

DESIGN AND FABRICATION OF A ROBOTIC ARM FOR INTERIOR WALL PAINTING

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Abstract- Automation is the use of various control system for operating equipment automatically. The implementation of automation in the construction industries is not a widely used concept in the construction sector of Bangladesh. The implementation of automation can be the right means to increase the speed of the operation and hence improve the accuracy of the productivity of the construction industry. For example, painting operation in the construction operation is done manually which is time consuming for completion of operation and may cause accidents or any other unintended hazardous incidents. To avoid such incidents and increase the productivity, a programmable robotic system can be implemented. This paper describes the development of a robotic arm for interior wall painting. The system is divided into two major parts namely hardware and software. In hardware part, mechanical design & fabrication along with electrical and electronic system is described and in software part control algorithm is described. Mechanical part consists of an arm with painting brush and a base for the support of the arm. This arm has two link mechanisms with three joints. Joint is driven by servo motor which is controlled by programmable logic through microcontroller. For simplicity, low weight and short painting time is considered in this design. The system of the project is able to perform repeatable motion and work. Experiments had shown the success of the system in its intended tasks.

Keywords: Automation, Implementation, construction industry, Robotic arm, Algorithm.

1. INTRODUCTION

Using of various control systems for processes in factories, operating equipment such as generators, boilers and heat treating ovens, heat and power generation system, guiding and controlling the movement of ships or aircraft and other applications with minimal or reduced human effort is defined as Automation [1]. The term industrial automation is generally defined by ISO as an automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes for handling different processes and machineries in industries to replace human being [2]. Some processes have been completely automated. The biggest benefit of automation is that it saves labor; however, it is also used to save energy and materials and to improve quality, accuracy and precision. Two common types of automation are feedback control, which is usually continuous and involves making calculated adjustments, and those that perform series of discreet steps, often based on system logic. In general, the use of applying a layer coat of paint or any other kind of substance, which covers up partial or entire wall or product, are to extend the life, to give an extra credit on the looks or finishing. In order to produce a skillful panting job continuously without compensate more time, a design of an automation system should be

placed. The result of automation would not downgraded the finishing of painted surface, in fact, the use of robotic arm for interior wall painting would give a similar finish to all walls and the output of the productivity can be increased enormously. In this case, the consistency and the repeatability of the machine motion itself are placed in a good benefit, where the use of robotic arm for painting can be done faster and with a lower cost without losing the finishing of walls. The facts that robotic arm keeps a lower cost is supported by the facts that, amount of paint that are used in unit area is fixed without any loss of paint. As we know, an automation system would be a high capital expenditure but, the surface that is produced with a great quality would return back the cost of the automation itself. "Machine Design deals with the creation of new and better machines and improving the existing ones"[3]. A new or better machine is one which is more economical in the overall cost of production and operation. "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. These factors motivate the development of an automated

robotic painting system. There have been few research projects in the literature but they did not produce a mature system acceptable by the market yet” [4]. The main advantages of automation based projects as following-

- 1) Increased throughput or productivity.
- 2) Improved quality or increased predictability of quality.
- 3) Improved robustness (consistency), of processes or product.
- 4) Increased consistency of output.
- 5) Reduced direct human labor costs and expenses.
- 6) Decrease unintended incidents or accidents.
- 7) Increased efficiency.

Automatic painting machine can be used for industrial purpose. It will help us to complete painting in short period of time and will increase efficiency. It will also retard monotony for doing same work.

2. COMPONENT DESCRIPTION

Here variable resistance is used for adjust frequency, voltage regulator for supplying +5 voltage to Microcontroller, crystal oscillator is used to create electrical signal with a very precise frequency, capacitor is used for blocking direct current while allowing alternating current to pass, switch is used for controlling the robotic arm manually or automatically, push button is used to control the arm manually. A simple program is developed to control the servo motors and also to control motion of the arm. Then the program is loaded into the PIC16F73 microcontroller. The programming language is microC.

3. METHODOLOGIES

Two main push buttons are available in this circuit for both automatic and manual process. When the automatic switch is off the microcontroller sends signal to servo motor which is in the base. Then this servo motor rotates to the left side. Then servo motor in the arm starts to rotate. This rotates the arm in the downward direction. Then the third servo motor starts to rotate the wrist to take color from the reservoir such as a box with color. Then the servo motor rotates in the opposite direction respectively. When the arm reached to the required position then the servo motor in the wrist rotates between +90° to -90° to paint repeatedly. The clock frequency for PIC16F73 is 4 MHz. These are internal clock frequency. It can be selected as the necessity of the data processing. This frequency is selected at the time of loading hex file into the microcontroller by the loader.

3.1 Block Diagram

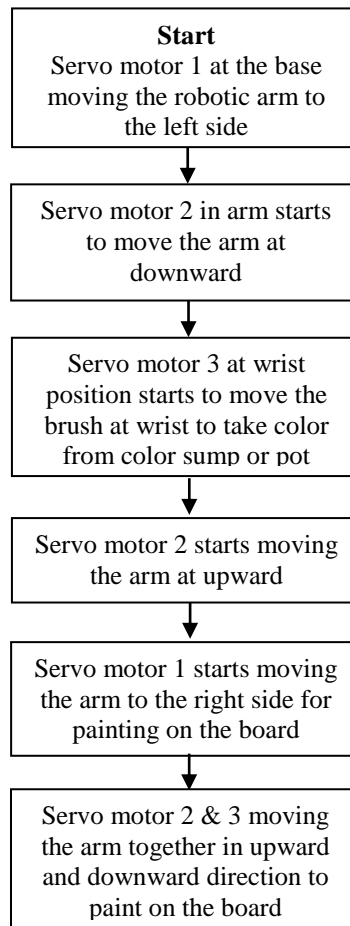


Fig 1: Block diagram of robotic arm for interior wall painting

4. WORKING PRINCIPLE

The physical system of an automatic painting machine is an arm with brush which uses servo motor to run. Aluminum plate is used to make the arm. The aluminum plates are joined by screw and nut to make the arm. Here three servo motors are used to move the arm in required position. The base is also made by aluminum. A counter weight is used to balance the weight of the arm. A plastic box is used as the reservoir of the paint. The box is placed on the left side of it. The arm move to left to take the paint. Three servo motors give motion in three different directions. One is used to move the arm to the left side. Two are used to move the arm in upward and downward direction. A simple program is developed to control the servo motors and also to control motion of the arm. Then the program is loaded into the PIC 16F73 microcontroller. The principle of the program is to control the movement of motor by is controlled by various sensory signals from the controller. The software is used as an interface between an operator and the electronics. The whole mechanical setup of this project is shown in figure 1 in next page.

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