Design and optimization of the structure of house decoration robot

Min Wang [a], Lihua Cai [b], Jiang Yao [c], Qunbiao Wu [d], Xiaokun He [e]

Suzhou Institute of Technology, Jiangsu University of Science & Technology, Zhangjiagang, 215600, China.

[a]2510826372@qq.com, [b]justcailihua@163.com, [c]768730558@qq.com, [d]just_wqb@163.com, [e]807220131@qq.com

Abstract

In order to improve the quality and effect of house decoration, design a new house decoration robot. The electric putter thrust lifting module is calculated based on the mechanical and main bearing parts of the finite element is analyzed and optimized. The analysis and calculation results show that the thrust force of the electric push rod for the house decoration robot is 1500N. And its structure, strength and stiffness meet the design requirements.

Keywords

Decoration Robot; Structure Design; Optimization.

1. Introduction

With the development of modern economy and the improvement of people's living standard, people have begun to pay more and more attention to their living environment, and people's housing is closely related to people. Therefore people pay more attention to quality problems. Housing decoration as everyone knows, wall spraying is one of the priority among priorities. Wall spraying is not only a heavy workload, and spraying requirements are very high, which leads to the wall spray accounted for a large proportion of the house decoration time. The family decoration is facing many problems, Such as the shortage of workers, the low spraying efficiency. Also the spraying effect is not satisfactory.

At present, domestic and foreign equipment for wall spraying is hand-held spray gun or roller brush, which means that spraying workers hold these equipment to spray the wall. However, the spraying efficiency and spraying quality of this kind of working methods can not meet the requirement of the quality of wall spraying. Although there have been some automatic spraying equipment, but these devices are bulky, or ponderous. For example domestic production "Da Vinci No. 1",is not very good in the use of narrow space room. Now existing automatic spraying equipment is mainly realized by the mechanical arm. But because of the difficulty to control the mechanical arm, the way in the narrow space of the spraying effect cannot meet the requirements.

Based on the analysis of the existing way of house decoration, this paper introduces the design of a new house decoration robot. Based on the mechanics, the force condition of the lifting module of the house decoration robot and the thrust force of the electric push rod are calculated, Also finite element analysis and structural optimization are carried out on the main load-bearing parts, so as to improve the reliability of decoration painting robot.

2. Structural Design of House Decoration Robot

In this paper, an intelligent robot which can spray the wall of family is designed.

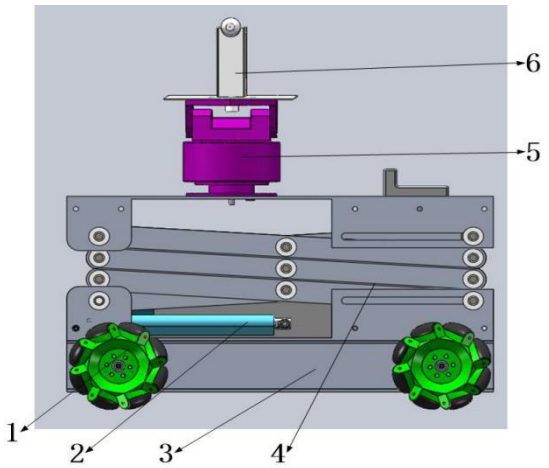

Fig.1. overall structure of house decoration robot

1 Mecanum wheel; 2 electric putter; 3 moving mechanism; 4 scissor lift module;
5 pan-and-tilt; 6 spraying equipment;

The overall structure of the house decoration robot is shown in Fig. 1. When the machine gets the position of the wall which needs spraying, the bottom of the house decoration robot motor start started the Mecanum wheel in the specified movement, driving the overall mechanism to the location which is specified to reach the designated position. The electric push rod is energized, through a fixed pulley force reversing function, pushing the transmission rod along the chute to lift the module in accordance with the requirements of mobile, when the lifting module uplift to the specified location, the electric push rod stop motion, and the table will move follow the rules. The paint is sprayed on the wall from the spray module to finish the job of the wall painting.

