

Controlling of Manipulator for Performing Advance Metal Welding



Aditi Saxena, Jitendra Kumar, Kamal Sharma, and Debanik Roy

Abstract The regulation of a mechanical manipulator device is a critical step for a simpler and accurate method of welding. In order to ensure accurate metal arc welds, the direction and pace of the deceiver should also be monitored using only a measurement control device using welding parameters such as temperature, swelling speed, and the friction that happens in the gripper, since the number of connections increases their difficulty. This research is performed with assistance of SIMULINK to monitor two-link solid robotic manipulator systems. A mathematical model was developed that serves as an interface and then a Fuzzy-PID regulator is attached whose output acts as a reference into the system. The deceiver has a complex behavioral model. The controlling machine has been further improved using genetic algorithm by simulation results it is found that the Fuzzy PID does have the lowest error value in comparison to the Fuzzy PI, Fuzzy PD, and PID controllers.

Keywords Controlling · Robotic welding · Welding parameters · Fuzzy-PID controller · Genetic algorithm · Integral absolute error

1 Introduction

Generally, welding may be characterized as a localized coalescent of metals or non-metals (normally known as welding parts) that are mostly heated to a correct depth, pressurized, or pressurizing with or without the use of extra filling metals. The methods of welding are very relevant only for a few applications [1]. Arc welding is among the most common; (i) arc welding refers to a wide variety of welding techniques, using an electrical circuit to combine and merge heat. It is thought to be the largest single community of processes after assembly and machining in the metal manufacturing sector in the global metal manufacturing industry. The very first method of welding from historical standpoint was welding through forge where the slurry is heated and then marked to remove slacken and oxides [2] (Fig. 1).

A. Saxena (✉) · J. Kumar · K. Sharma · D. Roy
IET Department of Electronics and Communication Engineering, GLA University, Mathura
281406, India

Fig. 1 Various welding methods

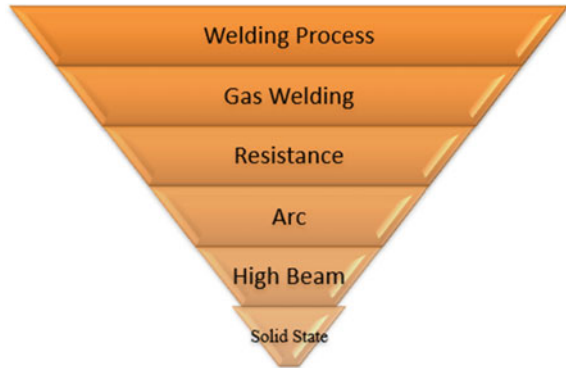


Fig. 2 Three-link manipulator diagrams



Another option is fusion welding, in which the heat input must be strong enough to dynamically dissolve the dual weld pieces. In this type of welding voltage should be low and current should be high. Developed energy sources can also display data with a variety of output waveform, which can be modified in actual environments based on the input signals. In case of arc soldation management, photographs of the arc, soldering tank, bottom body or ground needle or sold readiness could be necessary where system input is needed. Arc length analysis and electrode adhesive may also provide valuable method detail. Different processing parameters and disruptions also influence arc intensity. In the sensory portion of the electromagnetic range, the sold tank also absorbs radiation. As the strength of the arc itself is much smaller, it is being used to measure the efficiency of the bolt, so it could be found that a substantial deal of potential research opportunities in the field of welding control was also available, especially a visual information control system, since the technical materials are becoming cheaper. In this paper, an application of control system has been displayed that how precisely one can perform welding with the help of control system for this process two-link manipulators system have been used [3] (Fig. 2).

2 Controller Structure Designing Through Simulink

Different controllers designed is being shown and discussed here optimization technique that is genetic algorithm is also being introduced and explained here.

Fig. 3 PID controller diagram



2.1 PID Controller Design

On the dynamics of robotic manipulator having two links the structure with a reference wave, a sine wave is being given to check whether the output is tracked with the reference wave or not. Here the gains are being manually tuned so self-tuning is being performed here [4, 5] (Fig. 3).

PID controller is being applied at the input of the plant two PID controllers are being used, respectively, one for first link of the manipulator arm and other for the second link of the manipulator plant. Theta 1 here represents the output of link 1 and out 2 represents the output of link 2. Scope will help to display the result in form of graph.

