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Design and Implementation of Autonomous Paint Spraying Machine Using PLC

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ABSTRACT

The main objective of the project is to paint the wall of tall buildings with automated structure using PLC. The construction projects are getting bigger and more complex; however, there is a huge demand for painters. As a result, the amount spent for painting also got accreted. Currently automated robot path planning has always caused a bottleneck for the spray painting processes because typical manual teaching methods are time consuming, error-prone and skill dependent. The project is to avoid the fatal accidents confronted by the painters while painting tall buildings. Here we provide automatic spray painting machine to solve this problem in all kind of buildings. In this project the time spent for painting is reduced and so it is a cost efficient, by avoiding the wastage of paint during painting the openings of the wall. As a result, this project is not only used to protect the lives of the painters but also to reduce the amount of time exploited for painting.

Keywords: Programmable Logic Controller, Screw Mechanism, Autonomous Paint Spray, DC Motor, Frame

I. INTRODUCTION

Building and construction is one of the major and intrinsic field used in industries around the world. In this fast paced world, the construction industry reaching its pinnacle. However, the building industry's labour force is insufficient. This insufficient labour in the construction industry is because of the difficulty in the work and the time consumed by the work. In construction industry, during the work in tall buildings or in the sites where there is more risky situations. Other causes for the labour shortage include people believing that these forms of employment are not as prestigious as other occupations as their education levels have improved. Robotics and automation applications and practises in the construction industry began in the early 1990s with the goal of optimising equipment operations, improving protection, improving workspace awareness, and ensuring a quality atmosphere for building occupants. Following that, the building industry has seen rapid advancements in robotics and automation. The creation of service robots has recently gained popularity as a result of society's need for robots to relieve humans of repetitive and dangerous tasks.

In developing countries, like India and China, the increasing population stimulates the construction-related activities such as interior finishing and painting. Painting is classically done by humans and generally requires exhaustive physical efforts, has no special machines to lift the painters, and involves exposure to dangerous chemicals. Chemicals can seriously harm a human painter's vision, respiratory system, and overall health.Because of these factors, painting is an excellent candidate for automation. Egypt builds over 100,000 apartments each year, with an estimated painting area of 40 million square metres (based on an average 100 m2 apartment area with 400 m2 painting area).Because of the renovation work and the projected population growth in the future, the surface area of painting has increased. This demand faces difficulties that will be difficult to meet with human painters in the next decade. As a result, the creation of a painting machine capable of performing painting tasks with minimal human interference is needed, which will improve painting quality.There is a real and pressing need for an autonomous painting machine. In the automobile industry, automated painting has been used to paint millions of cars on assembly lines with great success. The robotic device is fixed in the assembly line, and spray painting is used in this industry.Domestic painting robots should be distinct in that they should be mobile, allowing them to drive around and paint fixed walls.Also, the domestic painter robots should use sprayer instead of roller which is the common practice in the market to attain customer satisfaction.

II. COMPARATIVE STUDY OF VARIOUS PAINT SPRAYING TECHNOLOGIES

Design and working of autonomous wall painting robot: Mohamed Abdullatif [1].The design and operation of an autonomous wall painting robot are described in this paper. It was represented the conceptual design of a movable painting robot that would be used to paint the interior walls of a residential building. The robot uses a roller to apply liquid paint to the wall and maintains contact with it. The robot allows the roller to scan the painted walls both vertically and horizontally. The robot can change its position in front of the wall with ease.

Protecting paint from rusting. Dhaval Thakur. This paper provides basic details about manufacturing companies in small and medium-sized businesses. Have to paint for protecting from rusting so the spray application consumes maximum time and with the application, paint that needed a professional worker appeared. They cannot manage robotic arrangement for higher efficiency so the rise of the such process have to be made which is affordable, gives better accuracy, consumes minimum time for coating, so the aim is to create a mechanism that uses dipping technology to coat the product. Having semi-automatic arrangement which is suitable for our requirement and which can be valuable for small and medium scale industries.

