

Structure Design and Analysis of a New Greeting Robot

Heqiang Ling^{1,3}, Yi Shen^{1,2,3,*}, Zhenglin Zhang^{1,3}, Shujun Zheng¹, Dong Zhang¹

¹(School of Mechanical and Power Engineering, Jiangsu University of Science and Technology, Zhangjiagang, China)

²(Zhangjiagang Industrial Technology Research Institute, Jiangsu University of Science and Technology, Zhangjiagang, China)

³(Service Center of Zhangjiagang Camphor Tree Makerspace, Zhangjiagang, China)

Abstract: With the development of science and technology and the improvement of economic level, the service robot has been developed rapidly in recent years. As one of the service robots, the greeting robots are being welcomed in the exhibition halls, science and technology museums, exhibition centers, banks and other places. In view of this, a new greeting robot, including its head, arm, body and chassis, is designed in this paper. Furthermore, the drive mode of the greeting robot is also designed. Finally, we carry out the motion simulation of the greeting robot, and the simulation result verifies the validity of the designed greeting robot.

Keywords: Service robot, Greeting robot, Structure design, Drive mode, Motion simulation

I. Introduction

With the development of science and technology, the improvement of social living standard and the development of robot technology, the application range of robots is expanding rapidly. Now, the robots are applied to all walks of life and serve human production and life. In order to attract customers and improve service quality, many shopping malls, hotels, companies often arrange a certain number of greeters in front of their doors. This welcome way not only spends a lot of material resources, but also increases the labor costs greatly. In addition, because the greeters are engaged in monotonous repetitive work, their enthusiasm for work is greatly reduced, which affects the quality of service. So the design of a greeting robot has become the needs of social development.

The Beijing Senhan Technology Co., Ltd. is a high-tech enterprise with independent intellectual property rights of humanoid robots. The company designed and developed a variety of service robots. The greeting robot as shown in Fig.1 is one of the main robots. The robot can automatically detect the arrival of customers, and can take the initiative to meet and greet the audience.



Fig.1 Greeting robot of Beijing Senhan Technology Co., Ltd.

In the past ten years, many domestic and foreign scientific research institutes have also conducted in-depth study of the greeting robot. Li et al. [1] introduced a head structural design of greeting robot. In the robot, there are four motion modules on its head, including eyes, eye lids, jaw and neck. Its head can achieve six degrees of freedom: up_down and left_right movement of eyes, opening_closing movement of eye lids and jaw nodding and head shaking movement of neck. Lu et al. [2] designed a greeting robot which is controlled based on AT89S52 single-chip computer. Furthermore, the pyroelectric infrared sensor is used as the detector. Zeng et al. [3] designed a highly intelligent greeting robot. The robot is controlled based on STM32 control system and

* Corresponding author. E-mail: sheny456@hotmail.com

is equipped with LCD display and home-made special function keyboard. The robot can complete the online motion planning and voice switching control. Furthermore, the robot has the functions of automatic recognition and automatic charging. According to the operational characteristics of the greeting robot, X.F. Zhang [4] designed the structure of a greeting robot chassis. In the structural design, not only the modular idea is used, but also the drive wheels with suspension are designed to improve the stability of the robot movement and climbing performance. In addition, some infrared geodesic sensors are also added in the chassis to realize the obstacle avoidance.

In order to better improve the service quality of the greeting robot, the structure of a new greeting robot is designed in this paper. The structure consists of a head, two arms, a chassis and other components.

II. The Head Design of the Greeting Robot

Considering that the greeting robot needs to watch the guests when it works, a camera is added in the head of the greeting robot. The used camera is a kind of USB drive-free high-definition webcam as shown in Fig.2.



Fig.2 Webcam and WIFI data transmission module of the greeting robot

The webcam supports real-time video capture with 1280×720 resolution and its imaging distance is: 7CM. With the help of WIFI data transmission module, the webcam can realize wireless video transmission with no less than 30 frames per second. In addition, because the welcome robot head also needs to have up and down pitch and left and right rotation of the movement function, the pitching movement of the robot head is controlled by two steering gears and the rotation of the head is controlled by a stepper motor. The whole head of the designed greeting robot is shown in Fig.3.

