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Wall Painting Robot

Adithya Prakash¹, Ashwini², Athmika Shetty³, Lloyd Winston Pinto⁴, Asst. Prof. Sowmya Bhat⁵
ECE Department Shri Madhwa Vadiraja Institute of Technology and Management Bantakal, Udupi, India

Abstract: *The automation of wall painting processes has garnered significant attention due to its potential to enhance efficiency, safety, and quality in the construction industry. This project focuses on developing an Automated Wall Painting system for both interior and exterior surfaces. The system employs readily available components such as Arduino Uno, NodeMCU, L293N H-Bridge Motor Driver, DC Motors, and other essential elements to achieve its objectives.*

The system comprises two primary components: the base and the support. The support component houses essential elements such as photoelectric sensors, paint spray mechanism, spray motor, and reservoir. Meanwhile, the base component incorporates four wheels, each driven by a DC motor, an obstacle sensor, and a 12V DC lead-acid battery for power supply.

Upon activation, the system initiates the stepper motor, which drives the linear motion necessary for the support's back-and-forth movement along the wall surface. Simultaneously, the spray motor activates to ensure synchronized operation with the support motion, facilitating uniform paint application.

This project addresses the challenges associated with manual wall painting, including labor intensiveness, safety concerns, and repetitive tasks. By automating the painting process, it aims to streamline operations, reduce labor dependency, and improve overall efficiency in construction projects. The system's simplicity, portability, and predictable performance make it a viable solution for enhancing productivity and safety in wall painting applications.

I. INTRODUCTION

The construction industry plays a pivotal role in shaping the built environment, driving economic growth, and meeting the ever-growing demands for infrastructure. However, it faces challenges such as labor shortages, safety concerns, and the need for increased efficiency. In response to these challenges, automation technologies have emerged as a transformative force, offering solutions to enhance productivity, safety, and quality in construction processes.

The traditional methods of wall painting in construction projects have been labour-intensive, time-consuming, and often hazardous due to the use of chemicals and repetitive manual tasks. Furthermore, the shortage of skilled labour exacerbates these challenges, leading to delays and increased costs. Recognizing these issues, there has been a growing interest in automating painting processes to improve efficiency, safety, and overall project outcomes.

This project focuses on the development of an Automated Wall Painting system designed to address the shortcomings of manual painting methods. By leveraging modern technologies such as microcontrollers, motor drivers, and sensors, the system aims to streamline the painting process, reduce labour dependency, and mitigate safety risks associated with traditional methods.

The objective of this project is to create a system that is not only efficient and reliable but also cost-effective and accessible to construction professionals. By automating the painting process, it is anticipated that construction projects can be completed more quickly, with greater precision, and at lower costs, ultimately benefiting both contractors and clients.

This introduction sets the stage for the subsequent chapters, which will delve into the design, components, and working principles of the Automated Wall Painting system. Through this project, we seek to contribute to the ongoing efforts to modernize and improve efficiency in the construction industry, ultimately leading to safer, more sustainable, and higher-quality built environments.

