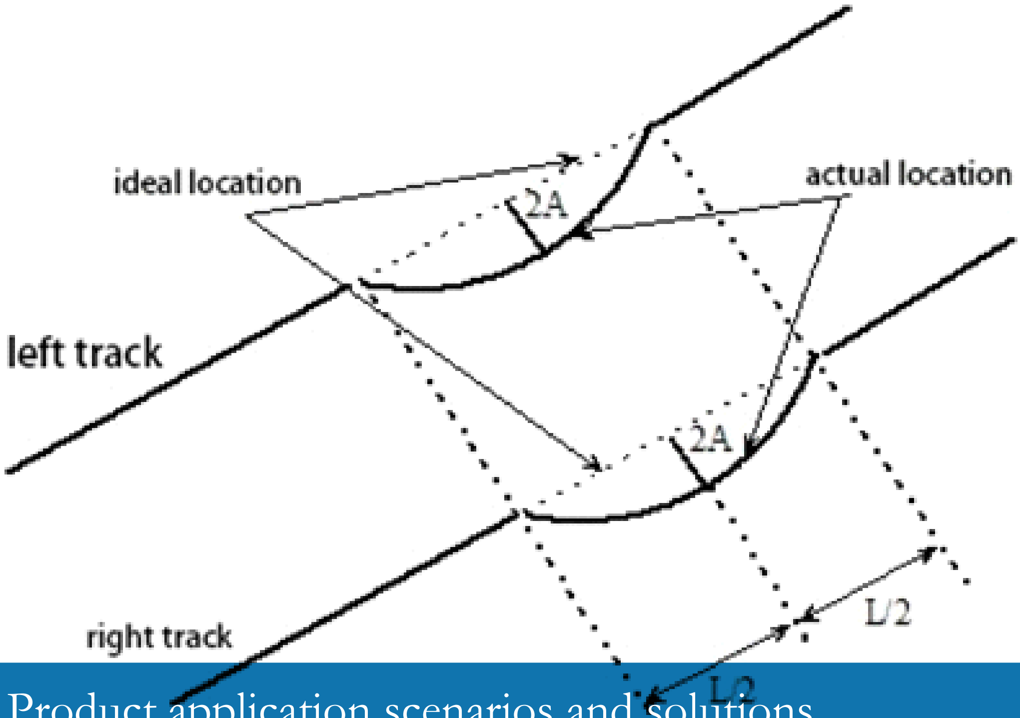
3) The track direction is not smooth. It refers to the horizontal geometric position deviation between the actual track centerline and the ideal track centerline along the length direction.

4) Uneven track gauge. It refers to the deviation between the actual gauge and the nominal gauge.

Track irregularity can be divided into periodic track irregularity, random irregularity, and local irregularity. Periodic track irregularity is caused by the irregularity formed by track joints with track length as the wavelength. Random unevenness is caused by errors in track laying, maintenance, and wheel rail wear, which varies from time to place. Local unevenness is caused by specific structures of the line (such as switches, transfer lines, sidings, transition curves, branching lines, bridges, etc.) or accidental locations (such as local diseases of the line). The unevenness of the track causes significant wheel rail force, which not only damages the track structure itself, but also directly affects or endangers the safety of high-speed driving. Track irregularity is an external disturbance to the locomotive and vehicle system, which is the main source of vibration in the locomotive and vehicle system.

The functional description of the random variation law of track irregularity is an important basic data for the dynamic analysis of locomotives, vehicles, and track systems. This dynamic analysis is an important means for the design, maintenance, and quality evaluation of modern locomotives, vehicles, and tracks.

Case 1: Gyroscope Track Inspection Vehicle



Product application scenarios and solutions

This article mainly discusses the irregularity of track direction in track irregularity (see Figure 1). The unevenness of the track direction is caused by the positioning deviation of the track centerline during track laying and major repair operations, the accumulation of lateral residual deformation of the track panel, uneven wear on the side of the track head, failure of fasteners, and inconsistent lateral elasticity of the track.

There are two main methods for detecting the smoothness of track direction:

1. Inertial reference method
2. Short string measurement method

The inertial reference method is an orbit measurement method based on the principle of inertial navigation to describe the trajectory of the orbit and determine the geometric state of the orbit. This method requires the use of high-precision strapdown inertial navigation systems, typically used for high-speed track inspection vehicles. Its principle is the same as that of strapdown inertial navigation system, and details can be referred to relevant literature of strapdown inertial navigation system. When using this system, initial alignment is usually required to determine the directional matrix between the geographic coordinate system and the carrier coordinate system, and then navigation calculations begin. The advantage of using inertial reference method to detect track conditions is rapid measurement, while the disadvantage is expensive price.

The string measurement method is an earlier method for measuring the smoothness of track direction, which is usually used for track detection cars. Among them, the track irregularity detection technology based on fiber optic gyroscope (FOG) is currently the most advanced track detection method in string measurement. The core issue of using gyroscopes to measure track direction is precision angle measurement. Based on this, the transfer function relationship between the angle change of the track inspection instrument and the track direction is established, and the track irregularity information is extracted from it.

The measurement of track irregularity is based on several chord lengths, such as 10m chord, 20m chord, 30m chord, 70m chord, 300m chord, etc. This is also known as wavelength, and each wavelength has a corresponding allowable deviation for track irregularity. The deviation of short wavelength has a significant impact on low-speed driving, while the deviation of long wavelength has a significant impact on high-speed driving.

Railway Engineering

Case 2: Application of inclination sensor in railway monitoring

Product application scenarios and solutions

Railway transportation is one of the most important modes of transportation, and in recent years, it has been continuously developing, with high-speed trains, intercity trains, and train speeds becoming faster and faster. However, faster speed also comes with greater danger, and accidents occur everywhere. How to ensure driving safety and create a stable and efficient driving environment is currently the most urgent demand.

A train is a special type of transportation that operates on railway tracks, with a complex and ever-changing operating environment. It is often affected by various factors such as wind, snow, earthquakes, mudslides, landslides, tunnel foreign objects, geological mutations, etc. It is easy to cause deformation of the railway tracks and be covered by foreign objects, seriously threatening the safety of train travel.

The sensor designed and produced by Mai Xinmin Micro Company has a maximum measurement accuracy of $\pm 0.01^{\circ}$ @25 $^{\circ}$C. It can not only accurately measure the tilt and deformation of iron objects, but also monitor the tilt changes of the surrounding environment of the track in real time. Especially in some inaccessible areas, preventive alarms are made in advance to avoid major accidents.

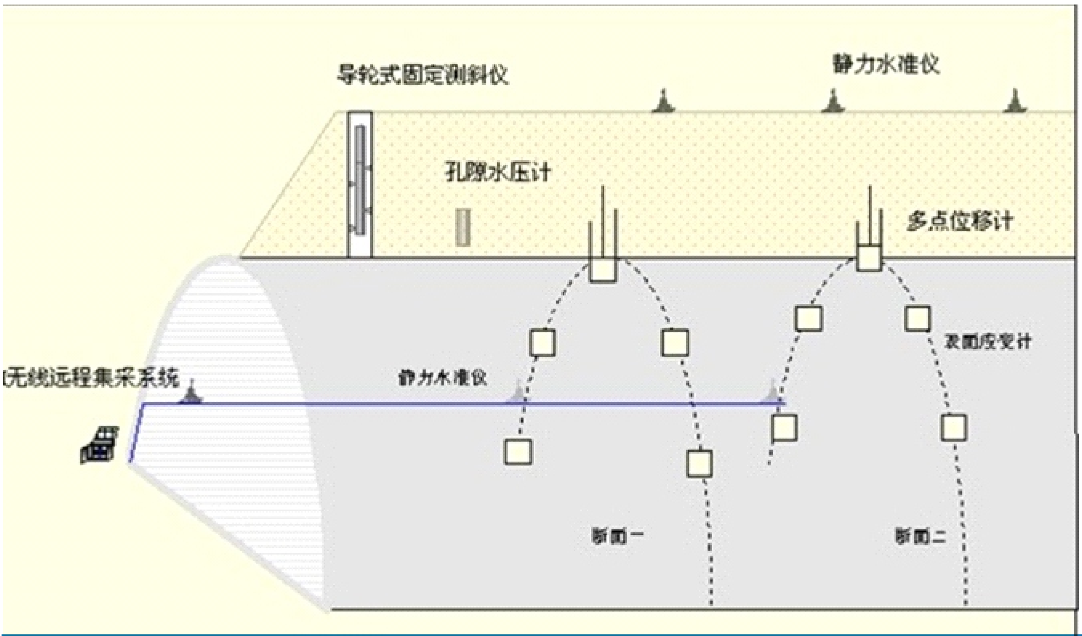
Railway Engineering

Case 3: Application of sensors in monitoring settlement of railway track

Product application scenarios and solutions

To ensure the high-speed and healthy development of railways, a remote automatic monitoring system for roadbed settlement is developed based on technologies such as laser measurement, advanced sensing, and wireless networks. The monitoring system includes four subsystems: laser automatic measurement of surface settlement, simultaneous automatic measurement of roadbed layered settlement and lateral displacement, automatic measurement of roadbed lateral profile settlement, and data acquisition and wireless transmission. The automatic measurement of surface settlement is achieved using laser measurement and automatic calibration technology; The simultaneous automatic measurement of layered settlement and lateral displacement of the roadbed is achieved using Hall sensors, laser ranging, and inclination sensors; The automatic measurement of the settlement of the transverse section of the roadbed is achieved by driving the inclination sensor by the master and slave motors. The monitoring system has been validated in the laboratory and designed for engineering purposes, and has been tested on-site at a high-speed railway station.
The inclination sensor can be well applied in the control system to achieve real-time monitoring of the overall settlement, local settlement, and settlement of different layers in the cross-section of the roadbed. The signal output from the inclination sensor is transmitted to the computer through wireless transmission or various wired networks, and then processed, analyzed, and stored by computer software。

Case 4: Static level and inclinometer for monitoring and warning of subway deformation



Product application scenarios and solutions

In cities in China that already have subways, there are more and more deep excavations along the subway line (very close to subway tunnels). How to protect the running subway tunnels during excavation is a very practical problem. The use of information technology construction and monitoring methods can effectively guide the construction process of foundation pits. The methods of time and space effect, reverse construction, grouting, and foundation pit reinforcement used in construction can all achieve the goal of protecting adjacent tunnels and controlling deformation. However, conventional subway deformation monitoring methods are quite difficult to monitor in running subway tunnels, mainly because the subway operation interval is very short and measurement personnel
are absolutely not allowed to enter during operation. Therefore, there must be a simple, unmanned, and automatic dynamic monitoring method that can quickly complete the deformation monitoring of the tunnel in a short time interval and submit monitoring data for the construction of adjacent foundation pits. To ensure the safe operation of the subway, it is necessary to continuously monitor the deformation of the tunnel during the excavation process of the foundation pit.

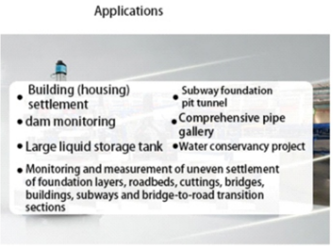
Due to the fact that subway tunnels are in a fully enclosed operating state for more than two-thirds of the day, monitoring personnel are absolutely not allowed to enter the tunnel to work. Therefore, it is necessary to set up an automated monitoring system in the tunnel to replace manual operation and achieve continuous and accurate monitoring of horizontal and vertical displacement of the tunnel. Considering the short interval between subway operations, the monitoring system used should be able to complete deformation monitoring of the tunnel (affected section) within 3-5 minutes, in order to grasp the deformation laws and characteristics of the subway tunnel caused by foundation pit excavation construction.

