Fabrication of Automatic Wall Painting Machine

B. Sai Krishna
Final Year Student
Mechanical Engineering
B.I.T.M College, Ballari.

Chandrashekar. M
Final Year Student
Mechanical Engineering
B.I.T.M College, Ballari.

B.V Sandeep Kumar
Final Year Student
Mechanical Engineering
B.I.T.M College, Ballari.

Vinay Kumar. P
Final Year Student
Mechanical Engineering
B.I.T.M College, Ballari.

Abstract — **The primary aim of the project is to design, develop and implement Automatic Wall Painting Robot which helps to achieve low cost painting equipment. Despite the advances in robotics and its wide spreading applications, interior wall painting has shared little in research activities. The painting chemicals can cause hazards to the human 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. When construction workers and robots are properly integrated in building tasks, the whole construction process can be better managed and savings in human labor and timing are obtained as a consequence. In addition, it would offer the opportunity to reduce or eliminate human exposure to difficult and hazardous environments, which would solve most of the problems connected with safety when many activities occur at the same time. These factors motivate the development of an automated robotic painting system.**

Keywords- Wall Painting Machine, Automation, IR Sensor

I. INTRODUCTION

Building and construction is one of the major industries around the world. In this fast-moving life construction industry is also growing rapidly. But the labors in the construction industry are not sufficient. This insufficient labor in the construction industry is because of the difficulty in the work. In construction industry, during the work in tall buildings or in the sites where there is riskier situation like interior area in the city. There are some other reasons for the insufficient labor which may be because of the improvement the education level which cause the people to think that these types of work are not as prestigious as the other jobs. 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 labors automation in painting was introduced. The automation for painting the exterior wall in buildings has been proposed. 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 robot is simple and portable. The robot is designed using few steels, conveyor shaft, spray gun and a controller unit to control the entire operation of the robot. This robot is compact because of high speed and pressure capabilities they have. They also have a very small weight to power output ratio and predictable performance i.e., losses are minimum due to a smaller number of moving parts and so gives expected performance. Due to elegant and simple control systems it 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.

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

1. Mobile platform
   - Frame stand
   - Wheel
   - DC motor
   - Battery
   - Control unit
2. Spray gun mount
   - IR sensor
   - Solenoid valve
   - Sprocket
   - Flow control valve
   - Spray gun

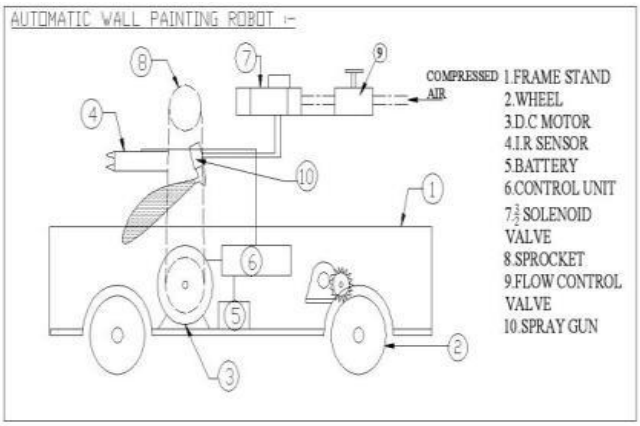

Fig.1: Block diagram of Automatic Wall Painting Machine

II. LITERATURE REVIEW

Mohamed Abdullatif [1] In this paper author describe the design and working of an autonomous wall painting robot. The conceptual design of a movable painting robot to be used for painting interior walls of residential building had been described. The robot uses roller fed with liquid paint and keeps contact with the wall surface. The robot enables the roller to scan vertically as well as horizontally to the painted walls. The robot can manoeuvre to adjust itself in front of the wall.

Dhaval Thakur et. al. [2] This paper gives basic information about small and medium scale industries manufacturing components have to paint for protecting from rusting so the spray application consumes maximum time and paint which required the skilled worker emerged with the application. 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 objective has to developed such mechanism which coat the object with the dipping technique having semi-automatic arrangement which is suitable for our requirement and which can be valuable for small and medium scale industries.

P. Keerthanaa et. al. [3] They studied that automatically paint the wall surface of given dimension has been designed and implemented in effective manner. The approach uses Infrared transmitter and Infrared receiver to identify the appearance of wall. The microcontroller unit to regulate the movement of the DC motor. The robot is cost effective, reduces work force for labours, and reduces time consumption. 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.

Berardo Naticchia et. al. [4] In this paper, they shown that automated painting can be not only aimed at correcting productivity, but also quality checking. A robot arm with high precision is required. An automated system to convert the normalized coordinates of the liquid colours to be reproduced into the movement speed of the robot end tool and valve opening end of the mixing board. Most of the work will be probably necessary to achieve high resolution. Because of the shape of full-scale robots, probably also the resolution of the human scale robot will be lower. Another particularity of the small-scale arrangement is of course the ability to access some hard places of buildings under construction, where human range robots could not be allowed.

