

Design of multifunction cleaning vehicle based on WIFI signal control monitoring

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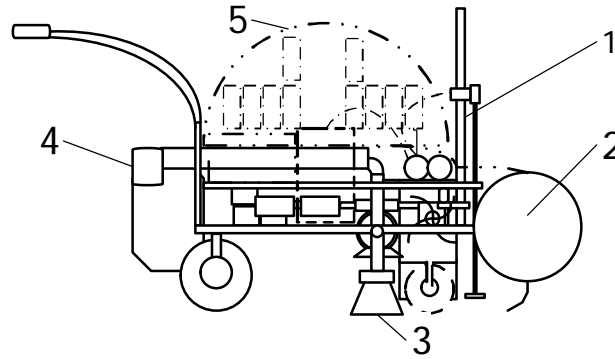
Abstract. Taking the problems of existing cleaning vehicles into consideration, a multi-functional cleaning vehicle is designed, which includes the transmission module, the transmission module, the removal of ice and snow module, the cleaning module, the watering module, the energy module, and the WiFi control module. The driving force is provided by the solar cell, and can be controlled by WIFI signals. The main structure and design calculation of the cleaning vehicle are described in detail, and the parametric modeling is modeled by SolidWorks. The paper also determines the connection between the agencies and rational layout, and the composition of the overall system to carry out a detailed introduction and analysis.

Introduction

At present, most of the snow removal on the city roads is conducted by large snow machine, and the snow removal on the campus and park road is mainly conducted by small snow machine. Existing snow machines are mainly divided into rolling brush type machines and shovel snow machines [1]. All of the above types of snow removal machines can't achieve all of the purposes of the cleaning jobs. They mainly use diesels, gasoline engines, which are not conducive to environmental protection, and the function is relatively simple. Except for the winter snow, the device is idle in other seasons [2]. In this paper, a design scheme of multi-purpose cleaner is proposed. The main feature of this car is to realize remote control by WiFi. The solar energy [3] is used to provide power. When the road is covered with snow, the spiral equipment with a blade and a brush is used for removing snow and ice. When the car is idle, it can be used for watering, purling, and clearing dust away, etc, which can replace the traditional manual work and can greatly improve the efficiency of cleaning.

Gross structure design

The multifunctional cleaning vehicle is based on WiFi signal, which can remove snow and ice, clean the ground, and water the flowers and trees. The whole system is modular, and can be used manually or controlled through the WiFi signals. When it's working, the motive power is provided by the driving force and the driving force is transmitted to the working part. The driving module is provided by the motive power to realize differential steering and walking control [4-6]. The snow can be collected in the container by the snow and ice removal module. The cleaning module is driven by the original motivation and the ground floor is cleaned by the two brushes. The watering module sprays water out through the pump and the automatic lifting device [7]. Solar panel module provides energy for vehicle. The multifunctional cleaning vehicle Design scheme is shown in Figure 1, and the control block diagram of each module is shown in Figure 2.



1. sprinkler module 2. Removal of ice and snow module 3. clear module 4. collect module 5. energy module
Fig 1: Multifunctional cleaning vehicle Design scheme

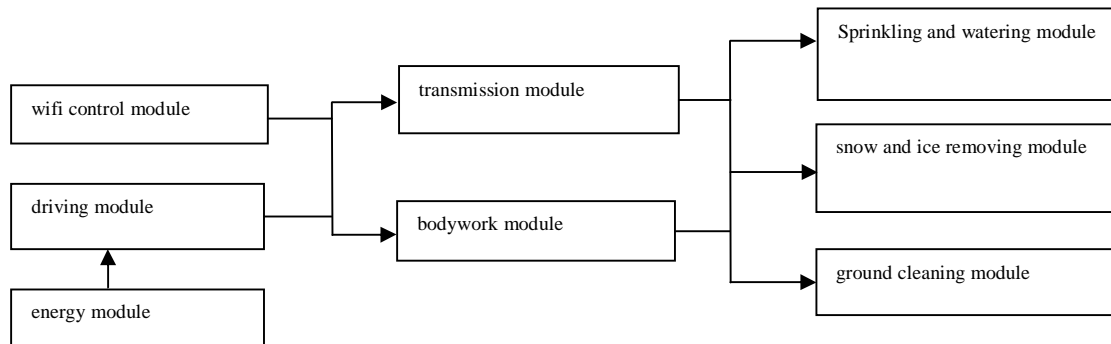
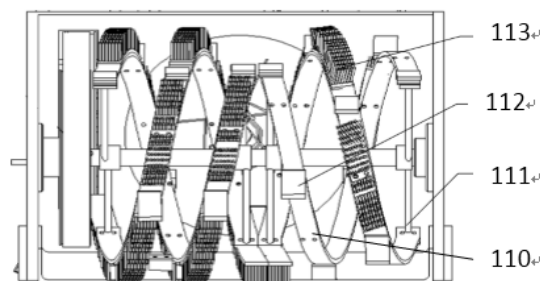


