Automatic Wall Painting Robot

Ganesh Nangare[1], Shubham Jadhav[2], Gaurav Shinde[3], Jatin Suryawanshi[4], Ketan Waykar[5]

[1]Assistant Professor, Department of Mechanical Engineering, JCOE Kuran, Maharashtra, India.

[2,3,4,5]U.G. Student, Department of Mechanical Engineering, JCOE Kuran, Maharashtra, India.

Savitribai Phule Pune University

Abstract **-** The main aim of this paper is to design, expand and realize Automatic Wall Painting Robot which applications Inside wall painting has shared little in research activities. The painting chemicals are found very many harmful to human painters which were causes the problem to eyes and respiratory system of human being. Also the nature of painting process that requires habitual work and hand rising makes it dull, time and effort irresistible. When construction workers and robots are correctly included in building tasks, the whole construction process can be improved run and reserves in human labor and timing are obtained as a outcome. In addition, it would offer the chance to reduce or remove human exposure to difficult and hazardous environments, which would solve most of the trouble, connected the protection and it occurs they action many more time. The wall painting robot motivates the development of autonomous robotic painting system.

Keyword: Robot, Hazards environment, Design and Analysis. Etc.

I. Introduction

Thermal Robots are manmade machines which do the required task as directed, i.e. the instructions given by human being. In many industries like automobile, the total motor assembly is done with the help of robots. The robots are typical fixtures operated with PLC's or dedicated control systems. Also material handling inside an industry is done with robots. In foreign countries robots are used are waiter in hotels, peons in banks, delivery boy, etc. In our day to day life also, glass cleaning or spray painting applications are done with robotics. In similar fashion, we are going to implement a robot in academic environment. The application of wall Painting with the help of robot is shown here. Mechanical fixture is provided. It has the ability to move in horizontal and vertical direction. At the top most surface, Sprayer mechanism is provided. It is operated on DC supply.

When started, the base motor starts and the dc motor moves in horizontal direction. If DC motor is started the lead screw starts rotating, the hex nut on the lead screw moves in upward direction if motor rotates in clock wise direction. The supporting fixture is fabricated with the hex nut. If sufficient height is reached, the dc motor stops & the spray mechanism motor starts. It sprays paint on the wall in wiping fashion. By controlling the horizontal and vertical travel the painting activity can be completed.

A. Objective

The actual targets for development of the wall painting robot, in order to solve the aforementioned situation, were set as follows:

1) To improve safety by eliminating works on scaffolds.
2) To make machine structure simple to enable easy mounting.
3) To be usable not only on internal and external walls of structures but also in various other places such as on walls of civil structures.

The aims and objectives of the project are to design a system for painting of wall which is:

1) Autonomous
2) Efficient
3) User-friendly
4) Transportable
5) Cost-effective
6) Reduce strenuous and repetitive task
7) Increase safety

B. Problem Statement

Paint application on the external surfaces is easy and can be done without much difficulty, despite the large diameter or long length of pipe. But painting the inner-walls of the pipe becomes increasingly difficult with the increasing length of the pipe. The length of the pipe does-not permit the application of paint as these inner walls become in-accessible. Hence there is need of a special device that will coat the entire inner-wall of the pipe irrespective of the diameter of pipe or length of pipe.

C. Future Scope

Machines have been designed to support human beings by helping them to do tedious, dangerous and back breaking works. However, the industry has made only limited use of high technology production concepts. There is general need to nurture the development of successful research and development programs in Automation and Robotics. Machines have been employed in various tasks, including materials handling, various interior and exterior finishing tasks and quality control. The high expectations of stemmed from the very serious problems the industry is facing:

1) Continuously declining productivity
2) A high accident rate
3) Low quality
4) Insufficient control of the construction site
5) Vanishing of a skilled workforce

II. Design Procedure

Design consists of application of scientific principles, technical information and imagination for development of new

or improvised machine or mechanism to perform a specific function with maximum economy &efficiency.
Hence a careful design approach has to be adopted. The total design work has been split up into two parts.

A. System Design.

In system design we mainly concentrated on the following parameters:

1) System Selection Based on Physical Constraints
2) Arrangement of Various Components
3) Components of System
4) Man Machine Interaction
5) Chances of Failure
6) Servicing Facility
7) Scope of Future Improvement
8) Height of Machine from Ground
9) Weight of Machine

B. Mechanical Design.

Mechanical design phase is very important from the view of designer .as whole success of the project depends on the correct deign analysis of the problem.
Many preliminary alternatives are eliminated during this phase. Designer should have adequate knowledge above physical properties of material, loads stresses, deformation, and failure. Theories and wear analysis, He should identify the external and internal forces acting on the machine parts
These forces may be classified as

1) Dead weight forces
2) Friction forces
3) Inertia forces
4) Centrifugal forces
5) Forces generated during power transmission etc

In, mechanical design the components are listed down & stored on the basis of their procurement in two categories

