

Design of Automatic Car Washing Machine System based on Image Processing

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ABSTRACT: *With the development of Internet of Things technology and automation technology, people's way of car washing has gradually changed, and it has become a trend to replace human-powered car washing by machine washing, which can not only reduce labor costs, but also save resources. However, the current car washing machine is only for reciprocating cleaning of vehicles, and cannot focus on cleaning the heavy dirty areas on the vehicle surface, resulting in insufficient cleanliness, which greatly limited the development of car washing machine. This paper proposes an automatic car washing machine based on image processing. The image processing algorithm is used to detect dirt on the surface of the vehicle, such as dirt and bird excrement, so as to control the car washing machine to focus on cleaning the dirt of the car body, which greatly improves the cleanliness of the car washing machine.*

KEYWORDS: *automatic car washing machine; Image processing; Stain detection.*

1. Introduction

With the development of automation technology, automobile has become an usual means of transportation in people's lives. According to the relevant data, the number of cars in China has exceeded 300 million and the car ownership is increasing year by year. With the private car entering people's daily life, car washing has become the daily consumption of private car owners. In recent years, with the increasing labor cost of human-powered car washing, slow cycle of human-powered car washing, high water consumption and other issues, the automatic car washing machine is getting more and more of the market share. Yet, the car washing machine currently on the market still needs the assistance of human washing, the degree of automation and insufficient washing cleanliness greatly limits its development. The traditional car washing machine can only performs the reciprocating car washing operation, but the vehicle cannot be cleaned in a targeted manner. This paper introduces an automatic car washing machine system based on image processing [1], which greatly improves the cleanliness and environmental protection of the

automatic car washing machine.

2. Machine-vision based car washing machine architecture design

The car washing machine control system is consist of image acquisition and processing module, sensor module, system control module and motor drive module. Its composition diagram is shown in Figure 1.

The image acquisition and processing module adopts an industrial-grade camera to capture images on the upper and two sides of the vehicle and then transmits the acquired images to the control unit. The control unit first runs the corresponding image processing algorithm to obtain the position information of the dirt points (such as sludge, bird excrement and other dirt that are not able to be removed easily) on the surface of the vehicle to be cleaned [2]. Then, the coordinates are sent to the car washing control unit, the car wash control unit obtains the coordinates of the body dirt point and sends the coordinates information to the car washing controller to conduct a remain cleaning operation on the dirt points.

The sensor module contains a peripheral ultrasonic ranging sensor and a pressure sensor. The purpose of the all-around distance measuring sensor is to determine whether the parking position is suitable after the vehicle is driven into the washing machine. If it is not suitable, the normal operation cannot be worked and the vehicle is prompted to move the position. The pressure sensor is installed on the spray bar of the car washer. Once the pressure is abnormal, it will stop working immediately.

The car washing motor module consists of a water pump motor, a three-phase stepping motor, an air compressor and a single-phase asynchronous motor. The three-phase stepping motor, a limit switch and a single-phase asynchronous motor control operation of the automatic car washing machine spray bar. The water pump motor and the air compressor separately provide high-pressure water and air outlet for the spray bar to complete the high-pressure car washing and air drying process.

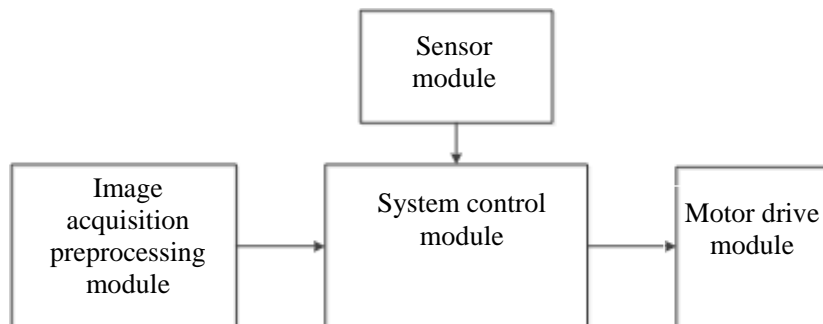


Figure 1. Overall module structure of the system

3. Process of design of car washing machine

The car drives into the car washer, starts the car washer, and the all-round sensors detect that the vehicle is driving in the correct position. Start the camera collect images from the front and two sides of the vehicle. After the collection is completed, the data will be transferred to the image processing unit and image processing algorithm will be used for image processing to obtain the coordinates of the spot position. Send the location coordinates of the spots to the system control module, start the cleaning work with high-pressure water around the vehicle body, the control system operates on the position of the high-pressure water to stay on the stain according to the position coordinates of the vehicle, and then spray the clean out fluid. After a few seconds, the high-pressure water is restarted to clean the body and the key parts of the vehicle. Finally, air drying is started and all the work is completed, the user is prompted to wash the car. The car washing process is shown in Figure 2.