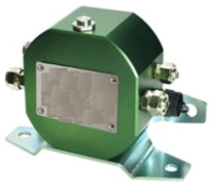
Composition of automated monitoring system

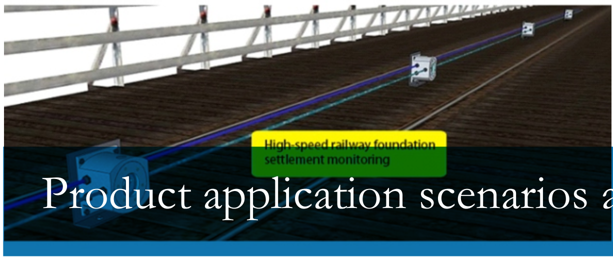
A complete automated monitoring system refers to the realization of functions such as automatic observation, recording, processing, storage, report preparation, early warning and prediction without the intervention of operators. It consists of a series of software and hardware, and the entire system configuration includes: foundation pit inclinometer, pressure differential static level, laser rangefinder, surface strain gauge, measurement and control terminal (GPRS), communication cable and power cable, computer and specialized software.

Railway Engineering

Case 4: Static level and inclinometer for monitoring and warning of subway deformation







Product application scenarios and solutions

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Railway Engineering

Case 5: Subway Rail Transit Roadbed Settlement Inclination Monitoring

Product application scenarios and solutions

Project Background

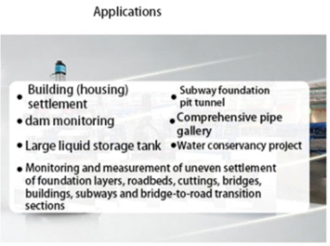
With the rapid development of the economy, many cities in China have gradually increased their efforts in urban subway construction. The underground excavation tunnel engineering of urban subways must be constructed inside the rock and soil. Regardless of the burial depth, excavation tunnel construction will inevitably disturb the underground rock and soil, leading to the destruction of the original equilibrium state and gradually shifting to a new equilibrium state. Excavation of underground rock and soil will inevitably lead to surface settlement and deformation, and local surface settlement to a certain extent will have an impact on the normal use of underground pipelines and the safety of ground buildings. During the construction period, effective measures should be taken according to requirements to reduce settlement and deformation, so as to prevent damage to buildings such as ground houses, roads, pipelines, and the ecological environment from deteriorating. During the operation period of the subway, it is even more important to accurately grasp the safety situation of the tunnel and ensure the safety of the subway and important facilities.

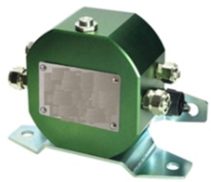
BREEZE CO.,LTD developed static level (settlement monitoring) and inclination sensor (inclinometer) can provi online monitoring and warning of subway settlement deformation indicators. The vertical direction can detect a minimum elevation change of 0.2mm, with an inclination of 0.001 ° .

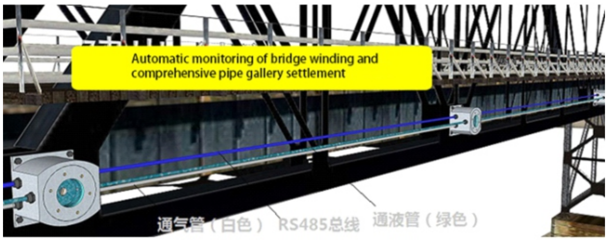
The system reflects the settlement and deformation of subway tunnels in real-time through static level sensors installed on site. The data acquisition instrument collects, analyzes, and summarizes data from each sensor, and transmits the data to the monitoring room through optical fiber or other transmission methods. The monitoring and warning software arranged on the server of the room manages the system data.

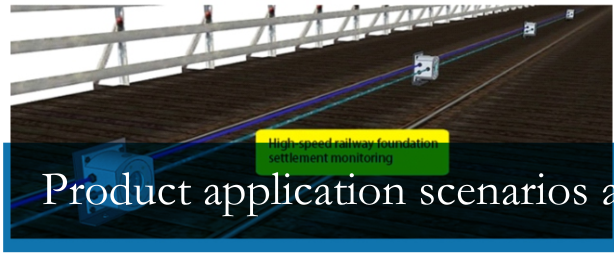
Once the monitoring value reaches or exceeds the warning value, corresponding measures shall be taken to deal with it, stop the operation of fixed lines or take reinforcement measures to ensure the safe operation of subway tunnels.

Case 5: Subway Rail Transit Roadbed Settlement Inclination Monitoring









Product application scenarios and solutions

3. Data processing and control subsystem: composed of a small computer system, server system, and software system arranged in the monitoring center

4. Auxiliary support system: including subsystems such as external cabinets, external chassis, power distribution and UPS, and lightning protection.

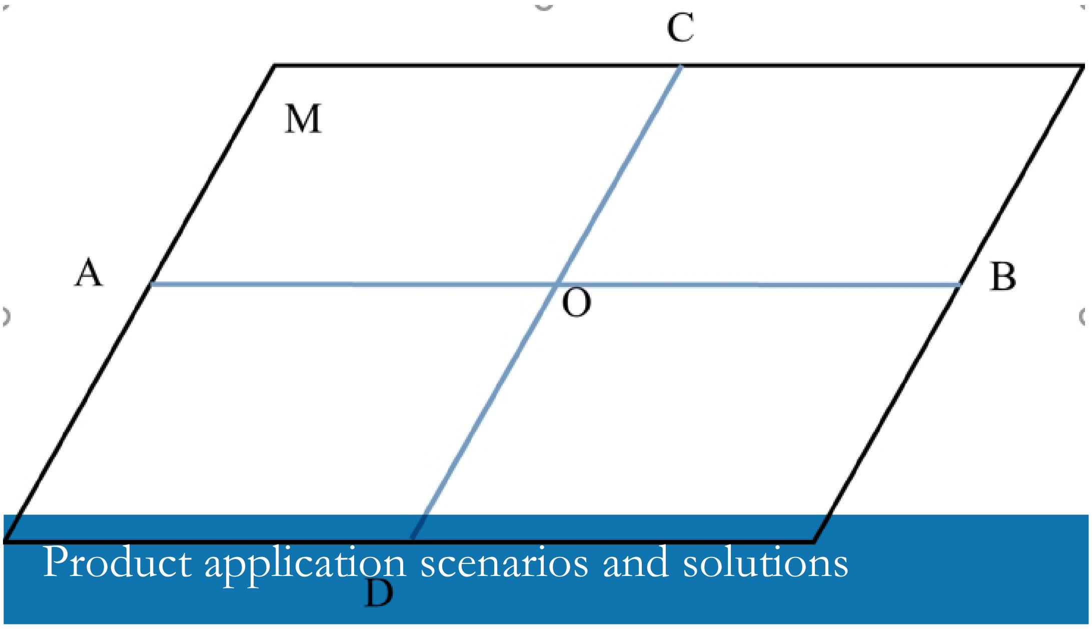
By installing the Mai Xinmin micro online monitoring system to provide services for the daily safety management and safe operation of subway rail transit, we can greatly improve our understanding of the mechanism of settlement disasters, comprehensively improve the level of subway safety supervision and daily management, and enhance the early warning and response capabilities of enterprises, society, and governments to settlement disasters, Establish a comprehensive evaluation method for settlement deformation risk that is more convenient for safety management and risk control during subway operation.

Product application scenarios and solutions

The inclination sensor is installed on the vehicle and ship to monitor the tilt attitude angle and acceleration while driving. When the vehicle or ship body exceeds 35° , there is a risk of rollover, so the inclination angle cannot exceed 35° . When the vehicle hull angle is greater than 15° , an alarm signal is required. If necessary, corresponding protective measures should be taken or the motor of the hull should be forcibly stopped to ensure the safe navigation of the vehicle and ship.

Vehicles and ships

Case 1: Inclination sensor vehicle body auxiliary leveling device



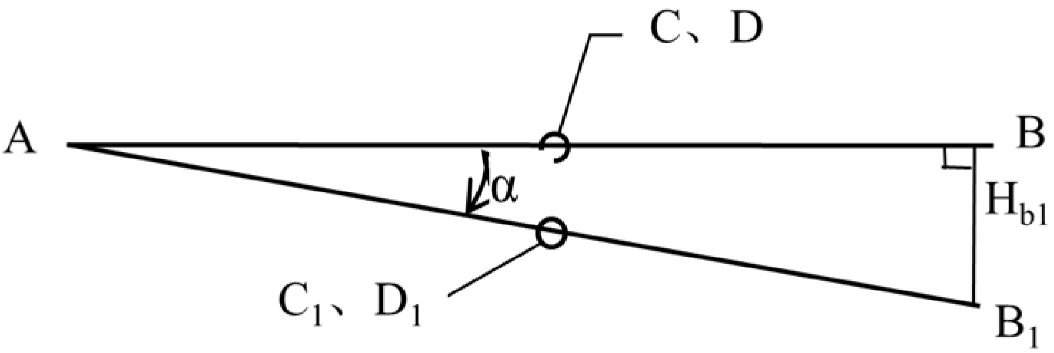
Product application scenarios and solutions

1. Overall project requirements
a) Convert the inclination angles of the car body platform in two directions measured by the inclination sensor into the vertical adjustment amounts of the four support points, and output them on the display interface to provide the operator with the basis for adjustment.
b) Detect the level condition of the car body platform and give an alarm reminder when it is out of tolerance.

2. Mathematical calculation model deduction:
a) Determination of standard horizontal plane
Take any standard horizontal section M of the vehicle body, and simplify the four adjustment supports of the vehicle body into the four endpoints A, B, C, and D of two perpendicular intersecting line segments located in the horizontal plane M. The intersection point is the center point of the horizontal plane. O, as shown in Figure 1:

a)Establishment of calculation model
Under normal circumstances, the initial state of the horizontal plane of the vehicle body is generally in an inclined state. Any tilted plane can be realized by rotating a horizontal plane in two steps: when a plane is tilted, its tilted state can be decomposed into two perpendicular intersecting straight line segments in the plane, each tilting the same or The states formed at different angles, as shown in Figure 1, when the plane M is tilted, can be decomposed into the first step: rotate the plane by an angle α with CD as the rotation axis, the second step: then rotate the plane with CD as the rotation axis. AB rotates the axis of rotation through an angle β. In other words, any tilted plane can be returned to a horizontal state by rotating the plane by an angle -α with CD as the rotation axis, and then rotating the plane by an angle -β with AB as the rotation axis. α and β here are the inclination angles of the plane along the AB axis and CD axis, which can be measured by a high-precision dual-axis horizontal sensor system in this project. From this, through a series of mathematical calculations, the values of the respective heights Ha, Hb, Hc, and Hd required for the tilted plane M to return to the horizontal state can be obtained by adjusting the four pivot points A, B, C, and D. The process is as follows:

Case 1: Inclination sensor vehicle body auxiliary leveling device



Product application scenarios and solutions

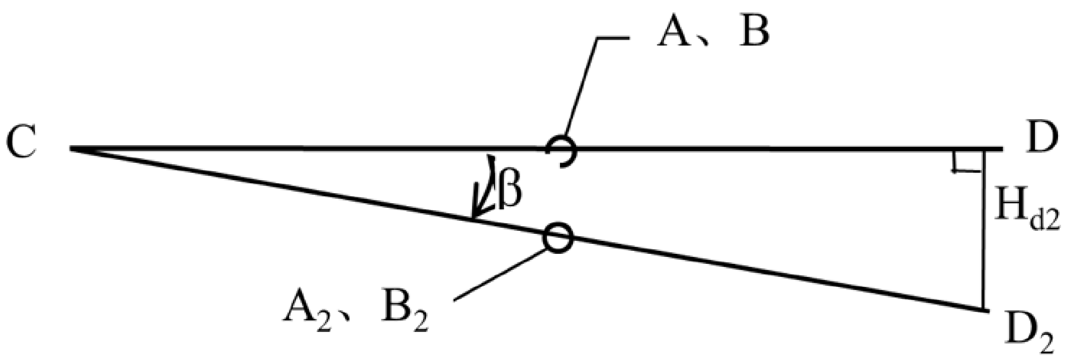
First, further transform and set the above process. When rotating, translate the rotation axis to the two straight lines passing through point A and point C of plane M, and determine the direction of rotation as point B downward and point D downward. When When the rotation angle is not large (no more than 10o in this project), the second rotation is considered to be the initial state where the plane is still horizontal. During the first rotation, the descending heights of the four points A, B, C, and D are respectively Ha1, Hb1, Hc1, and Hd1. The descending heights of the four points A, B, C, and D during the second rotation are respectively Ha2, Hb2, Hc2, Hd2, and finally the total heights dropped by the four points A, B, C, and D are Ha, Hb, Hc, and Hd respectively.