1) Design parts
2) Parts to be purchased

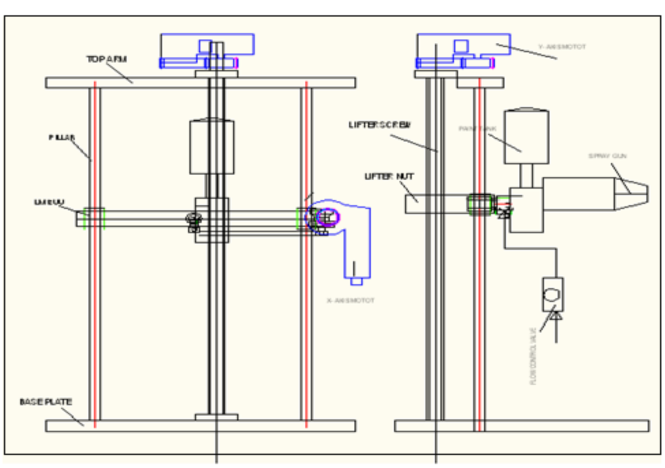

Fig. 1 Block Diagram of automated wall painting robot

III. WORKING PRINCIPLE

The machine consists of a painting arm with an end effecter spray gun that covers the walls vertically with translator motion and a mobile platform to give horizontal feed to paint the whole area of the wall. The painting arm has a planar two link mechanism with two joints. Joints are driven from a gear motor through a screw-nut mechanism and slider crank mechanism as well. Certain distance is maintained from the facing wall and to avoid collision with side walls. When settled on adjusted distance from the wall, the painting process can be started autonomously. Simplicity, relatively low weight and short painting time were considered in our design. Different modules constituting the mechanism have been separately tested then integrated. Experiments have shown successfulness of the machine in its intended tasks.
DP/DT switch has a central OFF position, when operated to one of the ON position, the motor will rotate in clockwise direction, operating the worm gear box and thereby the pinion shaft. The pinion rotates to rotate the gear and thereby the main shaft and stand in clockwise direction taking the stand to close position.
When other ON position is operated the motor will rotate in counter clockwise direction, operating the worm gear box and thereby the pinion shaft. The pinion rotates to rotate the gear and thereby the main shaft and stand in counter clockwise direction taking the stand to open position.

IV. DESIGN AND MATERIAL SELECTION

A. Using ASME Code for Design of Shaft

Since the loads on most shafts in connected machinery are not constant, it is necessary to make proper allowance for the harmful effects of load fluctuations

According to ASME code permissible values of shear stress may be calculated from various relations.

$\tau_{max} = 0.18\ S_{ut} = 0.18 \times 800 = 144\ N/mm^2$

Shaft is provided with key way; this will reduce its strength. Hence reducing above value of allowable stress by 25%

$$\tau_{max} = 0.18\ Sut \times 0.75 = 108\ N/mm^2$$

This is the allowable valve of shear stress that can be induced in the shaft material for safe operation.

Assuming 100 % efficiency of transmission

$\text{Power} = \frac{2\pi\ NT}{60}$ $\quad T = \frac{60 \times 20}{2 \times \pi \times 24} = 10.23$ N-m

$T_{design} = 8$ N-m

B. Check For Torsional Shear Failure of Shaft

Assuming minimum section diameter on input shaft = 19 mm

d = 19 mm

$$T_d = \frac{\pi}{16} \times \tau_{act} \times d^3 \quad \tau_{act} = \frac{16 T_d}{\pi d^3}$$

$$= \frac{16x\ 31.8\ x\ 10^3}{\pi\ x\ 19^3}$$

$$\Rightarrow \tau_{act} = 8.29\ N/mm^2$$

As $\tau_{act} < \tau_{max}$

Pinion shaft is safe under tensional load.

C. Design of Crank Pin

We know that

T = force x radius

8000 = force x 100 Force = 80 N

Assuming pin diameter =10 mm

Table No. 1 Material Selection

Designation	Ultimate Tensile Strength N/mm²	Yield Strength N/mm²
EN 24	800	680

Check for Direct Shear of Crank Pin

$$\text{Shear stress} = \frac{\text{Shear force}}{\text{Shear area}} = \frac{80}{\frac{\pi}{4}\ x\ d^2}$$

$$= \frac{318\ x\ 4}{\pi\ x\ 10^2}$$

Shear stress = 1.0185 $N/mm^2 < 144\ N/mm^2$

Design of crank pin is safe.

D. Design of Slider Pin

We know that

T = force x radius 8000 = force x 100

Force = 80 N Assuming pin diameter =10 mm

Table No. 2 Material Selection

Designation	Ultimate Tensile Strength N/mm²	Yield Strength N/mm²
EN 24	800	680

Check for Direct Shear of Crank Pin

$$\text{Shear stress} = \frac{\text{Shear force}}{\text{Shear area}} = \frac{80}{\frac{\pi}{4}\ x\ d^2}$$

$$= \frac{318\ x\ 4}{\pi\ x\ 10^2}$$

Shear stress = 1.0185 $N/mm^2 < 144\ N/mm^2$

Design of slider pin is safe.

