Structural Design of Leaf Sweeping Vehicle

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Abstract—Leaf sweeping compressor is a new type of high efficiency sweeping equipment which integrates leaf sweeping, compression recovery and transportation. It can be widely used in the cleaning of urban residential areas, highways, parks and other areas. The design of this paper is a leaf sweeping compression device, the sweeping device, transmission device, compression device analysis and design. The collected leaves are compressed and processed into small solid pieces for easy transportation, storage and utilization. The cleaning roller is used to solve the problem of sticking to the conveyor belt on the surface of the residual leaf, and the working efficiency is improved by mechanical extrusion. In this design, the motion analysis and calculation of each mechanism are carried out, and the main parts are drawn, modeled and simulated by using Solidworks and other software to solve the problem of the coordination of the mechanism motion. The overall design realizes the intelligent automation of leaf litter collection, which will have broad application prospects in urban sanitation applications.

Keywords: leaf sweeping, strong extrusion, conveying device, automation

1. Introduction

As one of the sanitation equipment, leaf cleaning vehicle is a new type of efficient cleaning equipment integrating road cleaning, garbage compression, recycling and transportation[1]. The main problem of leaf cleaning vehicle in our country is the same defect as the sweeping vehicle of automobile chassis transformation, and there are also shortcomings such as low efficiency, high energy consumption, large noise, bad compression effect and bad cleaning effect[2]. According to the working environment of the litter sweeping compressor, the structure of the litter sweeping vehicle is designed in this paper.

2. Overall structure design

In order to improve the working efficiency of the litter sweeping compressor, the design principle of the litter sweeping compressor designed in this subject is determined[3]. The details are as follows:

As shown in the figure 1, as a small cleaning equipment, designed into a four-wheeler form, the two rear wheels using universal wheels can achieve the minimum turning radius, convenient in narrow areas and reciprocating tracking cleaning [4].

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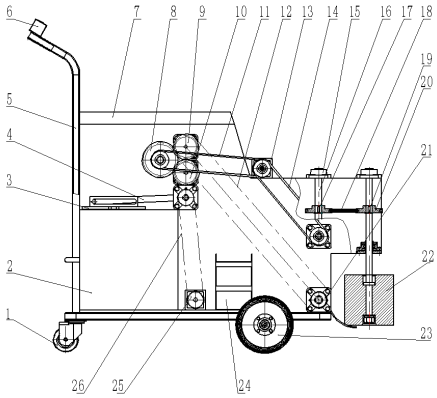

1. Casters; 2. Storage box; 3. Compression plate; 4. Rocker; 5. Upper handrail; 6. Switch; 7. Box; 8. Gear 2; 9. Gear 1; 10. Brush roller; 11. Take 1; 12. Transport chain; 13. Motor; 14. Take 2; 15. Bearing seat; 16. Vertical axis; 17. Flat key; 18. Tape 3; 19. Elastic stop ring; 20. Belt wheel; 21. Driven roller; 22. Cleaning wheel; 23. Front wheels; 24. Battery; 25. Sprocket; 26. Roller chain.

Figure 1. The scheme diagram of sweeping compressor

The leaf sweeping mechanism is composed of a pair of relatively rotating sweep impeller, the axis of the sweep impeller is vertically arranged with the ground, and the sweep blade is distributed on the sweep impeller, and the rotation of the sweep impeller drives the sweep blade to sweep the leaves into the car and transfer the leaf chain[5]. The leaf conveying mechanism is composed of a transfer chain arranged at an Angle, which is composed of a chain plate, a driving wheel, a driven wheel and a slender iron bar uniformly distributed on the chain plate. The driving wheel drives the delivery chain to drop the fallen leaves into the storage box.

During the working process of the cleaner, the power is provided by the DC motor and the battery is used for power supply. The specific work flow is as follows: The motor located in the upper part of the box transmits the power to the horizontal shaft through the belt drive, and the horizontal shaft and the vertical shaft are driven by the bevel gear, which converts the transverse rotating motion into the longitudinal rotating motion. The vertical shaft transmits power to the sweeping shaft through belt transmission, and the sweeping shaft drives the sweeping impeller to rotate and clean the fallen leaves. The leaves are swept into the conveyer by a sweeping impeller[6].

3. Transmission system design

3.1 Selection of motors and batteries

3.1.1 Determination of working resistance:

Working resistance, part is the resistance F_f of the lifting device movement in the structure, and the other part is the resistance F_k formed by the contact between the sweeping wheel and the fallen leaves during the working process, so the total resistance is the sum of the contact resistance between the sweeping wheel and the fallen leaves and the resistance of the transmission device movement:

$$F_z = F_k + F_f \tag{1}$$

Check the reference data: the density of fallen leaves is 0.79g/cm^3, as shown in the following figure, considering the limit case: the gap between all the sweeping blades of the sweeping wheel is filled by fallen leaves, then the weight of fallen leaves is:

$$\mathrm{V} = \pi(R^2 - r^2)h = 4400cm^3 \tag{2}$$

the weight of fallen leaves is

$$\mathrm{G} = \rho \mathrm{V} g = 0.79 \times 4400 \times 9.8 = 35\mathrm{N} \tag{3}$$

The working resistance of a single cleaning wheel is about 35N, and there are two cleaning wheels in total[7], as shown in figure 2:

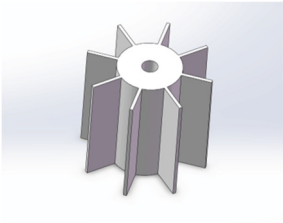

Figure 2. Sweeping wheel model diagram

$$F_z = F_k + F_f = 35 \times 2 + 35 \times 6 = 280\ \mathrm{N} \tag{4}$$

3.1.2 Determine the size of the operation speed

The normal walking speed of people who check the data is 5 km/h, but when only manpower is used, the weight will become larger, on the contrary, the speed will become smaller, taking 3.6 km/h, that is, Vm=1 m/s.