In the first step, as shown in Figure 2, the calculation plane takes the side line where CD moves parallel to point A as the rotation axis. When rotated clockwise by an angle α, point B rotates to the position of point B1. At this time, the height of fulcrum A remains unchanged (That is, Ha1 is 0), the height of point B drops to point B1, the drop distance is Hb1, and points C and D drop by Hc1 and Hd1.

In the second step, as shown in Figure 3, the calculation plane uses the side line where AB moves parallel to point C as the rotation axis. When point D rotates downward by an angle β, point D rotates to the position of point D2. At this time, the height of fulcrum C is not Change, the height of point D decreases by Hd2, point A decreases by Ha2, and point B decreases by Hb2.

Through the above analysis and calculation, a solution can be drawn: In this project, when the horizontal plane of the car body is in an inclined state, the lengths connecting the four adjustment supports A and B, C and D are known, and the horizontal lengths along the AB and CD directions are known. The inclination angles α and β can be measured by the inclination angle sensor, and the adjustment amounts Ha, Hb, Hc, and Hd is adjusted so that the vehicle body is adjusted from a tilted state to a horizontal state.

Case 1: Inclination sensor vehicle body auxiliary leveling device



Product application scenarios and solutions

3. Determination of adjustment methods in actual operation

a)In the process of establishing the calculation model, we adopt the method of setting both transformations to rotate clockwise. However, in actual situations, the angle of the two rotations that synthesize the final effect may be clockwise or counterclockwise. This is reflected in the calculation model that the α and β angles may take positive or negative values, which in turn makes The final adjustment values of the four adjustment points are also positive or negative, that is to say, when the operator adjusts the height of the four outriggers, some need to be raised and some need to be lowered.

The initial position of the car body can generally only be adjusted higher but not lowered. This requires appropriate conversion to convert the adjustment values of the four adjustment points. First, determine the adjustment point with the highest relative height and adjust it. The height is not adjusted, which saves the workload and adjustment time of the adjustment personnel; the second is to convert the adjustment amounts of other adjustment points into only adjusting them higher and not lowering them to adapt to the actual terrain conditions of the position operation.

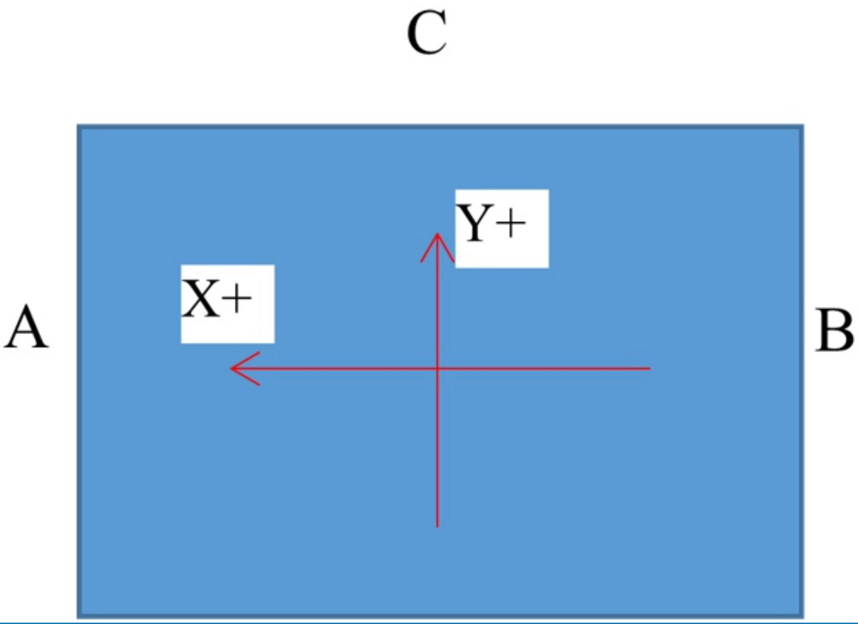
Parameter conversion plan: Sort the four calculated values, take the adjustment point with the minimum value as the highest point, do not adjust, subtract the adjustment value of the minimum point from the adjustment values of the other three points, and set it to these three points The final upward adjustment value is output to the display for operator use.

b)Combined with the specific positive and negative direction settings of the inclination sensor angle and the sensor installation direction, determine the positive and negative relationship between α and β angles in the calculation model.

The positive and negative relationship between sensor angles corresponding to the above calculation model is as follows

Vehicles and ships

Case 1: Inclination sensor vehicle body auxiliary leveling device



If the specific sensor direction setting or installation direction does not match the above figure, the positive and negative angles of α and β should be changed accordingly according to the specific conditions.

Case 2: Vehicle wiper angle measuring instrument

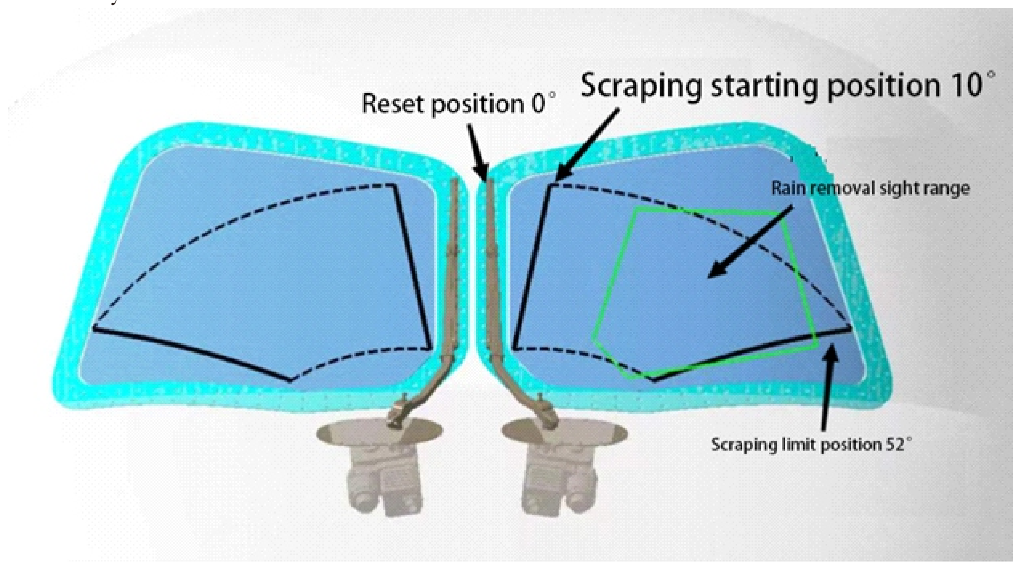
Product application scenarios and solutions

1 Function and accuracy requirements:

a) Able to measure the rotation angle of the left and right wiper output shafts (mainly measuring the angle of the wiper output shaft at the wiper starting position and wiper limit position relative to the reset position, as shown in Figure 1), and the rotation plane is tilted to the horizontal plane.

b) The fastest wiper rotation speed is 132 cycles/minute, and the angle display speed must be fast enough to ensure that the minimum and maximum angles of a single cycle can be read, or the minimum and maximum angles within a period of time can be recorded and displayed. All data are displayed on the computer and can be printed.

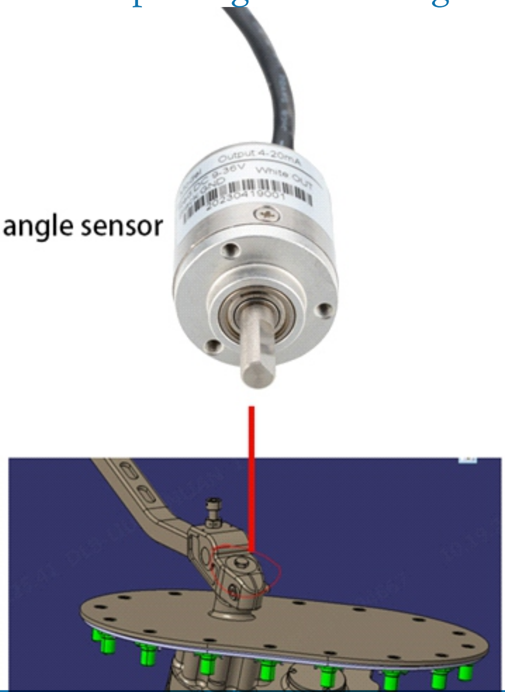
c) The angle measurement range is 90° (can measure clockwise and counterclockwise), and the measurement accuracy is ±0.1° .

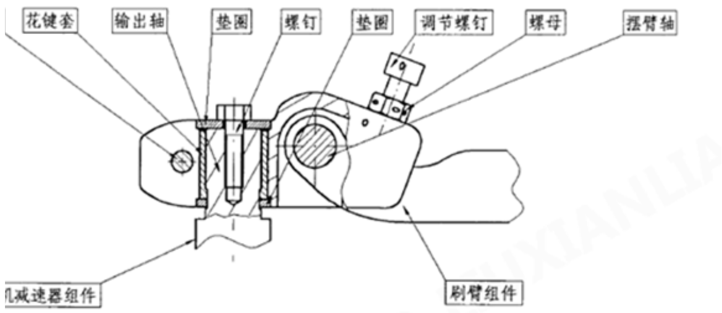


Vehicles and ships

Case 2: Vehicle wiper angle measuring instrument

MK245B angle sensor





Product application scenarios and solutions

The G800-A micro series angle sensor integrates MEMS technology, is small in size, and has low power consumption. It adopts magnetoelectric induction technology, uses differential array magnetic sensitive elements, and non-contact angle measurement to measure the rotating shaft. It uses a permanent sensor installed at one end of the rotating shaft to sense The parallel magnetic field strength of the magnetic magnet is processed by the MCU to implement programmable intelligent control of linearity correction, temperature compensation, standardized digital filtering of the output signal, zero point setting, and multiple different slope settings to achieve the absolute angle of the output sensor within the range of 0 to 360° . Location. Accuracy 0.3° , multiple outputs RS232, Rs485, RS422, CAN, 0-5V, 0.5-4.5V, 0-10V, 4-20mA, 0-20mA optional

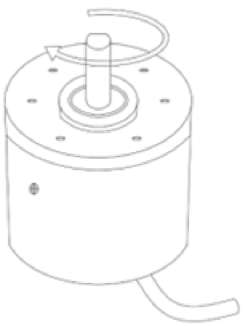


Figure 1.1 The direction of the arrow is the clockwise rotation direction of the sensor.

