ABSTRACT

Cam mechanisms are used in a wide variety of engineering system applications. The most common application of cam is valve actuation in internal combustion engines that transform one of the simple motions, such as rotational or translational, into any other motions including complex motions. Cam devices are versatile and almost any arbitrary-specified motion can be obtained.

The present research work investigation is based on Genetic Algorithm for optimal cam profile design by developing a predictive computer simulation program. The approach does not limit the optimization of the particular cam design but is also used for optimization of follower slenderness with tubular cross-section for robustness and light weight. The Genetic Algorithm discussed in the present work can be applied to optimize cam profiles, in principle, for any type of cam mechanism. The method described in the present work is applied to optimize cam profile for valve operation with cam follower mechanism in an internal combustion engine.

The primary objective of this work is to create a complete systematic approach for cam profile design including follower slenderness design automation with respect to the simulated computer model of cam mechanism. The specific objective is important since a wide variety of cam mechanisms are used to convert the rotational to reciprocating movement of the cam follower, which transmits the movement to an operated device. The cam controls the movement of cam follower by its profile. The design of cam profile for low speed cam mechanism is relatively simple because the components of cam mechanism are considered to be rigid bodies whereas, for high speed cam mechanism it is more complicated. For high speed cam mechanism the cam profile is designed from dynamic perspective because the components of the cam mechanism cannot be assumed to be rigid bodies. Further, the cam profile for high speed is designed for a specified motion, but the displacement of the cam follower does not necessarily follow the cam profile because of the elasticity of the components of the cam mechanism.

The principle of the cam profile optimization is described and discussed in the work. The boundary shape of the cam profile is represented by a B – Spline curve, which makes it possible to express the cam shape in parametric form. A unique characteristic of spline function for cam motion program is that a piecewise polynomial constructed of B-splines can be made to have continuous derivatives up to any order. The advantages of B-spline curves
are that any number of constraints can be satisfied without increasing the degree of resulting B-spline curve. A real coded Multi-objective Genetic Algorithm is developed to solve the problem. By using Genetic Algorithm it is not only possible to design and optimize the cam profiles but can also be applied for the automation of the profile design process which can further be utilized to directly manufacture the required cam either by CNC machines or by Rapid Prototyping method. Furthermore, in classical methods it is necessary to have a feasible initial solution otherwise they are not able to converge towards feasible regions.

The Generic simulation method based on Genetic Algorithm can be used effectively for automatic cam profile determination and systematic predictive computer simulation of cam mechanisms. The results obtained suggest that a systematic evolutionary cam profile optimization approach is capable of finding better solution with respect to the simulation model along with the defined set of objective and constraints, than an intuitive trial and error method.