Research on the strategy of auto paint repair system based on computer 3D modeling

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Abstract. With the rapid development of the auto repair industry, the continuous use of painting robots, auto paint repair automatic painting has also made progress. In this paper, firstly, the development of automotive paint technology and the main content of auto paint repair and auto paint spraying are described, and the strategy of auto paint repair and auto paint spraying system based on computer three-dimensional modeling is studied for readers' reference.

Keywords: 3D Modeling, Auto Finish Paint Repair, Automatic Painting System, Control System Software

1. Introduction
The development of science and technology has an important impact on people's lives. Through the use of spraying robots in auto paint repair, the efficiency of auto paint repair is improved, and it is conducive to environmental protection.

2. Development of automotive coating technology
Automobile coating refers to coating on the bridge car and other types of vehicle body and parts of the paint, generally refers to the new car paint and auxiliary materials and vehicle repair with paint. Automotive coatings mainly include primer, middle paint, finish paint, which can be divided into natural paint and metal flash coating. Automotive coating is the fastest developing coating variety, the amount of coating is second only to architectural coating, but also the highest performance requirements of the coating variety, automotive coating represents the highest level of the current coating industry [1]. DuPont, BASF and PPG are the world's top three automotive paint manufacturers, with DuPont Specialty Coatings accounting for 46 percent of the market, BASF accounting for 28 percent and PPG for 24 percent.

2.1. Primer
Automobile primer should have good construction, high penetration rate, high corrosion resistance, low density, low solvent content and strong anti-pollution ability. At present, electrophoretic paint is generally used in automotive primers. The electrophoretic paint used in China is generally the third and fourth generation of products, including Aksu D2035, Limberts 8911, PPG ED4, Kansai HB2000,
9120, Herbergs G1083, GL183, AquaEC3000, BASF 25 and so on [2]. In order to reduce the pollution of the coating industry and build a new environment-friendly industry, the electrophoretic paint used in the production line of the world automobile company will be developed in the direction of high penetration rate, low facial base ratio, good edge and corner coverage effect, and lead-free.

2.2. Paint
In the bottom coating after the completion of the smooth surface and poor smoothness of the coating, this is the use of the coating to fill the role. In the coating requirements and primer and finish has a good combination, good grinding, with a certain elasticity and filling, can repair by the bottom of the rough itself caused by the small defects, improve the appearance, but also can reduce the damage of UV on the bottom [3]. At present, western Europe's waterborne medium coating is mainly waterborne polyester amino resin type and closed type isocyanate polyurethane type, the production process has been quite mature. Japan Kansai Coating Company developed waterborne polyester amino medium coating, the construction viscosity of solid has reached 61, VOC content of 12%, drying condition is 140°C/30min. Achieve the same performance as the solvent-based coating.

The water-based automotive finish is of great significance in the water-based automotive finish. Automotive finish must have good weather resistance and excellent appearance, can be easy to repaint, repair, polishing. PPG's CER Amniclear Automotive Surface Coating is a water-based nanomaterial that is the world's leading in abrasion resistance. Scratch-resistant, easy-to-clean paint. In the future, the research of topcoat should focus on the decoration, appearance, weather resistance and the combination of topcoat with bottom and middle coat.

3. Main contents of auto finish paint repair auto spray paint

3.1. Composition of automobile repair paint
We all know that the automotive original paint is mainly its thermosetting acrylate components in 130~145°C baking curing from the original paint hardness, water resistance, fish, light and outdoor weather resistance are very good. So in the process of car finish repair obviously the whole vehicle is not able to be placed in more than 100 degrees of high temperature to bake. The lack of this key condition for the repair paint, to nearly meet the quality requirements of the original factory paint must seek a breakthrough in its composition that is, the repair paint has the characteristics of two components, low temperature curing [4]. At present, China's auto repair paint has developed to the fifth stage, two-component acrylic polyurethane repair paint. The repair paint of this component has the characteristics of fast drying, high hardness and good water resistance.

However, some famous automotive paint companies abroad have already turned the research direction of automotive paint to high solid content and water-based [5]. This breakthrough can significantly reduce VOC emissions to meet the appearance requirements of the paint while also being resistant to stone-impact and scratch-resistant.

Therefore, the composition of the car repair paint itself plays a vital role in the quality of the paint repair, and the domestic automotive paint manufacturers have a long way to go.

3.2. Base material treatment before spraying
Modern cars mainly use galvanized steel and aluminum alloy as car shell materials, but also some partial use of engineering plastics as car shell materials. Be sure to use a special oil remover to clean the damaged area before sanding it. Otherwise the dirt on the surface of the paint film will remain in the sandpaper scratches produced when grinding, and it will be more difficult to clean and remove oil in the later period.

When the substrate is playing, we should pay attention to the choice of sandpaper 60# for rough grinding, 1200+ and above for fine grinding if the processed substrate is still greasy or pinhole, then the spray out of the repair paint after baking will appear fisheye or walk bead paint defects; To influence finish quality [6].
3.3. **Color mixing technology**  
The color blending of auto finish repair coating is very complicated. At present, the main methods used are manual color blending and computer aided color blending. Generally speaking, car repair coating is composed of three parts, master part, resin part, solvent, additive part. Masterbatch by the high pigment content of the dominant paste composition, metal paint series masterbatch and monochrome paint series masterbatch. Resin is the main component of coating film, masterbatch also contains part of the resin, is one or several parts of the resin [7]. Solvent is mainly to adjust the viscosity of the finished coating, and there are also some solvents in the masterbatch and resin parts. All solvents in the coating must be designed according to the curing mode and operation mode of the coating.