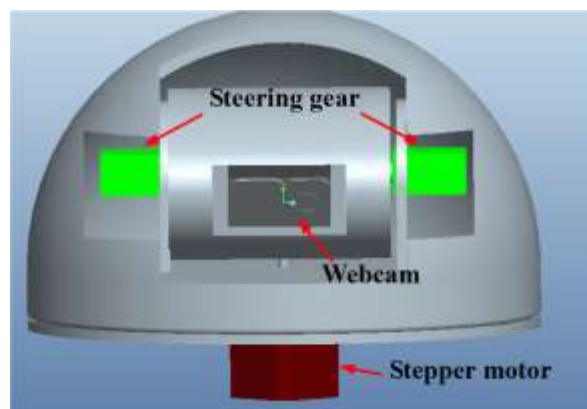


Fig.3 The head structure of the greeting robot

III. The Arm Design of the Greeting Robot

In order to better show the service of guide and interpret for a greeting robot, it usually needs its arms to cooperate with its service behavior. So, two arms are designed for the greeting robot in this paper. The arm includes a hand, forearm and upper arm. Because the gestures of the designed greeting robot in this paper are relatively simple, and taking into account the design cost and the ease of control, the robot arms are made into one by screw connection among three joints. Then the robot arm is fixedly connected to the shoulder of the greeting robot. The shoulder is fixed on the shaft of the stepper motor, which is installed into the body of the greeting robot, by the flange. Thus, the movement of the robot arm is mainly driven by the stepper motor. The structure of the robot arm and its connection mode are shown in Fig.4.

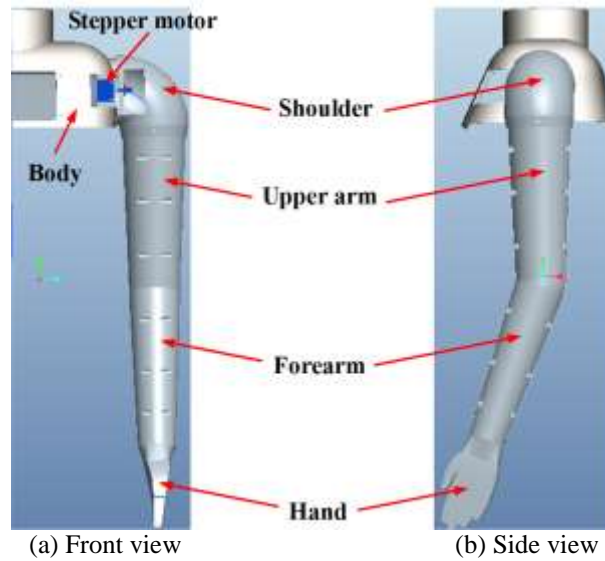


Fig.4 Structure of the robot arm and its connection mode

IV. The Body Design of the Greeting Robot

The body of the greeting robot is the main part of the service robot. The head, arms and chassis etc. are connected into one by it. The robot body consists of three annular shells called the chest, waist and skirt respectively, as shown in Fig.5. The three annular shells are fixed by crew connection. A touch screen is installed on the chest shell for the human-computer interaction. In this paper, a capacitive touch screen whose type is DMT80480T070_07WT is adopted. Its display size is 154.1mm × 85.9mm and the resolution is 800 × 480, and it supports RTC, buzzer and 128-segment sound playback. The waist shell is engraved with the unit logo. An ultrasonic sensor and a laser radar are installed on the front surface of the skirt shell. The ultrasonic sensor is mainly used for the close distance obstacle avoidance. The laser lidar is mainly used for the environmental scanning and SLAM by the greeting robot. Some speaker holes are formed on the back surface of the skirt shell, and a loudspeaker is mounted on the inner wall of the skirt shell for the voice communication of the service robot.