E. Design of Nut

In design of nut the major dimension is the height or length of the nut. It is decided by considering the bearing criterion. Nut is also required to be safe under shearing. The failure of nut in shearing takes place at its core diameter and the area of core diameter of screw resisting shear is less than the area at the core diameter of nut.

Secondly the materials for nut & screw are different to avoid greater friction at contacts.

Table No 3 Material Selection

Material	Allowable tensile stress N/mm²	Allowable shear stress N/mm²
Phosphor bronze	400	210

Design the Nut

$$Pb = \frac{W}{\left(\frac{\pi}{4}\right)(d^2 - d^2)n} \qquad n = \frac{3770}{\left(\frac{\pi}{4}\right)(21^2 - 17^2)\ 11} = 5$$

As; n = no of the threads in contact.

L_n = length of nut. P = Pitch

$$n = \frac{L_n}{p} \qquad L_n = n\ x\ p \qquad L_n = 30$$

Normally it is recommended that ratio of length or height of nut (n)to core diameter (dc) should be in between 1.2 to 2.5 for solid nuts.

L_n = 1.2 x 30 = 36 mm

Considering length of nut = 36 mm

VI. METHODOLOGY

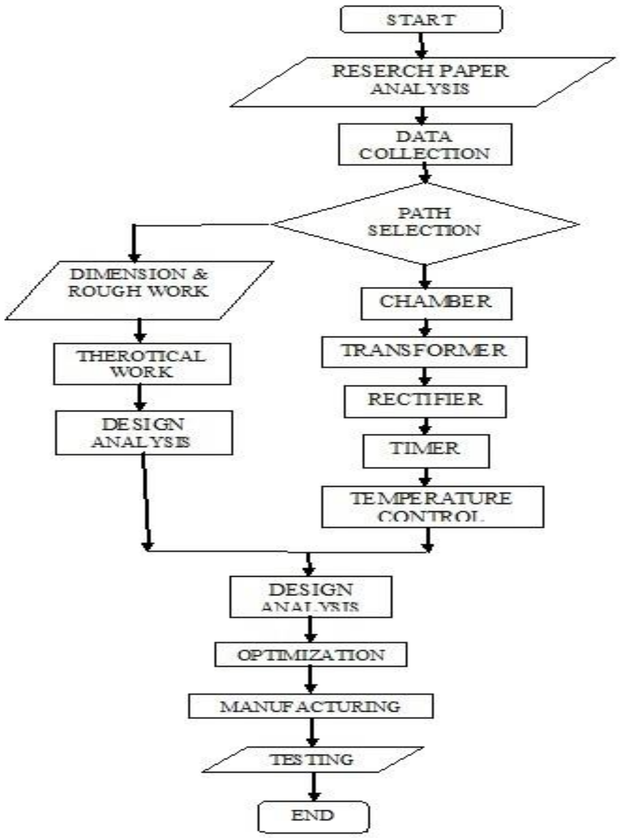

Fig. 2 Flowchart of Methodology

ACKNOWLEDGMENT

We take this opportunity to thank all those who have contributed in successful completion of this dissertation. We would like to express our sincere thanks to our guide Prof. G.R. Nangare who has encouraged us to work on this topic and valuable guidance wherever required. We wish to express our thanks to, Dr. D.J. Garkal Principal, JCOE, Kuran, Prof. G.N.Kadam H.O.D. Mechanical Engineering Department JCOE, Kuran and Project Co-coordinator Prof. G.R.Nangare for their support and help extended. Finally, we are thankful to all those who extended their help directly or indirectly in preparation of this paper.

REFERENCES

[1] Mohamed T. Sorour, Mohamed A. Abdellatif, Ahmed A. Ramadan, and Ahmed A. Abo-Ismail,"Development of Roller-Based Interior Wall" International Journal of Painting Robot, World Academy of Science, Engineering and Technology Volume - 59, PP 10-15, 2011,

[2] S. M. S. .Elattar, "Automation and robotics in construction: Opportunities and challenges" International Journal of engineering research, Volume -13 (2), PP 5-10, 2008.

[3] Naticchia, A. Giretti, A. Carbonari, International Journal of "Robotized System For Interior Wall Painting, Proceedings Of The 23rd ISARC" October 3-5,Tokyo, Japan, 2006. Volume - 5. PP 3-8

[4] Johan Forsberg Roger AarenstrupAke Wernersson, "A Construction Robot for Autonomous Plastering of Walls and Ceilings," Volume 6, PP 20-23 2000.

[5] International Journal of Innovative Research in Science, Engineering and Technology Vol. 2, PP 1-15, July 2013.