Design and implementation air quality monitoring robot

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Abstract. Robot applied in environmental protection can break through the limitations in working environment, scope and mode of the existing environmental monitoring and pollution abatement equipments, which undertake the innovation and improvement in the basin, atmosphere, emergency and pollution treatment facilities. Actually, the relevant technology is backward with limited research and investment. Though the device companies have achieved some results in the study on the water quality monitoring, pipeline monitoring and sewage disposal, this technological progress on the whole is still much slow, and the mature product has not been formed. As a result, the market urges a demand of a new type of device which is more suitable for environmental protection on the basis of robot successfully applied in other fields. This paper designs and realizes a tracked mobile robot of air quality monitoring, which can be used to monitor air quality for the pollution accident in industrial parks and regular management.

1. Introduction

With the pace of the reform of traditional industries by Internet plus,the robot brings industry change.According to a series policies released in 2015, such as the "Made in China 2025" plan [1] and the robot industry development plan (2016-2020) [2],the development of service robot industry has been top-level designed, realizing the intelligent equipment andautomation of manufacturing process.

Currently, the frontier technology research on environmental protection equipment industry in China is not enough[3], and the market share of the advanced environmental protection technology and equipment is still under 10% [4], causing high investment and operation cost in environmental engineering projects under unstable operation. Therefore, the environmental protection equipments call for intelligent upgrade, and that has certain market capacity.

Some research has been carried out, an international team of scientists in Germany's Max Planck institute recently developed a miniature robot to quickly remove pollutants and heavy metals in industrial waste water[5], researchers at the MIT developed a group of robots called "Seaswarm" to adsorb and process oil pollution[6], and researchers at the university of Bristol developed sewage disposal robot using microbes in the stomach to purify waste water and generate electricity[7].

Through the analysis of market size and demand urgency of the segment field of the environmental protection equipment, the development direction of environmental protection robot mainly contains: 1) emergency robots, 2) water and air pollution control robot, 3) solid waste treatment robot.

Furthermore, with the rapid development of social economy, especially in recent years, a lot of high-rise buildings, underground buildings and large petrochemical enterprises continue to spring up in China, leading the number of potential accidents of hazardous chemicals and the radioactive

material leakage and combustion, explosion, collapse increasing. Due to the particularity of the construction and enterprise's production, serious environment pollution will be accompanied by the accident. In addition, emergency workers cannot make a quick and efficient disposal decision under the high temperature, dark, toxic and smoke circumstance, unless confirm the kind of pollutant, pollutant emissions and concentration. Only then can they reduce the environmental damage and casualties. It follows that, in the face of increasingly complex environment pollution accidents in industrial park, emergency monitoring robot appears increasingly important to solve the mentioned problem better. Therefore, this paper presents a tracked mobile robot to monitor air quality in cases of emergency.

2. Function Design

Instead of on-site personnel into the complex and hazardous atmosphere, the emergency monitoring robot, as a special disposal method, must have the following features:

2.1. Mobile function.

Adopting the caterpillar way, the intelligent family moving platform must have a certain cross-country ability and adaptive ability to judge alone and cross barriers in view of the situation of the pollution in situ.

Table1. The external sensors

No.	measured parameter	effective range	resolution	data output method	volume
1	CO	0~1000ppm	0.05ppm	UART(3V) 、 DAC(0.4~2V)、 PWM	57.23*18*38.61mm
2	NO2	0~20ppm	0.1ppm	UART(3V) 、 DAC(0.4~2V)、 PWM	57.23*18*38.61mm
3	O3	0~20ppm	0.05ppm	UART(3V) 、 DAC(0.4~2V)、 PWM	57.23*18*38.61mm
4	SO2	0~100ppm	0.05ppm	UART(3V) 、 DAC(0.4~2V)、 PWM	57.23*18*38.61mm
5	PM2.5	0~999ug/m3	1ug/m3	digital	50*38*21mm
6	PM10	0~999ug/m3	1ug/m3	digital	50*38*21mm
7	CHOH	0~5mg/m3	0.01mg/m3		27.16*24.9*9.2mm
8	HCL	0～20ppm	0.1ppm	analog voltage /UART	φ23.5*30.5mm
9	H2S	0~100ppm	0.1ppm	analog voltage /UART	φ23.5*30.5mm
10	HCN	0~10ppm		DAC/UART	φ22*31.2mm
11	VOC	0~6000ppm	100ppb	analog voltage	φ20*21.1mm
12	wind speed	0~70m/s		RS485/RS232	180*180*160mm
13	wind direction	0~360º		RS485/RS232	230*190*70mm
14	anemometer	0~60m/s	0.01m/s	RS485/RS232	Φ148×158mm