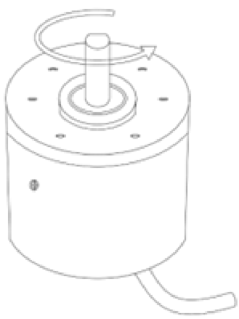
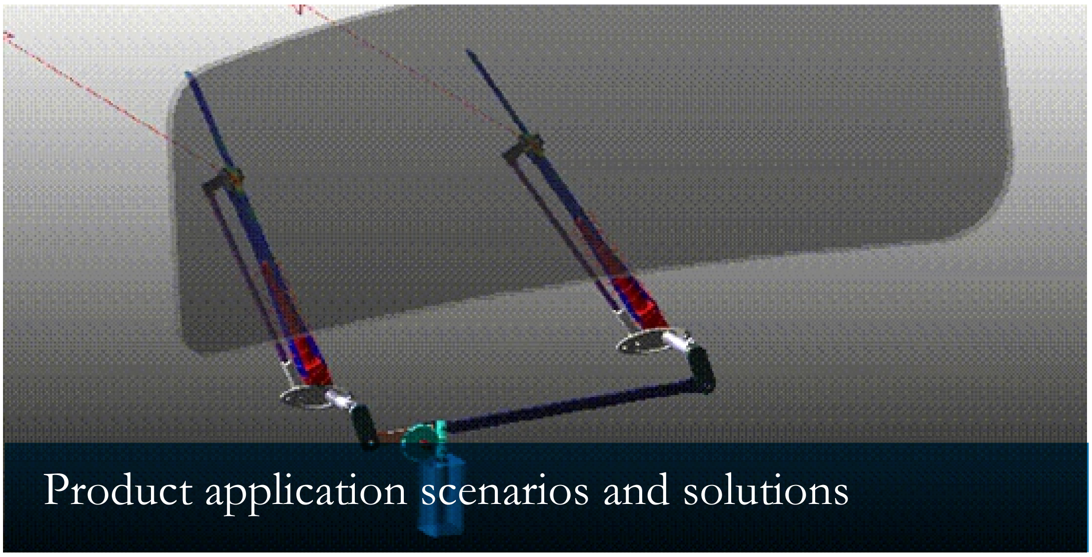


Figure 1.2 The direction of the arrow is the counterclockwise rotation direction of the sensor.

Vehicles and ships

Case 2: Vehicle wiper angle measuring instrument



All products have been calibrated, protected against reverse and pulse spike voltages, and tested for long-term aging stability before leaving the factory. Each process is precise and rigorous, and high-quality bearings are used to ensure reliability under different working conditions and long-term use cycles; it has non-contact point, long life, high resolution, low temperature drift, excellent linearity, precise reset, high frequency response, multiple protections, anti-interference, vibration and impact resistance, suitable for water, oil, gas and other harsh industrial environments, making it a cost-effective angle sensor. It is also an ideal product for the replacement of contact angle sensors (such as conductive plastic potentiometers, encoders, and angular displacement sensors).

Vehicles and ships

Case 3: Inclination sensor is used in vehicle-mounted system wireless positioning anti-theft tracking system

The vehicle load wireless positioning and anti-theft tracking system receives vehicle sensor fusion information through the vehicle main controller, obtains GPS satellite positioning information through the GPS module, and then communicates bidirectionally with the user terminal through the public mobile communication module through the public mobile communication base station, and emits local sound. Light alarm, GSM wireless transceiver, realize mobile and instantaneous control, characterized in that the sensor fusion information is extracted from the infrared sensor, vibration sensor, Hall switch element and air pressure sensor triggered by the inclination sensor, microwave Doppler sensor, Obtained after fusion and adjudication, the user terminal issues control instructions to the main controller after passing identity verification, realizing intelligent automatic monitoring with zero false alarms.
The T700-H inclination sensor developed and produced by BREEZE CO.,LTD can be well used in this control system, the control part and the execution part. The inclination data collection part includes the inclination sensor with its own GPS module and the signal output interface of the inclination sensor. With the analog-to-digital conversion interface of the microcontroller in the control part, the signal end of the ignition lock is connected to the input and output interface of the microcontroller; the microcontroller is connected to the GSM module through the serial port; personal information such as the user's mobile phone number is preset in the microcontroller. The execution part includes a control circuit that controls the relay of the vehicle's main control power supply and is connected to the input and output interface of the single-chip computer, and the vehicle alarm system is connected to the input and output interface of the single-chip computer. The inclination sensor can not only measure the form and attitude of the vehicle body, but also provide the location of the vehicle, provide reliable longitude and latitude for the tracking system, and shorten detection time.

Vehicles and ships

Case 4: Car four-wheel alignment

From the structure of the car, the installation between the steering wheel (front wheel), steering knuckle and front axle of the car has a certain relative position. This installation with a certain relative position is called steering wheel alignment, also called front wheel alignment. . Front wheel alignment includes four contents: kingpin caster (angle), kingpin inclination (angle), front wheel camber (angle) and front wheel toe-in. For the two rear wheels, there is also a relative position installed between the rear axle, which is called rear wheel positioning. Rear wheel alignment includes wheel camber (angle) and rear wheel toe-in one by one. This front wheel alignment and rear wheel alignment are collectively called four-wheel alignment

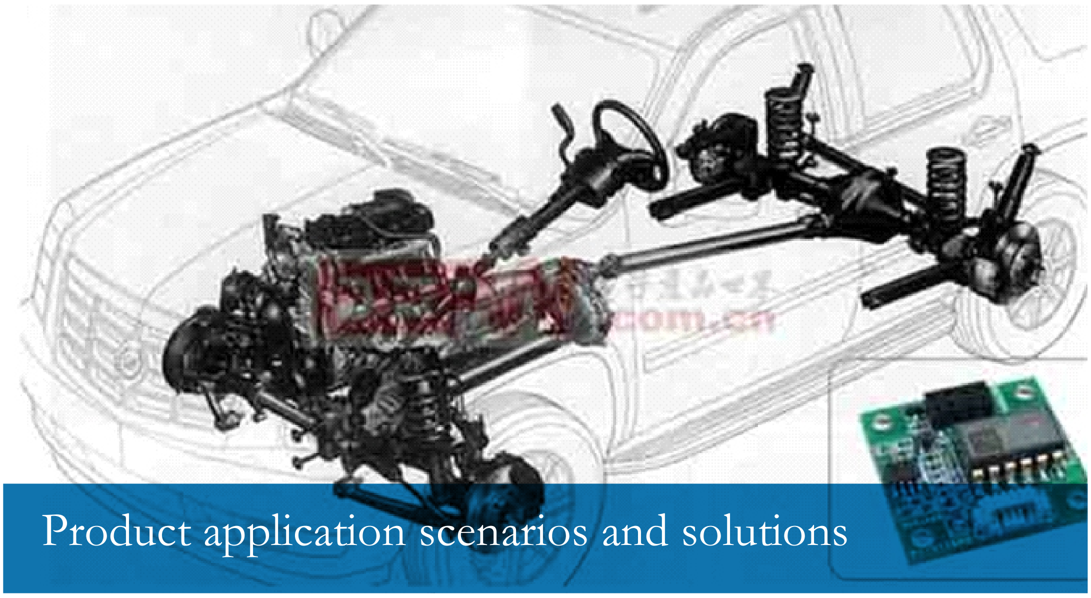
When the vehicle leaves the factory, the positioning angle is preset according to the design requirements. These positioning angles are used together to ensure the comfort and safety of vehicle driving. However, after the vehicle is sold and driven for a period of time, these positioning angles may change due to traffic accidents, severe bumps caused by potholes on the road (especially sudden bumps when driving at high speed), wear and tear of chassis parts, and replacement of chassis parts. , tire replacement and other reasons. Once the positioning angle changes due to any reason, uncomfortable symptoms such as abnormal tire wear, vehicle deviation, reduced safety, increased fuel consumption, accelerated wear of parts, heavy steering wheel, and floating vehicle may occur. Some symptoms make driving at high speeds very dangerous.

Four wheel aligner

The purpose of four-wheel alignment repair and maintenance services is to diagnose and treat the above-mentioned causes of vehicle discomfort through alignment angle measurement. Generally, a new car should have a four-wheel alignment after driving for 3 months. After that, every 10,000 kilometers of driving, tires or shock absorbers should be replaced, and a four-wheel alignment should be done promptly after a collision. Correct wheel positioning can ensure flexible steering, comfortable riding, maintain straight driving, extend tire life, and reduce vibrations caused by the road surface.

Vehicles and ships

Case 4: Car four-wheel alignment



Most of the instruments currently responsible for wheel alignment testing are "four-wheel aligners." During testing, the four-wheel aligner first measures the current four-wheel alignment parameters of the car, and then the computer automatically compares them with the stored values of the corresponding vehicle model to determine the four-wheel alignment parameters of the car. The deviation value is calculated after positioning, and the maintenance personnel can make corrections according to the prompts of the locator and then restore the original position.

Inclination sensor in wheel aligner

For different four-wheel alignment equipment, the key role is whether the measurement sensor is accurate. Modern cars generally use front and rear independent suspension. The main parameters detected by the four-wheel aligner are wheel camber angle, kingpin caster angle, kingpin inclination angle and toe-in and other parameters.

For the measurement of the above inclination angles by the four-wheel alignment measurement system, except for the toe angle, which is generally achieved through a turntable or angle sensor, inclination sensors are generally used for other angles. The inclination sensor is fixed on the mounting base of the four-wheel aligner, and then installed on the wheel of the car through a clamp.

Due to the structure of the car, the inclination angle measurement in the wheel alignment angle of the car is divided into two types: direct measurement and indirect measurement. It can be seen from the definition of wheel inclination that wheel camber can be measured directly using an inclination sensor, but this is not the case for kingpin inclination and caster. Since the kingpin is installed on the inside of the wheel, it generally cannot be measured directly through the inclination sensor. to measure. The wheel inclination angle measurement range should be approximately ± 15° . For models in use today, the adjustment deviation value of the inclination angle is generally about 5'. For example: the Volkswagen PASSAT B5 front wheel camber angle value is -0° 35' to ± 0° 25', so the measurement resolution of the sensor should be less than or equal to 5 '.

Vehicles and ships

Case 6: Ship inclination monitoring system solution

The "Ship Inclination Monitoring System" replaces the currently temporarily adopted horizontal instrument observation method. The specific implementation plan is as follows.

1. System Features

The "ship inclination monitoring system" and the original "six-point draft monitoring system" do not interfere with each other, but can complement each other. The "ship inclination monitoring system" can realize the functions of real-time display of inclination angle, over-limit alarm reminder, data storage and on-demand customization, making up for the shortcomings of the "six-point draft monitoring system" which only displays the ship's draft.

2. Implementation ideas

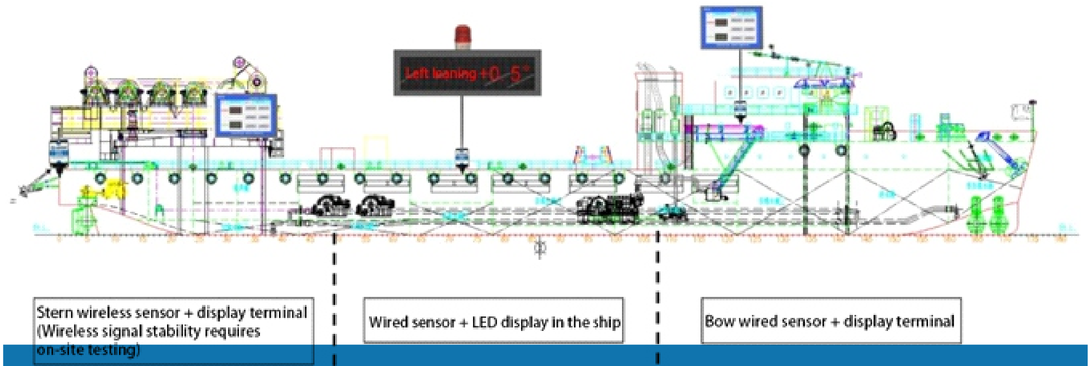
a) One dual-axis inclination sensor is arranged at the bow of the ship and is connected to the terminal display arranged on the load-adjusting console via wires to facilitate observation by the load-adjusting personnel. Compare with the reference of the LED inclination display in the ship to achieve dual-machine redundancy and avoid the failure of a single sensor to monitor the ship's inclination and affect the construction.

b) A dual-axis inclination sensor is arranged in the ship and connected to the LED large-screen display in the ship through a wired method. It is conspicuous and easy to read, which facilitates on-site command to flexibly command according to the ship's status. It can also be used for daily real-time monitoring of the ship's floating status, and with It has an over-limit alarm reminder function. When there is no need for load adjustment during small swing hoisting, the load adjustment console does not require dedicated personnel to be on duty.

c) Arrange a wireless dual-axis inclination sensor at the stern and connect it wirelessly to the terminal display arranged in the crane cab (wireless transmission needs to be determined after on-site test signal stability).

