IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 9, Issue 5, May 2021

DOI 10.17148/IJIREEICE.2021.9530

Automatic Wall Painting Robot using LabVIEW

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Abstract: The most common view of any construction site today is a set of scaffolds margined around the walls of the buildings with labourers hanging around those scaffolds struggling to reach here and there with a full stretch of their body. Also, most of the times the surrounding environments are very unhealthy that is almost an unbearable situation for the workers, forcing them either to quit or to welcome some deadly consequences to their health. The painting chemicals can cause hazards to the human painters such as eye and respiratory system problems. 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 the proposed project we designed a prototype of an Automated Wall Painting/Designing Robot that works on the concept of image processing technique using LabVIEW Software. The proposed algorithm manage to function on both Normal Wall Painting and Interior Wall Designing.

Keywords: LabVIEW Software, wall painting, robot, image processing.

I. INTRODUCTION

In this fast moving life, construction industry is also growing rapidly. The labours in the construction industry are not sufficient because of the difficulty in the work. The amount of risk involved in painting tall buildings is high. There are some other reasons for the insufficient labour which may be because of the improvement in education level which cause the people to think that these types of work is not as prestigious as the other jobs. The painting chemicals can cause hazards to the painters such as eye and respiratory problems. Also the nature of painting procedure that requires repeated work time and effort consuming [2].

Due to the advancement in technology, construction robotics has been realized and it will be a solution to above mentioned drawbacks. Applications of robotics in the field of automation started in the early 90's. The main aim of automation is to optimize equipment operations, improve safety, enhance perception of workspace and furthermore, ensure quality environment for building occupant [1], [3-5].

The advancement in the field of robotics and its wide spreading applications is well known. To make painting work easier, safer and also to reduce the number of labours, automation in painting is introduced. These factors motivated the development of an automated robotic painting system. The automation for painting both exterior and interior wall has been proposed in this paper.

II. HARDWARE IMPLEMENTATION

The block diagrammatic representation of the proposed system is shown in Fig 1. There are two modes of operation that can be performed with this robot. They are normal painting mode and the image/design painting mode. The initial choice is selected and signal is provided to Arduino board to perform the operation. The control circuit provides the required control signal to be processed. The signal from the control circuit triggers the motor and corresponding X-Y plotter action takes place. The two-stage compressor is used and its operation is controlled by solenoid coil. The hardware setup can be divided into four parts as

- Base structure
- Vertical setup
- Spray-gun setup
- Control circuit

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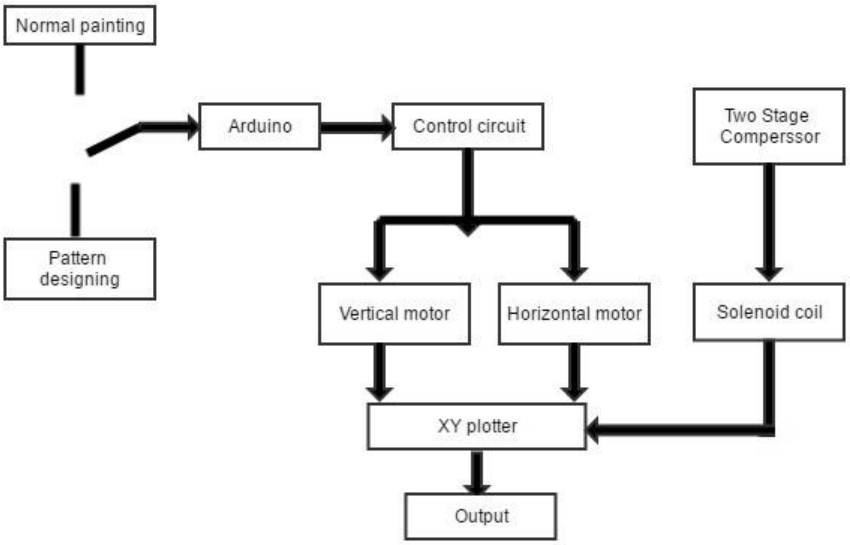

Fig. 1 Block Diagram of the proposed system

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A. *Base structure*

The base structure is in the shape of cuboid. Individual iron plates are welded by the process of cast iron welding. Iron is about 8 times heavier than water (its relative density is 7.87). This enables the horizontal movement along the x axis. The base is supported by four plastic wheels mounted on bearings. The rear sided pair of wheels are connected by a shaft through a gear setup coupled to a DC gear motor. This enables the linear motion and the front sided wheels motion depends on the rear sided wheels. The snapshot of the base structure is shown in Fig 2.

Fig 2 Base Structure

B. *Vertical Setup*

Threaded Structure forms the vertical setup. Here, a 1 m length rod is threaded all over and is encased inside a long four sided block. The rod is made up of stainless steel. The stainless steel is used because it possesses high oxidation resistance in air at ambient temperature, stainless steel is generally highly resistant to corrosive acids, stainless steel is a relatively poor conductor of electricity, with lower electrical conductivity than copper. The snapshot of the threaded setup used in this project is shown in the Fig 3.

