

Design and Development of Automatic Paint Spray Machine

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ABSTRACT:

Painting is an essential step in construction and maintenance, but the traditional manual process is labor-intensive, time-consuming, and often results in uneven coating. To overcome these limitations, this project proposes the design and development of an Automatic Wall Paint Spray Machine. The system employs a spraying mechanism mounted on an adjustable frame that can move vertically and horizontally along the wall surface. The paint flow and nozzle movement are controlled automatically to ensure uniform coverage, reduced paint wastage, and improved surface finish. By minimizing direct human involvement, the machine enhances worker safety and reduces fatigue caused by prolonged manual painting. This technology is especially suitable for residential, commercial, and industrial buildings, providing faster completion of painting tasks with consistent quality. Furthermore, the system can be integrated with sensors to maintain a constant spraying distance from the wall, ensuring high precision and consistent coating thickness. The use of programmable controls allows customization of painting patterns, speed, and paint density based on the surface requirements. This not only improves operational efficiency but also significantly reduces human errors commonly seen in manual painting. With its user-friendly interface and low maintenance needs, the Automatic Wall Paint Spray Machine stands as a modern solution for large-scale painting operations, ultimately lowering project costs and enhancing overall productivity.

1. INTRODUCTION:

brushes or rollers, which is time-consuming, tedious, and produces uneven coating. Extensive areas like high walls or ceilings need extra equipment in the form of ladders or scaffolding, and hence the procedure becomes inconvenient and risky. Speed and finish quality are important in wall painting jobs. Paint work takes longer time, involves skilled workers, and puts physical pressure on labors. As demand for quicker and higher-quality construction is on the rise, automation is the better option. A wall paint spray machine that is automatic can spray the coatings fast and evenly with minimal wastage of paint and man power. One of the biggest issues with painting manually is that it's not consistent—things such as streaks, patches, and uneven thickness tend to ruin the quality of the finish. Also, lots of paint gets wasted in the manual process, and employees are subjected to toxic fumes for hours. Through automation, these issues can be avoided, resulting in greater efficiency, improved safety for employees, less material wastage, and a superior surface finish.

2. RESEARCH MOTIVE:

The primary motive behind this research is to explore and implement an automated solution that overcomes the limitations of manual wall painting while enhancing productivity, safety, and finish quality. With increasing demand for faster construction cycles and improved workmanship, it becomes essential to develop systems that can deliver consistent results with minimal human intervention. This project aims to

investigate the design, control mechanisms, and performance efficiency of an Automatic Wall Paint Spray Machine, offering a cost-effective and technologically advanced alternative to traditional painting methods. The research also seeks to optimize paint usage, reduce labor dependency, and create a scalable system suitable for various building environments.

Moreover, the adoption of an automated wall paint spraying system contributes significantly to modern construction practices, aligning with Industry 4.0 and smart automation trends. By integrating adjustable spray nozzles, controlled flow mechanisms, and programmed movement along the wall surface, the system ensures uniform application even on large or uneven surfaces. This innovation not only enhances operational efficiency but also reduces health risks associated with prolonged exposure to paint fumes and repetitive manual work. As automation continues to transform construction and maintenance processes, the development of such a system represents a step toward improved sustainability, accuracy, and overall project quality.



Fig:1. Automatic Paint Spray Machine

3. EXPERIMENTAL DETAIL:

The experimental phase of the project involved designing, fabricating, and testing the automatic wall paint spray machine to evaluate its performance. The system was mounted on an adjustable frame equipped with vertical and horizontal guide rails to enable controlled movement along the wall. A DC motor or stepper motor was used to drive the motion, while a spray gun connected to a pressurized paint container served as the painting tool. Motor speed and spray flow rate were regulated through a microcontroller-based control unit (Arduino), ensuring uniform paint distribution.

3.1 Design and Fabrication details

The primary motive of this research is to develop an automated wall paint spray system that improves the speed, uniformity, and safety of wall finishing while reducing material waste and operator fatigue. By replacing repetitive manual actions with controlled, repeatable motion and precise paint delivery, the project aims to produce consistent coating thickness and surface quality across varied wall geometries (including high walls and ceilings) with measurable reductions in paint consumption and labor time. Additionally, the research investigates sensor-guided spraying strategies and control algorithms that adapt to surface irregularities and varying paint properties, thereby contributing practical design guidelines and performance data for wider adoption of automation in building finishing trades.

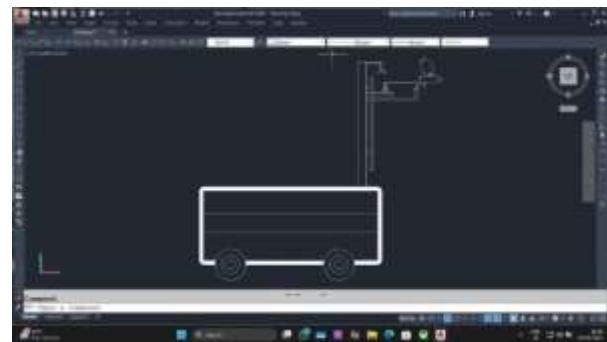
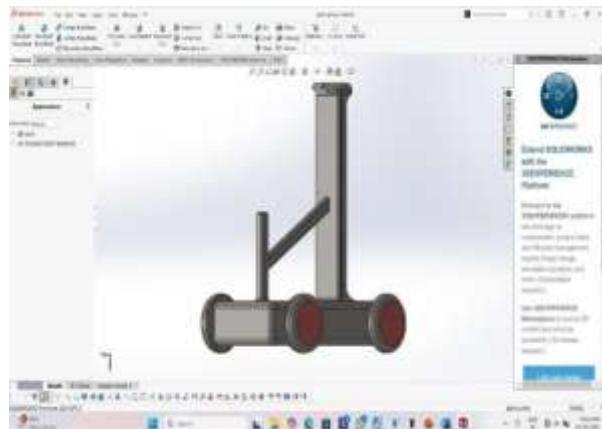