Vehicles and ships

Case 6: Ship inclination monitoring system solution



Product application scenarios and solutions

The system diagram is as follows

3. Equipment selection

a) Sensor:

b) display terminal

c) LED display screen: This display screen needs to be customized, and the display effect is as shown in the figure below

Vehicles and ships

Case 7: Application of inclination sensor to monitor ship navigation attitude

Product application scenarios and solutions

The inclination sensor is generally installed on the horizontal platform of the ship deck and is used a measure the inclination angle of the ship itself when the ship is traveling or docking. When the ship body exceeds 35°, there is a risk of capsizing, so the inclination angle cannot exceed 35°. When the angle of the hull is greater than 15°, an alarm signal is required. If necessary, corresponding protective measures should be taken or the motor of the hull should be forcibly stopped to ensure the safe navigation of the ship, especially in the case of wind and waves, so the inclination sensor is also required. It has become an indispensable measurement tool for the safe operation of ships.

Vehicles and ships

Case 8: Monitoring application of inclination sensor in sand mining ship

Product application scenarios and solutions

Sand mining ship, fishing boat is a fishing vessel, a collective name for ships that can catch, process, and transport fish. Fishing vessels are vessels that capture and harvest aquatic animals and plants, and also include some auxiliary vessels for modern fishing production, such as vessels for aquatic product processing, transportation, breeding, resource surveys, fishery guidance and training, and fishery administration tasks. Most fishing vessels are small. However, in order to adapt to continuous navigation and operation in wind and waves, they are required to have good stability, seakeeping and seaworthiness, and the structure needs to be particularly strong. The load capacity of fishing boats changes greatly during operation, ranging from tens to hundreds of tons for small and medium-sized fishing boats, to thousands of tons for large fishing boats, or even more than 40,000 gross tons.

In addition to the general marine equipment, fishing boats also need to be equipped with fishing aids and navigation and communication instruments such as winches, inclinometers and navigators. In particular, the inclinometer plays a very important role for the driver. The inclinometer, also called an inclination sensor, is an instrument that measures the inclination angle of an object in real time. The inclinometer can measure the real-time pitch angle and roll angle of a fishing vessel in real time. comes out and can be displayed through corresponding display instruments, so that the driver can control the current operating status of the ship in real time and adjust the operating direction in time, making it easier to maintain the stable operation of the ship. At the same time, it has gradually become the most commonly used and indispensable tool for drivers. one of the instruments.

Product application scenarios and solutions

During the flight of the aircraft, the attitude data of the INS+GNSS integrated navigation may lose satellite correction and drift gradually, even slowly.

Military and aerospace articles

Case 1: Application of fiber optic gyroscope radar and satellite tracking communication system

Generally speaking, the radar antenna is installed on the mast in a relatively open place, and its purpose is to avoid signal sources or electromagnetic radiation caused by various interferences. In order to ensure the stability and reliability of the work, the specially designed radar antenna is configured with a stable platform, which is not affected to a certain extent. However, in actual application, the radar antenna will tilt due to external vibrations, stagnation in its structure, and installation errors during actual use. The inclination sensor can accurately measure the angular deviation caused by various reasons. The real-time detection angle signal is transferred in the form of digital or analog quantity, and can be directly connected to identify the corresponding signal display instrument and the corresponding control system to realize real-time detection and control of the radar antenna and ensure its normal and stable operation.

Satellite automatic tracking system

The automatic satellite tracking system is used to ensure the accurate pointing of the satellite transmitting antenna to the satellite when the vehicle body is moving. Its main equipment is:

1. Antenna base: Use unloading and power storage methods to reduce the load inertia during antenna transmission.
2. Servo: adopt position loop or speed loop control method, use analog hardware to improve the circuit response speed and reduce the dynamic lag error of the servo tracking system.
3. Data processing: Use a dedicated mathematical solution platform to process the error signal and the dynamic signal of the carrier to calculate the control signal of the antenna.
4. Carrier measurement: Use strapdown inertial navigation measurement and other measurement methods to measure the change of the carrier, so that it can be reflected in the antenna tracking. Among them, the fiber optic gyroscope is a new type of navigation instrument developed based on the principle of optical interference. It has become an ideal main component of the new generation of strapdown inertial navigation system and is used to accurately determine the direction of the envisioned object. The quartz flexible pendulum accelerometer is a sensitive element made of fused quartz. The flexible pendulum structure is equipped with a feedback amplifier and a temperature sensor for measuring linear acceleration along one axis of the carrier.

Military and aerospace articles

Case 1: Application of fiber optic gyroscope radar and satellite tracking communication system

The fiber optic gyroscope three-axis inertial measurement combination consists of three fiber optic gyroscopes and three quartz flexible pendulum accelerometers. It can output the angular velocity, linear acceleration, linear velocity and other data of the carrier in real time, and has alignment, navigation and heading attitude reference. Various working methods such as benchmarks are used for the combined navigation and positioning of mobile carriers, and at the same time provide accurate data for the mechanical control device of the following antenna.

For the communication system in motion, its main performance requirements are: meter accuracy 1×10-4g; fiber optic gyroscope accuracy (bias stability) ≤1° /h; scale factor linearity ≤5×10-4.

satellite communication system
The function of the satellite communication system is to transmit television signals uplink to satellites and downlink them by transponders to ground satellite receiving devices. Its main equipment is: coder/decoder, modulator/demodulator, up/down converter, high power amplifier, duplexer and low noise amplifier.

The working principle of the "Mobile Communication" system
During the movement of the carrier, changes in its attitude and geographical location will cause the original alignment of the satellite antenna to deviate from the satellite, interrupting communications. Therefore, these changes in the carrier must be isolated so that the antenna is not affected and is always aligned with the satellite. This is the main problem to be solved by the antenna stabilization system, and it is also the prerequisite for uninterrupted satellite communication by mobile carriers.

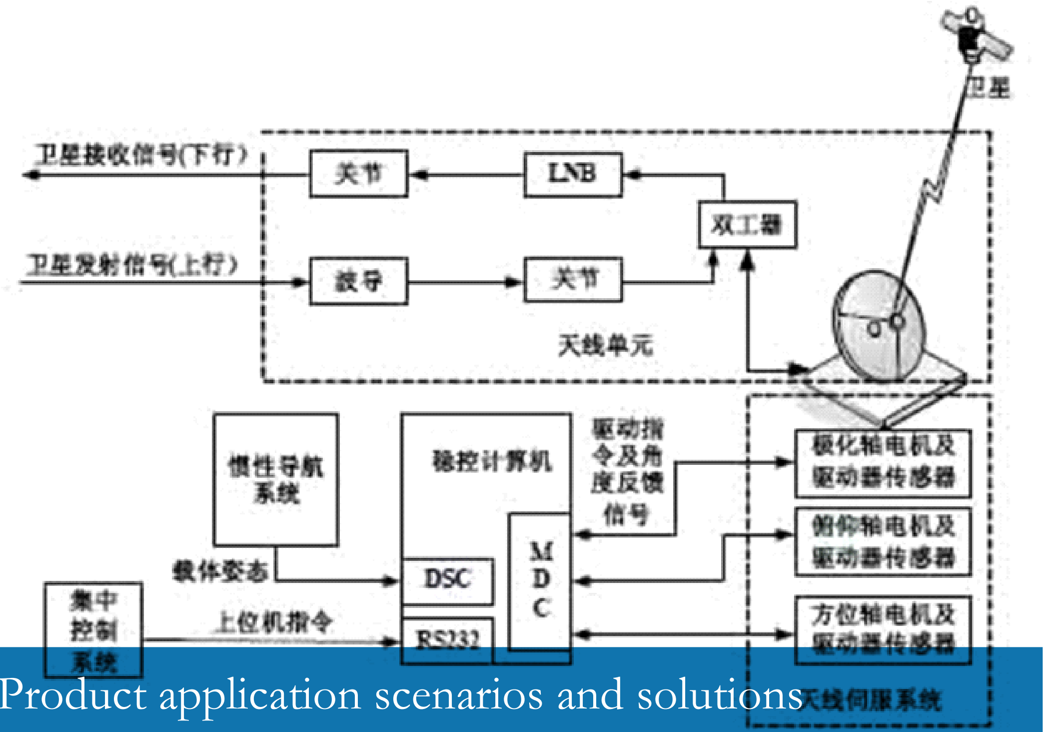
Military and aerospace articles

Case 1: Application of fiber optic gyroscope radar and satellite tracking communication system

The "moving-in-motion" tracking system uses GPS, theodolite, and strapdown inertial navigation systems to measure the heading angle, the longitude and latitude of the carrier's location, and the initial angle relative to the horizontal plane under initial static conditions, and then based on its attitude and geographical location , the satellite longitude automatically determines the antenna elevation angle based on the horizontal plane, rotates the azimuth while keeping the elevation angle unchanged to the horizontal plane, and automatically aligns with the satellite using the maximum value of the signal. During the movement of the carrier, the changes in the attitude of the carrier are measured, and converted into the error angle of the antenna through calculations on the mathematical platform. The azimuth angle, pitch angle, and polarization angle of the antenna are adjusted through the servo mechanism to ensure that the antenna is aligned with the star during the change process of the carrier. Within the specified range, the satellite transmitting antenna can track the geostationary satellite in real time during the movement of the carrier.
There are two system tracking methods: self-tracking and inertial navigation tracking. Self-tracking relies on satellite beacons for antenna closed-loop servo tracking; inertial navigation tracking uses changes in the sensitive carrier combined with gyro-inertial navigation for antenna tracking. This tracking method is sometimes called guidance. These two types of tracking can be automatically switched according to on-site conditions. When the system completes star alignment and switches to automatic tracking, it will work in a self-tracking mode; at the same time, the inertial navigation system also enters the working state and continuously outputs data such as antenna polarization, azimuth and pitch. When the antenna beacon signal is interrupted due to obstruction or other reasons, the system automatically switches to inertial navigation tracking mode.

Tracking on the move
When the carrier is moving, it is necessary to continuously track satellite signals or satellite beacon signals. Different tracking methods can be adopted according to the needs of different systems. According to the tracking principle, automatic tracking can be divided into three systems: step tracking, cone scan tracking and single pulse tracking.

Case 1: Application of fiber optic gyroscope radar and satellite tracking communication system



Product application scenarios and solutions

a) Step tracking

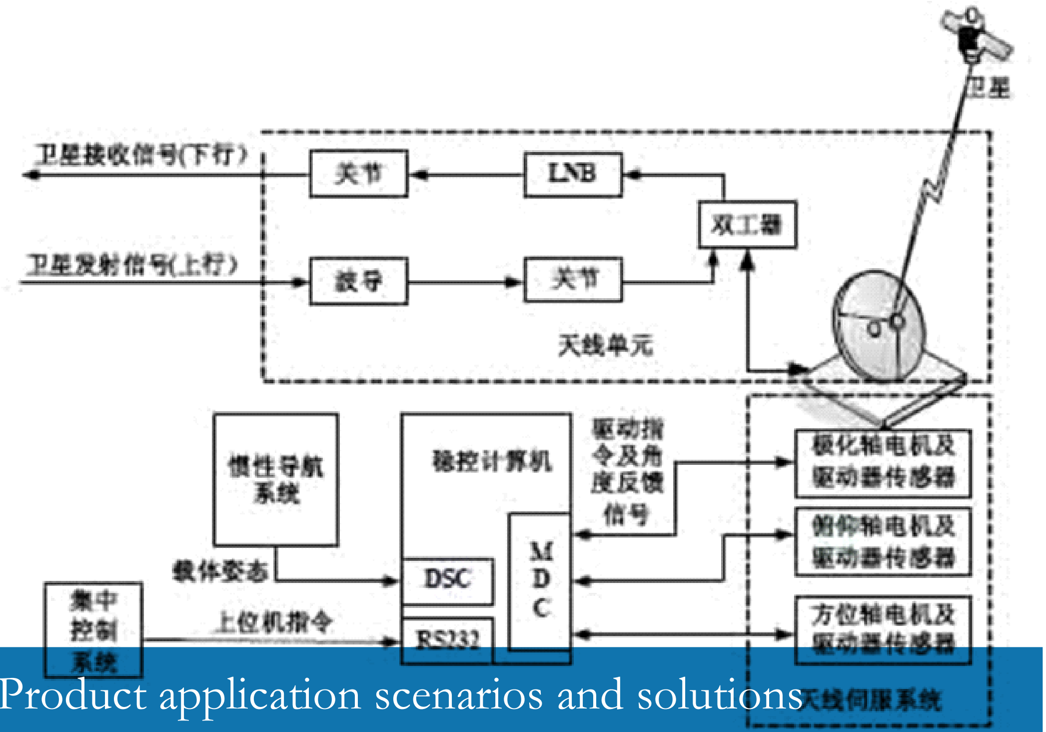
Step tracking is also called extreme value tracking. It controls the antenna step by step to rotate at a slight angle in the azimuth plane and the pitch plane, so that the antenna is gradually aligned with the satellite. It is not until the received signal reaches the maximum value that the system enters the rest state. After a period of time, it starts to enter the tracking state again, and so on. Figure 1 shows the functional block diagram of step tracking.

