International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 6 June 2022, pp: 514-520 www.ijaem.net ISSN: 2395-5252

Design & Development of PLC Integration for Robotic Welding

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Submitted: 01-06-2022 Revised: 05-06-2022 Accepted: 08-06-2022

ABSTRACT: In this project, we will be doing Design, Analysis & Manufacturing automation for circular parts welding with uniform weld structure using PLC.

We will be design & manufacturing the turntable which will be rotating at specific required speed depending upon the requirement of filler material to be added. Further the electrode nozzle is kept stationary, which will be kept in contact with the surface of component to be welded. Hence in this project, a detailed design for converting the conventional MIG welding (ARC) machine into an automated circular component welding machine has been proposed.

Along with this, main motive is to modify the existing MIG welding machine into portable robotic welding machine.

I. INTRODUCTION

Now-a-days in mass production, it is often required data to automate the manufacturing processes that were conventionally done manually. In presence, various welding techniques are used for the welding processes such as CO2 welding or Electric arc welding, TIG (tungsten inert gas welding), in that, various fixtures are used for various welding processes but in many applications, we use some techniques which does not work efficiently & accurately. Moving the electrode along the welding line is a skill full work and especially for circular components it becomes much more difficult.

To avoid such problem we implement welding rotator. The need of a special device which can rotate the job at an fixed rate to assist the welding process for circular component and ensure good profile and homogeneous welding.

Many different energy sources can be used for welding, including a gas flame, an electric arc, a laser, an electron beam, friction, and ultrasound. While often an industrial process, welding can be done in many different environments, including open air, under water and in outer space. Regardless of location, welding remains dangerous, and precautions are taken to avoid burns, electric shock, eye damage, poisonous fumes, and overexposure to ultraviolet light.

Developing a cost effective fully automated system for welding is beneficial for mass production industries and for the critical safety parts where the defects are not tolerable. Fully automated system for welding will reduce the manual intervention, as a person's work will be to only fix component on the machine and remove it after the welding is done and reducing man intervention will eventually lead to less welding defects, less safety incidents, higher production rate, etc

II. PROBLEM STATEMENT:

As the prices of cultivation and planting of sugarcane by cultivator machine is very high. In India, Sugarcane planting done about 6 to 8 tones seed per hector cause to excess labor required for plantation and the energy consumption for sugarcane cultivation is highest as compared to other crops like, wheat, potato, corn, rice, sorghum. Generally in market petrol or diesel engine cultivators machines are available, initial cost of this machine are too high and it's not easy buy a machine to every farmer's.

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Sugarcane creation is an intricate cycle and can be considered as a component of a few factors. The information on the general significance of the asset inputs impacting sugarcane creation is fundamental for the sugarcane cultivators for presenting helpful changes in their activity at the miniature level.

Figure No.1– Co2 Welding For Circular Pipes

III. NEED FOR PROJECT:

Robotic welding systems offer three main advantages: consistent weld quality, increased output, and decreased variable labour costs.

Consistent weld quality The welding task associated with the magnet coils is extremely labour intensive. With most labour intensive tasks, quality tends to decrease the longer the activity is continued.

Unlike a manual welder, a robotic system is not subject to fatigue and is able to sustain high quality welding for prolonged periods of time.

Well-designed robotic systems have the capability to repeat any taught action with the same quality results. This attribute is important since there are several different magnet configurations and each configuration is used multiple time increased output.

Industrial experience suggests that the average robot can weld at least twice as fast as a skilled manual welder. The increased speed helps avoid potential delay due to the welding operation, and a quicker turnover of magnet coils can be realized.

Decreased variable labour costs due to the increased output, overall labour time is shortened and labour costs are reduced. The limited availability of skilled, certified welders may pose a challenge. Conversely, general machine operators are more readily available and more affordable than skilled, certified labour.