3.1.3 Determine drive power

$$P = F_Z \cdot v_m = 280 \times 1 = 280\ \mathrm{W} \tag{5}$$

The parameters used are all the parameters in an ideal state, so we have to take into account that some special circumstances may occur when working, so the DC gear motor is larger and P=0.55KW.

Select the motor according to the calculated power and speed, because the working resistance has not been taken into account and to prevent special circumstances, the ZYT series permanent magnet DC motor with a larger power is appropriately selected[8]. And considering the problem of easy installation, select its parameters as shown in table 1.

Table 1. ZYT series permanent magnet DC motor parameters

Model number	ZLC 80-1
Output power	0.8kw
Rated voltage	48V
Output speed	3600r/min
Speed difference	100r/min

3.2 Belt drive design calculation

3.2.1 Fixed V-belt

The weaker part of the whole design is the belt drive, if there is a failure, it will affect the entire equipment, and the belt drive cost is very low, can be ignored, so here is the use of narrow V-belt[9].

According to P= 0.88kW and n=52 r/min, it is determined that the narrow V-belt of SPZ type is used in this design, as shown in figure 3:

Figure 3. Sweeping wheel model diagram

3.2.2 Determine pulley diameter

a) Determine the datum diameter of the pinion

The diameter of the small pulley can be taken from 63 to 100 mm. Check the data and determine d_{d1}=100 mm.

Check the band speed v:

$$v = \frac{\pi \cdot d_{d1} \cdot n_1}{60 \times 1000} = \frac{3.14 \times 100 \times 52}{60 \times 1000} = 30.27 m/s \quad (6)$$

Calculate large pulley diameter

Since$d_{d2} = id_{d1}$, the resulting number is rounded d_{d2}=150 mm.

4. 3D modeling

The first step of using SW modeling leaf sweeper is to complete the modeling work of all parts according to the obtained parts size, the specific modeling work is to first select a surface as the drawing plane, and then complete the drawing of the basic sketch, in the sketch to ensure that the size drawn is the size of the subject, and then exit the sketch command. The feature design of the part drawing is completed through some rotation, array, stretching, punching and other related commands in the feature command[10]. For more complex parts, it is sometimes necessary to enter the sketch again, edit and exit the sketch again to complete the feature establishment. The model drawings of other parts are shown below:

The three-dimensional modeling of the motor is shown in figure 4:

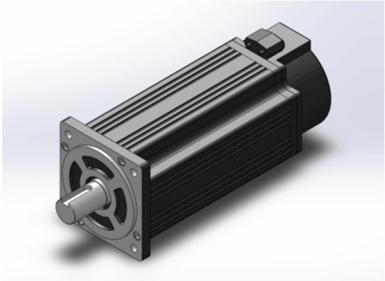

Figure 4. Three-dimensional model of the motor

The three-dimensional modeling of bevel gear is shown in figure 5.

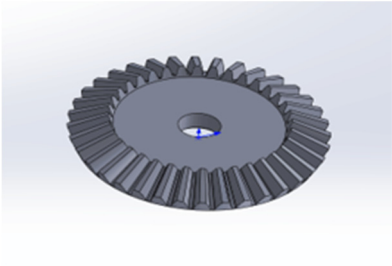

Figure 5. Three-dimensional model of bevel gear

The three-dimensional modeling of the drive wheel is shown in figure 6.

Figure 6. A three-dimensional model of the drive wheel

The three-dimensional modeling of the transmission chain is shown in figure 7:

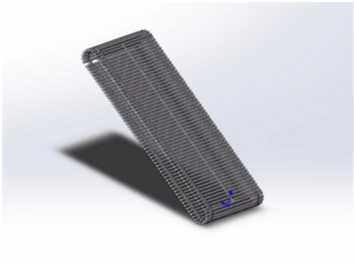

Figure 7. Three-dimensional model of transmission chain

The three-dimensional modeling of the wheel is shown in figure 8:

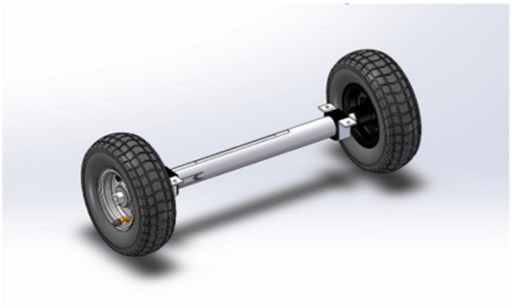

Figure 8. Three-dimensional model of wheel

To complete the modeling of parts through SW, it is necessary to coordinate the parts in the SW assembly module according to the mutual constraint relationship. In this topic, the lowest end of the frame is selected as a fixed frame, and then other parts are loaded through the same circle, coplanar, concentric, contact and other constraint commands in order to finally complete the formation of the assembly drawing. The following figure 9 shows the drawing of the assembly drawing of the litter sweeper.

Figure 9. 3D assembly model diagram

5. Conclusion

Based on the analysis of the existing data[11], this paper understands the current development status and trend of the leaf sweeping compressor, determines the main design scheme of this paper, and designs the leaf sweeping compression and transmission structure to meet the design requirements. And through the 3D modeling software to complete the 3D modeling. Through calculation to determine the parts that meet the requirements, to meet the rigidity and service life of the machine, to ensure its stability and to ensure the efficiency of the work. Research and improvement of leaf sweeping compressors is helpful to achieve the goal of urban clean, environmental protection and efficient management, and has positive significance to society and the environment.

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