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Review Article

OPTIMIZATION APPROACH FOR DESIGN OF SPUR GEAR BASED ON GENETIC ALGORITHM

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ABSTRACT

The problem of designing spur gear with minimum mass and smaller size without violating the constraints plays a major role in today's industrial world since the most commonly encountered mechanical power transmission require low weight. This paper presents a genetic approach to reduce the weight and thickness of the gear, also increases the power transmitting capacity and effectiveness using genetic algorithm (GA). It can be observed that the proposed optimal design with GA has the potential to yield considerably better solutions than the traditional heuristics. At the same time, the GA offers a better understanding of the trade-offs between various constraints.

Keywords: Optimal design, Genetic algorithm, Spur gear.

INTRODUCTION

In most of the machine tools and applications, power transmission becomes an essential criterion. Designing a mechanical power transmission unit is a very complex task. The complexity arises due to two opposing demands created from design and application, i.e., the size of the gear should be decided based on the safety by the designer and the application required the gears with smaller size. Furthermore, it is known that designing of a reducer is an iterative process in which it is necessary to make some tentative choices to determine the optimal size. Moreover, for solving such complex real design problem, conventional optimization techniques are very difficult to consider, taken into account a large number of design variables and the complexity which are highly non-linear nature. For the past decades, evolutionary algorithms such as GA are getting increasing attention to solve the complex mechanical power transmission design problems among the scientific and engineering community. At the same time, the simple trial and error type methods which are used to tackle this design problem are used more rarely.

In this research, four different parameters such as thickness, weight, power transmitting capacity, and number of teeth were considered for the optimization. In turn, these parameters reduce the weight and size of the gear along with the center distance. Furthermore, it improves the efficiency of the power transmission. Thereby, the size of the gear along with the assembly gets reduced, and on the other hand, the effectiveness of the power transmission also increased.

The various works done in the field of gear design optimization have been explained in Section 2. In Section 3, this formulation in detail. Section 4 contains an effective example of optimal design followed by a discussion and a comparison between an optimal design with GAs and traditional design (when we used a common trial and cut error procedure). Eventually, some suggestions regarding the possible extensions of the results of this study are presented.

LITERATURE SURVEY

Madhusudan and Vijayasimha [11] presented a computer program to design a required type of gear under a specified set of working conditions. A new computer-aided method for automated gearbox design was described in Lin and Shea [10]. An interactive physical programming was developed in Huang *et al.* [8] to optimize a three-stage spur gear reduction unit. An expert system for designing and manufacturing a gearbox is described by Aberšek *et al.* [1]. Li and Symmons [9] carried out a study for minimizing the center distance of a helical gear using American Gear Manufacturers Association procedures. An optimal weight design problem of a gear with an improved GA is presented in Yokota *et al.* [17]. A non-dominated sorting genetic algorithm (GA)-II was used in Deb and Jain [3] to solve a multiobjective optimization of a multispeed gearbox. Thompson *et al.* [15] presented a generalized optimal design of two-stage and three-stage spur gear reduction units in a formulation with multiple objectives. The benefits of the particle swarm searches in resolving different engineering designs are shown in Ray and Saini [12]. Two advanced optimization algorithms known as particle swarm optimization and simulated annealing are used in Savsani *et al.* [14] for minimizing the weight of a spur gear train. The results of the proposed algorithms were compared with the results obtained in Yokota *et al.* [17]. In Gologlu and Zeyveli [5], GA was applied to minimize the volume of a two-stage helical gear train. A complete automated optimal design of a two-stage helical gear reducer using a two-phase evolutionary algorithm is presented in Tudose *et al.* [16]. The motivation behind the work described in this paper is that evolutionary computing technology has now reached the level where it is computationally feasible to consider an automated optimal design. The studies referenced above have been instrumented to highlight the importance of using modern global optimization techniques in mechanical power transmission design (as opposite to conventional, trail, and error type methods), even when considering certain subproblems.

Thus, from the above literature, it becomes clear that the researchers were not concentrated on the above defined four parameters for optimization using GA.

SPUR GEAR

Gears are the friction wheels used to transmit the power between the shafts. These gears have the teeth's which will mate with each other, and thereby, it transmits the power. The gear wheel in which the power is given is called as the driven gear and the gear wheel, which rotated by the driven gear is called the driven wheel. The size of the gear pair decides speed and the amount of power to be transmitted. The gears can use to reduce or increase the speed, power, torque, etc.

Gears are classified based on the shape, nature, and application it is used. Some of the commonly used gears are spur gear, helical gear, herringbone gear, bevel gear, worm gear, rack, and many more. S p u r gears are by far the most common type of gear and with the exceptions of the "cog," the type of gear that has been around the longest. Spur gears have teeth that run perpendicular to the face of the gear. Hence, the spur gear is taken in this research to optimize.