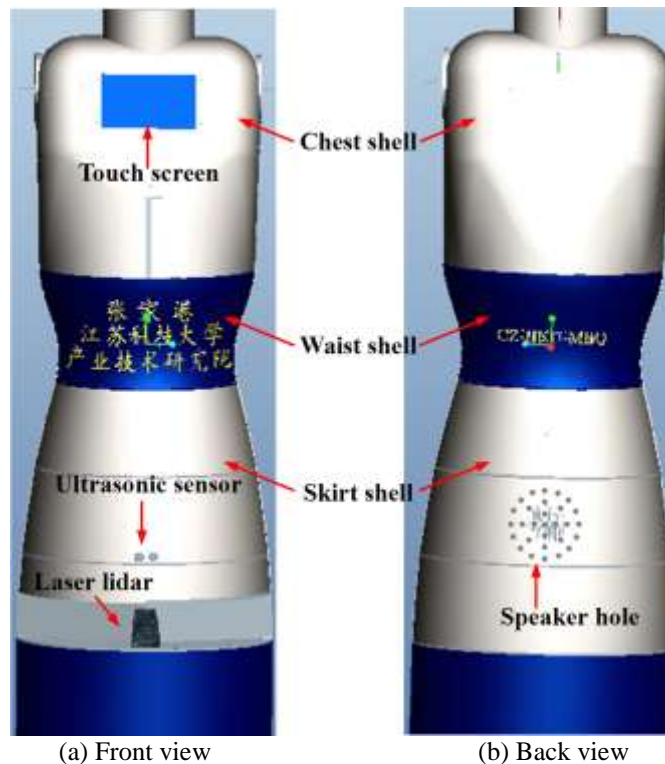


Fig.5 Structure of the robot body

V. The Chassis Design of the Greeting Robot

The chassis is another main part of the designed greeting robot. It not only supports the whole structure of the greeting robot, but also determines the drive mode of the robot. In this design, the robot is driven in differential mode by connecting two brushless DC motors to two wheels, as shown in Fig.6.

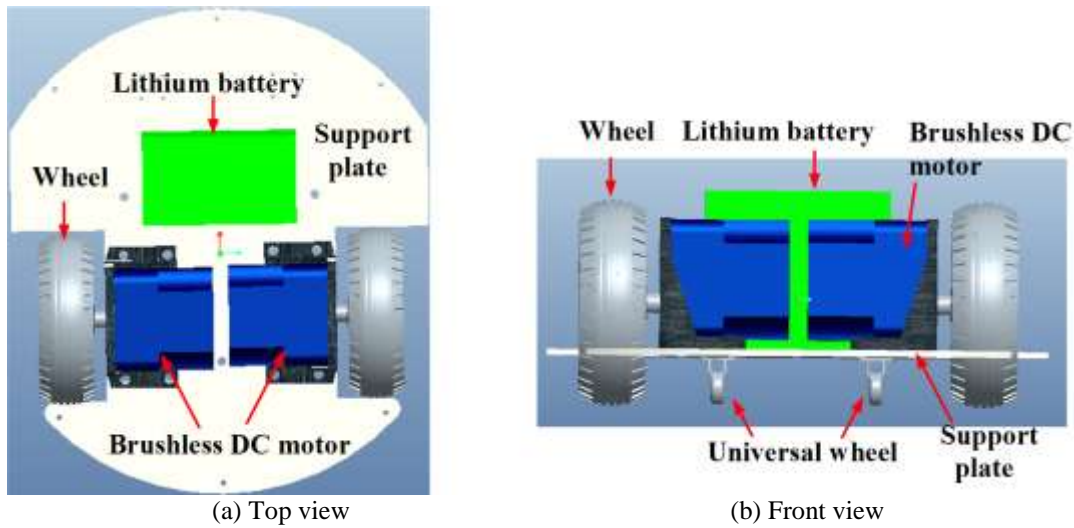


Fig.6 Structure of the robot chassis

The two motors mounted on the support plate are produced by Ningbo Zhongda Lide Drive Equipment Co., Ltd and their type is Z4BLD60-24GN-30S. The parameters of Z4BLD60-24GN-30S type brushless DC motor are shown in table 1.

