



# A new generation of intelligent environmental washing machine

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**Abstract.** The number of passenger cars in China is growing year by year, while the demand for supporting car washing services is also increasing. In this study, a new generation of intelligent and environmentally friendly car washing machine is innovated and designed. The integrated structure is used to select two kinds of rails in the air and on the ground according to the needs of different scenes. At the same time, it is equipped with a membrane-free filter tank. It can accurately solve the problems of water waste in the current industry, traffic congestion easily caused by large equipment area, and wear and tear easily caused by the cleaning process. The car washing machine will not only be suitable for traditional application scenarios, such as gas stations, large parking lots, etc., but also will further extend the application scenarios of small Spaces, such as power stations, three-dimensional parking lots and other small space areas.

**Keywords:** machinery manufacturing; car washing machine; environmental protection.

## 1 Introduction

China's domestic car ownership is rising, the relevant data show that by the end of 2022, the national commercial vehicle ownership of 319 million. At the same time, the supporting service of automobile after-sales is also constantly improving. In recent years, the automatic car washing service has also been paid attention by the national and local governments. In February 2023, the "Accelerating the transformation and upgrading of the manufacturing industry" issued by The State Council mentioned that the future of the manufacturing industry needs to develop in the general direction of green, low-carbon, circular and sustainable development, comprehensively implement green manufacturing, and forge new industrial competitive advantages.

At present, the research of car washing machine at home and abroad is mainly divided into two aspects, one is the structural innovation. For example, the DSM matrix based on the correlation degree of design parameters was established in Multi-module design of gantry washing machine to alleviate problems such as maintenance difficulties and resource waste of car washing machine<sup>[1]</sup>. In addition, at an earlier time, some foreign scholars proposed the theory of numerical simulation of the structure of the tumbling car washing machine, and improved the structure of the car washing machine through mechanical design<sup>[2]</sup>.

The second is the reduction of water consumption. The car wash peripherals are installed in the car wash, the position of the front and rear of the car is located by photoelectric sensors<sup>[3]</sup>, and the intelligent water recycling system uses the MBR membrane composed of a new composite carbon fiber material to recycle waste water<sup>[4]</sup>.

The third is the upgrading of the supporting facilities of the car washing machine. Related researchers Meng Yanan and others upgraded the control system of car washing based on PLC, reducing the labor intensity of car washing workers and improving the efficiency of car washing<sup>[5]</sup>.

Based on the above research, the author investigated and visited many enterprises such as Xiamen Dexiang Machinery Industry Group Co., LTD., and designed a new generation of dual-track intelligent environment-friendly car washing machine. The research adopts a one-piece structure and is equipped with a double-track selection, non-membrane filter tank, compared with the current market car washing machine, with small size, low water consumption, high cleaning rate advantages, and has applied for relevant patents to improve the realization of the technology.

## **2 Automatic car wash industry development status analysis**

In recent years, while encouraging the development of new infrastructure, the state has begun to strictly grasp the problem of clean sewage discharge from automobiles, guiding the transformation of China's car washing methods through policies, and promoting the popularization of automatic car washing machines by encouraging the development of green environmental protection. At the same time, since 2020, Hubei, Jiangsu, Shandong and other provinces have launched "contact-free" smart car wash services, and the safety brought by no contact has become the consensus of most people, and also provides more convenient services for owners.

Today, automatic car washing machines are mainly divided into two categories: contact car washing machines and non-contact car washing machines. Among them, the contact car washing machine is divided into gantry reciprocating car washing machine and tunnel car washing machine. The non-contact car washing machine usually uses CPU technology and uses the computer's light spot sensor to scan the car in a full range, and then cleans the body without difference. At present, the domestic automatic car washing machine has problems such as large area, high water consumption, low efficiency of car washing, and limited application scenarios.

### 3 Product design

The car washing industry urgently needs to reduce the amount of waste water generated in the car washing process, improve the cleanliness rate without damaging the body, and reduce unnecessary waste of land resources. This study designed and developed a new generation of dual-track intelligent environmental protection car washing machine, in order to improve the problems faced by the car washing industry.

#### 3.1 Product introduction

This design in response to the national "0" pollution, water conservation call, from the software development, hardware device update adjustment and structural transformation of three aspects to make countermeasures, designed a new generation of intelligent environmental washing machine. (The product details are shown in Figure 1.)