Takuya Gokyu et. al. [5] They have shared that construction of Wall-Surface Operation Robot plan to automate and increase the efficiency a series of restoration works by adding, changing of an attachment, new task for cleaning. Tile separation sensing and repair work to the initial functions of picture painting in a single and multiple colour is also done. The analysis of this example was introduced as a periodic inspection of the 10th year for the office building concerned. And, high profitability is expected because of presence of many similar structures.

Pal Johan et. al. [6] In this paper, they present a technique for increasing the speed at which a standard industrial manipulator can paint a wall surface. The approach is based on the perception that a small error in the direction of the end effectors does not influence the quality of the paint job. It is far more important to maintain constant velocity throughout the orbit. In doing this, they cast the problem of finding the optimal orientation at each time step into a convex minimized problem that can be solved efficiently and in real time. They show that aim to allow the end effectors to keep higher constant velocity throughout the orbit guaranteeing constant paint coating and substantially decreasing the time needed to paint the wall.

III. COMPONENTS USED

A. Frame Stand and Wheel

The frame stand is the steel welded in such a way that it can carry the whole equipment. The steels are welded strongly in welding laboratory with an idea to carry the entire robot with the control unit, battery and DC motor in the mobile platform and the IR sensor, solenoid valve and spray gun in the roller shaft. Four wheels are attached to the frame stand in order to move the robot in the direction specified. The movement of these wheels is controlled by the DC motor rotation which is controlled by the microcontroller. Since, it is obvious that if either the movement of front or back wheels is controlled automatically the movement of the other one will be controlled. Therefore, in this robot the movement of the back wheels is controlled using the DC motor such that the movement of entire robot is controlled.

B. DC Motor

DC motors are part of the electric motors using DC power as energy source. The basic principle of DC motors is same as electric motors in general, the magnetic interaction between the rotor and the stator that will generate spin. DC motors are widely used in speed and direction control because control of these motors is 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. But many of the DC drives have an inbuilt microcontroller that provides programmable facilities, message display on LCD, precise control and also protection for motors.

C. Battery

In order to provide supply to the controller unit battery is used. Lead acid battery is used in this project. The lead-acid battery is a rechargeable battery. Despite having a very low energy-to-weight ratio and a low energy-to-volume ratio, their ability to supply high surge currents means that the cells maintain a relatively large power-to-weight ratio. These features, along with their low cost, make them attractive for use in motor vehicles to provide the high current required by automobile starter motors.

D. Control Unit

The microcontroller used in the controller unit is AT89c52. The microcontroller unit is used to control the DC motors and the movement of spray gun fitted on the conveyor belt. Microcontroller unit is provided with the 5V signal and as soon as the supply is ON, LCD gets initialized. The controller sets to setting mode and the moving and painting distance are given as input to the microcontroller. The microcontroller controls the rotation of DC motor based on the distances given in order to control the wheel and conveyor belt movement. When IR receiver receives the signal, the conveyor belt moves and the spray gun goes to ON condition and if the conveyor belt stops, the spray gun goes to OFF condition. It contains relays for the control of forward and backward movement of the DC motors.

E. Power Supply Unit

The DC level obtained from a sinusoidal input can be improved 100% using a process called full-wave rectification. It used 2 diodes in this configuration. From the basic configuration we see that one diode is conducting while the other one diode is in “off” state during the period t = 0 to T/2 Accordingly for the negative of the input the conducting diodes. Thus, the polarity across the load is the same. The filter circuit used here is the capacitor filter circuit where a capacitor is connected at the rectifier output, and a DC is obtained across it. The filtered waveform is essentially a DC voltage with negligible ripples, which is ultimately fed to the load.

F. Liquid Crystal Display

A liquid crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals (LCs). LCs do not emit light directly. They are used in a wide range of applications, including computer monitors, television, instrument panels, aircraft cockpit displays, signage, etc. They are common in consumer devices such as video players, gaming devices, clocks, watches, calculators, and telephones. LCDs have replaced cathode ray tube (CRT) displays in most applications. They are available in a wider range of screen sizes than CRT and plasma displays, and since they do not use phosphors, they cannot suffer image burn-in. LCDs are, however, susceptible to persistence. A 16x2 LCD is connected to the microcontroller. The Fig.5 shows the LCD connection with microcontroller.

G. Relays

Relays are used throughout the automobile. Relays which come in assorted sizes, ratings, and applications, are used as remote-control switches. A typical vehicle can have 20 relays or more. The Fig.5 shows the connection of relay with the microcontroller.

H. Bearings

A bearing is a machine element that constrains relative motion between moving parts to only the desired motion. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts.

I. Gear Wheel Mechanism

The spur gears, which are designed to transmit motion and power between parallel shafts, are the most economical gears in the power transmission industry. The spur gear arrangement is used to move the conveyor in forward and direction

J. IR Sensor

IR sensor is used for this project. IR (Infrared) is the typical light source being used in the sensor for robot to detect opaque object. In this project, no programming, microcontroller and soldering are required. IR Sensor (IR Receiver and IR Emitter) the basic principle of IR sensor is based on an IR emitter and an IR receiver. IR emitter will emit infrared continuously when power is supplied to it. On the other hand, the IR receiver will be connected and perform the task of a voltage divider. IR receiver can be imagined as a transistor with its base current determined by the intensity of IR light received.