2.2. Monitoring function.

Carrying air quality monitoring sensors on the mobile platform of robot to perceptpollution scene, whileusing cameras to check the real-time pollution field condition through the communication network transmission for system processing.The sensorsare mainly divided into two kinds:1) the internal sensors, used to detect robot working parameters in the scene of the accident and feedback to the control system for the reasonable path planning, make the robot work orderly by reasonable arrangements according to the scene of the accident situation. 2) the external sensors, shown in the table 1, provide original monitoring data to the processing system, such as temperature, wind speed, wind direction, oxygen content and concentrations of toxicor flammable gases,and details as attached list.

2.3. Control and communication function.

It is composed of robot internal processing system, communication network, and the assistant decision system.

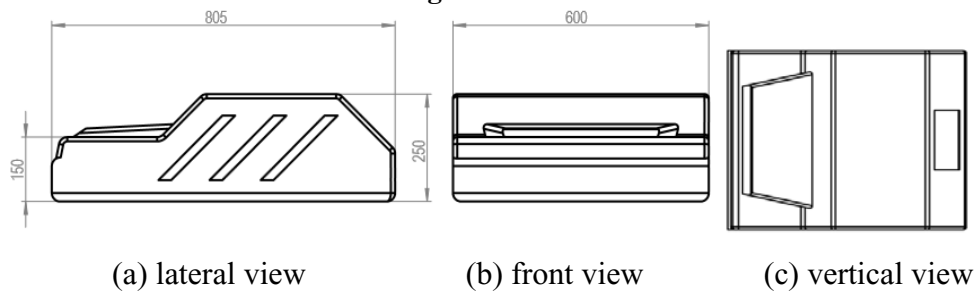*2.4. Anti-corrosion and explosion-proof function.*

Because of some extreme environment at the scene of the pollution accident, the electronic components and machinery materials of the robot must be anti-corrosion and explosion-proof processed to improve its corrosion, high temperature, dust, smoke, and other severe environment tolerance, which will ensure the stable working stateto achieve their missions.

3. Robot implement

On the basis of function design, the appearance design was done as shown in figure 1-2, and the robot prototype was finally manufactured in accordance with the design scheme, as shown in figure 3.

| (a) lateral view | (b) front view | (c) vertical view |
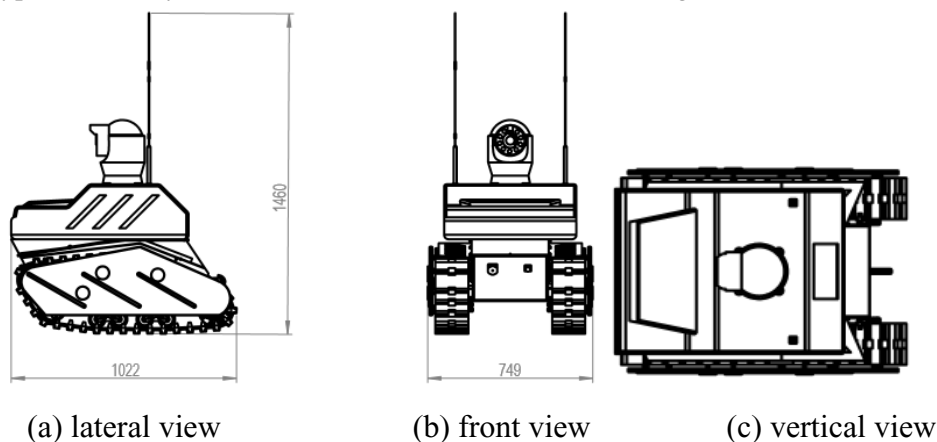
Figure 1. Size of the robot.

| (a) lateral view | (b) front view | (c) vertical view |

Figure 2. Size of Electric control panel.

(a) lateral view   (b) back view

Figure 3. Product picture.

4. Conclusion

As the intelligent equipment, robot has become the focus of researches and application at home and abroad in recent decades. It can be operated by human command,preset programs and the principle of artificial intelligence technology,and can work instead of human beings at where humans cannot reach. Therefore, the environmental protection robot has become an inevitable tendency with the development of environmental intelligent equipment.This paper designed an advanced air quality monitoring robot, which not only promotes the combination of robot and the environmental protection industry, but also gathers experiences for relevant intelligent equipment's research and development.

References

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