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THE APPLICATION OF IDEAL SHAPE PARAMETERS IN OPTIMAL SYNTHESIS OF PLANAR MECHANISMS

JACEK BUŚKIEWICZ

Institute of Applied Mechanics, Poznan University of Technology
e-mail: jacek.buskiewicz@put.poznan.pl

Abstract. A curve description invariant under affine transformations allows to minimize the design space in optimal synthesis of a planar mechanism. The paper introduces new curve descriptions and confronts them with functions developed for purposes of pattern recognition in computer image processing. Distance norms in the sense of the similarity of shapes are introduced. The norms are used as objective functions in the optimal synthesis of 1-DOF geared five bar linkage and minimized using the evolutionary algorithm. The mechanisms generating a wide variety of shapes are searched for, and the general conclusion are put forward.

1. INTRODUCTION

One of the most important branches of mechanism theory, mechanism synthesis consists in searching for a mechanism realizing desired motion under additional requirements: structural, geometric, kinematic and dynamic. There exists a wide spectrum of problems related to mechanism synthesis. When a mechanism approximates a required path, the optimal path synthesis is considered. The optimal synthesis is recently intensively investigated, therefore the literature closely related to the subject of the paper is presented. The problem is defined by a design space, an objective function (i.e. a distance between synthesized and generated curves), and an optimization algorithm that minimizes the objective function under additional constraints. To minimize the number of optimized variables and, consequently the time of numerical calculation a distance norm between two curves is expressed in terms of shape parameters instead of the curve points [1-8].

The paper presents the constructions of objective functions expressed in terms of some shape features. The satisfactory results were obtained when a curve was represented as the complex function. The real and imaginary parts were expanded into the Fourier series and their coefficients were normalized [1-4]. The same procedure was applied to such curve features as cumulative angular function or curvature [5-7]. The shape studies are carried out for purposes of pattern recognition in computer image processing. The properties of closed curves are investigated as belonging to the ideal shape parameters that do not depend on geometric transformations. The functional approach is one of the major directions developed. It consists in describing two dimensional objects by signatures, i.e. one-dimensional functions, e.g.: cross-section function for symmetric figures, radius-vector function, support function, width function, tangent-angle function, the curvature as a function of the contour arc length, and the distance of the curve from its centroid [9-14]. In general, these functions are not invariant under all the affine transformations. Therefore in shape analysis the Fourier transform and continuous wavelet are applied to normalize these functions.