Fig 2: Control block diagram of each module

Removal of ice and snow module

The main function of the module is to clear snow and ice, the original motivation will be transmitted to the spiral frame and the throwing snow impeller through A type belt and bevel gear, the brush and the blade fixed on the spiral frame are driven by the spiral frame, and the brush and the blade work alternately, The spiral frame collect snow in the front snow feeding opening, and collect snow in the collection box through the snow throwing cylinder. This module can clean up the dust and leaves on the road in the non-snow season [8]. The spiral frame belt according to a certain shape is low cost and easy to operate compared with the existing snowplow auger. The design about the surface of the spiral frame is provided with blade and brush, and the brush and blade is tangent to the earth when the spiral works and will not cause damage to the ground, the brush cleaning by the spiral path will eventually collect snow to the impeller completely [9]. Removal of ice and snow module is shown in Figure 3



113. Brush, 112.blade, 111.spiral frame, 110.spiral collector

Fig 3: Removal of ice and snow module

The spiral frame pitch is 350mm, the number of rings is 0.5, the diameter of the blade is 250mm. the diameter of the blade is 285mm after reinstalling the blade and the width is 25mm, the cutting diameter of the brush is 290mm and the width is 25mm, the blade surface and spiral frame surface

parallel when it works, the cutter head is tangent to the earth and can well finish cutting ice completely and protect the blade not worn. Among them:

$$n=500 \text{ r/min}$$

$$V_c = \frac{\pi d_s n}{60 \times 1000} = 7.46 \text{ m/s} \quad (1)$$

$$\frac{V_f = 0.8 \text{ m/s}}{f} \quad (2)$$

$$V_f = nf = 96 \text{ mm/s} \quad (3)$$

$$f = \frac{V_f}{n} = 0.096 \text{ m/s} = 96 \text{ mm/s} \quad (4)$$

Where: the n is the screw shaft speed, V_c is the cutting speed, V_f is the feed rate, f is the feed
The cutting tool works in a right angle, taking the hardness and wear resistance of the cutting tools into consideration [13], the force acting on the chip is shown in Figure 4:

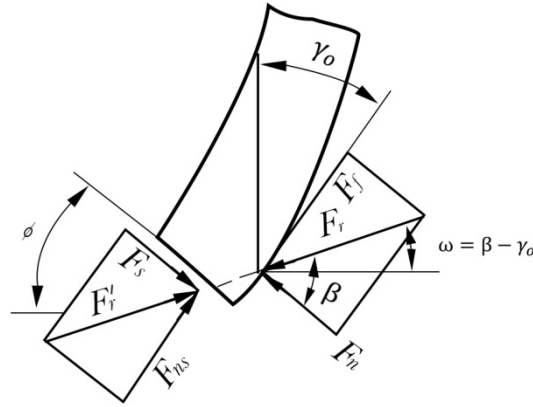


Fig 4:Right angle cutting force analysis chart

$$F_s = \tau A_s = \frac{\tau A_D}{\sin \phi} \quad (5)$$

$$F_s = F_Y \cos(\phi + \beta - \gamma_0) \quad (6)$$

$$F_Y = \frac{F_s}{\cos(\phi + \beta - \gamma_0)} = \frac{\tau A_D}{\sin \phi \cos(\phi + \beta - \gamma_0)} \quad (7)$$

$$F_c = F_Y \cos(\beta - \gamma_0) = \frac{\tau A_D \cos(\beta - \gamma_0)}{\sin \phi \cos(\phi + \beta - \gamma_0)} \quad (8)$$

$$F_P = F_Y \sin(\beta - \gamma_0) = \frac{\tau A_D \sin(\beta - \gamma_0)}{\sin \phi \cos(\phi + \beta - \gamma_0)} \quad (9)$$

$$\frac{F_P}{F_c} = \tan(\beta - \gamma_0) \quad (10)$$

$$\text{then : } \phi + \beta - \gamma_0 = \frac{\pi}{4}$$

Where: AD is the cutting layer cross-sectional area, As is the cross-sectional area of the shear plane, τ is the stress on the shear plane. Cutting force includes the main cutting force, back force, feed force:

$$F_c = C_{F_c} \cdot a_p^{X_{F_c}} \cdot f^{Y_{F_c}} \cdot V_c^{n_{F_c}} \cdot K_{F_c} \quad (11)$$

$$F_p = C_{F_p} \cdot a_p^{X_{F_p}} \cdot f^{Y_{F_p}} \cdot V_c^{n_{F_p}} \cdot K_{F_p} \quad (12)$$

$$F_f = C_{F_f} \cdot a_p^{X_{F_f}} \cdot f^{Y_{F_f}} \cdot V_c^{n_{F_f}} \cdot K_{F_f} \quad (13)$$