Table1 Parameters of Z4BLD60-24GN-30S type brushless DC motor

Performance	Parameter
Rated voltage	24VDC
Rated input power	60W
Rated current	3.8A
Rated speed	3000rpm ± 10%
Rated torque	0.191N.m
Reduction ratio	50K

In order to ensure the balance and the flexibility of the greeting robot, two universal wheels are symmetrically mounted on the support plate. The power of the greeting robot is mainly provided by a lithium battery mounted on the support plate. The capacity of the battery is 12v 10Ah. The support plate is connected with the robot body through screws.

VI. Overall Assembly and Motion Simulation of the Greeting Robot

6.1 Overall assembly of the greeting robot

In order to verify the validity of the design scheme of the greeting robot and the correctness of the structural dimensions of each robot component, the overall assembly is finished based on the Pro/Engineer software. Pro/Engineer is the software product of PTC (Parametric Technology Corporation) and is a 3D CAD/CAM/CAE feature-based, associative solid modeling software. It is one of a suite of 10 collaborative applications that provide solid modeling, assembly modeling, 2D orthographic views, finite element analysis, direct and parametric modeling, sub-divisional and NURBS surfacing, and NC and tooling functionality for mechanical designers [5, 6].

Fig.7 is the complete structure of the designed greeting robot through assembly. From the figure, it can be seen that the dimensions of the components designed at the beginning are correct and the assembled greeting robot meets the design requirements from the outside. Of course, whether the designed structure meets with the requirements of motion, the motion simulation needs to be carried out.

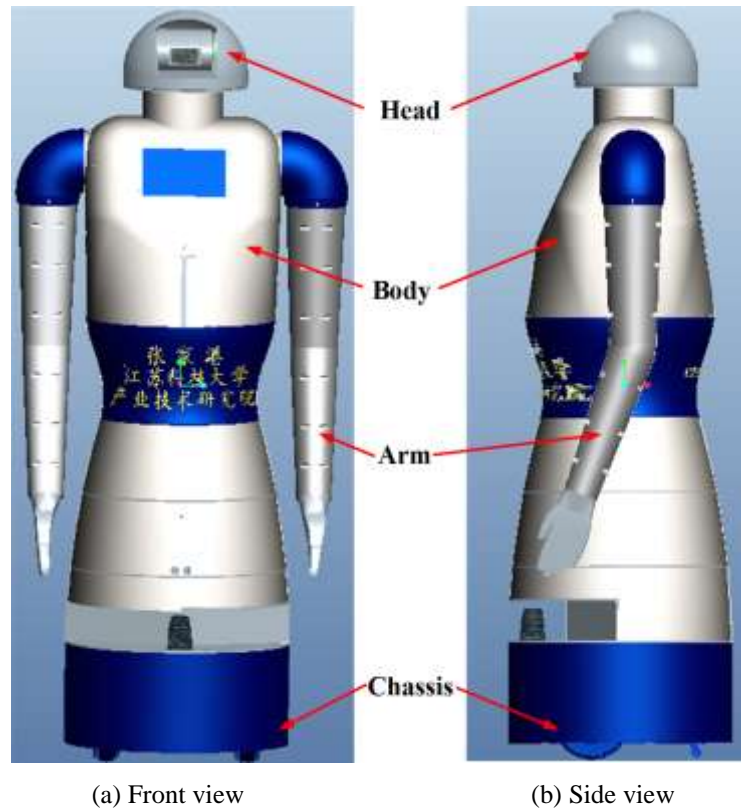
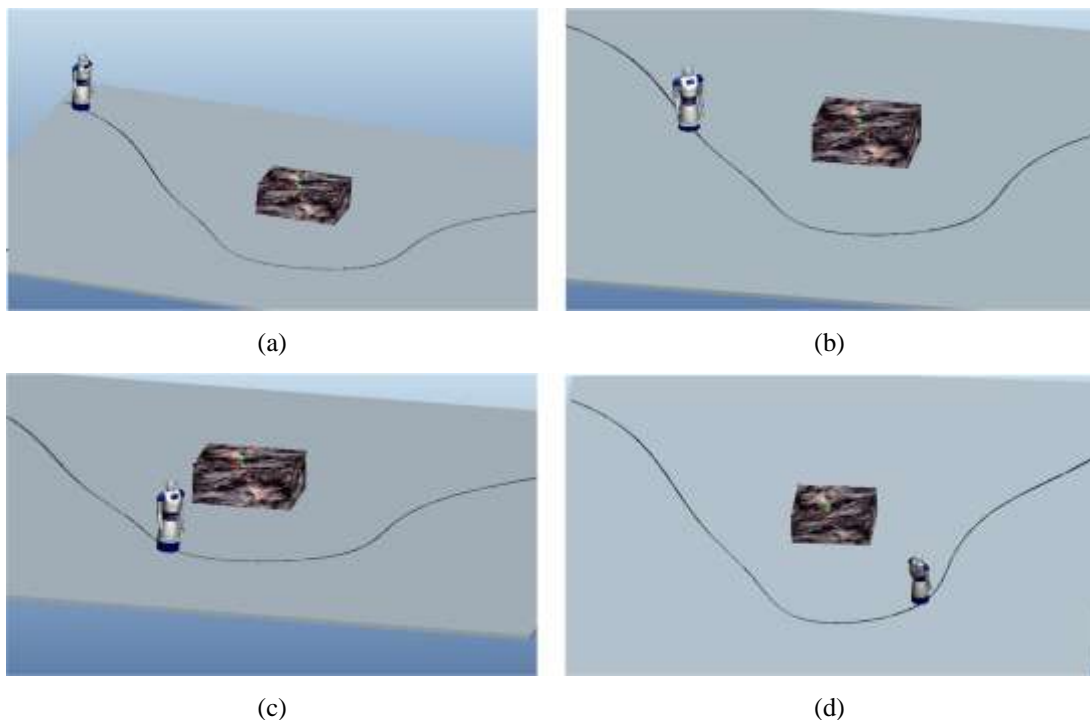