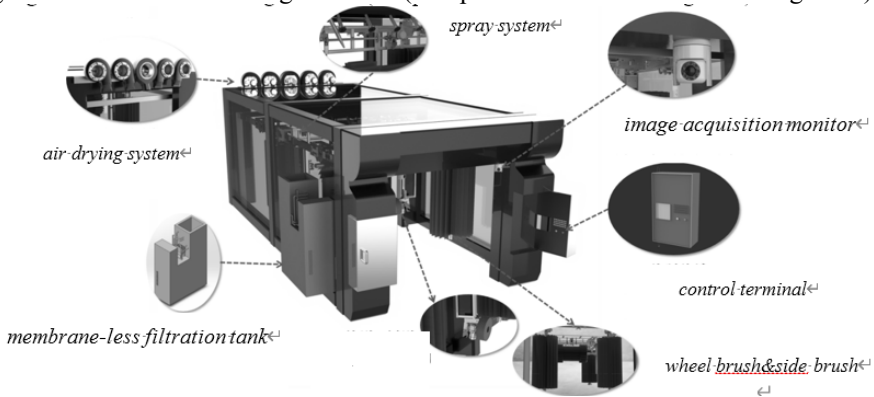


Fig. 1. Intelligent environmental protection car washing machine details

#### 3.2 Product introduction

In terms of structure, the integrated frame structure is adopted. It is composed of an "n" type inner frame and an "n" type outer frame, through which the size of the space required for installation is limited to a certain extent, and the structure of the car washing equipment is installed in the inner frame. The internal framework includes: Two brushes from the front cleaning team, Two brushes from the rear brush cleaning group and One brushes from the top brush cleaning group , the two front and rear large brushes are respectively arranged on both sides of the frame, and are independently equipped with corresponding rotating motors to drive rotation, the top brush is located in the center of the front and rear large brush cleaning group, and is independently equipped with a rotating motor and a vertical moving motor. To achieve rotation and vertical movement functions. The whole structure is also equipped with a foam spray unit and a drying aid spray unit.

In addition, the structure is also provided with two parallel set intervals of the walking track (air track, ground track), the three groups of cleaning groups can be linked, and through the walking track to move.

The three cleaning groups consist of three modes of movement:

(1) The front and rear large brush cleaning group is parallel to the top brush cleaning group, and the longitudinal movement of uniform speed is carried out at the same time to complete the cleaning of the body and roof.

(2) The rear large brush cleaning group is fixed with the top brush cleaning group, and the front large brush cleaning combination is combined to complete the cleaning of the front.

(3) The front brush cleaning group is fixed with the top brush cleaning group, and the rear brush cleaning combination is combined to complete the cleaning of the car tail.

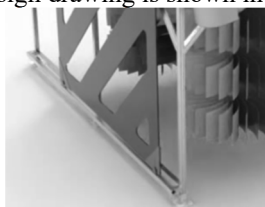
The integrated structure design is the shortest box type structure with scrubbing machine in China. It has a wide range of application and can be applied to most small and medium-sized Spaces. Its space length is between 6-6.5m, it is currently the shortest length in the industry.

In the aspect of orbit design, this research designs the air orbit and the ground orbit. The air track is installed on the top of the car washing machine, and the five linked brushes are run through the track to achieve the reciprocating and closing movement of the cleaning structure. (The air orbit design drawing is shown in Figure 2.)



**Fig. 2.** Air orbit design drawing

The ground orbit. The ground space in the frame of the car washing machine can also be selected to install the ground track. The ground track is suitable for places where there is no additional requirement for ground space, and the track requires less structural support, has a lower deformation rate and is easy to replace, so the cost is also low. (The ground track design drawing is shown in Figure 3.)



**Fig. 3.** Ground track design drawing

### 3.3 Product circulation tank

In order to improve the utilization rate of water resources of the car washing machine, the film-free filter water tank is used. The water tank is used for filtering and treating sewage, including the following parts: sewage tank, filter tank, circulation tank. The sewage pool is connected with the precipitation area, the precipitation area is connected with the purification area through the water outlet, and the circulating pool is connected with the purification area through the pipeline. The sewage in the sewage pool is filtered through the filter pool and then enters the circulating pool.

By collecting, purifying, filtering and reusing the sewage generated by the car washing machine, the waste of water resources is reduced and the cost of using the car washing machine is reduced. In the non-membrane filter tank, a sedimentation zone and a purification zone are arranged through the first partition board, and a plurality of filter cavities are formed in the side of the first partition board towards the second partition board through the second partition board, and filter the sewage by filling the filter chamber with filter substances (activated carbon and quartz sand).

The water tank also includes a deodorization box, the deodorization box is arranged on the outside of the circulation pool and communicated with the circulation pool, the filter pool has a special pipeline for filtered water recovery, the inlet end of the pipeline is connected with the top of the filter pool, and the top of the deodorization box is provided with an opening, the outlet end of the pipeline is towards the top opening of the deodorization box. (The Non-membrane filter tank design drawing is shown in Figure 4.)

The deodorant box comprises a deodorant box shell and a deodorant box partition board. The deodorant box partition is arranged inside the deodorant box shell, and the deodorant box shell is divided into a first deodorant chamber and a second deodorant chamber, the second deodorant chamber is connected with the circulating pool, and the first deodorant chamber is connected with the second deodorant chamber.

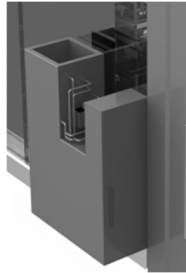


Fig. 4. Non-membrane filter tank

The sewage pool includes a grease trap, and a clear pool is set up in the circulating water tank. When the sewage goes through the above steps, it enters the clear pool, and the clear pool is connected with the filtered water recovery pipeline through the clean water drainage pipe to supply water.