Where: Cfc is the spiral frame of torque

$$C_{F_c}=20 \quad a_p=10 \text{ mm} \quad X_{F_c}=1.0 \quad Y_{F_c}=0.3 \quad f=96 \text{ mm} \quad K_{F_c}=0.2 \quad n_{F_c}=0.2$$

$$C_{F_p}=10 \quad X_{F_p}=0.9 \quad Y_{F_p}=0.3 \quad n_{F_p}=0.3 \quad K_{F_p}=0.2$$

$$C_{F_f}=10 \quad X_{F_f}=1.0 \quad Y_{F_f}=0.5 \quad n_{F_f}=0.4 \quad K_{F_f}=0.2$$

Unit cutting force is shown as follows:

$$k_c = \frac{F_c}{A_D} = \frac{F_c}{a_p f} = \frac{3283}{10.96} = 3.41 \text{ N/mm}^2$$

$$P_c = F_c V_c \times 10^{-3} = 105.3 \times 7.42 \times 10^{-3} = 0.78 \text{ KW}$$

$$Q_z = a_p f V_c = 7.123 \text{ mm}^2$$

there: k_c is specific cutting ice force P_c is cutting ice power Q_z is Unit-time cutting ice area

WIFI control module

This module controls the working of various function modules, specifically controlling: (1) moving and turning of the bodywork; (2) the switch of power head of snow or ice removing; (3) the switch of cleaning brush and vacuum pump; (4) the switch of plants watering or ground sprinkling as well as the elevating of spray nozzle; (5) supervise the surroundings of the bodywork. It is made up of router, control mainboard, mobile phone, laptop, controller, a front camera and rear camera. By controlling the handcart via WiFi, users can control the snow remover working outdoors just in the room. This can help users to avoid the bad environment in cold winter or hot summer. So it is convenient and reliable. Users can directly use their mobile phones to control the handcart, which costs less and more reliable in controlling.

Using router LAN or getting router access to public network to connect main control board and computer or mobile phone PC terminal gets access to corresponding network. Main control board via WiFi access receives the control signal of PC terminal and the main control board gives response to it. At the same time, the camera on the handcart with access to main control board and sensors will give feedback to PC terminal via main control terminal with access to WiFi signal [10-12].

Parametric modeling

SolidWorks is a solid modeling system which is based on feature and parameter, is the main trend of current CAD software. SolidWorks uses a single database, when client uses SolidWorks to model, it can not only create a single three-dimensional entity, but also automatically generate all

kinds of views by three-dimensional entities. In addition, it can also directly use the three-dimensional solid model of the components to simulate and assemble and

observe the movement of parts in dynamic state and it is easy to test parts' design parameters. SolidWorks has been

widely used in the design of its advantages, such as its modeling, visualization, image, short design cycle, the low cost of testing and the high quality of the products. The spatial structure of SolidWorks is more complex and it

brings the convenience to analyze the structure and performance and control the quality of the model. The structure of the multifunctional cleaning vehicle is shown in Figure 7:

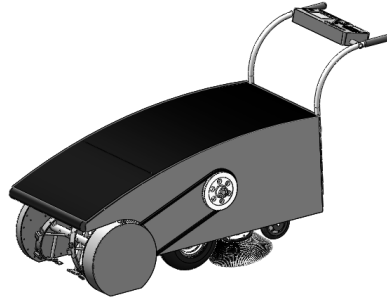


Fig 5: multifunctional cleaning vehicle model

Conclusion

WiFi control and monitoring of solar energy is more convenient, simple and easy to assemble. The operation is simple and reliable, can realize remote control and works suitably. The Snowplow body volume is relatively small, does not occupy space. In watering and some other aspects can be free to lift, rotate, the structure is simple and well-directed. The blade and brush works alternately can clean snow, dust, leaves, etc, which can save manpower and material resources. The walking tractor controlled with double drive, differential steering and the design is simple, easy to operate.

When cleaning the snow, the snow will be concentrated and transported to the specified position by the spiral frame rotation. The snow will be pushed into the collection box by the centrifugal force generated by the impeller, and the brush will completely clean the rest of the snow into the collection box; the car controlled by WiFi can realize remote control conveniently; the collection device, which comprises the vacuum pump, the plastic pipe, the collection box; the spraying device raised and lowered automatically achieve spray water out in every angle. The two cameras can be achieved for the full range of the car;

With solar energy as the main energy, controlled by mobile phone or computer connected to the WiFi, It can make up for the market gap by module the multifunctional cleaning vehicle based on WIFI signal control monitoring, and with environmental protection. It's more suitable and practical in the community, school and other similar environment.

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