Fig.7 Complete structure of the robot chassis

6.2 Motion simulation of the greeting robot

The motion simulation is also carried out based on the Pro/Engineering software [7, 8]. In order to successfully finish the motion simulation, first, the connection of various parts needs to be defined during the entire assembly process; then, each part of the greeting robot is simulated. The simulation results are shown in Fig.8 with six photos, (a)–(f), taken during the simulation video. From the figure, it can be seen that the designed greeting robot can realize the motion, which further verifies the validity of the design scheme.



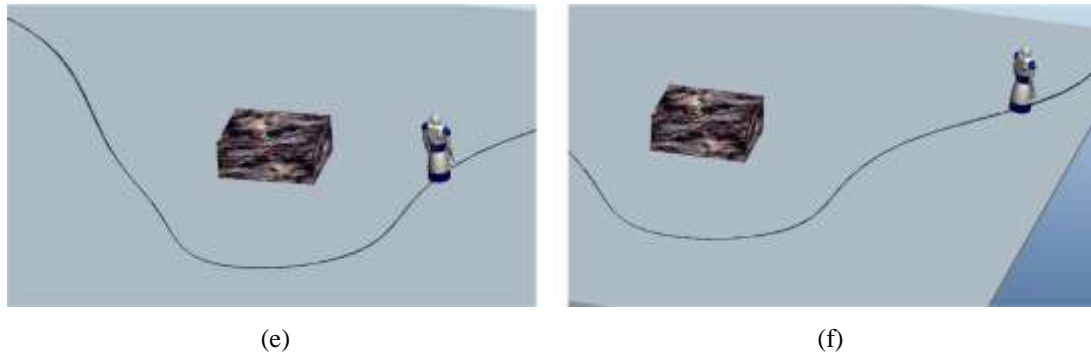


Fig.8 Motion results of the greeting robot

VII. Conclusion

With the development of society, service robots have entered the home service industry and are becoming an emerging and fast-growing high additional value industry [9]. In order to improve the service quality and the work efficiency, the greeting robot has been the focus of attention in recent years. In order to meet the social needs, a new greeting robot is designed in this paper. First of all, the robot head, hands and chassis are designed and introduced in turn. Then, the robot is assembled based on the designed components. Finally, the motion simulation is carried out and the simulation results also verify the validity of the designed greeting robot.

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