

# Research on mechanical system of civil fire extinguishing robot

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## Abstract

Due to the harm caused by fire, countries around the world continue to introduce various new response measures, but fire is still an important factor endangering human property and life safety. The concept of robot has a long history. It can help people work or replace people to do some dangerous work. It is a machine device that automatically performs work. With the continuous research and development and breakthrough of robot technology, many industries and fields have basically realized robot semi-automation, auxiliary work and even complete automation to replace human work. The field of fire extinguishing robot in China began to be developed in the 1970s, which is later than that in developed countries. Japan is a world leader in the field of fire extinguishing robots. In 2019, the first fire extinguishing robot system named "scrumforce" was deployed in Yuanshi Fire Department of Chiba county. Although the fire extinguishing robot has become a research hotspot, the existing fire extinguishing robot still has the problems of insufficient application range, low popularization rate and high cost.

## Keywords

Civil; fire; extinguishing robot; mechanical system.

## 1. Introduction

The concept of robot has a long history. It can help people work or replace people to do some dangerous work. It is a machine device that automatically performs work. Since the birth of the word "robot", it has been regarded as a synonym for high technology. In the future, intelligent automatic robots will act as people's right arm, help people work in dangerous places and help people explore in unknown fields. As long as the robot is under the absolute control of human beings, it will play a more and more important role in a more efficient and practical direction.

The civil fire extinguishing robot designed in this paper can be used to check whether there is fire in the house occasionally; It can also intermittently monitor whether there is a fire in some large warehouses. Monitoring is a repetitive work. If the flammable and explosive chemicals or other things at a certain position reach the set temperature, the fire extinguishing robot will give an alarm sound. If a flame is generated at this position, the fire extinguishing module will be started at the same time. The temperature limit shall be set according to specific conditions, such as different seasons or surrounding environmental factors, and the set temperature limit shall be changed flexibly; It can also be used for other purposes, for example, replacing foam with disinfectant and intermittent disinfection in some places<sup>[1]</sup>.

## 2. Domestic research status

Robots were studied by people in the early 1960s, but they played little role under the conditions at that time. Then, over time, they have played a variety of auxiliary roles in different industries, such as construction power, metallurgy and chemical industry, textile, agriculture and forestry, environmental protection, home use, medical treatment, military war, office entertainment and so on.

The development of fire extinguishing robots in China began in the 1970s. Compared with developed countries, the development of fire extinguishing robots is relatively late. In 1986, in the Seventh Five Year Plan, China proposed to vigorously promote the development of robotics, and established a robotics research base for the basic theories and basic elements of robotics, which laid a good foundation for the follow-up development of robotics in China. In 1994, Tsinghua University developed an intelligent mobile robot with path planning function and multi-sensor information fusion technology. In January 2003, the first generation of fire extinguishing robot developed in China was exhibited in Wuhan. The robot is equipped with six wheels, which can act flexibly and extinguish the fire with a water gun.

Most of our fire-fighting robots are still in the first generation, but they have also made some progress. For example, the fire phoenix 16 frequency 18 axis multifunctional variable flow hydraulic fire-fighting robot produced by Changzhou Changtan robot Co., Ltd. has many functions, such as fire-fighting, tunnel smoke exhaust, explosive discharge, rescue and so on. The technology of cutting-edge enterprises is breaking through the second and third generations, as well as representatives of CITIC Heavy Industry, Kaicheng intelligence, Harbin Institute of technology, special robots and other industries. At present, the mainstream in the market is crawler models<sup>[2]</sup>.

### 3. Research status abroad

Japan is a world leader in the field of fire extinguishing robots. In 2019, the first fire robot system named "scrumforce" was deployed in Yuanshi Fire Department of Chiba county. The fire fighting system consists of four fire fighting robots. The four robots can share fire information with each other. The artificial intelligence chip in the system can independently judge the fire situation, and automatically stretch out the hose to open the water gun.

Colossus, a robot developed in France, is equipped with a hose and a camera. It is fireproof and waterproof and can carry 1200 pounds.

In the United States, in addition to the thermiters-1t3 with the function of colossus in France, they have also developed a new generation of humanoid fire extinguishing robot, which has been experimentally applied in ship fire rescue. It can help evacuate victims of natural or man-made disasters, or perform complex tasks in dangerous and harsh environments.

With the continuous R & D and breakthrough development of robot technology, more and more industries and fields basically realize robot semi automation or even complete automation, and auxiliary work even completely replaces human work. Countries all over the world continue to introduce various new measures to deal with the harm caused by fire, but fire is still an important factor endangering human property and life safety. Nowadays, with the continuous increase of population and the frequent occurrence of fire accidents, human homes have brought many hidden dangers to social security. The timely fire fighting has become an urgent problem. In reality, fire hazards cannot be found in time. Once the fire spreads, it is difficult and time-consuming to put out the fire, which poses a great threat to people's production and life. Intelligent fire fighting robot can find and extinguish hidden dangers of fire source in time, prevent the expansion of fire, and alarm in time to ensure the personal and property safety of the owner. At the same time, firefighters can stay away from the fire and ensure their life safety<sup>[3]</sup>.

### 4. Working principle of fire extinguishing robot

At present, the fire extinguishing robot mainly uses single chip microcomputer as the control center, which can realize the functions of intelligent obstacle avoidance, automatic detection of fire source, automatic alarm and accurate fire extinguishing. It plays a role equivalent to the

CPU of computer motherboard; The internal infrared sensing circuit and ground gray-scale sensing circuit realize obstacle avoidance and route arrangement to find the flame. The infrared flame sensing is responsible for detecting the fire source. The motor drive is used as an auxiliary, and the voice control device is used to start the car, so that the robot can independently find the fire source, alarm and extinguish.

For example, a fire extinguishing robot is mainly composed of main controller CPU, detection device (various sensors), execution device and fire extinguishing device. In the past, fire extinguishing robots used ordinary single chip microcomputer as the main control chip. In recent years, the control chips arm series processor and AVR series single chip microcomputer with high operation speed and rich interface resources have been widely used, The rescue efficiency of the fire extinguishing robot is greatly improved.

However, all kinds of sensors and chips are very fragile components. Unlike other robots, fire-fighting robots are often in extreme conditions such as high temperature, corrosion, high humidity and toxicity, which are very easy to cause harm to robots. In order to resist such extreme conditions, we need to exchange high cost for high quality. For example, the ability of the chip to resist the outside world depends on the packaging. The higher the packaging requirements, the higher the cost.

The whole system includes main control module, sensor module, motion control module, sound detection module, power supply module, etc.

## References

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