The circulating water tank has a fully automatic backwash function, which can be backwashed in the filter chamber when the filtration is stopped, and then the impurities in the filtered material are washed out and discharged in the form of silt. At the

same time, the operation can be completed at any time by remote control, which greatly reduces labor costs and time costs.( The internal structure of the water tank is shown in Figure 5.)

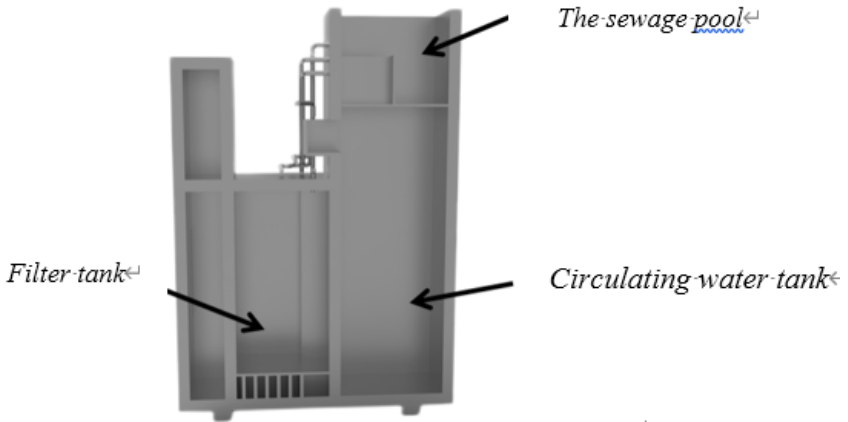


Fig. 5. Internal structure of the water tank

### 3.4 Product core advantage

Compared with the competitive products on the market, the dual-track intelligent environmental protection car washing machine has the following competitive advantages.

First, the car wash machine is more miniaturized. The overall length of this design is 6-6.5 meters, compared with other products on the market, it can save at least 1/2 of the floor area, effectively avoid the waste of land resources, but also reduce the cost of various materials.

Second, the scope of application is wide. Through the design of two different tracks, the air track and the ground track, the car washing machine will not only be limited to gas stations, communities, supermarket parking lots and other scenes, providing users with more selectivity, and improving economic benefits to a certain extent.

Third, it is sustainable. The combination of vehicle copying system and circulating water tank can minimize the possible damage to the car body while ensuring high cleanliness rate. In addition, the use of circulating water tanks greatly improves water saving efficiency.

### 3.5 Product application scenario Suggestions

The application scenarios of the dual-track intelligent environmental protection car washing machine designed by this research institute are mainly divided into two categories: one is the traditional use scenarios, such as large parking lots, communities, gas stations and other scenes; the other is the new use scenarios that can be expanded

due to the innovation and upgrading of this research, such as three-dimensional parking lots, power stations and other small space areas. This will, to a large extent, solve the current problems of high water consumption and large land area in the car wash industry.

## 4 Conclusion

As the number of cars in China grows year by year, so does the demand for fully automated car wash services. Compared with the traditional car washing machine, the new generation of car washing machine innovatively designed in this study adopts an integrated structure, combines two kinds of tracks in the air and on the ground, and is equipped with a membrane-less filtration tank, which has the advantages of small footprint, low water consumption, high cleaning rate and low wear rate compared with traditional car washing machines. In addition, it also responds to the country's call for "0" pollution and water conservation, and further promotes green manufacturing and sustainable development. The future development of the fully automatic car wash industry will pay more attention to environmental protection, efficiency and intelligence to meet the growing market demand and policy guidance.

## 5 Peroration

In the new pattern of development, the manufacturing industry is taking on a new mission. The new generation of car washing machine designed by this research institute integrates environmental protection, intelligence and efficiency, and increases the use of car washing machine in new application scenarios of power station and three-dimensional parking building. Supporting the air, ground double track selection and circulation water tank, maximize the land utilization rate, save water resources, for the green transformation and upgrading of China's manufacturing industry

## Acknowledgments

This research was funded by Xiamen University Tan Kah Kee College (no. YY2022W02) and Fujian Provincial Department of Education (no. FBJG20220123).

## References

1. Hongyu Z, Xuemin Z, Yao Z and Qian Z. (2022) Multi-module design of gantry washing machine. *Journal of mechanical design.*, 39(12): 133-139.
2. Sabet, Marques, Torres, Nova, Hattum and Nobrega (2014) Numerical Modelling of a Rollover Car wash Machine Structure. In: ACTA. Washington. pp. 52-58.
3. Marek G and Piotr W. (2023) Application of polypropylene microfiltration membranes for separation of wastewater from car wash. *Separation and Purification Technology.*, 2024, 331.125707.

4. Fayed, M., Shewitah, M.A., Dupont, R.R., Fayed, M. and Badr, M.M. (2023) Treatability Study of Car Wash Wastewater Using Upgraded Physical Technique with Sustainable Flocculant. *Sustainability* . 15 (11)085871.
5. Yanan M, Xiaoyan H, Feng Q and Zhimin C (2021) Design of Car Washing Control System Based on PLC. *Journal of Physics. Conference Series*, 1732 (1): 012015.

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