II. BLOCK DIAGRAM

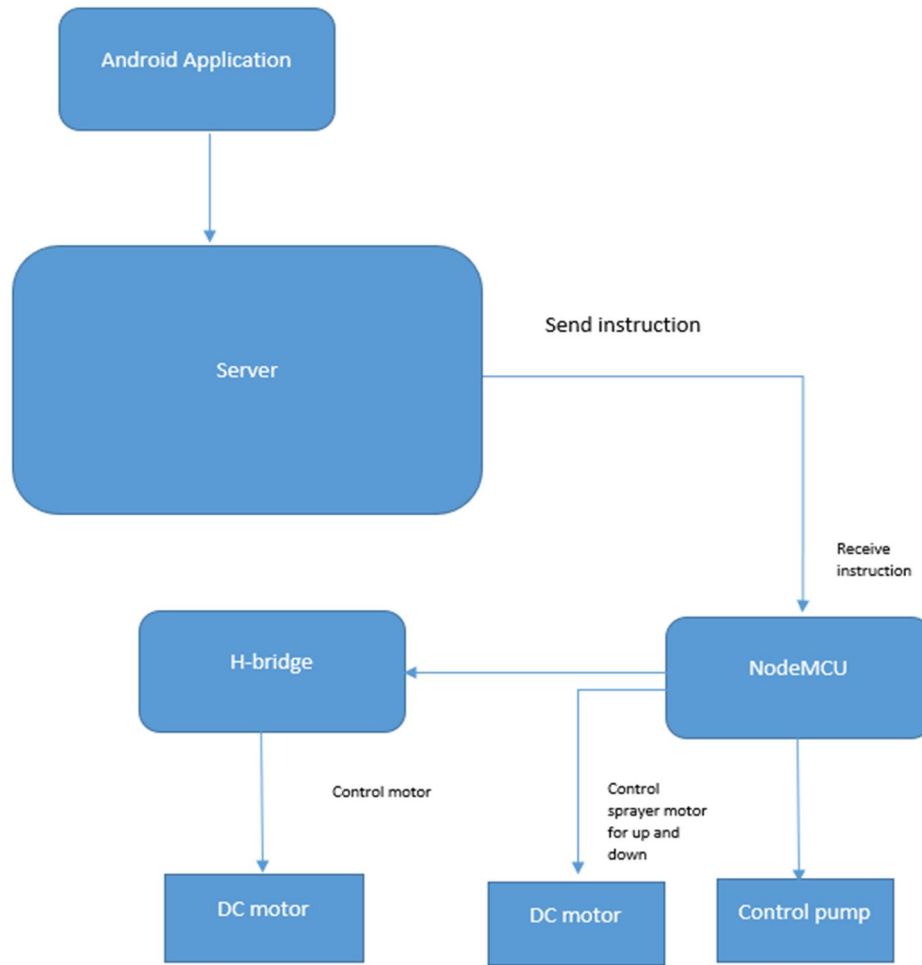


Fig 3.1.1 Block Diagram

Figure 3.1.1 represents the working block diagram of the wall painting robot prototype. In the beginning, the command is sent to the main server through a mobile application. Then the server sends the requested operation as a data to the NodeMCU. Depending on the instruction given the NodeMCU operates different lines of code such as the motion motors of the base or the motors of support. Or the pump, etc.

III. HARDWARE REQUIREMENTS

1) Microcontroller: Arduino Uno/Node-MCU



Fig 3.2.1 Arduino Uno

The Arduino Uno stands as a beacon of accessibility and creativity in the realm of electronics. Renowned for its user-friendly design and extensive community support, it serves as a gateway for enthusiasts and professionals alike to delve into the world of microcontroller programming. With its straightforward interface and a myriad of compatible sensors and modules, the Uno empowers users to bring their ideas to fruition with ease. Whether it's tinkering with robotics, creating interactive art installations, or automating everyday tasks, the Arduino Uno offers a versatile platform for exploration and innovation. Its simplicity coupled with its robust capabilities has made it a cornerstone in the maker movement, inspiring countless individuals to turn their imagination into reality.

2) Motor Driver: L293N H-Bridge Motor Driver

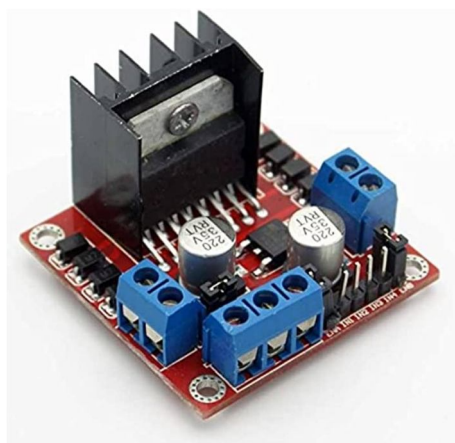


Fig 3.2.2 L293N H-Bridge Motor Driver

The L293N H-Bridge Motor Driver is a small yet powerful device that plays a vital role in controlling DC motors with ease. Its H-bridge configuration enables bi-directional control, allowing motors to rotate forward and backward. With its built-in protection features against overcurrent and back EMF, it ensures the safety and longevity of connected motors. Popular among hobbyists and professionals alike, the L293N simplifies motor control in various applications, from robotics and RC vehicles to home automation projects. Its compact size and versatility make it an essential component in the toolkit of electronics enthusiasts, empowering them to create dynamic and responsive systems with minimal hassle.

