Automatic Paint Spraying Machine Using IR Sensor

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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 labour 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.

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 labours in the construction industry are not sufficient. This insufficient labours inthe 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 more risky situation like interior area in the city. There are some other reasonsfor the insufficient labor which may be because of the improvement the education level which cause the people to thinkthat these types of work is not as prestigious as the other jobs.The construction industry is labor-intensive and conducted in dangerous situations; therefore the importanceofconstructionrobotics has been realized and is grown rapidly. Applications and activities of robotics and automation inthis construction industry started in the early 90"s aiming to optimize equipment operations, improve safety, enhanceperception of workspace and furthermore, ensure quality environment for building occupant. After this, the advances inthe robotics and automation in the construction industry has grown rapidly.

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 labor automation in painting was introduced. The automation for painting the exterior wall in buildings hasbeen proposed. Above all these the interior wall painting has shared little in research activities. The painting chemicalscan cause hazards to the painters such as eye and respiratory system problems. Also the nature of painting procedurethat requires repeated work and hand rising makes it boring, time and effort consuming. These factors motivate thedevelopment 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 andportable. 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 havea very small weight to power output ratio and predictable performance ie., losses are minimum due to less number ofmoving parts and so gives expected performance.Due to elegant and simple control systems it can control noisevibration and does silent operation and no vibration is produced. It has longer life, flexibility and it is efficient anddependable, and the installation is simple and the maintenance is also easy. Some of the conditions that have to beconsidered while using this robot is that the system is operates in pneumatics, so it needs air tank or compressor and theelectric shock is always there, which makes the machines ugly and dust and dirt are adhering to them. The life of theparts like seals, packing and gaskets etc., are very short but, they are essential to prevent leakage so that the systembecomes costlier.

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

II. THE MOBILE PLATFORM DESIGN

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 are controlled by the DC motor rotation which is controlled by the microcontroller. Since it is obvious thatif either the movement of front or back wheels are controlled automatically the movement of the other one will be controlled. Therefore, in this robot the movement of the back wheels are 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. These devices transform electrical energy into

mechanical energy. 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 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. 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.

Controlling of DC motor using Microcontroller

1. Microcontroller provides us only digital logic (1 or 0)
2. The polarity can't be provided from microcontroller
3. The motors can't be connected to Controller as mostly motors runs on voltage higher that +5V, and Motors demands high current (depends), this can be remove by use of a "H Bridge "here four transistors are used to change polarity.

1) Specification of DC motor: The specification the DC motor used in this project is mentioned as follows:

- Voltage -12V
- No load speed -810 rpm
- Load speed -120rpm
- No load current -75mA
- Load current -1400mA
- Power -17W

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. IC AT89C52 is a low-power, high performance, 8-bit microcontroller with 8kB of Flash programmable and erasable read-only memory (EPEROM) ,256 bytes of RAM,32 input/output (I/O)lines, three 16-bit timers/counters, a six-vector two-level interrupt architecture, a full-duplex serial port, on-chip oscillator and clock circuitry. AT89C52 is designed with static logic for operation down to zero frequency and

supports two software selectable power-saving modes. The idle mode stops the CPU while allowing the RAM, timers/counters, serial port and interrupt system to continue functioning. The power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next hardware reset is activated. When the microcontroller receives the signals from IR sensor, it will be taking a decision to operate the machine.

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.

G. 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.

H. 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.

1) IR Sensor Features:

- Input voltage: 5VDC
- Sensing Range: 15cm
- Output signal: analog voltage
- Emitting element: Infrared LED

2) IR Transmitter and Receiver:

IC 555 timer and BD140 are used to produce the IR wave forms. The 555 Timer is connected in Astable mode. The output of 555 timer is given to the transistor so that transistor switched on/off simultaneously according to the pulse from the 555 timer. IR LED is connected to the transistor T1 (BD140).The IR transmitter circuit is to transmit the Infra-Red rays. This Infra-Red rays are received by the receiver circuit is called "IRreceiver".

3) 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.

III. 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 1.
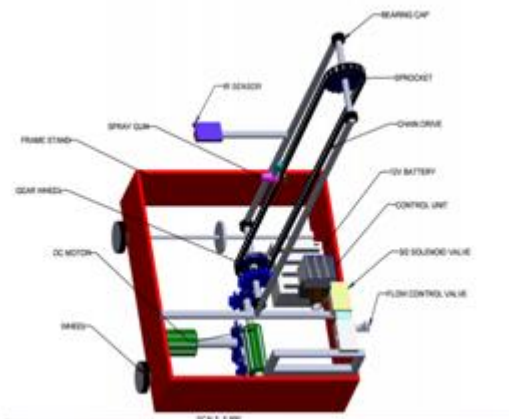

Fig 1

CONCLUSION

Automatically paint the wall of given dimension has been designed and implemented. The approach uses IR transmitter and IR receiver to detect the presence of wall. The microcontroller unit to control the movement of the DC motor. The robot eliminates the hazards caused due to the painting chemicals to the human painters such as eye and respiratory system problems and also the nature of painting procedure that requires repeated work and hand rising makes it boring, time and effort consuming. The robot is cost effective, reduces work force for human workers, reduces time consumption. In the future the painting robot can be enhanced by using image processing in order to scan the objects and obstacles that are present in the wall so that those objects can be automatically omitted while painting.

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