A review of process parameter optimization of Milling process by using Harmony Search Algorithm approach

Maulik. B. Nagarchi¹ Prof. D.A. Patel²
1P.G. Student ²Associate Professor
1,2Department of Mechanical Engineering
1,2Sankalchand Patel College Of Engineering, Visnagar, Gujarat

Abstract— milling is the machining process of using rotary cutters to remove material from a work piece advancing (or feeding) in a direction at an angle with the axis of the tool. The quality and productivity of the parts produced by milling process is significantly affected by various manufacturing parameters of milling machine. Hence optimization of milling process parameters is necessary in order to improve the quality or productivity of parts. The purpose of this paper is to explore the reviews for various optimization methods used for process parameter optimization of milling process and application of Harmony search algorithm approach. This review of work can be helpful to the other researchers to carry out further work in the same era.

Key words: Milling, Optimization, Harmony search algorithm.

I. INTRODUCTION

The cost, time and quality of production are highly dependent on the cutting parameters such as the number of passes, depth of cut, speed, and feed. So, determination of optimal cutting parameters with regard to technological requirements, capability of machine tool, cutting tool and the part material is a crucial task in the process planning of parts. The quality and productivity of the parts produced by milling process is highly depends upon various process parameters used in this process. So, the selection of efficient machining parameters is of great concern in manufacturing industries, where economy of machining operation plays a key role in the competitive market. Many researchers have dealt with the optimization of machining parameters. However, most work done on the optimization of cutting conditions in machining is mainly focused on turning operations, while milling has received relatively little attention with regard to the optimization of cutting parameters. From the early 1900s, the importance of using optimal cutting parameters was identified, but progress in the development of optimization strategies has been very slow. Harmony search algorithm is the new Meta heuristic method and it is powerful tool for optimization of process design. The primary advantages of this method include simplification in optimization and feasibility of study of interaction between different parameters.

II. LITERATURE REVIEW PART-1 PROCESS PARAMETER OPTIMIZATION OF MILLING PROCESS

Piyush Pandey et al. This experimental study described the development of process in terms of MRR and Surface finish, using Taguchi’s L₁₈ orthogonal array. It was fond that the S/N ratio with Taguchi’s parameter design is a simple, systematic, reliable and more efficient tool for optimizing multiple performance characteristics of CNC milling process parameters. Analysis of variance (ANOVA) is also employed to identify the level of importance of the machining parameters on the multiple performance characteristics namely material removal rate and surface roughness. Assumptions of ANOVA are tested using residual analysis. After careful testing, none of the assumptions was violated. ANOVA results showed that CUTTING SPEED AND FEED RATE are the powerful control parameters for the material removal rate and DEPTH OF CUT AND FEED RATE calculated as powerful factors for controlling the surface finish of Mild Steel. [1]

Ali R. Yildiz et al. In this paper, a new hybrid optimization technique (HDRE) based on the differential evolution algorithm and receptor editing property of immune system is developed and successfully implemented to the optimization of machining parameters in milling operations. Significant improvement is obtained with the proposed hybrid technique in comparison to the results by ant colony algorithm, hybrid particle swarm algorithm, immune algorithm, hybrid immune algorithm, genetic algorithm, and the feasible direction method and handbook recommendations. From this study observe that the proposed hybrid approach performed effectively on the optimization of machining parameters of the milling operation problem finding better solutions compared to other approaches in the literature. These results show that the proposed hybrid approach is an important alternative for optimization of machining parameters in milling operations. In addition, the proposed hybrid approach is a generalized solution method so that it can be easily employed to consider the optimization models of milling regarding various objectives and constraints. The possible future works include application of the proposed work to the other metal cutting problems such as turning, drilling, grinding operations in manufacturing industry as well as design optimization problems. [2]

Azlan Mohd Zain et al. This study has applied the GA technique to estimate the optimal solutions of cutting conditions that lead to the minimum surface roughness value. By reviewing the application of GA for the machining optimization problem involving tool machining parameter of the radial rake angle in the milling process of titanium alloy (Ti–6Al–4V), which focuses on the surface roughness performance. This study has found that the GA technique has been the effective technique for estimating the better results in terms of the best point and average
minimum values of surface roughness compared to the experimental and regression results. It has also been discovered that the optimal value for each of the cutting conditions recommended by the GA which leads to the minimum surface roughness values are satisfied by the cutting conditions range applied in the real experiment. [3]