Design and implementation of sprayer in effective manner.P. Keerthanaaet. Al. They discovered that an efficient concept for automatically painting the wall surface of a given dimension had been developed and implemented. To recognise the appearance of a wall, the method employs an infrared transmitter and receiver. The microcontroller unit that controls the DC motor's movement. The robot is cost-effective, eliminates labour force requirements, and saves time. The drawback of the project is that the robot continues painting later the end of the wall so it can be eliminated by adding some indicating objects such as alarms.

III. MECHANISM

Screw mechanism: Lead screws are used in this project which works on the screw mechanism. Screw, simple machine, arrangement of moving and stationary mechanical parts used to perform some

useful work or to provide transportation. Many of the first devices were the result of human attempts to develop war-making capabilities; the term basically consists of a solid cylinder, typically made of metal, around which an inclined plane, simple machine, consisting of a sloping surface, whose function is to reduce the force necessary to lift a load.

To raise a body vertically a force must be applied that is equal to the weight of the body, i.e. winds spirally, either clockwise or counter-clockwise. It's used to join two objects together, raise a heavy object, or shift an object a certain distance. The thread is the ridge that forms the inclined plane; the ridge may be roughly triangular, square, or rounded in cross section. The pitch is the vertical difference between some point on one thread and a corresponding point on the next thread. A thread may also be inserted into the hollow cylinder's inner surface. Two screws of the same pitch and diameter, one on the outer surface of a solid cylinder and the other on the inner surface of a hollow cylinder. As in the popular nut and bolt, they can be positioned so that one is spirally pushed into the other. The external, or male, screw is found on the bolt's surface, while the internal, or female, screw is found on the nut's inner surface.

Figure 3.1 Diagram of lead screw

This theory is implemented in the popular jackscrew used to lift cars, buildings, and other heavy objects. The internal screw is in the base, the external screw is on a metal cylinder, and a lever or handle is fastened at the top of the cylinder. The external screw rises up the internal screw as the handle is rotated, raising the object on top of the jack. The mechanical advantage of the jackscrew, like every other screw, is based on the ratio of the circumference by which the handle passes and the pitch of the screw. However, since a screw's operation involves a lot of friction, the amount of work, in physics and mechanics, is described as the transfer of energy by a force acting to displace a body. Work is equal to the product of the force and the distance through which it produces movement put into this machine is much greater than the amount done and the efficiency is small. However, when compared to the enormous load raised, the small amount of effort needed to turn the handle makes such a device incredibly valuable. The screw is commonly used to fine-tune tools and devices, such as in the micrometre screw and the gasoline engine's arburettor (for regulating the flow of gasoline).The first few threads of the self-tapping screw have notches that can break female threads in a hollow cylinder. Wood and metal screws, carpenter's and machinist's vises, a boat or aeroplane propeller, Archimedes' screw, and a variety of other devices are examples of screw applications.

IV. DESIGN METHODOLOGY AND IMPLEMENTATION

A. PROGRAMMABLE LOGIC CONTROLLER

A Programmable logic controller (PLC) is a computing device designed for use in industrial control systems and other systems where higher reliability of the system is required. It was initially developed to use instead of hardwired relays, timers, and counters used in the industry automation process, but today it is being used by all types of manufacturing processes including robot.

Nowadays all the factory they have some machine or equipment running on PLCs. Due to its ruggedness and ability to withstand rough environment, many of

