CHAPTER - II

LITERATURE REVIEW

2.1. Overview

The general manufacturing difficulty can be stated as the achievement of expected quality of goods with given machinery, cost, time, and material constraints. Product quality characteristics such as surface roughness it is difficult to commit that these desired effects will be achieved. This review covered in this work presenting the various techniques and methods that are utilized by the encouraging researchers for predicting the surface roughness. The ultimate output of the work is beneficial to manufacturing industries to produce the goods within low cost and minimum time.

The aim of this chapter is to study and summarize the work previously done by researchers using different ways, their thinking process to achieve the objectives, methods and strategies. The work of each researcher along with its limitations and benefits is overviewed exploring brief and sufficient content. This will cover the most relevant work published work recognized in good journals, conferences, books and in media. The review focuses mainly on end milling since this is one of the most common cutting processes.

2.2. Classification of conventional work

To classify the selected papers there are four main categories [2]. These are:

(i) Machining theory based approach
(ii) Examine the influence of different factors conducting experiments and the result analysis.
(iii) Designed experiments and
(iv) Artificial intelligence (AI)

The current work presented a review of the different techniques that are used for predicting the roughness of surface and some comments related to
each approach can be found in the respective articles and papers [4 – 56]. The trend that is formed encourages more automated systems building for online monitoring, measuring or control and is mainly driven by the fact that the processes themselves have been automated to a great extent. All the methodologies and techniques described in this review consist of limitations when compared to one another, but the trend shows that the methodologies and techniques based artificial intelligence are reliable and accurate.

2.3. **Soft Computing**

Metal cutting analyses review pointed out that “Despite the large number of attempts, past and present, to analyze metal cutting, a basic relationship between the various variables is still lacking” [57]. The technological development in computer systems, soft computing techniques and computer based finite element methods are encouraged for modeling of input output variables and machining processes optimization [58–62]. Imprecision, uncertainty, partially correct, and approximation is tolerated in conventional computing where as in advanced techniques such as soft computing knowledge and experience are utilized [63].

2.3.1. **An overview of soft computing application to milling process**

A multi-point cutting tool process in which the cutter rotates at some suitable speed whereas the work piece material feeds past the multi-point cutter is called milling process. The input machining parameters *depth–of-cut, Feed, and Speed* may be adjusted to optimum value to achieve the desired goods cost and minimum time of machining [64 – 70].

2.3.1.1. **Surface roughness**

The surface roughness prediction in milling process using end milling cutter with the application of adaptive network based neuro-fuzzy inference system was investigated [71]. Depth-of-cut, feed-rate, and rotation speed of tool were utilized as input cutting parameters. The Adaptive network neuro-fuzzy inference system was modeled using triang MF and trap MF membership functions. The accuracy of prediction was
achieved up to 96 % with error (average) of four percentages with triang MF. ANFIS was also used to predict roughness of surface roughness on work piece material of aluminum alloy machining with high speed milling was proposed [72].

Genetic algorithm based forecast of surface-finish in domain of end-milling-machining is reported [73]. The computation technique genetic algorithm was available to researcher since from 1992 [74].

An empirical surface model was developed using genetic algorithm for end milling of work piece material medium carbon steel [75]. Minimum surface roughness in milling with optimum cutting conditions was investigated for mould surfaces [76]. Genetic algorithm is also used to optimize tool geometry variables such as nose radius, cutting environment (depth of cut, speed, feed etc.), and rack angle to reach expected surface finish in end milling process without coolant was described [77].

Determination of optimum cutting conditions for end milling process was proposed in an approach for desired surface roughness [78]. The particle swarm optimization observed to be near to optimal results as compare support vector machine for surface roughness prediction.

The work is reported using work piece and tool setting in an end milling process using fuzzy-network based model to predict surface-roughness [79]. Depth-of-cut, Feed and Speed, vibration, cutting tool diameter, cutting tool material, and work-piece material are used as input variables for fuzzy system. The authors found 90 % accuracy during prediction studies of surface-roughness with an average error of 10%.

A fuzzy logic based expert system was described for input parameter optimization for forecasting of surface-finish as well as in an high-speed machining for milling of hardened work piece materials of Rockwell hardness up to 45 HRC [80].

A neural network application was observed in for tool wear prediction in computer numerically controlled milling process using sensor fusion
2.4. Conclusions and discussion on Literature Review

A comparison of these different approaches proposed that Artificial intelligence models take into consideration the techniques of the equipment used and the real machining system, information that is stored in the experimental data used to develop the models. On the other hand, the theoretical approach is based on conventions and idealizations, which are responsible for errors and limitations.

Other advantages of the artificial intelligence approach are that the models generated are more reliable and accurate, they possibly consists of the highest level of computers based integration and that this modeling technique can be used in combination with other more conventional techniques. With these facts taken into consideration, it can be concluded that there are not so many efforts as would have been expected.

It must also be noted that even though some accurate models have been developed there are still problems need to recognized and deal with. Some areas like high accuracy material removal, where surface-roughness is of very important, are still need investigation and factors such as the multi-point cutting-tool deflection or the thermal-conditions must be introduced to future models for a more realistic representation of surface roughness. The integration of the existing models to a more general advisory system, which could be used by a machine tool operator for example, could be another very useful and practical application. Finally, the set of parameters that are thought to influence surface roughness and thus have been investigated by the researchers is diagrammatically displayed with fishbone diagram (Fig. 1.4) with the parameters that affect surface roughness [1] in previous chapter.

Advanced optimization technique described in literature review such as soft computing techniques has been effectively employed for prediction of output parameters like surface roughness, tool wear etc. Hybrid of neural network and fuzzy logic also observed as better prediction modeling technique [82 -118].