Manual color matching is based on the operator's visual view of the reference color palette. Determining the hue of the reference color plate, determine its color composition, repeatedly adjust contrast to determine no color difference, and then determine the saturation and shading difference, repeatedly adjust the contrast to adjust the brightness and saturation, and finally make the blending of the paint color and the reference color plate without visual color difference operation process. Artificial color mixing is characterized by visual, repeated contrast, large color difference and slow speed [8]. Visual fading color requires operators to have color judgment and color mixing knowledge, and the process of repeated comparison requires operators to have patience. Color judgment and knowledge of color blending are essential qualities for the personnel of color blending. Color judgment refers to the determination of the color of the reference color board, to determine its main composition. Monochrome and complex color, the transformation between various colors, the stability of color, color saturation, color shading, etc., these knowledge are essential for color operation personnel.

Computer palette is using computer to digital reference swatches of color, shade, and with it has been deposited in the computer in all kinds of masterbatch standard color comparison, calculation, determine the reference to the determination of color swatches fish, toning homework personnel using computer three formulation coating, reuse chromatic meter to determine chromatic aberration, computer or artificial toning process of fine-tuning. The preliminary work of computer color mixing is very heavy. First of all, the master color should be standardized and data-oriented, and then the data should be established in the special color mixing computer. The accuracy of computer color mixing depends on the standardization of master color and the practicability of data. So at present most of the automotive repair paint color center technical support and masterbatch are from the strength of large companies. Computer color mixing features fast speed, small color difference, small workload, visual and computer combination (Figure 1: auto repair personnel color mixing).

![Figure 1. Auto mechanic's color mixing](image)

3.4. **Selection of paint**  
Car repair paint according to pigment composition is divided into natural paint and metal paint (including pearlescent paint); according to the curing method is divided into low temperature and high temperature curing type, low temperature refers to less than or equal to 80 bureau C, high temperature refers to greater than or equal to 120 C. According to the composition, it can be divided into single component and two component. The two component repair topcoat consists of a coating part and a curing agent. According to the resin chemical composition is divided into nitro repair coating,
polyester repair coating, acrylic repair coating, polyurethane repair coating.

The coating methods of automobile repair coatings include ordinary air spraying and electrostatic air spraying, and the general operation process is as follows:

For the repair part of the smoothness treatment (scraping ash, reinforcement correction, etc.) a rough grinding (over 600) a fine grinding (over 1200) → wipe one (paint in the middle) a spray repair finish a paint edge fog treatment → curing (low or high temperature) → polishing (Figure 2 automotive finish repair paint) [9].

3.5. **Spraying Process**

Restricted by the shape of the operation area, the auto finish repair can not be mechanized as the original paint spraying, completely need to rely on the maintenance technician manual spraying. Therefore, in order to achieve finish repair quality as consistent as possible with the original car, the entire spray implementation process to personnel. Equipment, environment requirements are extremely high.

If the wind speed in the spraying room is too large, the spray gun atomization effect is not good, which can easily lead to the paint surface blotching. If the spray gun moves too fast or the gun distance is too large, the paint surface will appear orange peel. If the spray gun moves too slowly or the gun distance is too close, the paint surface will appear hanging. Therefore, spraying technique is good or bad, directly lead to the quality of paint repair.

4. **Research on the strategy of auto paint repair auto spray system based on computer 3D modeling**

Spraying robot is a kind of special robot mainly used for surface coating, which can meet the needs of environmental protection, efficiency and flexible production, so it is expected to replace manual operation in modern spraying line. The thickness, uniformity, gloss and fullness of coating are important indexes to evaluate the surface quality of coating. Spraying robot is easy to meet the requirements of safety, environmental protection, high efficiency and high-quality spraying, the future of automatic coating development inevitable trend.

4.1. **Control system software design**

In order to meet the needs of production, according to the requirements of different workpiece spraying process, the design of the spraying manipulator control using automatic control working mode, using ladder diagram language programming.

For the control system, the program design should include public program, Robot motion control program, using STL instruction design.

4.2. **3D modeling of key components of spraying system**

In the development of robot off-line control system, the realization of 3D graphic simulation of robot model is an important link. The three-dimension graphic simulation of robot is to establish a virtual robot model and its working environment. To some extent, 3D modeling and simulation, the premise and foundation of automation, can be analyzed and evaluated through model simulation of the
feasibility and reliability of the design scheme. 

The design of main parts of surveying and mapping of the system and records, and using the parameters of technology development company is famous for its parametric design of the product design software Pro/E 3 d modeling, using Pro/E assembly parts for the assembly and the three-dimensional entity model of spraying robot system model has carried on the part of the structure analysis of three-dimensional modeling) (FIG. 3 cars. 

![Figure 3. 3D modeling of automobile](image)

5. **Conclusion**

To sum up, in the auto paint repair model of automatic painting construction, more and more mechanical spraying has replaced the manual operation [10]. Facts show that the spraying efficiency of the robot is high, and the spraying quality is stable and reliable. Therefore, the application of spraying robot should be increased to promote the development of auto spray paint repair.

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