IV. OBJECTIVES:

Objectives of complete Project work :

The main purpose of this research is to develop this system & in order to approach this purpose, we follow.Design the indexing table rotary motion of component to be welded.Load caring capacity up to 25 kg.Material procurement & drawing release for manufacturing.Fixture design for welding gun fitment for angular motion during loading & unloading of job.Utilization of Mitsubishi PLC for automation work of complete project work.Utilization of pneumatic cylinder for griping job / locating the welding gun.Testing & completion of complete project within prescribed time

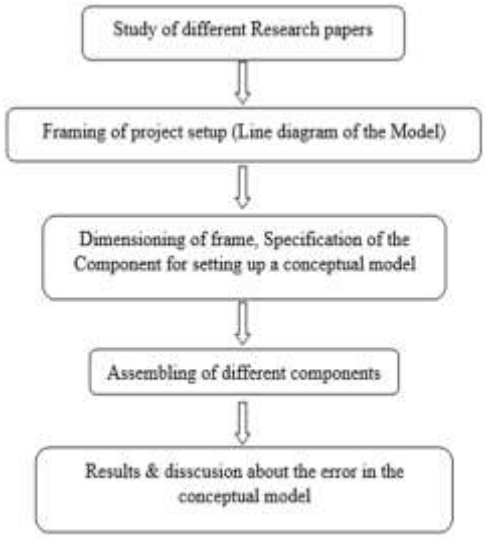
Basic objectives:

Reduce operator effort and increase efficiency

Multi field application that is industry, household, agriculture, etc. Generation of smooth & homogeneous finish Multi-purpose application is that system should be compactable with other applications such as Sand blasting, Spray painting etc.

V. METHODOLOGY:

Procedure of working cycle:



Automated system for welding is the required for mass production as MAKE IN INDIA is on higher priority. So in order to compute the production rate of china we have to implement such machine in higher scale. So if machine cost is kept lower it will be in higher demand. So above methodology is utilized to develop the automated system.

Methodology of Design & Analysis:

A parameter study is done to evaluate the most crucial parameters for FE analysis of axial ball bearings. The parameters that are evaluated are mesh density, contact stiffness, osculation, load level, geometrical nonlinearity and material nonlinearity. The studies are performed by means

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of the FE software Ansys. The accuracy of finite element analysis depends on different parameters such as element type, boundary condition and how the loads are applied etc. Therefore the FE model is nothing else but an approximate realization of the reality. The parameter study can be done by physical tests. However it will increase the cost, time and resources consumed and therefore FE analysis is more suitable choice, at least for parameter evaluation.

VI. THEORETICAL ASPECTS OF THE WORK:

In this focus on the restricted part method is taken on including Pro Engineer and Ansys as a business CAD and FE program. Limited component procedure (FEM) is a method for harsh game plans of fragmentary differential circumstances. The going with segment contains a couple of fundamentals of the applied theories given that per client has a hidden data on fundamental essential mechanics, machine parts, and nuts and bolts of the restricted part methodology.

ANSYS:

Ansys is a business, generally helpful FE programming which has been Javailable start around 1971. It might be used in a couple of utilizations for example to focus on the warm hotness stream, fluid stream, alluring fields, acoustics/vibrations and to wrap things up hidden mechanical issues.

CONTACT IN ANSYS:

A small bunch of ways of dealing with contact are accessible in Ansys. In any case, the one portrayed here is punishment based contact since it gives short computation times and along these lines is utilized.

PENALTY BASED CONTACT:

Whenever a punishment based contact is utilized, Ansys adds a spring coefficient (k component) when two surfaces interact with one another, to forestall entrance and to move load. However infiltration will happen to move force, which isn't true in all actuality. Hence the punishment based strategies are delicate to the decision of the spring coefficient. The spring coefficient Ansys utilizes during estimations is the item between the "typical firmness factor" determined by the client and a reference factor determined by the program. An extra angle (aside from the precision) to think about while choosing the "typical solidness factor" is the assembly conduct. A stiffer contact will bring about more estimation cycles, since skipping could happen.

