JOURNAL OF INFORMATION, KNOWLEDGE AND RESEARCH IN MECHANICAL ENGINEERING
ISSN 0975 – 668X| NOV 15 TO OCT 16 | VOLUME – 04, ISSUE - 01

THE REVIEW-FABRICATION AND ANALYSIS OF A WALL BASED PAINTING MACHINE USING CAD/CAM SOFTWARE

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ABSTRACT- *Nowadays robots are widely used in many applications such as military, medical application, factories, entertainment, automobile industries etc. However, the application of robot is still not widely implemented in construction industry. In construction industry, robots are designed to increase speed and improve the accuracy of construction field operations. It can also be used to do hazardous and dangerous jobs in construction. For example, currently house painting is done manually. This process can be simplified using a special dedicated robot. It is very difficult and troublesome for human being to work in an upright position, especially for painting, cleaning and screwing in the ceiling for a long time. Painting in an upright position is also very dangerous for the eyes. To overcome this difficulty, a wall painting robot system is proposed, designed and developed. The testing results indicate that the performance of the painter robot is better compared with that of using manual painting technique.*

Keywords: construction robotics, Wall Painting Robot, motor controlling, Painting machine.

I. Introduction

Despite the advances in the robotics and its wide spreading applications, painting is also considered to be the difficult process as it also has to paint the whole building. To make this work easier and safer and also to reduce the number of labours automation in painting was introduced. Above all these the interior wall painting has shared little in research activities. The painting chemicals can cause hazards to the painters such as eye and respiratory system problems. Also the nature of painting procedure that requires repeated work and hand rising makes it boring, time and effort consuming. These factors motivate the development of an automated robotic painting system. This project aims to develop the interior wall painting robot. This automatic wall painting robot is not designed using complicated components. This robotis simple and portable. The robot is designed using few steels, conveyor shaft, spray gun anda controller unit to control the entire operation of the robot. This robot is compact because ofhigh speed and pressure capabilities they have. They also have a very small weight to poweroutput ratio and predictable performance i.e. losses are minimum due to less number ofmoving parts and so gives expected performance. Due to elegant and simple control systemsit can control noise vibration and does silent operation and no vibration is produced. It has longer life, flexibility and it is efficient and dependable, and the installation is simple and the maintenance is also easy. Some of the conditions that have to be considered while using this robot is that the system is operates in pneumatics, so it needs air tank or compressor and the electric shock is always there, which makes the machines ugly and dust and dirt are adhering to them. The life of the parts like seals, packing and gaskets etc., are very short but, they are essential to prevent leakage so that the system becomes costlier. The development of service robots became popular recently due to the fact that the society needs robots
to relax humans from tedious and dangerous jobs. In Egypt, as well as other developing countries, 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 and involves exposure to dangerous chemicals. Chemicals can seriously impair the vision, respiratory system and general health of the human painter. These factors make painting an ideal candidate process for automation.

Mechanical System Design

The construction of the automatic wall painting robot consists of two main parts. They are

A). Mobile platform

1. Frame stand
2. Wheel
3. DC motor
4. Control unit
5. Blower
6.Spray nozzle

Frame Stand and Wheel

The frame stand is the steel screwed in such a way that it can carry the whole equipment. The steels are screwed strongly in workshop. Four wheels are attached to the frame stand in order to move the robot in the direction specified. The movement ofthese wheels is controlled by the DC motor rotation which is controlled by the controller.

Electrical and electronic system

There are main parts in the electrical and electronic system of the painter robot. They are: the power supply module, the sensor module, the electro-pneumatic system, an AC induction motor drive system, and a control panel. A proper distributionof power supply is required to activate the components of the system. The AC and DC voltage are supplied and distributed as depicted. Normally, a 12-volt direct current is required for most of the electrical and electronics components, such the sensors, the pneumatic valve and the limit switches. In this project a commercial switching power supply unit is used to convert the AC voltage from the mains source to a 12-volt DC source.

DC Motor

DC motors are widely used in speed and direction control because control of these motors are easier than other motors. The motion of a DC motor is controlled using a DC drive. DC drive changes the speed and direction of motion of the motor. Some of the DC drives are just a rectifier with a series resistor that converts standard AC supply into DC and gives it to the motor through a switch and a series resistor to change the speed and direction of rotation of the motor.

Control unit

The controller unit is used to control the DC motors and the movement of spray gun fitted on the conveyor belt. Controller unit is provided with the 12V signal and as soon as the supply is ON. The controller sets to setting mode and the moving andpainting distance are given as input to the controller. The controller controls the rotation of DC motor based on the distances given in order to control the wheel and conveyor belt movement.

The sensors are used to determine the following:

1) Does the arm reach the correct position for painting the ceiling?
2) Is there any obstacle at the front, rear or side?
3) Do the actuators move more than the maximum limit?