In this method, the precession of the antenna is divided into two types: search step and adjustment step. After the search step, the entire tracking system begins to work, including signal data sampling, field strength memory, comparison, etc. After several searches and the direction in which the antenna should rotate is determined, the antenna returns to its original position and then moves toward the satellite. Turn one step in direction. This last step is called the adjustment step. Therefore, the main difference between the adjustment step and the search step is that the antenna will not return to its original position after the adjustment step, but the search step is different. No matter how many times the search step is performed, as long as the specified number of times is completed, the antenna will return to its original position, and then the antenna will rotate one adjustment step. In actual systems they can be separate or the same step.

b) Single pulse tracking

The characteristic of the single-pulse tracking method is that the antenna beam is fixed. Within a pulse interval, the size and direction of the antenna beam deviation from the satellite can be determined, and the error signal of the antenna azimuth axis and pitch axis motion is obtained to drive the servo system, so that the antenna Quickly align satellites. Single pulse tracking has multi-speaker mode and high-order mode mode. Multi-speaker mode usually has two types: amplitude comparison and phase comparison. For parabolic antennas, multiple horns are usually configured, and error signals are generated by amplitude comparison for tracking. The high-order mode method is to extract the high-order mode generated in the feed waveguide as a position error signal for tracking when the symmetry axis of the antenna deviates from the satellite direction. The tracking speed and tracking accuracy of the single pulse tracking system are several orders of magnitude higher than the cone scanning tracking system and the step tracking system, but its equipment is complex and the cost is relatively expensive.

Case 1: Application of fiber optic gyroscope radar and satellite tracking communication system



Product application scenarios and solutions

c) Cone Scan Tracking

Cone scanning tracking is to move the feed horn in a cone around the symmetry axis of the antenna, or to tilt and rotate the antenna sub-surface, so that the antenna beam rotates in a cone shape. When the antenna axis is aligned with the satellite, the beacon level will be amplitude modulated by a very low frequency signal. The modulation frequency is the same as the beam rotation frequency, and the modulation depth is related to the distance of the beam from the satellite. If the deviation is large, the modulation depth is large; if the deviation is small, the modulation depth is shallow; if there is no deviation, the modulation depth is equal to zero. The phase of modulation is related to the direction of beam deviation, so the pointing error of the antenna beam can be detected from the amplitude and phase of the modulated signal, and the direction and size of the motor-driven antenna rotation can be determined based on the pointing error.

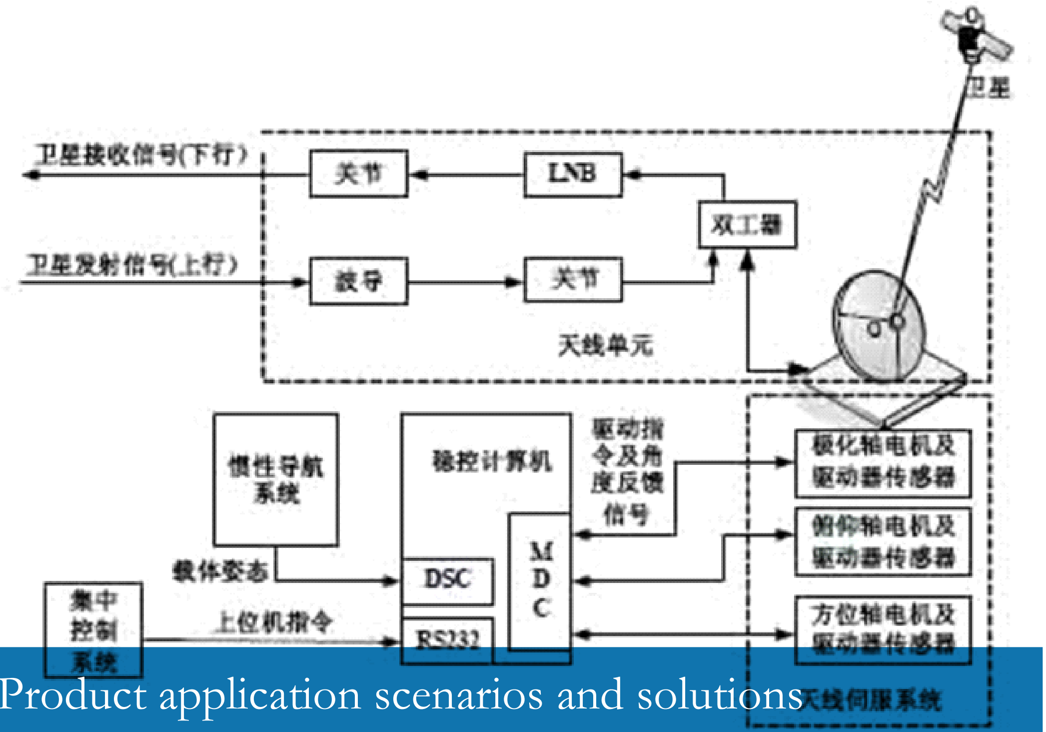
Comparison of three tracking systems

Judging from the working methods of the three tracking principles, they are essentially the same. They all compare and determine the rotation direction and amplitude of the motor after obtaining multiple AGC signals. Step tracking is to sample in the azimuth and elevation planes respectively and then drive the motor to drive the antenna to rotate in the azimuth and elevation planes; cone scanning tracking is to make the feed source make a conical movement driven by the motor and compare the size of the signal level in the process. To align the satellite; single pulse tracking can determine the rotation direction and amplitude of the motor within one pulse.

The accuracy and speed of single pulse tracking are relatively high, but the system is more complex and the cost is high, so it is generally suitable for places with high accuracy requirements. Although the accuracy of cone scanning can meet the requirements of general systems, the structure is relatively complex and the signal loss is relatively high. Large, and the tracking speed is relatively slow; while the speed and accuracy of step tracking are between the two, and the entire system is relatively simple and easy to implement, so it has been widely used.

Military and aerospace articles

Case 1: Application of fiber optic gyroscope radar and satellite tracking communication system



Product application scenarios and solutions

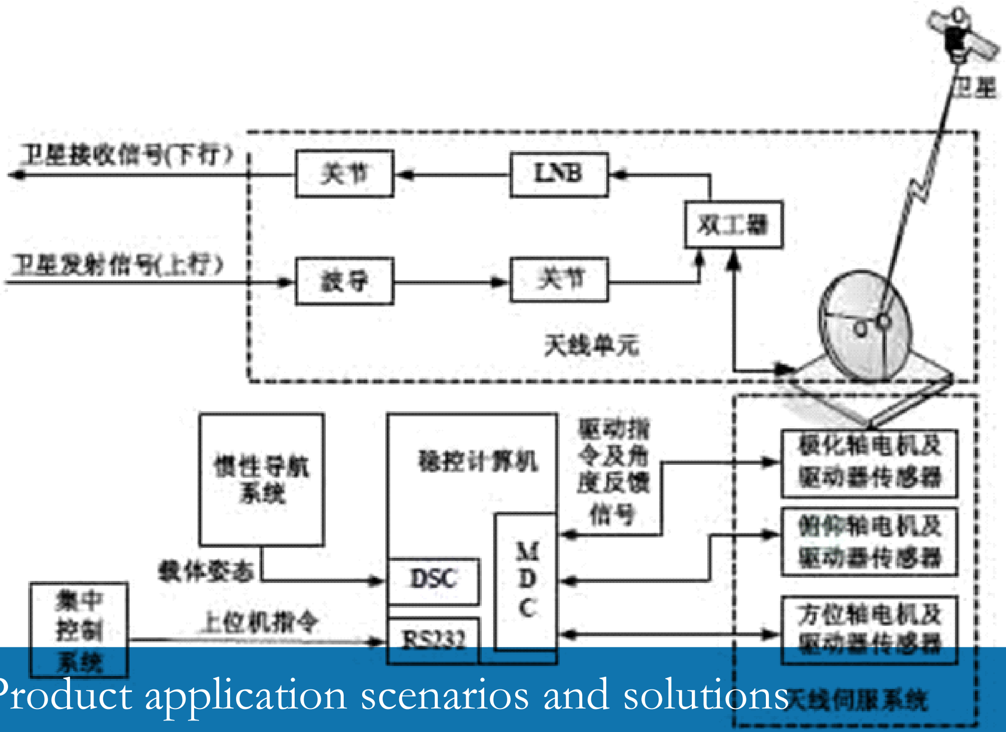
stabilization technology
For a communication-in-motion system, if there is only tracking, the antenna will easily lose signals under large fluctuations in the carrier, causing communication interruption. Therefore, an antenna stabilization system is necessary to isolate interference caused by carrier motion. There are two ways to implement the stabilization system of vehicle antennas: 1. Physical platform stabilization; 2. Strapdown stabilization.

1. Physical platform stability: A stable platform is used to isolate the vehicle antenna from the vehicle body. The movement of the vehicle body is isolated from the vehicle antenna system by the stable platform. This is equivalent to fixing the vehicle antenna on the ground plane, making it easy to achieve precise satellite alignment, and there is no need to adjust the direction of the antenna after aligning the satellite. This method divides the vehicle antenna stabilization system into a stable platform system and an antenna servo system. The antenna's stable star alignment relies on a stable platform, which has poor autonomous capabilities, complex systems, and high relative costs.

2. Strapdown stabilization: Using the information provided by the gyroscope, GPS, etc. on the carrier, through coordinate transformation, a mathematical platform is established to calculate the correction amount of the servo system. The system has been widely used due to its simple structure, good reliability, small size, low cost, and easy maintenance.

The "Moving Communication" vehicle can transmit digital TV, radio, and data signals in two directions via satellite at a driving speed of 20 to 100km/h, ensuring that the moving carrier can carry out uninterrupted broadband multimedia satellite communication during the movement.

Case 1: Application of fiber optic gyroscope radar and satellite tracking communication system



Product application scenarios and solutions

Features of the "Mobile Communication" system

1. "Mobile Communication" has the following advantages in live broadcast:

→During the rebroadcast process, autonomous tracking is used to track satellites, making full use of the characteristics of satellite communication such as large coverage area, strong anti-interference ability, and stable lines, and can realize point-to-point, point-to-multipoint, and point-to-master station mobile satellite communications.

→"Mobile Communication" vehicle has the characteristics of flexible and maneuverable broadcasting, which can ensure fast and real-time static and dynamic live broadcast

→The automatic re-acquisition time is short, and communication can be quickly restored after driving out of the communication blind spot.

→Compared with OFDM "non-directional" mobile microwave equipment, the "communication on the move" vehicle does not require operators of receiving and transmitting equipment to work in harsh environmental conditions, saving manpower and material resources, and reducing electromagnetic radiation pollution

→The number of nodes in the signal transmission process is reduced, which improves the quality and reliability of broadcasting.