VII. CONSTRUCTION & WORKING:

The job to be welded is placed on the indexer table and considering the welding process and electrode feed rate the speed regulator is adjusted to give desired table speed. The table carries indexer buttons as per no of welds and position of the same. Table is indexed to the first stop position. Now by pressing the single switch all the operations will start working simultaneously.
Such as

1. Griping workpiece.
2. Locating the welding nozzle.
3. Initiating the welding.
4. After 360 angle completion, relay off machine off the welding process .Welding gun moves to its initial position.
5. Job ready to unload.
6. Buzzer blinks for 2 sec.

Process completed.

CONCEPTUAL DIAGRAM:

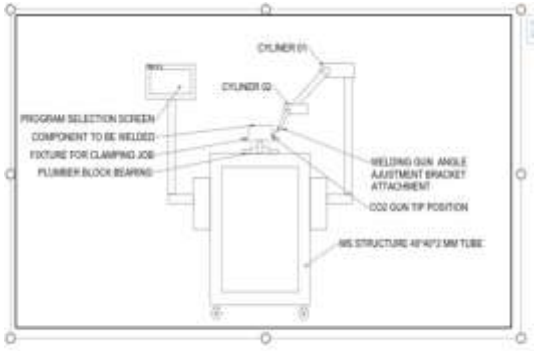

Figure No.2 – Conceptual Block diagram

COMPONENT SPECIFICATION:

1) Delta PLC - DVP14SS2:

The 2nd generation DVP-SS2 series slim type PLC keeps the basic sequential control functions from the DVP-SS series PLC but with faster execution speed and enhanced real-time monitoring capability

Fig. 3 : - Delta PLC - DVP14SS2

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Specifications:

- Rated Operating Voltage: 48V
- Rated Power: 800W
- No Load Current: 4.0A
- No Load Speed: 450 RPM
- Rated Torque: 102Kg-cm
- Rated Speed: 350 RPM
- Rated Current: 15.6A
- Efficiency: 80%
- Gear Ratio: 6:1
- Wight (approx.) = 5 kg

2) DOP- B03S211

Figure No.4 – DOP-B03S211

Specifications:
4.3-inch (480 x 272 pixels) TFT LCD 65536 colors
2 sets of COM ports, supports RS-232 / RS-422 / RS-485
For data transfer/download: RS-232, USB
Complies with IP65 standard
Supports horizontal / vertical display
PC editing software, DOP Soft is compatible with operating systems: Windows XP, Windows Vista, Windows 7

3) DC Motor PWM Speed Regulator 1.8V, 3V, 5V, 6V, 12V-2A speed control switch function:
Features

1. Input supply voltage: 1.8V- 15V DC.
2. The maximum output power: 30W
3. Output current : 2A(Max).
4. With resettable fuse.
5. Equipped with LED indicator.
6. Potentiometer with switch function for PWM adjustment

Figure No.5 – DC Motor PWM Speed Regulator 1.8V, 3V, 5V, 6V, 12V-2A speed control switch

The DC Motor PWM speed regulator 1.8V, 3V, 5V, 6V, 12V-2A speed control switch function for DC Motors allows controlling the direction of a DC Motor using a PulseWidth-Modulated (PWM) DC Voltage with a Duty cycle fully adjustable from 0%100%.
The motor speed controller can easily provide a continuous current of 2A to your DC Motor or other DC Load. This motor speed controller allows controlling the direction of a DC Motor using a Pulse-Width- Modulated(PWM) DC Voltage.
With a resettable Fuse, It can automatically break the connection and automatically recover. With a LED Indicator and a rotary switch, convenient to use.
Operating Instruction:

1. Connect your DC Motor (or DC Load) to the motor terminals as indicated on the wiring diagram.
2. Connect a Voltage of 1.8V-15V DC to the circuit making sure of the correct polarity of the connection. Note that the Voltage applied to the Motor will be the Supply Voltage applied to the circuit.
3. You can now control the speed of the motor through the Potentiometer.