2.2 Optimized PID Controller Design

In this design, we have optimized the controller using Genetic Algorithm (GA). This algorithm is more suitable in comparison to the other existing algorithms. The main purpose of this algorithm is to reduce the value of error as low as possible that integrates the absolute error without adding any sort of weight to the error. In the figure, we can see that the input of PID controllers 1 and 2, respectively, is being connected with Integral Absolute Error. The absolute block is being attached with an integrator this combination gives IAE(Integral Absolute Error) in output. After this genetic Algorithm is being applied for optimization and an optimized result will be obtained [6, 7] (Fig. 4).

Fig. 4 PID diagram



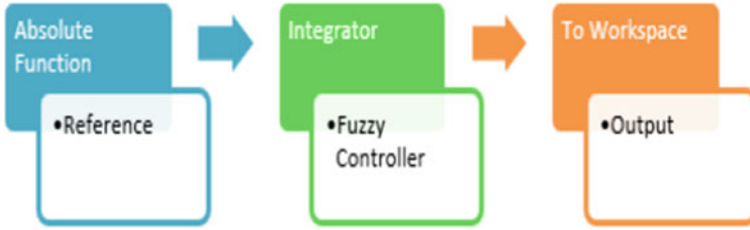


Fig. 5 PD controller structure

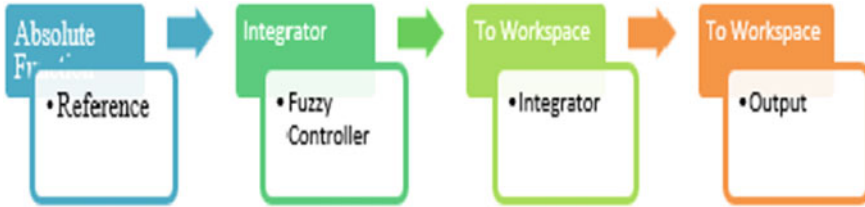


Fig. 6 Fuzzy PI diagram

2.3 Fuzzy PD Structure

There are some input and output value in a fuzzy set which are being mapped with the help of membership function. Fuzzy logic controller intakes a value from 0 to 1 as low as possible and can easily deal with non-linearities. A simple PD controller is being attached with fuzzy logic. PD control and IAE are being used here as an objective function for GA optimization [8] (Fig. 5).

2.4 Fuzzy PI Control Interface Structured Design

In this design, an integrator has been used that leads to Fuzzy PI control [9], that is then linked with the Fuzzy Logic System and IAE as an objective function (Fig. 6).

2.5 PID Fuzzy Control Interface Structured Design

In Input a reference wave is there than a PID controller is being joined consecutively a fuzzy logic controller is being attached with integrator and above all the steps genetic algorithm has been used in all the stages [10] (Fig. 7).



Fig. 7 Optimized Fuzzy-PID controller model diagram

3 Results and Discussion

3.1 Fuzzy-PID Structure

In PID controller plant result the figure here represents the perfect tracking of the sine wave which we have given as a reference wave, sine wave is being perfectly tracked by the output of the manipulator [11] arm for the two links so we can say that by applying PID controller the output is able to track the input for welding purpose also Precise tracking is required in order to perform welding at the correct position. Here we can do self-tuning by adjusting the value of the gains (Table 1).

0.04438 the dynamic model description of this plant is being discussed above because of PD controller the stability increased, Maximum Peak Overshoot decreased, settling time decreased but at the same time its disadvantage is that it cannot be used for fast moving process variable like flow, pressure and hence this controller is not fit for [12] advance welding purpose. In fuzzy PI controller error value 0,411,467 PI controller is the most popular controller; it has two tuning parameters to adjust integral action PI controller provides a balance of complexity and capability but it has sluggish response to sudden disturbances and cannot lead to give precise result in advance welding. In Fuzzy PID, after GA optimization is 0.0399573 this is the least value of error that we have obtained so far. Fuzzy controllers are less costly they cover a wide range of operating condition PID controller has fast warm up time accurate set point temperature control which is necessary to keep in mind during welding with the help of this controller we can perform precise welding genetic algorithm (GA) [13, 14]. Genetic Algorithm consist of various steps like Population, Selection, Reproduction, Mutation, Crossover, Stopping criteria, etc.