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Fig 3 Vertical Setup

C. *Spray gun setup*

Two different spray equipment are used. A spray gun of nozzle diameter 2 mm is employed for normal painting supplied with an optimum pressure of 8 bar and another spray gun of nozzle diameter 0.5 mm supplied with an optimum pressure is employed for pattern designing. Both the spray guns are of convergent – divergent type painting at a spread of 5 cm each. The snapshot of the spray gun setup used in this project is shown in the Fig 4.

Fig 4. Spray gun Setup

D. *Control Circuit*

Control Circuit consists of components like opto-isolator, solenoid and battery. The opto-coupler circuit acts as an isolation between two electrical circuits. When a 220 V source supplies low voltage equipment through step down transformer, the circuit works steadily initially. With continued operation, there are chances of formation of back voltage and leakage current leading to damage of circuit components. The snapshot of the control circuit is given in Fig 5.

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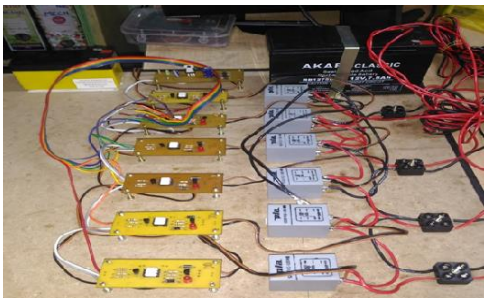

Fig 5 Control Circuit

In this proposed system a low cost, simple and portable robot is designed. This robot is designed using four plastic wheels, bearings, long threaded rod and parallel iron bars weighing around 8 kg. They also have a very small weight to power output ratio and predictable performance i.e., losses are minimum due to less number of moving parts and so gives expected performance. Optimum pressure levels are maintained for both spray gun and spray nozzle. Due to elegant and simple control systems it can control noise, vibration and thus silent and vibration free operation is resultant. The added advantages are longer life, flexibility, efficient installation is simple and the maintenance is also easy.

III.SOFTWARE IMPLMENTAION

LabVIEW is an application software which is developed by National Instruments. It has several advantages over other simulation software and it is capable of interfacing with more than one hardware components and performs the operation and delivers results at high accuracy. The main advantage with this software is that the code developed using this software can be converted into executable file of several formats depending on the needs. This ensures that the LabVIEW package is required at development stage and thereafter it is not required. It is capable of creating a stand-alone application [6]. The added advantage of LabVIEW is that image processing is very simple and it is capable of reading the details of an image and process it and control the entire hardware based on the processing result.

Image Processing is core feature of LabVIEW package. It is simpler to synthesize the image and process it for further analysis than any other image processing tool. Image processing is made possible by special Add-On named VISION.

This package consists of several inbuilt commands to process the image and retrieve the data from the image. Each command is dedicated for a specific task and for specified images. The coding pattern varies with image type. The common image type is JPEG and the coding pattern is very easier with JPEG files.

To work on with this tool, initially the image is to be acquired. This is done in two ways, either the image is directed from memory via file browser or it is directly acquired from the user with the help of camera. The only disadvantage with the second process is that the image clarity would not be as much as required.

This vision package which is a part of LabVIEW application software which provides an environment for image processing both at basic level and at extended levels. This is incorporated into LabVIEW application using VI PACKAGE MANAGER, providing the proper required details for smooth interfacing [7].This Vision Add-On uses the basics of IMAQ (Image ACQUISITION) principles.

There are several methods to process the image with this package, But the special algorithm used in our project is to convert the image into an binary image and this binary image consists of image pixel value representation as either ‘0’ or ‘1’. If the encoded value is ‘0’,then the colour of that image is available and it has to be painted, else if the value is ‘1’, it confirms the absence of colour and the pixel can be skipped off and the process proceeds till the end size of the image. The Fig 6, 7 shows the run-time working window that appears while the desired mode is “normal painting mode”. Fig 8, shows the practical output which has been evolved with our setup.

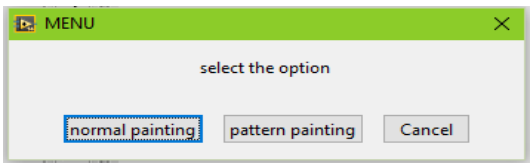

Fig 6. Normal Painting

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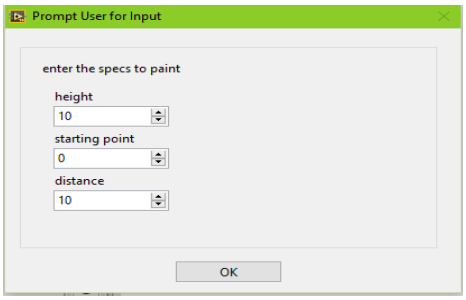

Fig 7. Normal painting

Fig 8 Practical output for normal painting.

IV. CONCLUSION

In this article, a robot has been designed to accomplish the task of wall painting and wall designing. The difficulties due to labour work and other respiratory diseases can be avoided using this automated setup. The automated painting system developed is a simple technique involving the implementation of LabVIEW coding that makes the control easier. The pattern output depends upon the image processing functioning in the LabVIEW platform. This project was successfully developed according to the concept of Vision Add-On, IMAQ and will surely be a worthy attempt to try out in a large scale.

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