3) 20MM4 Bolts Pillow Block Square Flange Bearing UCF205-16

Features:
Superior Quality - Made of bearing steel and cast iron housing high hardness and durable provide long service time.
Easy Install - 4-bolt housing with ball bearing insert for ready-to-mount installation.
Premium Manufacture - Double side rubber sealed bearing waterproof and dustproof work well in various environments.
Efficient Work - High speed running low noise.
Wide Use -Widely used in various of machinery.

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Specifications: Model: UCF205-16.
Material: Bearing Steel + Cast Iron
Housing Name: Pillow Block Bearing,
Inner diameter: 20mm,
Outer diameter: 52mm,
Thickness: 34.1mm,
Size: Approx. 9*9*4cm/3.5*3.5*1.6in,
Item Weight: 727g/25.6oz,
Packing Weight: Approx. 753g/26.6oz,
Packing Size: 10*10*5cm/3.9*3.9*2.0in, Package List: 1 * Pillow Block Bearing.

Fig.6:-Bearing UCF205-16

Indexing plate:
Material used: - Mild steel

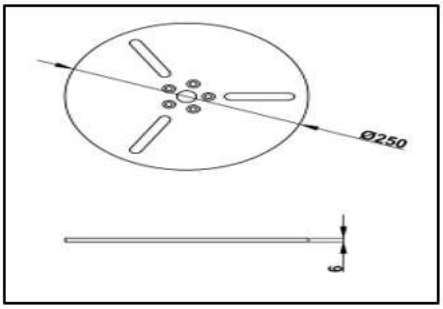

Fig.7:- Indexing plate

Base Frame 01:
Material used: - Mild steel

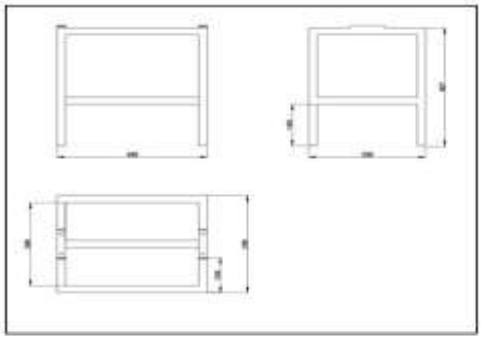

Fig.8:-Base Frame 01

Frame 02:

Material used: - Mild steel

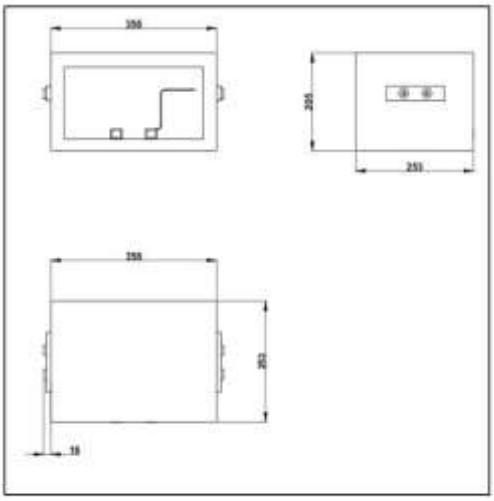

Fig.9:-Frame 02

Bracket:
Material used: - Mild steel

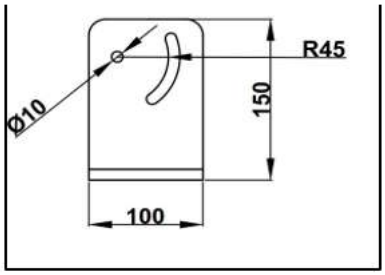

Fig.10:-Bracket

Design of Machine:
Experimental Setup:

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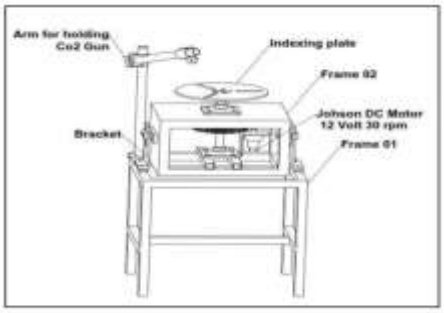