→Can reduce the operating costs of live broadcasting of large-scale and complex scenes

2. However, there are still some shortcomings in "Mobile Communication", mainly:

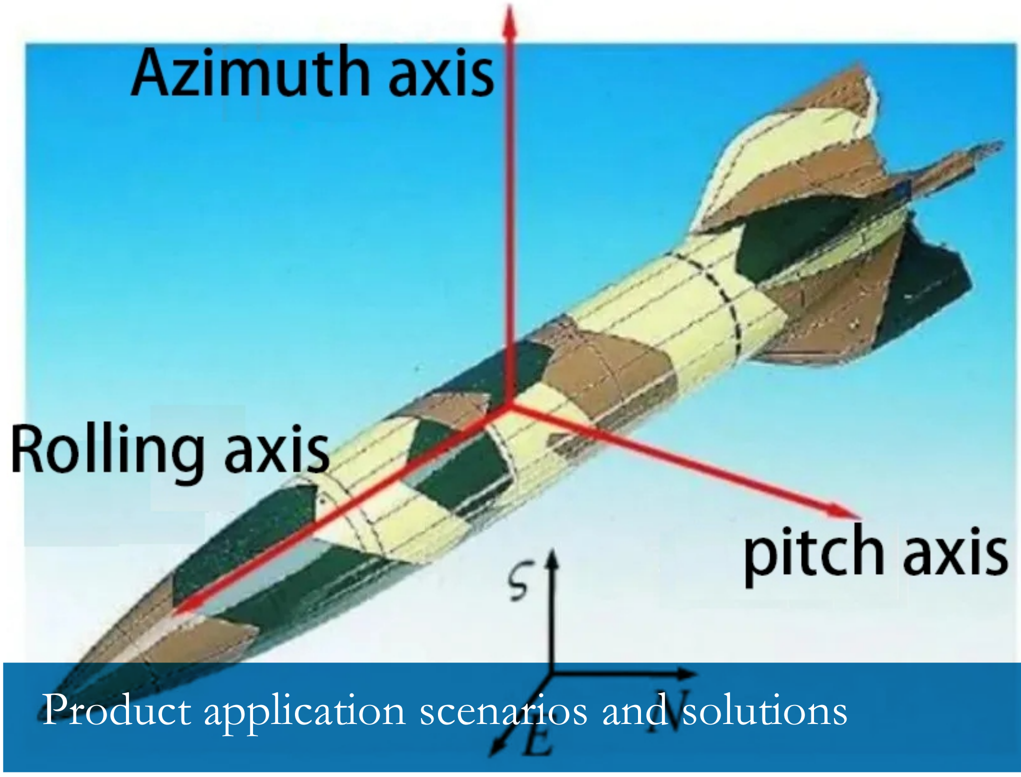
→When the broadcast environment is complex (too high, too many buildings, bridges, mountainous areas, etc.), signal interruption may occur.

→Using two "mobile communication" vehicles to transmit different TV image signals, it is difficult to achieve a flashpoint-free connection when the images are broadcast (both vehicles encounter flashpoints at the same time)

→It is difficult to transmit signals between the "moving communication" vehicle and the mobile signal collection vehicle (the directions and positions of the two vehicles are constantly changing).

Military and aerospace articles

Case 2: Application of gyroscope in short-range guidance



Product application scenarios and solutions

Gyroscopes are widely used in the field of artillery guidance, mainly used for tasks such as navigation, stability control and target tracking. The following are some application cases of MEMS gyroscopes in the field of short-range guidance:

1. Missile guidance system: MEMS gyroscopes are used in missile guidance systems to help the missile maintain a stable flight path and adjust the flight angle to track the target. These gyroscopes are typically used to measure the missile's rotation speed and direction in order to adjust the missile's course in real time.
2. Artillery shells and rocket guidance: In the short-range guidance of artillery shells and rockets, MEMS gyroscopes are used to measure the rotation and tilt of the ballistics to ensure that the warhead accurately hits the target.

Product application scenarios and solutions

Inclination module: Commonly used in medical equipment and human body detection; it can provide higher reliability, longer service life and higher accuracy, thus being more deeply applied to medical equipment.

Medical devices

Case 1: Application of tilt module in medical equipment

Inclination module: widely used in medical equipment and human body detection, etc.
The inclination sensor is installed in the control handle of the operating table, and controls the motor transmission process by controlling the movement of the handle in the roll and elevation directions to achieve precise control of the inclination angle of the surgical cart. In addition, it is widely used in rehabilitation beds, automatic wheelchairs, etc.

In the application of medical devices, a small on-site failure problem is a major event related to the patient's life and health. The ever-changing inclination sensor technology can provide higher reliability, longer service life and higher accuracy, thus being more deeply applied to medical devices.

Human-machine navigation

Product application scenarios and solutions

The human-machine navigation and positioning work is mainly completed by the integrated positioning and directional navigation system. The integrated navigation system outputs position and attitude information in a real-time closed-loop, provides accurate direction reference and position coordinates, and at the same time predicts the aircraft status based on the attitude information in real time.

Human-machine navigation

Case 1: A5000 - 9-axis AHRS attitude and orientation reference system integrated human-machine navigation in robots

Product application scenarios and solutions

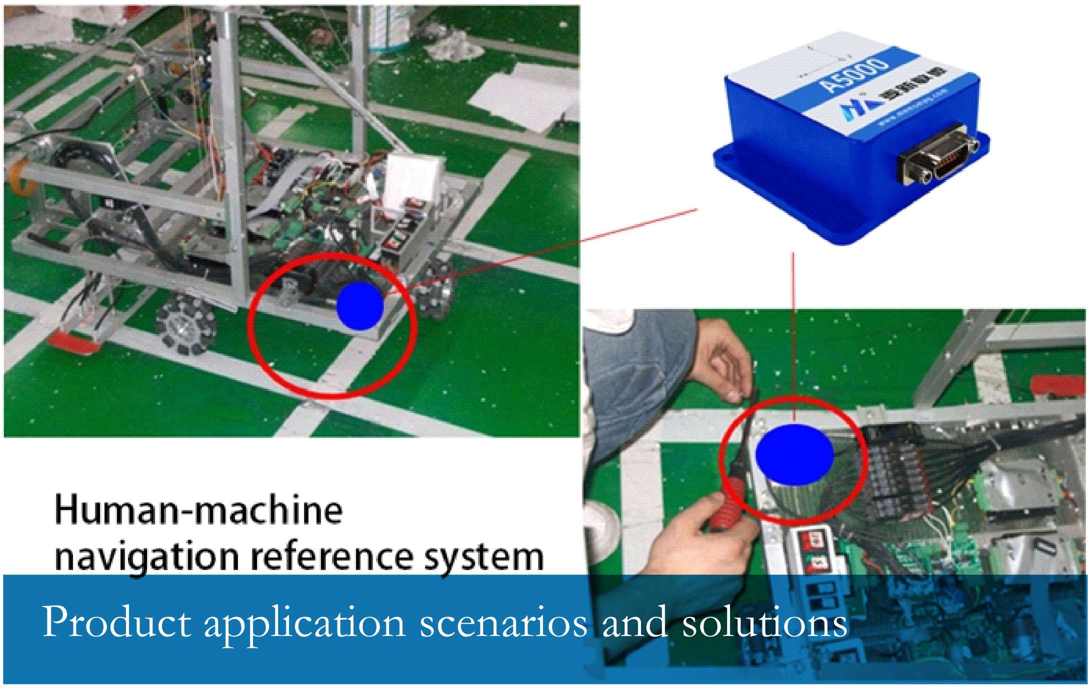
The "Asia-Pacific College Student Robot Competition Domestic Selection Event" has been successfully held for six times to select China's domestic robot-making champion team to compete for the Asia-Pacific crown. A college student from Beijing University of Posts and Telecommunications used AHRS to measure the posture of the robot in three axes, and finally entered the competition for the final championship.

BREEZE CO.,LTD's A5000 is an excellent miniature AHRS product
for measuring attitude and heading. Its internal processor has low power consumption and small output heading angle drift; it also provides calibrated three-dimensional acceleration, angular velocity and magnetic field strength. It is a measurement product with excellent performance for the stabilization and control of cameras, robots, vehicles and other series of equipment. For detailed technical specifications of this product, please refer to the product description.

Product installation method: Since there is a magnetic sensor inside the sensor, it is recommended to stay at least 30cm away from ferromagnetic materials during installation. The installation screws should be made of copper or aluminum, and a shock absorbing device should be added.

Human-machine navigation

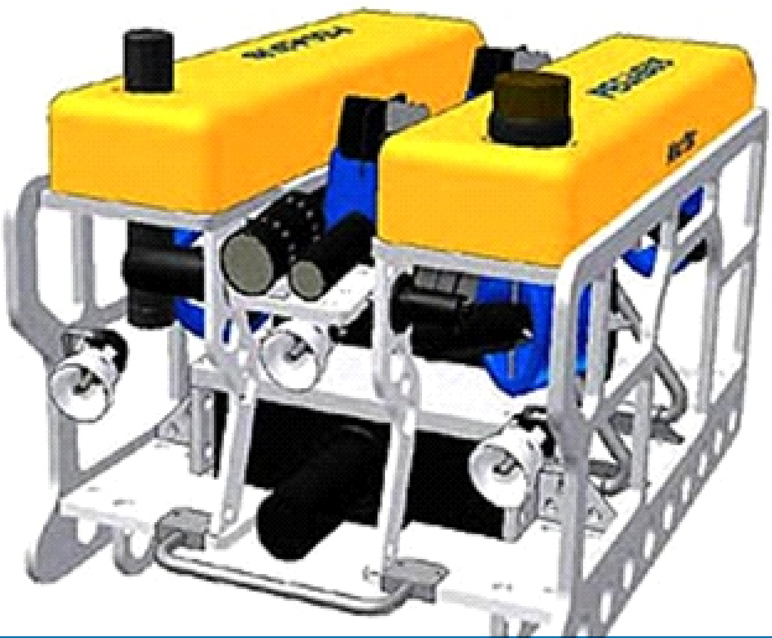
Case 1: A5000 - 9-axis AHRS attitude and orientation reference system integrated human-machine navigation in robots



A5000's 9-axis attitude and orientation reference system, three-axis (gyro, accelerometer, magnetometer) and temperature sensor, accurate attitude measurement in harsh environments of motion and vibration, high-performance drift stability, 200HZ update frequency, wide temperature range: - 40℃ ~+85℃, output interface: TTL/RS232/RS485/RS422, etc. optional.

Human-machine navigation

Case 2: IMU (Inertial Measurement Unit) navigation control in underwater robots



Product application scenarios and solutions

Underwater robots, also known as unmanned remotely operated submersibles, are robots used for extreme underwater operations. This kind of robot is often used in harsh and dangerous underwater environments or in situations that the human body cannot reach. The invention and application of underwater robots have brought possibilities to applications such as underwater object detection, underwater photography, underwater breeding, underwater detection, and underwater scientific research. Since it is an unmanned underwater operation, in addition to an automatic control system, an underwater communication system and a water environment detection system, the underwater robot must also have a precise navigation and positioning system. Among them, the electronic compass plays an important role in determining the heading of the underwater robot.

During the operation of underwater robots, their movements usually need to be controlled and adjusted through automatic control systems and communication systems so that they can reach the correct operating location. To ensure that the robot can successfully reach its destination, the underwater position must be monitored and adjusted. Among them, the robot's sonar can be used to detect obstacles and approaching objects to avoid collisions during underwater navigation. The GPS positioning system is used to measure the real-time coordinate position of the underwater robot. The electronic compass can measure the robot's azimuth navigation and send its own heading to the control system to compare with the destination location and make corresponding navigation. Adjustment. Especially when working remotely, the measurement of heading is even more important.

Human-machine navigation

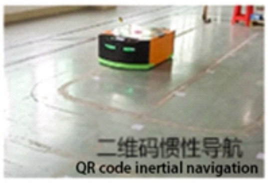
Case 2: IMU (Inertial Measurement Unit) navigation control in underwater robots

Product application scenarios and solutions

BREEZE CO.,LTD's U3000 is a high-performance IMU module product that uses MEMS process technology and related calibration algorithms, making the product extremely precise in heading measurement accuracy. Our company has many years of experience in R&D and manufacturing of heading sensor products. The product has stable and reliable measurement values, low power consumption and small size. It is a popular product that can meet various measurement requirements.