K. Single Acting 3/2 Solenoid Valve

A solenoid is an electrical device that converts electrical energy into straight line motion and force. These are also used to operate a mechanical operation which in turn operates the valve mechanism. Solenoids may be push type or pull type. The push type solenoid is one in which the plunger is pushed when the solenoid is energized electrically. The pull type solenoid is one in which the plunger is pulled when the solenoid is energized. The Solenoid control valve is used to control the flow direction is called cut off valve or solenoid valve. This solenoid cut off valve is controlled by the

electronic control unit. This solenoid valve is used to painting operation into the materials.

IV. EXPERIMENTAL SETUP

A. Experimental Setup

Fig. 2: Experimental Setup

The construction of Paint Spraying equipment consists of a frame which is used for mounting the components such as D.C motor, Battery, electronic timer unit, solenoid valves, flow control valve and spur gear arrangement. The stand (or) base is to carry the whole machine. The whole experimental setup is shown in Fig.2. The two-conveyor roller is fixed to the two ends of the frame stand with the help of end bearing with bearing cap. The conveyor roller shaft is coupled to the D.C. permanent magnet motor with the help of spur gear mechanism. This total arrangement is used to transfer the material from one place to another place with the help of conveyor.

B. IR Sensor Setup

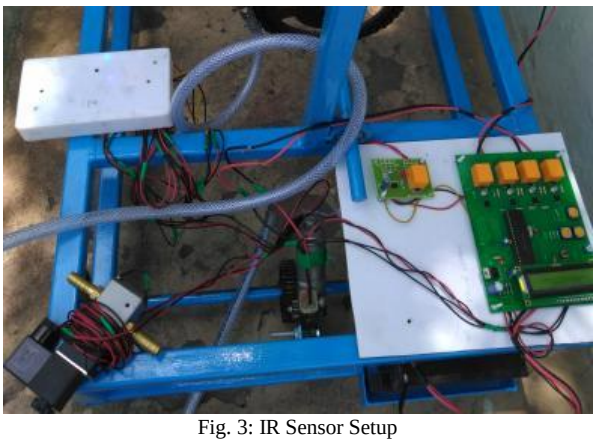

Fig. 3: IR Sensor Setup

The IR transmitter and IR receiver circuit is used to sense the material. It is fixed to the frame stand with a suitable arrangement. The spray gun is fixed to the frame stand to spray painting in the material. The spray gun painting operation is controlled by the flow control valve, single acting solenoid valve and Microcontroller unit. This high pass filter is used to eliminate the high frequency signal due to external unwanted signal. In our circuit simple R-C high pass filter circuit is used. The Zener diode (5.6 Volt) also used to cut off the high voltage signal from the input signal. The sensors are giving the low output signal when there is any object in their conveyor.

C. Spraygun Setup

Fig. 4: Spray Gun Setup

The Fig.4 shows the experimental setup of spray gun in which the silver colored box is the spray gun. The board covered with the plastic box is the IR sensor circuit since it is covered with plastic box in order to avoid unnecessary detection of walls on the sides.

D. Microcontroller Setup

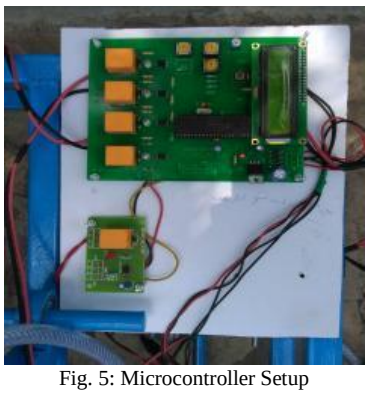

Fig. 5: Microcontroller Setup

The 12V signal from the battery is given to the power supply unit where it gets regulated to 5V. The 5V signal is given to the microcontroller unit. Once the supply is ON, LCD gets initialized. The microcontroller sets to setting mode and the moving and painting distance is given as input to

microcontroller. The microcontroller (by using microcontroller program) "ON" the relay -1 (conveyor Motor Stop-Connected to port-p2.0)) and "ON" relay-2 & 3 (solenoid valve is ON-Painting Operation) for given seconds and once again "OFF" the relay-1 and operation continues. Reset switch is connected to the pin number 32 of the microcontroller unit. When the IR receiver receives the signal, the conveyor belt moves and spray gun goes to ON condition. If the conveyor belt stops then the spray gun will go to OFF condition.

E. Mobile Platform Setup

Fig. 6: Mobile Platform

The Fig.6 shows the experimental setup of mobile platform. The steels welded together to carry the entire robot is considered to be the platform which is fitted with four wheels for the movement of robot such that making it to be mobile platform.

V. CONCLUSION

We have designed and fabricated the prototype model for testing purpose which is limited to a certain height, but it can be developed and the limit can be increased. Also, our model requires an external compressor for the compressed air this can be eliminated by using an in-built compressor.

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