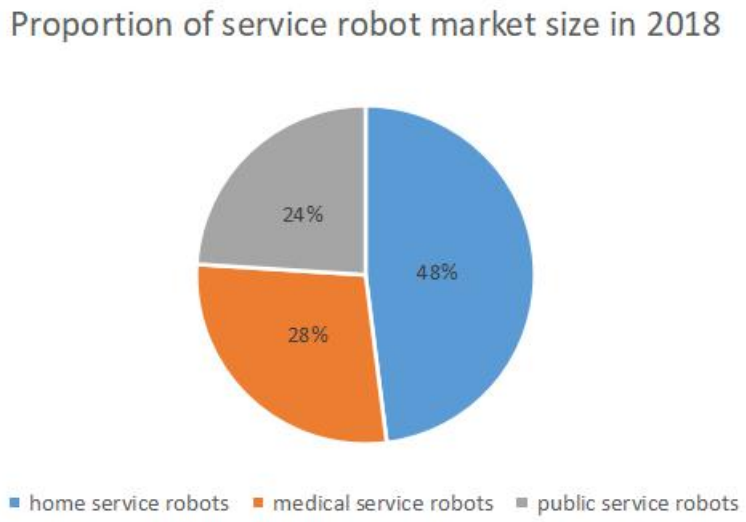
# Part Ⅰ Introduction to Existing Service Robots

Service robots are an emerging kind of robots; they started late. In 1999, there were only less than 7,000 service robots in the world, but in the 1970s, 20 years ago, industrial robots have formed a relatively mature industrial chain. After entering the 21st century, service robots have began with a rapid development. Today, annual sales of home service robots have exceeded 300,000 units.

As so far, there is no strict definition of service robots. For better induction, they can be summarized as a variety of high-tech integrated advanced robots that provide necessary services to humans in an unstructured environment. By classification, we can have a general understanding of it: Service robots are generally divided into three types: home service robots, medical service robots and public service robots. The market size of them in China in 2018 was 4.48 billion U.S. dollars, 2.54 billion U.S. dollars and 2.23 billion U.S. dollars, of which the market size of home service robots accounted for the highest proportion, about 48%.




The reasons for the dominance of home service robots are concentrated in two aspects: First, with the increase in household disposable income and consumption upgrades, more and more families have begun to purchase robots to perform simple tasks and that promotes the development of this industry. Second, the relatively low technical height and accuracy requirements for home service robots, it is a home service robot with relatively low technical height and accuracy requirements simplify the research and development of the robots, and that's suitable for mass production. Thus, they occupy a large market share. According to the survey report released by Silan Technology, currently the most common service robots in China include sweeping robots, educational robots, entertainment robots, shopping mall shopping robots and bank counter robots.

Nowadays, the service robots on the market are becoming more and more intelligent. Most service robots have been able to implement functions such as autonomous path

planning and autonomous obstacle avoidance, and can move freely in various complex environments, which also represents the future of service robots. The future development direction is to integrate with high-tech navigation and interaction technology to achieve complete intelligence.

## Part Ⅱ The Ideal Service Robot

Next, the ideal service robot will be described from the four aspects: security, interactivity, accuracy and interconnection.

**A. Security**

Service robots should have stricter safety requirements than industrial robots, not only "does not cause harm to people", but should avoid all unpleasant collisions and frictions, especially domestic and medical service robots. This requires the use of vision and temperature sensing technology to stop all unnecessary robot movements before contact occurs, which can avoid a decline in the service quality of the robot.

**B. Interactivity**

In order for humans and service robots to achieve good interactivity, that is, to make robots understand human instructions and provide feedback in high quality, the following aspects need to be made:

1. Image recognition. The robot should be able to use visual sensing technology to make a correct understanding of human movements, types of objects, and changes in the external environment, such as understanding the direction of human gestures, facial expressions, identifying items that people need, and identifying the weather. Wait. Through efficient and accurate image recognition, improve the robot's understanding and decision-making capabilities, achieve better interactivity, and better complete services.
2. Speech recognition. The robot uses auditory sensing to correctly and efficiently recognize human voice instructions and provide feedback, improving communication efficiency, enabling people to more easily manipulate the robot to complete tasks without using a remote control and a computer, greatly improving the robot's "class Feeling "and work efficiency.
3. Machine learning. In the service process of robots, unpredictable work scenarios and work objects often appear. This requires the robots to have strong machine learning capabilities, to learn and update the things that do not exist in the existing knowledge reserve, in the future. Used at work. For example, the robot could not recognize "my phone" originally, but a person can tell the robot through learning from demonstration: "My left hand is 'my phone'." Then the robot can learn and record. Next time when the person speaks: "Bring 'my phone'." The robot can accurately identify a specific phone to a person.

**C. Accuracy**

There is a close relationship between accuracy and safety. The requirements for robot accuracy include three aspects, namely the accuracy of instruction recognition, navigation accuracy, and motion accuracy. The requirements for the accuracy of instruction recognition are included in the interactivity, which will not be repeated here, and the two requirements are mainly described.

1. Navigation accuracy. Navigation accuracy is related to the rationality, efficiency and safety of the robot's motion trajectory. After making the optimal path planning, the robot can accurately reach the destination along the path to avoid all collisions and waste of time. This requires the combination of laser navigation and visual recognition. Let the robot update the map in real time to achieve the optimal path.
2. Motion accuracy. In this regard, it is required that the robotic arm of the robot can perform posture changes according to the plan and update the surrounding conditions in real time, accurately pick up the target item under the premise of avoiding collision, and output sufficient force so that it does not fall and complete the action accurately.

**D. Interconnection**

The increasing number of service robots has also led to the emergence of multiple robots working cooperatively. Therefore, it is required that the robots not only achieve good interaction with humans, but also that the robots should be reasonably divided and efficiently connected. This requires Robots have high swarm intelligence characteristics. For example, a manager robot and waiter robots can exist in a restaurant. The manager robot can obtain the needs of different customers and make quick deployments. They can issue instructions to the waiter robot to perform different tasks to achieve reasonable allocation of resources and avoid confusion in the restaurant.

In summary, an ideal robot should have the above four characteristics at the same time, in order to meet the growing human requirements for service robot performance.