The main load-bearing parts of the house decoration robot which is described in this paper are lifting modules. The lifting module is designed to move up and down through the scissor type structure by the way of quadrilateral deformation principle. The cutting fork plate of the scissors type lifting mechanism is made of 45 steel. The material has high strength and meets the requirement of use. There are holes at both the ends and the middle of the fork plate, the hole is used to connect with the other fork plate. For the reasons that axis is easy wear, we choose optical axis which is of 45 steel after quenching.

3. Force and Electric Push Rod Thrust Analysis

The scissors type lifting mechanism is shown in Fig.:

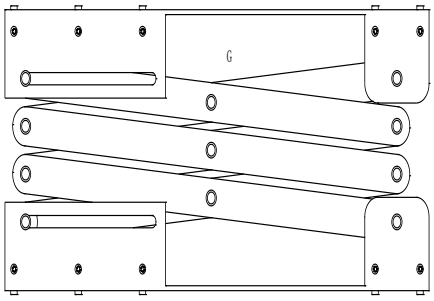

Fig. 2 Scissors fork type lifting mechanism

In order to analyze the force state and size of the force, this paper will choose two interaction rods to analyze, and then to simplify the mechanism to verify the force state and to solve the thrust of the electric push rod. As shown in the following Fig.

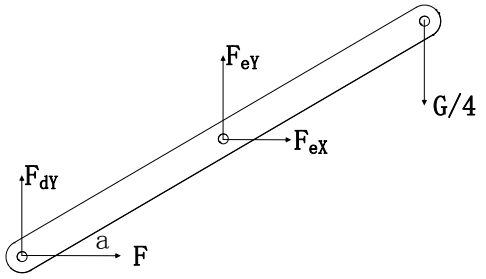

Fig. 3 forked plate stress 1

The force shown in it is calculated as:

$$F_{eY} + F_{dY} - \frac{G}{4} = 0$$

$$F_{eX} + F = 0$$

$$F_{eY} \cdot \cos\alpha - F_{eX} \cdot \sin\alpha - \frac{G}{4} \cdot \sin\alpha = 0$$

After calculations can be obtained:

$$F_{eX} = F$$

$$F_{eY} = \frac{F\sin\alpha + \frac{G}{4}\sin\alpha}{\cos\alpha}$$

$$F_{dY} = \frac{G}{4} - \frac{F\sin\alpha + \frac{G}{4}\sin\alpha}{\cos\alpha}$$

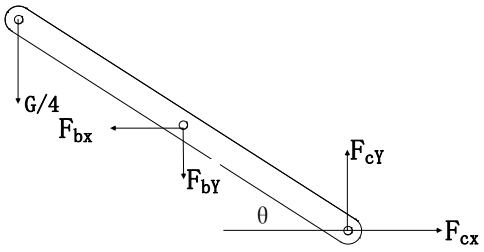

Fig. 4 forked plate stress 2

The force is calculated as

$$-\frac{G}{4} - F_{by} + F_{cy} = 0$$

$$-F_{bx} + F_{cx} = 0$$

$$F_{by} \cdot \frac{l}{2} \cdot \cos\theta + F_{bx} \cdot \frac{l}{2} \cdot \sin\theta + \frac{G}{4} \cdot l \cdot \cos\theta = 0$$

Because in the structural design $F_{bx} = -F_{eX}$, $F_{by} = -F_{eY}$, $\alpha = \theta$, so $F_{bx} = -\mathrm{F}$,$F_{by} = -\frac{F\sin\alpha + \frac{G}{4}\sin\alpha}{\cos\alpha}$。

So you can get it by calculation:

$$G = \tan\alpha \cdot F$$

The above formula is the force of the lifting device when lifting. According to the critical value above, we can choose the more suitable electric push rod.