Fig 11:- Experimental Setup

CAD Design:

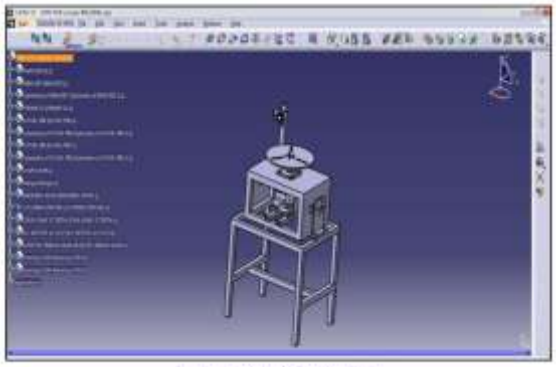

Fig 12:- CAD Model (3D view)

Fig 13:- CAD Model (Front view)

VIII. RESULTS

MANUAL WELDING PRODUCTION RATE			
Day		TIME (HRS)	QTY
Day 1	2 INCH JOB	11	144
Day 2		11	137
Day 3		11	142
Day 4		11	147
Day 5		11	146

AUTOMATION WELDING PRODUCTION RATE			
Day		TIME (HRS)	QTY
Day 1	2 INCH JOB	11	264
Day 2		11	262
Day 3		11	261
Day 4		11	259
Day 5		11	263

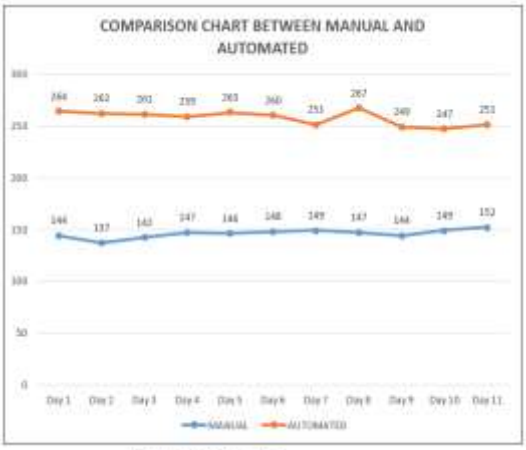

Fig 47:- Results graph

ADVANTAGES:

- Time saving.
- High efficiency
- High skilled worker is not required.
- Min chances of getting defects such as blow holes, weld spatters, cracks, overlap, lack of penetration/fusion, etc.
- Continuous and uniform weld obtained.
- Faster production
- Better quality Safe to use.
- Portable

DIS-ADVANTAGES

- The main disadvantages of the SPM is high initial cost.
- Maintainance of the machine is high.
- The machine can be used only for circular welding of component and not for other type of component.
- Design of the job rotary machine is complex.

APPLICATIONS

- The automotive industry uses GMAW for both production and maintenance.

- Robotic assembly lines use GMAW for time-efficient manufacturing processes.
- Pipefitters use GMAW during the welding of pipe joints.
- The rail industries uses GMAW for fast, durable repairs or construction of railroad track

IX. CONCLUSION

Heavy load capacity of table is 80 kg safe load Adjustable table speed (0 to 75 rpm) Auto stop feature, to start and end process operational precise positions. Multiple indexer positions, enables to make staggered welded joints. Easy operation, as table automatically stops as per indexer button position and next operation is started by merely pressing the inching switch. Compact, the entire drive assembly fitted below the table itself, and the controls are placed on the front at ergonomic positions. Low power consumption (50 watt) From above report it is conclude that for the complete circular welding as well as the spray painting in required angle with perfectly and efficiently in mass production .

X. FUTURE SCOPE

It will play vital role in mass production system and in following process like painting, air washing, wire winding, circle marking, any geometrical shape welding, act as indexer, CO2 welding of circular or staggered welded joints, electric arc welding of circular or staggered welded joints, plastic Moulding for multiple position dies, bottle filing plants. Etc.

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