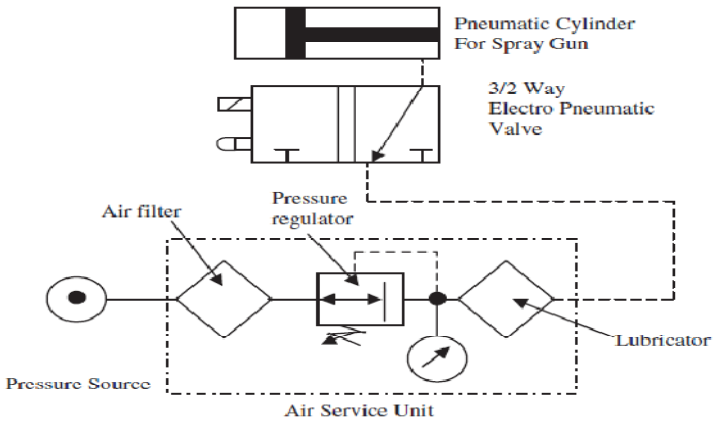


Fig 1: pneumatic system of the robotic system

II. System Requirements

At first, we have to make explicit statement about the assumptions needed for the robot operation and can be summarized as follows:

1) The robot moves on flat terrain and no inclination.
2) The painting wall is vertical, smooth and flat without any obstructions, such as windows or hangers.
3) The painting fluid is supplied by a human user to a tank in the robot.
4) Roller maintenance and cleaning is also left for user.
5) The walls to be painted are instructed by the user through a suitable interface.

The motion requirements of the robot arm is shown inFig.1 which shows the basic need to move the roller vertically for painting and the need for horizontal motion to make direct contact with the wall and to depart from the wall.
Figure 2 shows the motion requirements of the robot base for placement of the whole robot and manoeuvring. The robot needs to move parallel to the wall to make lateral feed motion and to move normal to the wall to start and depart the painting process.

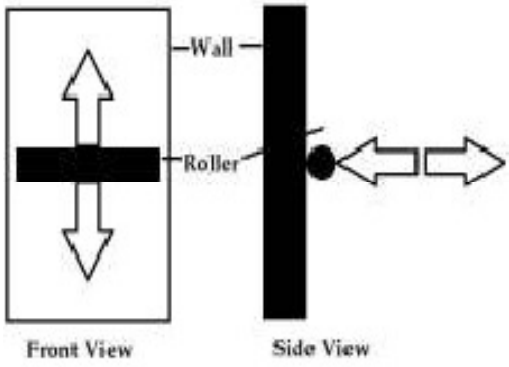


Fig.2. the motion requirements for the painting arm.

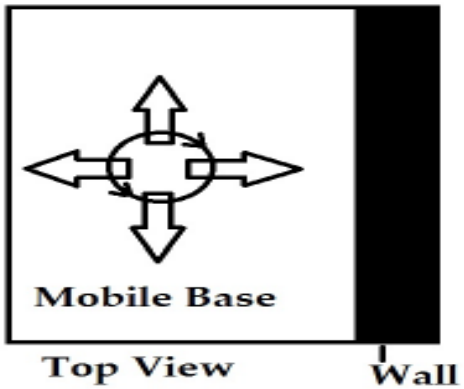


Fig.3Motion requirements for the mobile base.

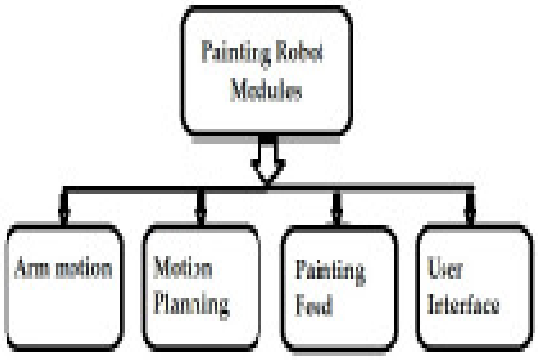
III. CONCEPTUAL SYSTEM DESIGN

The system modules can be described as shown in Fig.3, which consists of an arm motion controlmodule, motion planning module, paint feedmodule and a user interface module. Another painting quality inspection module is intended in the future using vision system.

• Arm
For the arm, and referring to Fig.1, the requiredmotion is 2DOF, vertical motion and motion into thedirection normal to wall surface. There are severalsolutions for such motion such as making a simplemulti-link mechanism for the vertical linear motion.

• Mobile Base
The mobility requires fitting the arm on a mobile base,and referring to Fig.2, it is required to have 3 DOF asindicated that is two planar moving directions and onefor rotation to adjust robot pose relative to the wallplane. Although a simple two wheel differential drive can achieve this motion requirements, it will take long time for the robot to make the lateral feed motion after each vertical roller stroke. Therefore it is better to use the three wheel or four wheel arrangement.

Although three wheel arrangement seems a good choice, in the sense of easier control, but due to the expected high loading on the wheels whether due toweight or dynamic forces of painting, the wheel slippage will be problematic.



• The Painting Feed Module

A standard commercial module is used that make automatic painting fluid feed to the roller. The responsibility of ensuring enough amount of painting fluid and controlling its colour is left for the human user at this stage, though it can be improved in the future to generate some messages for the user when the fluid is below the limits.

Conclusions

The painter robotic system has achieved optimum benefits with regard to reliability, safety appearance, and ease of use. All the objectives set up for this system have been achieved successfully. In terms of mechanical design, the *X*-axis, the *Y* axis, the *Z*-axis module and the end-effectors module were designed and fabricated properly. All motor mountings and couplings were properly adjusted. All the prismatic joints were developed successfully. In terms of electrical and electronic systems, the power distribution module, the sensor module, the electro-pneumatic system, the AC induction motor driving system and the control panel were developed successfully. In terms of software development, the author had written a control program for the painter robot.

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