Review of Small-sized Robot Detecting Air Microorganism

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Abstract: Facing the increasingly air pollution, the research on robot detecting air microorganism becomes a hot spot. This paper reviews air microorganism robot, air sampling method and small-sized robot and analyzes the characteristics of various robot and sampler, which provides reference for research of new robot detecting air microorganism.

Introduction

Small ground reconnaissance robot has wide application field. At the scene of the pollution accident site or natural disasters, the robot can replace human work. The small ground reconnaissance robot has characteristics of small volume, light weight, portable and easily adapting to the complex terrain. The United States and other more developed countries are now committed to the research and development of miniature ground robots. American troops have developed several series of miniature robot prototype and equipment of micro-robot. The reconnaissance robot of Japan is small and high control precision[1]. The robot implementing relief activities in large-scale disaster has been realized. Since the terrorist activities both at home and abroad, some universities and research institutes in our country have carried out the ground reconnaissance robot research that required for the future battlefield and counter-terrorism operations need. Some important achievements have been obtained.

The research on ground reconnaissance robot involves coal mine environment detection, radiation detection, explosive-handling robot, the Marine environment detection, lunar exploration, biochemical detection and other fields[2].

In face of increasing environmental degradation, air pollution has become a serious threat to the health of residents. Air microorganism is the microbes that suspend in the air, which are closely related with air pollution, environment quality and human health. By air microorganism sampling, the biological environmental information can be obtained. At present commonly used air microorganism sampler is manual operation. In a dangerous environment or areas inaccessible to humans, the sampling is not desirable. So the research on remote automatic sampling air microorganism robot is great of importance.

Several air microorganism sampling robots

The overall structure of small-sized robot detecting environment includes air microorganism sampling system, self-state of robot perception system, ground mobile mechanism, controlling system, position system and wireless transmission system.

A kind of intelligent air microorganism sampling robot is designed and implemented, as fig.1 shows. This robot includes indoor remote control unit, airflow control unit, three dimensional motion control unit, paw control unit, lettering control unit, power management unit, GPRS communication module, security monitoring module, the information storage module, solenoid valve control, the system clock module, LCD touch screen module and light vehicle refrigerators, etc. The robot can work automatically and continuously in the harsh environment[3].

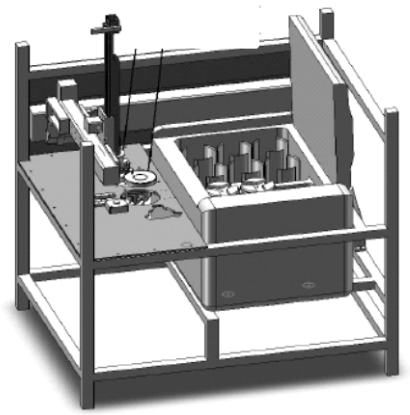

Fig.1 Structure of intelligent air microorganism sampling robot[3]

To satisfy the needs of the air microorganism development including automatic sampling of air germs, networking and intelligence, a remote automatic and continuous sampling air microorganism robot system was developed[4]. The robot includes paw controlled by an electromagnet, two-level Andersen sampler, lettering unit of plate identification mechanism, robot arm, control system etc, as shown in fig.2. The volume of robot is 490x320x695mm, and the mass is limited to 20kg.

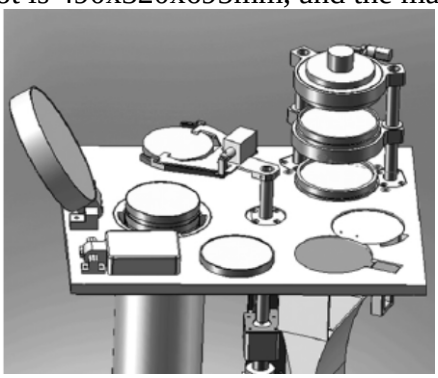

Fig.2 Remote automatic air microorganism sampling robot[4].

Presently, few researches on air microorganism sampling robot are implemented. The range of detection is small.

Air microorganism sampling

According to the different sampling principle, the commonly used air microorganism sampler is divided into six types. 1) The impact type sampler includes gas, liquid and solid type hybrid. 2) The subsidence type sampler includes natural subsidence and thermal subsidence. 3) The filter type sampler includes sampling and insoluble soluble membrane filter membrane sampling. 4) The electrostatic adsorption sampler. 5) The cyclone type sampler includes Errington type with flow rate of 75 L/min small and Powell type with flow rate of 350 L/min large. 6) The centrifugal impingement sampler includes Reuter centrifugal type RCS and LWC.

Impact sampling is the most widely used in air microorganism sampler. Air containing microbial particles goes through the nozzle of sampler by pump suction. There is a block surface set vertically to the block surface. When air flow sprays onto the surface, microorganism will be seized. According to different medium block surface, the impingement is divided into liquid and solid type. BioSampler is a common liquid impingement sampler developed by SKC Company. It has high capture efficiency. The best collection efficiency on bacillus subtilis monomer can be up to 99.8%[5]. Biostage sampler is based on the principle of solid impingement[6]. At present, this kind of sampler has grown to level 8. It has high capture rate, firm structure, stable performance and easy disinfection. Using Andersen sampler of level 6, the capture rate of a single bacterial size particle can be nearly 100%. But the sampler has complex structure, overlap possibility of colony and small sampling flow.

Subsidence type sampler is a sampling method that let the microbial particles settle to the culture

medium using the air microorganism particle gravity[7]. This method is rough and can't determine the air flow and bacteria on small particles suspended in air.

Filter sampling capture particles through air filter[8]. The principle is not only the interception of the filter material, but also the chronic impact, Brownian motion, electrostatic adsorption and gravity settling. The same with impact method, great total number of bacteria and low number of living bacteria are obtained.

Electrostatic field sampler collects microbes in air using high voltage electrostatic field[9]. When microbes carry a certain amount of charge, the particles will be adsorb by opposite charge collection surface. The sampler has a large capacity, high condensed air ration and high collection rate for small particles. But the defect is ultraviolet radiation and ozone in electrostatic will have bad influence on survival of the microbes. The sampling efficiency is low.

The principle of centrifugal impingement sampler is using the centrifugal force when air flow in the rotating path[10]. The particles with inertia impact deposition in the collection surface. This sampler has simple structure, small volume, light weight, low noise, convenient for use and high collection efficiency.

There is few sampling technique to assure keeping the original state of specimen. After sampling using a sampler, some air microorganism was damaged. Because the microorganism can't stand the impact of the high-speed airflow and mechanical impact, it will make the results of study have a lot of errors.

Small-sized robot

There are many prototypes of small-sized robot were developed. The mobile way of robot mostly includes wheel, crawling and foot type[11]. Wheel structure is flexible and less power consumption. The wheel type requires better road surface, so the scope of application is limited. Crawling structure is able to adapt complex terrain, but the maneuver performance greatly reduced and high power consumption. Foot type robot has good flexibility, adaptability and low power consumption, but its stable performance needs to improve.

A mountain climbing robot and foot type walking robot with a variety of size limited in 1cm was developed in Japan. A wheel mobile robot with one cubic inch was made by MIT. Intelligent vehicle is a typical way of wheeled mobile. An intelligent vehicle applying for granary monitor is designed and realized. The designed vehicle can monitor the granary environment and collect the important parameters all day.

Conclusion

The research on remote automatic sampling air microorganism robot is great of importance. Presently the research on air microorganism sampling robot is less. Because of the limited moving area, the existing air microorganism robot has small detection scope. The sampling technique and small-sized robot both have great research results. A new robot detecting air microorganism requires further research.

Acknowledgement

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