Human-machine navigation

Case 3: IMU installed on AGV car for precise positioning



Product application scenarios and solutions

Normally, when we use AGV cars, we will preset the driving path of the AGV car in advance, and then use instructions to let the AGV car go to the predetermined work station to complete the transportation work. The AGV car is equipped with an IMU to achieve positioning. What are the benefits of this positioning method? Woolen cloth?

After the IMU is installed on the AGV car, a positioning device is installed at the main site. The AGV car uses the calculation of the IMU deviation signal and the collection of the ground positioning block signal to determine the position and direction of its own body. Finally, the speed and position are obtained through integration and calculation, and then From arrival to the purpose of navigation and positioning of the vehicle. The AGV car can achieve precise docking at the workstation by installing an IMU.

The technical method of installing IMU on AGV cars to achieve positioning was applied earlier. This technology is mature and highly flexible, allowing the AGV cars to have higher positioning accuracy, easy combination and compatibility, and a wide range of applications.

The precise positioning of AGV trolleys is very important for transporting materials. Only accurate parking can ensure the production rhythm, and seamless connection can truly realize the automated transportation process. The precise positioning of AGV trolleys is an important link in logistics transportation.

Product application scenarios and solutions

Users use our remote Internet of Things and sensor monitoring software to summarize and analyze the data, and obtain the changes in tilt, settlement, and defects of the building for dynamic identification.

Internet of Things Monitoring

Case 1: T70-F wireless inclination sensor, applied in storage shelf safety monitoring

When storing goods in warehouses, shelf safety issues cannot be ignored. There are countless accidents caused by hidden dangers in warehouses every year. Among them, accidents caused by tilted shelves and collapses cost many companies and people a heavy price. Therefore, preventing storage shelves from collapsing is a top priority.

Especially during this carnival shopping festival when warehouses are bursting, shelf safety monitoring is urgent.The traditional form of shelf monitoring is to manually observe the status of the shelf, which cannot detect shelf abnormalities in time, such as tilt due to aging, tilt due to forklift collision, tilt under long-term load, etc. For shelf safety monitoring, BREEZE CO.,LTD has developed the T70-F wireless inclination sensor and monitoring solution, which can monitor local deformation and tilt of the shelf in an all-round and real-time manner that cannot be observed with the naked eye.

Internet of Things Monitoring

Case 1: T70-F wireless inclination sensor, applied in storage shelf safety monitoring

Product application scenarios and solutions

Fix the inclination sensor on the top of the shelf to monitor the verticality of the shelf's columns. Once the inclination value exceeds the set threshold, an alarm will be issued in time. This can restore the shelf to health at the lowest cost in the first time, and at the same time, it will have an impact on the warehouse's shelf layout and forklifts. KPIs, shelf health predictions, and safety accident prevention have a sufficient data basis.

Case 2: Application of inclination sensor water conservancy valve automatic control system

Inclination sensors are widely used in water conservancy valve automatic control systems. At present, the front-end equipment of the flap water valve control system generally consists of a flap water valve, an oil cylinder, and a cable-type valve opening meter fixed on the oil cylinder. The oil cylinder and the upper end of the valve are connected through a rotating shaft, and the expansion and contraction of the oil cylinder drives the opening and closing of the valve. During the expansion and contraction process of the oil cylinder, the steel cable is driven to expand and contract, and there is a certain functional relationship between them. As long as the length of the steel cable is measured, the real-time angle of the gate can be calculated. However, since the external steel cable is exposed outside, it is easily corroded, causing instability of the actuator. Therefore, in recent years, new non-contact control technology has gradually been adopted, that is, a non-contact method that uses an inclinometer sensor to measure the angle of the cylinder. Effectively make up for the shortcomings of the original system.

Internet of Things Monitoring

Case 3: Inclination sensor application monitoring IoT billboard system

Product application scenarios and solutions

BREEZE CO.,LTD's tilt sensor is used to monitor the Internet of Things billboard system. Once the tilt angle of the billboard exceeds the set safety value, the monitoring data will be transmitted in real time through the wireless network, and automatic warning and reminder text messages will be sent based on the monitoring results. Notify relevant departments to deal with various safety hazards as soon as possible.

Many cities have experienced strong winds and other severe weather, and we have to be more careful when walking under these "Big Macs" (large billboards). Especially cities in coastal areas are hit by some typhoons every year. In order to improve the level of urban safety management and facilitate regulatory agencies to quickly grasp emergencies, BREEZE CO.,LTD proposed a supervision method that uses sensor technology to monitor the inclination of large advertising plaques, and promoted the installation of inclination sensors on many large outdoor billboards in urban areas. , monitor possible safety hazards at any time.

Internet of Things Monitoring

Case 3: Inclination sensor application monitoring IoT billboard system

Product application scenarios and solutions

The process and principle of using an inclination sensor to monitor outdoor advertising plaques: In this type of monitoring application, during installation, the inclination sensor is usually installed and fixed on the back of the advertising plaque. Then, keep the horizontal or vertical axis of the inclination sensor parallel to the ground or vertical direction, swing and calibrate the inclination sensor back and forth, and observe the corresponding relationship between the X and Y axes of the sensor and the actual horizontal and vertical axes and the angle changes. At the same time, by setting a certain safe inclination range, when the inclination of the billboard gradually changes to the set warning value, an alarm message can be automatically sent to the terminal.

In order to improve the level of urban safety management and facilitate supervision units to quickly grasp emergencies, a supervision method is proposed to use sensor technology to monitor the inclination of large advertising plaques. Our company organized the engineering department and technical engineers to design and implement the large outdoor advertising monitoring system, as well as The core issues of the early warning level formulation method and the hazard level prediction method were discussed in detail. Among them, the design part of the large outdoor advertising monitoring system includes system architecture, functions, database and software and hardware integration design.

Internet of Things Monitoring

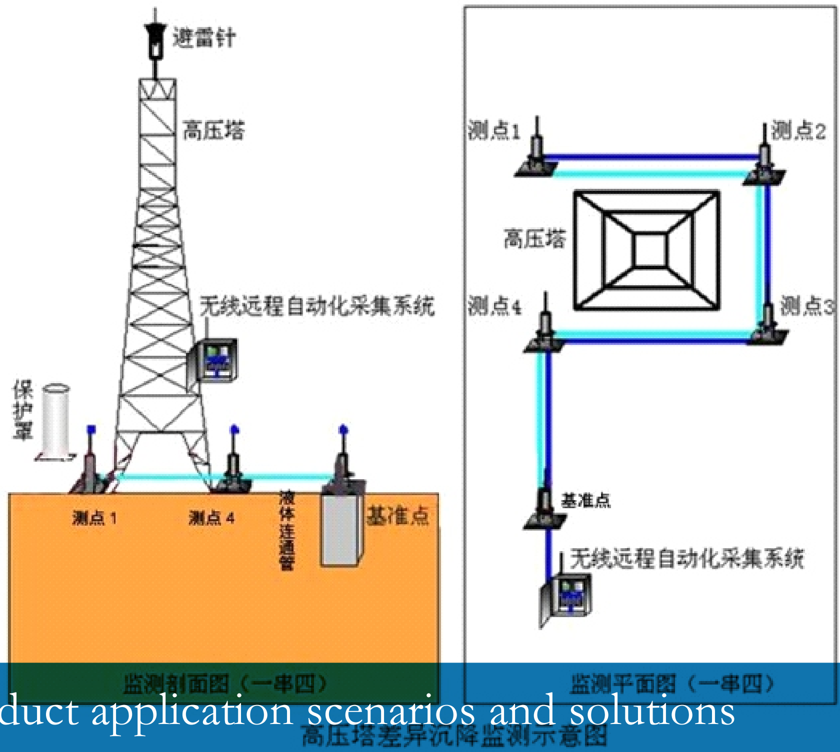
Case 3: Inclination sensor application monitoring IoT billboard system

Product application scenarios and solutions

The system consists of a front-end information collection device and a back-end information processing and display part. Among them, the MEMS inclination sensor in the front-end information collection device is used to collect the inclination data of large advertising plaques at certain intervals, and the monitoring data is transmitted to the back-end server through GSM wireless network (3G/4G/5G) communication, and finally the server

Complete data analysis, data warehousing, monitoring and early warning, and web interface and mobile terminal display. The system has the characteristics of all-weather and real-time performance, which greatly saves labor costs while improving the efficiency of supervision of large advertising plaques. It is a useful attempt to apply Internet of Things technology in the field of "smart cities".

Case 4: Signal tower deformation and settlement monitoring design plan



Monitoring system design principles: 1. Reliability; 2. Advancement; 3. Scalability; 4. High cost performance; The main technologies and products of the system are mature, stable and practical, and can fully meet the needs of practical applications, technology development and information management. Ensure accurate monitoring under harsh weather conditions. In the event of a sudden power outage, the system can operate 24/7 without interruption.

The network design ensures the reliability of network operation, and the entire system can still run even if an accident occurs at any node. The sensor has been calibrated by the national metrology department and has relevant metrology certificates. Using mature core technologies, various equipment selections should consider brands with good technical support, strong service capabilities, stable equipment performance, and good scalability in the market to ensure that the design is scalable and forward-looking. In system construction, we should not blindly pursue high configuration, but should design a system structure with good scalability on the premise of ensuring that the system is reliable, select products with good scalability and upgrade capabilities, and modularize the system structure to ensure that the entire system scalability.

1. Monitoring scope: a) Structural settlement monitoring b) Incline and horizontal displacement monitoring
2. Monitoring content: Use sensors, collectors, and wireless transmission systems to conduct real-time, comprehensive wireless automated monitoring of the overall settlement, differential settlement, and tilt of the signal tower.
3. System composition: The system consists of sensors (static level, inclination sensor), data acquisition device, wireless signal transmission device, central signal receiving and processing device, computer room and computer software system. The system establishes an open data interface and supports remote expert consultation through dedicated lines or the public Internet when the network or bandwidth allows, access or remote viewing.

Internet of Things Monitoring

Case 4: Signal tower deformation and settlement monitoring design plan

Product application scenarios and solutions

4. System function: The on-site data is sent to the monitoring center PC through the wireless GPRS transmitting device. The software automatically converts the measurement data and directly outputs the monitored physical quantities using the network for data transmission or internal LAN to complete the collection and monitoring of sensor data. The software can set upper limit alarm commands, mobile phone text message alarms can be controlled at all times, and PC can be connected to the network for data collection and monitoring.
5. Sensor parameters: inclination sensor (tilt horizontal displacement monitoring), accuracy: 0.3-0.001° optional, collection frequency: 100Hz; static level (structure settlement monitoring), accuracy: ±0.1MM, range: 0.2-2000MM; communication Method: GPRS, Bluetooth, ZigBee (optional); Transmission distance: GPRS (3G4G network), Bluetooth <10M, ZigBee <250M can be customized.
Sensor type: small size, low power consumption, hydraulic static level, customized inclinometer for pole tower monitoring inclination measurement. It integrates a 24-bit ARM high-end system with a resolution of 4 seconds and a response frequency of up to 100HZ. Power supply: Mains power, solar energy, lithium electrical appliances are optional; power consumption: less than 1.5W; input voltage: DC9-36V; operating temperature range: -40℃～+85℃;

Forecast and early warning: Real-time analysis and interpretation of each monitoring data, making single or multiple comparison alarm functions, conducting audible and visual alarm SMS platform in the computer room of the reservoir area for the occurrence of forecast and early warning situations, and establishing an elimination mechanism during the processing of forecast and early warning. Ensure that forecasts and early warnings are processed in a timely manner;

System management: Provides good management support for the information release platform, making the information release platform more flexible.

LET THE FEELING OF POSTURE & POSITIONING BE EVERYWHERE

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