the engineers, they started doing control using PLCs. In the real time operating system, it has high ability to produce outputs to specific inputs within a very short span of time. Generally PLCs can be referred as superior to microcontroller. It is essentially made up of a processor module, the power supply, and the I/O modules. The processor module consists of the CPU and memory. In addition to a microprocessor, the CPU contains an interface through which it can be programmed (USB, Ethernet or RS232) along with communication networks. The power supply is usually a separate module, and the I/O modules are separate from the processor. The types of I/O modules include digital (on/off), Analog (varying with time), and special modules like high-speed timers and counters. The Input/ Output devices are connected to the I/O modules. Microcontroller needs an extra hardware to interface sensors, communication modules and actuators, whereas PLCs are designed to interface with sensors, actuators, and communication modules. PLCs usually compatible with Ethernet and several RS- serial series like RS-232, RS-485 for communication. Due to the arrival of the internet of things nowadays, PLC devices are now capable of transmitting/receiving data over wireless communication interfaces. Low technical knowledge is required for programming in PLC. It is comparatively easy to troubleshoot and diagnose faults. Modern PLC devices usually come with a HMI display screen that makes things easier to monitor without additional hardware.

B. PROGRAMMING, IMPLEMENTATION AND WORKING

From the current problem section, it is understood that existing technologies are insufficient to handle and solve the problem in construction field. In order to solve this problem, we propose our autonomous spray painting machine. It mainly consists of two vertical frames and a horizontal frame between it. It contains a holder which has a spray gun. It sprays the paint particles on the wall. The PLC is fed with the ladder logic. The sprayer works with the help of air supplied from the air compressor. When the switch is closed, the motor starts to work and the horizontal starts moving upwards. When it reaches the top of the frame, the holder- containing the spray gun- moves in horizontal direction.When it reaches the end of the frame, the horizontal movement stops and the vertical movement starts. After travelling a limited distance, the vertical movement stops. The process is reiterated till the sprays gun reaches the end of the frame. Relays and motor drives are used for the proper functioning of the system.

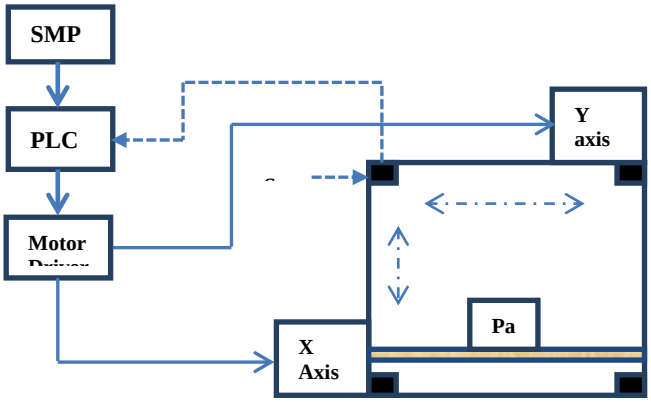

Figure 4.1 Block diagram of the machine

V. RESULT

Dimension of the samplewall= 4×3 feet

The automatic spray painting machine will help in the industries to do spray painting very easily and it will be very useful for the industrial technological up gradation. The frame is moved and kept in front of the walls. The dimension of the frame is 4feet in length and 3 feet in width. When the apparatus is switched on,the holder in between the horizontal rails of the frame, is connected to the two stable vertical rails, moves both in the vertical and horizontal direction. The sprayer sprays the paint on the wall. Air compressor is use to control the spray gun. The motor controls the movement of the rails. All the circuits work in good condition. The PLC

controls all the components of the system. We have tested the quality of the paint, without gaps on the walls. It is fully automated.We come to conclude that, automatic spray painting techniques to be reduces the overall cost of the spray painting system. The IR sensor detected the openings of buildings and stopped to paint at that spot.

VI. CONCLUSION

The work carried out by us is very useful for the workers working in the painting department. This automatic spray painting system reduces the overall cost of the spray painting systems and it will help to perform the specific work with a short period of time. This machine can be used in walls in industries and houses, and in any other buildings. It saves human power and time as well as labour cost. It helps humans to be exposed to less difficult and hazardous conditions.We designed and built a prototype model for testing purposes that is limited to a certain height, but it can be improved and the height limit raised. Also, our model requires an external compressor for the compressed air this can be eliminated by using an in-built compressor.The number of sprayers and their nature of movement can be changed for further more improvements in future

VII. REFERENCES

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