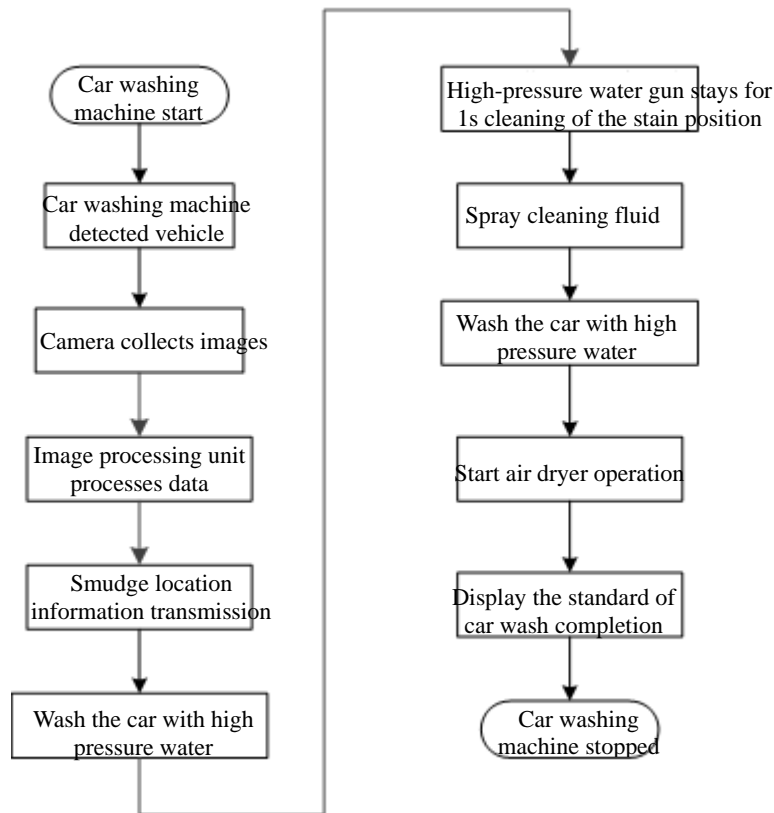


Figure 2. Car wash process design

4. Hardware module design

This car washer adopts stm32-f407 of STM company as the main control system [3]. It is a MCU based on cortex-m4 core, with 143 pins, which has traits with strong real-time low power consumption and rich communication functions. The working temperature of STM32 f407 chip can be between - 40 and 90 degrees and a variety of industrial standard interfaces are integrated, which fully meet the requirements harsh environment of car washing. In the image acquisition part, the mv-ca060-10gc industrial camera of Hikvision is used to collect images on the top and both sides of the vehicle. The Gigabit Ethernet interface provides 1Gbps bandwidth and the maximum transmission distance can reach 100m without relay. It has 128MB on-board cache which can cache multiple images is used for burst transmission or retransmission to support automatic exposure control, user-defined lookup table LUT, gamma correction and so on.

The hardware design is mainly in the main control process, after the image acquisition and processing of the stain position and sensor signal are processed by STM32 internal program, the output terminal controls of car washer to perform the corresponding car washing action [4] [5].

According to the design of the system, it is necessary to achieve the data transmission between the industrial computers and STM32. The computer needs to send the information of the location of the acquired image spots to the control unit after processing. Meanwhile, STM32 needs to feed back the control signal to the control software of the computer. This design adopts the RS485 bus communication interface [6].

The main control module of this design needs STM32 chip to realize the electric switch control of the high-pressure water gun valve, limit switch relay and cleaning liquid valve of the car washing machine after receiving the image data and control signal of the industrial computer.

5. Software system design

The software system design of this paper includes image processing algorithm design and main control module software design. This project detects the image of the vehicle need to be cleaned, and extracts the region of interest based on the color and contour features according to the characteristics of the vehicle surface dirt different from the body. The main control module of the car washing machine is STM32 series of chips. Based on the characteristics of the chips, the software system needs to complete the reset, detection and other operations, and converts the data processing to send control signals to the motor. The STM32 control flow is shown in Figure 3.

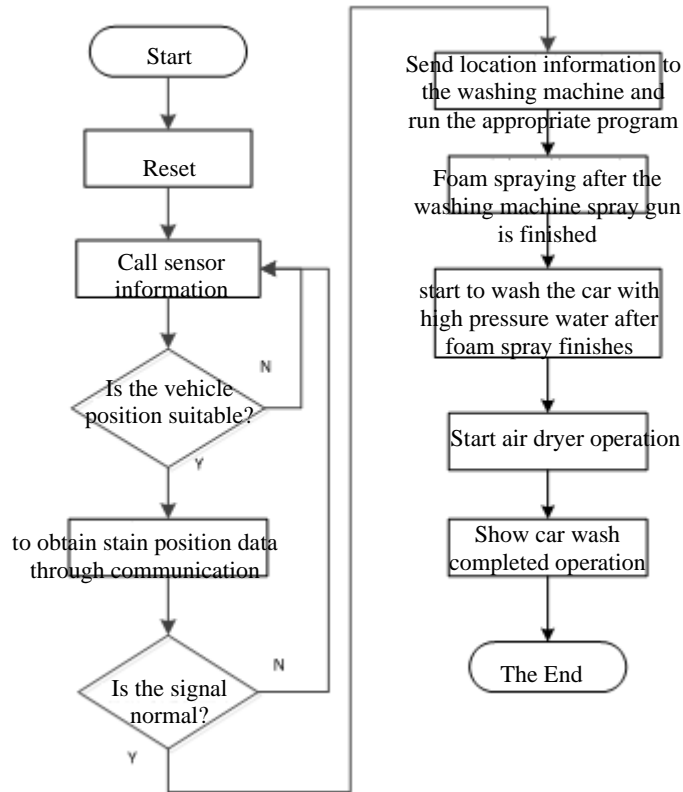


Figure 3 STM32 control flow chart

6. Conclusion

Aiming at the present situation and problems of auto washing machine, this paper designs a kind of auto washing control system based on machine vision, which uses machine vision algorithm to identify the stains on the vehicle surface, and controls the parameters of car washing, and cleans the stains on the vehicle surface. The system improves the cleanliness of car washing machine and provides a more efficient and clean car washing service.

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