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The design of a meteorological pollution monitoring vehicle with multi-terrain movement

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Abstract

Recent yeas have witnessed a spurt of progress in environmental protection technology. The meteorological pollution monitoring vehicle is a new type of product , which can carry out real-time and continuous meteorological survey, pollution monitoring, location of pollution source and other work under various terrain conditions. It can not only do ordinary pony-weather station, but also do pollution degree detection, where is close to the ground. In the aspect of meteorological data acquisition, taking the meteorological sensor as the core, which can transform the environmental information into electrical signal. In the end, the meteorological information is obtained through the hardware circuit. In terms of mechanical structure, the moving crawler and double-layer shock absorption structure are adopted to ensure the stability of movement in complex terrain and realize the function of autonomous course reversal.

Keywords

Meteorological pollution monitoring; sensors; mechanical structure.

1. The basic idea of design and invention

The research will be divided into five steps: drawing planning, mechanical structure design, raw material purchase, project assembly and forming and project test. Based on drawing planning, we focus on mechanical structure design in order to achieve reliable work in complex terrain; Secondly, various sensors are determined according to the requirements to realize meteorological data acquisition, data processing and real-time data display. Finally, after the product is assembled and formed, all kinds of data tests are carried out to realize the expected goal. We divided the project into four parts: sensor part (data acquisition part), data transmission part, data display part, mechanical structure part. The scissor lifting platform is equipped with the wind direction and speed sensor, which uses the linear push rod to realize the lifting of the gimlet and realize the fixed-point measurement of wind speed and direction. Other meteorological sensors are located above the moving crawler. In the aspect of mechanical movement, the moving caterpillar is adopted, which is combined with the double-layer shock absorption structure and the mechanical chassis to realize the movement of complex terrain and ensure its movement stability The specific idea is as follows:

1.1. Determine the research direction:

By analyzing the level and existing problems of present meteorological pollution monitoring equipment at home and abroad, we found that there were shortcomings in continuous and timely monitoring of environmental quality changes and predicting the trend of changes. We decided to invent a weather station car that could solve this problem.

1.2. The design of mechanical structure:

Based on the complexity of the working environment of the monitoring vehicle, the merits and demerits of its mechanical structure determine whether it can complete the stable movement.

Consequently, We have considered the mechanical design technology and lifting structure, The overall structure is shown in Figure 1-1.

Figure 1-1 the picture of real products

Figure 1-2 the scissor lifting platform

Mechanical design technology： As a result of the working environment of monitoring vehicle is extremely complex, the movement stability determines whether to finish the work, so we decide to use crawler type, double damping structure (as shown in figure 1-2) ,which have sufficient strength and rigidity .And its wear-resisting performance is good. Besides, it has enough traction, which can realize complex terrain movement stably. We use a high-torque brushless motor to provide power.

Lifting structure: we use the shear type lifting gimlet, which shear fork mechanical structure ensures the lifting platform has higher stability. The lift of the platform depends on the straight push rod. The platform uses to carry wind speed sensor and wind direction sensor achieving the fixed point measurement of wind speed and wind direction, as shown in Figure 1-2:

2. The design and installation of sensor:

The sensor module is the core of collecting environmental information[7]. We select the required sensor by understanding their the appearance, pin, principle, working mode, power supply, precision and reliability. The sensor used in this product has the PM2.5 sensor that used to detect air quality; the air detection module that used to detect methanol, benzene, carbon monoxide and other air components; the gas sensors specially use to detect a single gas content sensor. For example, MQ137 gas sensor is used to detect ammonia. MQ131 gas sensor is for ozone detection. MQ7 gas sensor is for detecting carbon monoxide, etc.

Control part design: Based on the complexity and importance of control, we use the powerful STM32 single chip microcomputer as the main control board to control the sensor, lifting structure, deceleration motor, etc. We use embedded development technology to control the meteorological pollution data collected by sensors, remote wireless communication and mechanical movement. The ADC module is used to convert the analog signal into a digital signal representing a certain proportional voltage value so as to read data. Timer and its input capture function are used to measure the wind speed, and IIC bus is used to connect the microcontroller and its peripherals.

3. The design of data transmission part:

These meteorological data collected from sensors in the stm32 through data processing , high precision and fast ADC module(the Analog - digital converter) with the aid of the IIC, SPI bus extension technology, can realize real-time read pollution meteorological data[2]. In the end, we use NRF24L01 (the connection with SCM communicates through SPI interface) to transmit data to the upper computer wirelessly .Thus, the user can watch directly.

4. The design of data display part:

the collected data should be visually presented to people after transformation and processing for reference. By comparing the difference between open mv and open cv, we decided to adopt low cost, more powerful open mv computer vision library. And we use wireless video transmission and video image processing technology with the aid of FPV (First - Person - View) remote control module. Under the help of the 2-D camera controlled by the pan-head, it can realize visualization and transmit the surrounding environment to the server in the form of images in real time for people to carry out environmental monitoring. At the same time, with the aid of the database, data processing technology and the Internet of things, we use the processing of data and the position of the GPS to determine formation pollution distribution including kinds of pollutants, accurate positioning detection of different locations and different pollutants concentration. We use wind speed and direction sensors to predict the future movement trend of the polluted area as well.

5. Design of moving part:

In view of the design purpose is to replace the outdoor operation of personnel, to protect the safety of personnel, so we use remote control. Embedded development technology[4], algorithm debugging technology and single-chip control principle are used to control the motor. The

FUSI6 remote controller is used to control the mechanical movement of the product chassis and lifting structure remotely.

At the same time,We also use the PDR algorithm and the inertial navigation technology[5], so that it can independently plan the optimal route for returning when it encounters an unexpected situation (such as power shortage and poor communication condition).The PID algorithm and HI2XX nine-axis gyroscope[6] are used to maintain a stable speed in the process of autonomous movement

6. Conclusion

Firstly, the project can continuously measure the amount of pollutants in the air and display real-time data on the server side as well as the intensity map generated from the measurement data.

Secondly, the project uses error analysis and data processing technology to process the data measured by wind speed and direction sensors to predict the change trend of pollution distribution and range. Thirdly, We can control it remotely and make it work in contaminated industrial areas, farmland, and nuclear contaminated areas.

All in all, compared with the existing large-scale meteorological pollution monitoring equipment, this project has the advantages of simple design structure, lower production cost, higher cost performance and more flexibility. I hope this project can contribute to environmental monitoring and environmental protection.

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