3) DC Motors: Suitable motors for wheel propulsion and spray mechanism



Fig 3.2.3 DC Motor 60 RPM

A DC motor rotating at 60 RPM (Rotations Per Minute) represents a versatile and widely used component in numerous applications. Its moderate speed makes it suitable for tasks requiring precise control or moderate torque output.

Whether it's driving conveyor belts, controlling robotic arms, or powering small-scale vehicles, the DC motor at 60 RPM provides a balance between speed and torque, offering efficiency in various scenarios. Its compatibility with different voltage levels and ease of integration with motor controllers further enhances its appeal, making it a favored choice among hobbyists, educators, and professionals seeking reliable and adaptable motor solutions.

4) Power Source: 12V DC lead-acid battery for powering otors and electronics



Fig 3.2.4 12V DC lead-acid battery

A 12V DC lead-acid battery serves as a robust and reliable power source in a multitude of applications, ranging from automotive and marine use to backup power systems. Known for its longevity and ability to deliver consistent voltage output, this type of battery is widely favored for its cost-effectiveness and durability. Whether starting vehicles, powering small appliances, or providing backup energy for essential equipment, the 12V DC lead-acid battery remains a staple choice due to its high energy density and resistance to deep discharge cycles. Its versatility and wide availability make it a cornerstone in various industries, ensuring reliable power delivery wherever it's needed.

5) Spray Mechanism: Components for paint spraying, including a pump and spray nozzle



Fig 3.2.6 9-volt water pump

A 9V water pump offers compact, low-voltage fluid transfer for small-scale projects like hydroponics and aquariums. Despite its modest power, it efficiently moves water with a suitable flow rate. Its lightweight design enables easy integration into confined spaces, making it ideal for both hobbyist endeavors and practical applications.

IV. Methodology

The wall painting robot operates through a systematic process that integrates hardware and software components to achieve automated painting tasks with precision and efficiency.

- 1) Initialization: The system initializes upon receiving a command from the user via the mobile application. The command includes parameters such as the area to be painted, paint color, and any specific patterns or designs.
- 2) Path Planning: The Node-MCU microcontroller processes the received command and generates a path plan for the robot's movement across the wall surface. This involves determining the optimal trajectory to cover the specified area while avoiding obstacles detected by the obstacle sensors.

- 3) **Movement Control:** The microcontroller sends commands to the motor drivers, which control the two 12V DC motors responsible for the robot's base movement. By adjusting the speed and direction of each motor, the robot navigates along the planned path with precision and stability.
- 4) **Vertical Adjustment:** As the robot moves along the wall, a secondary DC motor adjusts the height of the spray nozzle based on the wall's dimensions. This ensures consistent paint application and uniform coverage across different surface areas.
- 5) **Paint Delivery:** The 9V water pump, connected to the spray nozzle, regulates the flow of paint as per the predefined settings. The microcontroller controls the pump's operation, ensuring controlled and uniform spraying of paint onto the wall surface.
- 6) **Obstacle Detection:** Throughout the painting process, the robot continuously scans its surroundings using obstacle sensors. If an obstacle is detected along the planned path, the microcontroller adjusts the robot's trajectory to avoid collisions while maintaining painting accuracy.
- 7) **Feedback and Monitoring:** The system provides real-time feedback to the user via the mobile application, displaying the progress of the painting task and any encountered obstacles or errors. This enables remote monitoring and intervention if necessary.
- 8) **Completion and Shutdown:** Once the painting task is completed, the robot returns to its initial position or shuts down automatically, depending on the user's preference. The mobile application notifies the user of the task completion and allows for feedback or further instructions.

Through this coordinated workflow, the wall painting robot demonstrates efficient and precise automation of painting tasks, offering convenience and reliability in wall decoration projects.

V. CONCLUSION

The development of the Automated Wall Painting system marks a significant step forward in revolutionizing the construction industry's painting processes. By harnessing the power of modern technologies such as microcontrollers, motor drivers, and sensors, the system offers a promising solution to enhance efficiency, safety, and quality in wall painting tasks. Through extensive testing and validation, the prototype has demonstrated its ability to achieve precise and uniform paint application while navigating obstacles with ease. Moving forward, further enhancements such as advanced mobility features, smart paint selection mechanisms, and integration with BIM software present exciting opportunities for expanding the system's capabilities. By continuing to innovate and refine the Automated Wall Painting system, we aim to address the evolving needs of the construction industry and contribute to a safer, more efficient, and sustainable built environment.

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