Fig:2. 2D Design of Automatic paint spray machine

Beyond immediate productivity gains, the automated paint spray machine has broader environmental and economic benefits. Optimized paint application lowers volatile organic compound (VOC) emissions and reduces the volume of wasted paint sent to landfill, supporting greener construction practices. Economically, the system can lower project labor costs

and shorten schedules, enabling contractors to handle more jobs or offer premium, faster service. Finally, by reducing manual exposure to fumes and high work positions, the system improves worker health and safety—making it attractive to both large contractors



and smaller renovation teams.

Fig:3.3D Design of Automatic paint spray machine

4. DESIGN CALCULATION

DC Motor Calculation

30RPM

12 VOLT

18 WATT

Torque of the Motor

$$\text{Torque} = (P \times 60) / (2 \times 3.14 \times N) \quad \text{Torque} = (P \times 60) / (2 \times 3.14 \times N)$$

$$\text{Torque} = 5.72 \text{ Nm}$$

$$\text{Torque} = 5.72 \times 10^3 \text{ Nmm}$$

Gear Ratio

$$I = Z_2/Z_1 = 48/12 = 4.0$$

Pitch Diameter

$$d = M.Z_1 = 2\text{mm} \times 12\text{mm} = 24\text{mm}$$

$$= 0.024\text{m}$$

$$D = M.Z_2 = 2\text{mm} \times 48\text{mm} = 96\text{mm}$$

$$= 0.096\text{m}$$

Center distance

$$a = (d+D)/2 = (24+96)/2 = 60\text{mm}$$

$$= 0.060 \text{ m}$$

5. PRINCIPLE:

The Automatic Paint Spray Machine operates on the principle of atomization and controlled automated motion. Atomization is the process of breaking liquid paint into fine droplets using air pressure or a high-speed motor-driven pump. When paint passes through the spray nozzle at controlled pressure, it forms a uniform mist that deposits evenly onto the wall surface.

The machine uses a motorized mechanism to regulate both the paint flow rate and the movement of the spray nozzle. A 12V DC motor or stepper motor drives the horizontal and vertical motion of the spray head along a guided frame. By automating both the nozzle path and the spraying speed, the machine maintains a constant distance from the wall and ensures uniform coating thickness. Sensors or preset controls help maintain consistent pressure, spray angle, and coverage area.

The combined action of atomization, controlled paint delivery, and automated nozzle positioning eliminates manual errors and improves surface finish. Thus, the machine ensures high precision, reduced paint wastage, faster operation, and improved safety by minimizing human exposure to chemicals and physical strain.

6. CONTROL SYSTEM:

The control system of the automatic paint spray machine is designed to regulate the spraying process based on distance sensing and automated switching. The Arduino Uno serves as the central controller that receives input from sensors and activates the spraying mechanism through electrical control components.



Fig:4. Control System

The system uses an Arduino Uno-based control unit that manages the movement and spraying operations. An ultrasonic sensor continuously measures the distance between the nozzle and the wall to maintain an optimal spraying gap, ensuring even paint distribution. The Arduino processes this sensor data and activates a relay module, which controls the paint pump and spray motor to start or stop the flow as needed. Through this coordinated sensing and actuation, the machine achieves consistent coating quality, reduced wastage, and minimal human involvement.

7. CONCLUSION:

The automatic paint spray machine represents a major advancement in the field of surface finishing and coating technology. In earlier times, painting was carried out manually using brushes and rollers, which required considerable time, labor, and skill to achieve an acceptable finish. However, such methods often resulted in uneven coating, visible brush marks, and significant paint wastage. With the introduction of automation and spray technology, the painting process has become faster, more efficient, and highly precise. The automatic paint spray machine eliminates the limitations of manual methods by ensuring uniform application of paint through controlled air pressure and atomization.

This system operates on the principle of converting paint into fine particles or mist using compressed air or hydraulic pressure, which are then evenly sprayed onto the surface. The machine consists of essential components such as a compressor, spray gun, paint tank, air regulator, and control unit, all of which work in synchronization to deliver an efficient coating process. The uniform distribution of paint not only enhances surface appearance but also improves adhesion and durability. Moreover, it can easily reach complex shapes and corners that are difficult to paint manually.

In industrial applications, especially in the automobile and manufacturing sectors, the automatic paint spray machine has become indispensable. It ensures a high-quality finish on car bodies, machinery, and equipment while maintaining production speed and consistency. In the furniture and construction industries, it provides smooth coatings on wooden, metal, or concrete surfaces, improving both aesthetic appeal and protection against environmental factors such as

moisture, corrosion, and sunlight. The machine's ability to deliver precise paint thickness contributes to material savings and enhances the overall efficiency of the production process.

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