In the initial state, the angle of the a is set to 10 degrees. Therefore, the minimum thrust of the electric push rod is 1023N, due to its overall quality of 18KG, taking into account the design, processing and other issues .The added safety factor is 1.4. Then the thrust force of the electric push rod is 1433N, So the thrust force of the electric push rod is 1500N.

4. Finite Element Analysis

The transmission bar is an important transmission part in the whole organization. In the lifting module of the house decoration robot, the force of the transmission bar is maximum, and excessive force will cause the transmission rod deformation, which will affect the safety and stability of the whole structure so we need to do the finite element analysis, the stress state and deformation analysis to improve the reliability of equipment.

According to the design requirements, the electric push rod thrust is 1500N, the average load distribution hypothesis in the middle of both sides of the transmission rod, so each end bearing 750N, electric putter thrust through the steering function applied to the fixed pulley transmission bar, and the end of the transmission rod can slide in the chute, so when doing the analysis, we will give the two ends of the transmission bar adding constraints, simulating the state that transmission bar bears the maximum force. 750N is applied to the two sides of the middle of the transmission rod, and the simulation results are shown in Fig. 5-7.

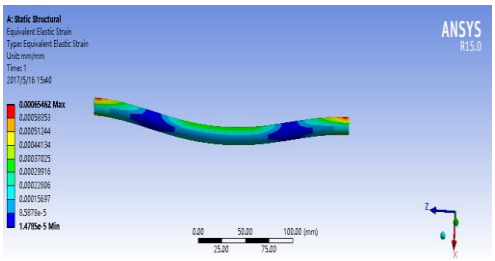

Fig.5 Strain diagram of the transmission bar

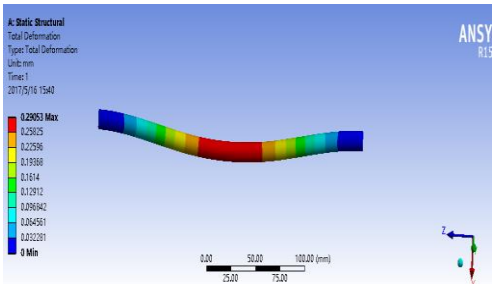

Fig.6 Displacement nephogram of transmission bar

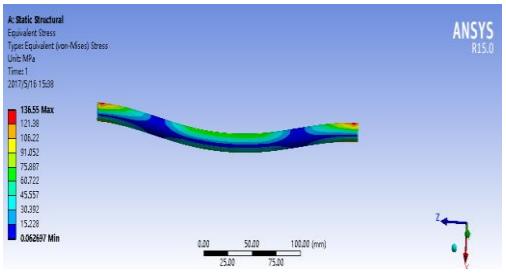

Fig.7 Stress diagram of transmission bar

From Fig.7 can be found in the transmission loading rod the maximum stress is located in the middle position of the transmission bar, the maximum stress is 136.55MPa, less than 45 of the steel material yield limit which is 300MPa, so the transmission bar strength meets the requirements. As can be seen in Fig.s 5 and 6, the maximum displacement of the transmission rod is not in the same position as the maximum stress, and the maximum displacement is 0.29mm. The displacement is very small and almost negligible, so it meets the requirements of use.

Scissor plate as the loading force in the most complex lifting device, is the main component of lifting modules, which are long and thin, so it is easy to be deformation and deformation of the parts, so we need to check the strength, improve the reliability of the equipment. The original design of fork plate thickness is 5mm, and fork in the selection of materials is Aluminum Alloy, grade 1060-H14. According to the requirements of the design and calculation results, in the three round of the fork plate under different loads, so in order to calculate the fork plate if it is able to bear the load required and the maximum tension will be put on the forked plate which is 750N to finite element analysis.