Table 1 Controllers error value

Controllers	IAE values
PID without optimization	0.2218
PID using GA	0.0429
Fuzzy PD using GA	0.04438
Fuzzy PI using GA	0.04114
Fuzzy PID using GA	0.03995

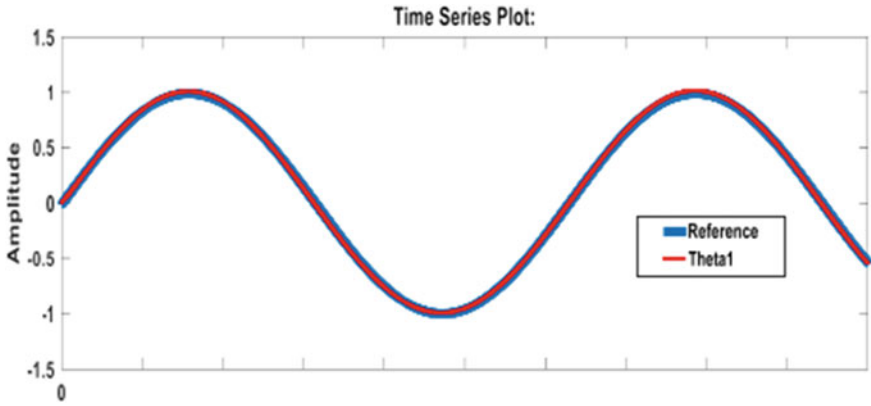


Fig. 8 Model plant results after simulation showing tracking

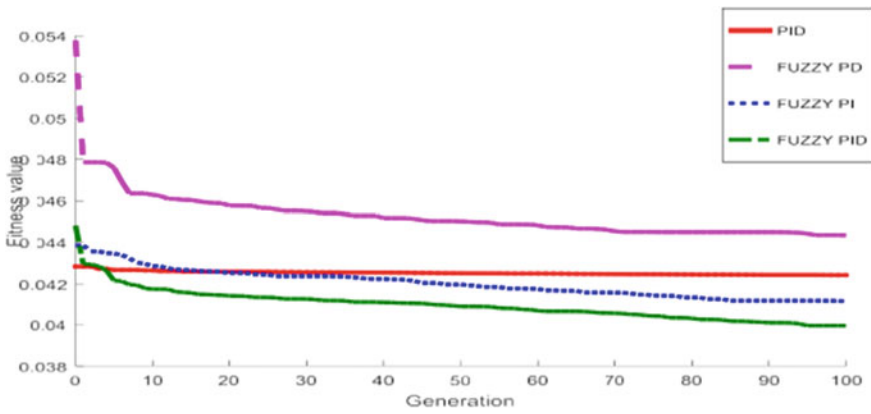


Fig. 9 Different fitness value of controller

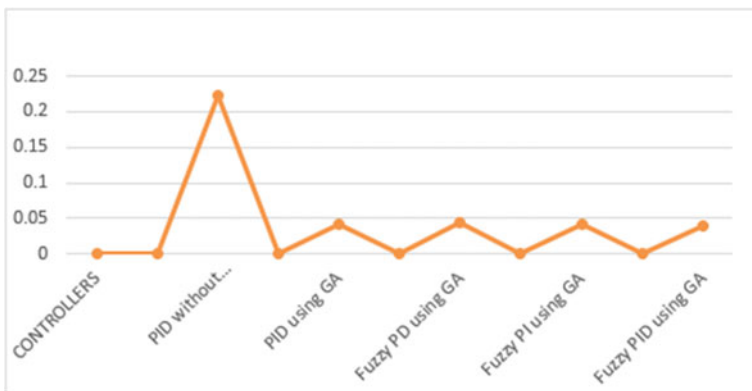


Fig. 10 Graph representing comparison of all the three controllers

[15]. The figure drawn above shows the best fitness value of the various controllers after optimization and as a result found that least value of error is 0.03995. Which means tracking is almost perfect and error rate is even below 1%.

4 Conclusion

The stimulated result of a simple PID controller is seen here. We are able to get perfect monitoring of the reference and actual paths, which can assist us in doing precise welding in the correct position. A controller is being developed to manage all non-linearities and overcoming the vibration that occurs at the end effect or during the welding process. It has the properties of providing a short rise time and low overshoot, which helps to do accurate arc welding. This proposed optimized dynamic Fuzzy-PID model can be used to position the robot arm in the pre-defined path and perfect tracking of the path could be done this controller has a potential application in manipulator control for various purposes like arc welding, casting, to bear a payload and further many more.

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