P.G. Benardo et al. From this study observed that ANNs are a powerful tool, easy-to-use in complex problems where not all of the parameters are straightforwardly engaged. ANNs can be used reliably, successfully and very accurately for the modeling of the surface roughness formation mechanism and the prediction of its value in face milling. Given the accuracy that was achieved it is safe to conclude that all the significant factors were included in the DOE process. The most influential were found to be: the feed rate per tooth, the Fx component of the cutting force, the depth of cut, the engagement of the cutting tool and the use of cutting fluid. The research in the present paper can be extended towards two different directions. Firstly, by investigating more cutting tool and work piece material combinations thus building a database of trained ANNs for a variety of cases. Secondly, the reverse problem is also worthy of consideration. Given a desired value of surface roughness as well as the cutting tool and work piece material, it is necessary to determine the optimum cutting conditions that must be used in order for that value to obtain. The ANN developed in the present paper can deal with is by a trial-and-error process but it is by no means the optimum way to cater for this problem. [4]

III. LITERATURE REVIEW PART-II HARMONY SEARCH ALGORITHM APPROACH FOR— OPTIMIZATION

D. Manjarres et al. This article has posed an overview of the recent applications where the music-inspired Harmony Search algorithm has been shown to be an effective meta-heuristic to solve computationally involved optimization paradigms. This overview is broken down into a set of categories divided by application area, which serves as a useful tool for experimented practitioners and beginners to get a brief description of the latest activity and trends around HS in every such area. For the sake of brevity each category is briefly introduced to the reader by commenting on the most-cited articles found at each application group. As stated in most of the contributions cited in this review manuscript, the HS algorithm features a great potential and efficiency when seeking near-optimal solutions to computationally hard optimization problems. Indeed, the excellent behavior of this Meta-heuristic solver has been widely proven in such references by resorting to intensive simulation-based studies, further buttressed by different statistical hypothesis tests. In light of the sharp increase of activity around HS noted in the last years, it is expected that the computational benefits stemming from this meta-heuristic will span to other emerging fields (e.g. genomics, business intelligence, crime prevention, forensics, smart grids, renewable energy and many other disciplines linked to the so-called Big Data concept), as well as unchain new functionalities and variants of the nominal HS algorithm itself. [5]

Kang Seok Lee et al. Pure discrete size and integrated discrete size and continuous configuration optimization methods for structural systems, based on the HS algorithm, were proposed in this paper. Several standard truss examples from the literature were also presented to demonstrate the effectiveness and robustness of the proposed method. The results were compared to those obtained using current discrete optimization methods, especially GA-based techniques. The illustrative examples revealed that the HS optimal results were better than those obtained from all previous investigations. Also, the convergence capability of the proposed HS approach outperformed that of the GA-based methods. Therefore, our study suggests that the new HS-based method is a potential powerful search and optimization technique for solving structural optimization problems with discrete sizing variables. [6]

O. Zarei et al. In this study, application of harmony search algorithm for optimization of multi-pass face-milling has been investigated. The optimum value of machining parameters including number of passes, depth of cut in each pass, speed and feed are obtained to yield minimum total production cost. The HS algorithm which is a recently developed optimization algorithm has been used as an effective optimizer. The algorithm ability has been demonstrated using an illustrative example and the performance has been compared with GA. Results reveal that the HS algorithm converged to optimum solution with higher accuracy and efficiency in comparison with GA. [7]

Zong Woo Geem et al. This paper reviewed several traditional optimization techniques and existing heuristic methods, and showed the potential of the development of a new algorithm. The algorithm was devised using the analogy of the music performance process and was named Harmony Search. Advantageous features of Harmony Search that are different from other methods are: HS makes a new vector after considering all existing vectors rather than considering only two (parents) as in the genetic algorithm, and HS does not require the setting of initial values of decision variables (for example, initial pipe diameters). These features help HS in increasing flexibility and in finding better solutions. [8]

IV. PROBLEM FORMULATION

In today’s competitive market the quality of parts like surface finish, mechanical strength, dimensional accuracy and manufacturing cost etc. is most important things to satisfy and attract the customers. But as discussed earlier the quality of parts produce by milling process are highly depends upon various process parameters of the process. For that, process parameter optimization of milling process should be carried out. There are different methods of optimization of process parameter like factorial design, Taguchi method, central composite design, response surface methodology as well as conventional and non-conventional algorithms etc. without brief review it is difficult to say which one is better. This paper describes the potentiality of the implementation of harmony search algorithm for the process parameter optimization of Milling process.
V. CONCLUSION

By the above exhaustive literature review, we can say that optimization of milling process parameters is necessary in order to achieve higher quality of the parts. Harmony search algorithm approach is a versatile tool for design optimization. If we analyze the Harmony Search algorithm in the context of the major components of Meta heuristics and try to compare with other Meta heuristic algorithms, we can identify its ways of handling intensification and diversification in the HS method, and probably understand why it is a very successful Meta heuristic algorithm. There are different optimization methods but as shown in above reviews researchers got better results with HSA approach because the implementation of HS algorithm is also easier. There is some evidence which suggest that HSA is less sensitive to the chosen parameters, which means that we do not have to fine-tune these parameters to get quality solutions, so the time and cost are reduced concerned with manufacturing.

REFERENCES