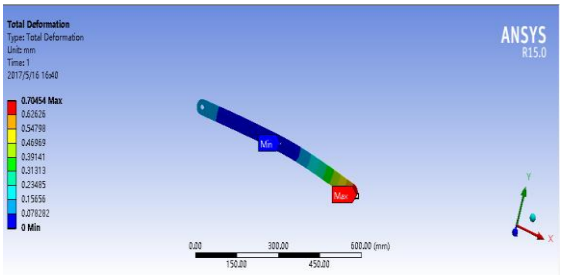

Fig.8 Displacement nephogram of the fork plate which material is Aluminum Alloy

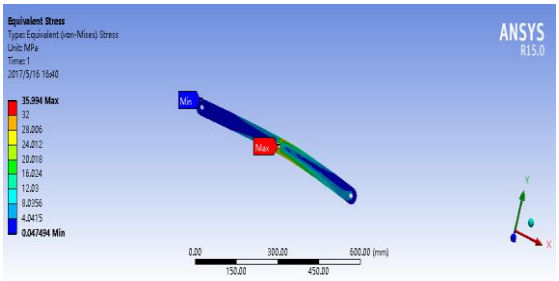

Fig.9 Stress diagram of fork plate which material is Aluminum Alloy

Fig.8 shows the displacement, when the fork plate by force reached 750N, the maximum displacement reached 0.70454mm, which is the largest deformation, so the deformation of fork plate has a great impact, We need to optimize the structure, or the strength and rigidity of higher material.

Choose the strength and stiffness of the higher 45 steel as the material, instead of Aluminum Alloy materials, to improve the overall carrying capacity of the forked plate. The simulation results are shown in Fig.11 and Fig.10.

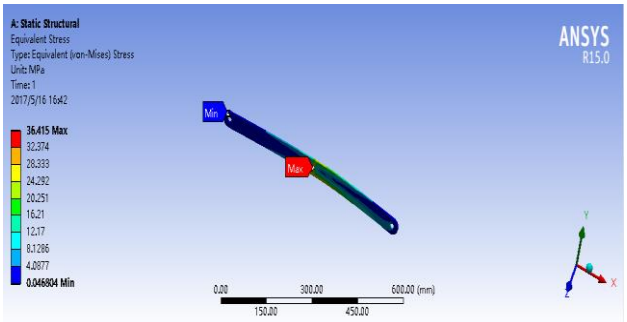

Fig.10 Stress diagram of fork plate which material is 45 steel

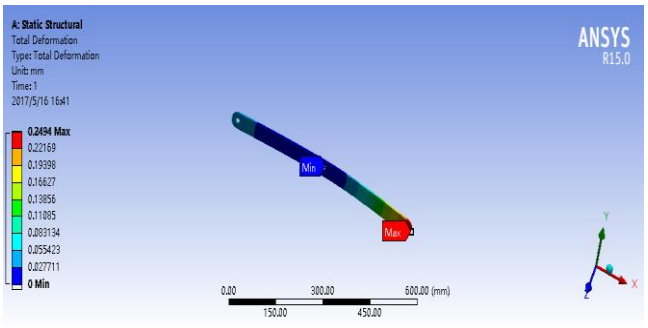

Fig.11 Displacement nephogram of the fork plate which material is 45 steel

It can be seen from Fig. 10, the maximum stress at the fork plate under maximum force, the maximum stress is 36.415MPa, less than 45 of the yield limit of 300MPa steel, so the structure can satisfy the strength requirements. As you can see from Fig. 10, the maximum displacement is 0.2494mm, and there is no interference in actual operation. So the fork plate is optimized to meet the design requirements.

5. Conclusion

In order to improve the quality and effect of house decoration, design a new house decoration robot, mechanical and electric putter thrust lifting module on the kinetics of family decoration based on robot was calculated, and the main bearing parts of the finite element analysis and structure optimization. The analysis and calculation results show that the thrust force of the electric push rod for the house decoration robot is 1500N. And its structure, strength and stiffness meet the design requirements.

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