The calculus of variations (A Blaisdell book in the pure and applied sciences)

Chapter 5
Fields of Extremals and Sufficient Conditions for the Simplest Problem of the Calculus of Variations in n-Variables

Dean A. Carlson and George Leitmann

Abstract In a 1967 note, Leitmann observed that coordinate transformations may be used to deduce extrema (minimizers or maximizers) of integrals in the simplest problem of the calculus of variations. Subsequently, in a series of papers, starting in 2001, he revived this approach and extended it in a variety of ways. Shortly thereafter, Carlson presented an important generalization of this approach and connected it to Carathéodory's equivalent problem method. This in turn was followed by a number of joint papers addressing applications to dynamic games, multiple integrals, and other related topics.

For the simplest vector-valued variables problem of the calculus of variations, making use of the classical notion of fields of extremals, we employ Leitmann's direct method, as extended by Carlson, to present an elementary proof of Weierstrass' sufficiency theorem for strong local and global extrema.

5.1 Introduction

Coordinate transformations have long played a significant role in the analysis of many important problems in control theory as well as other disciplines. For dynamic optimization problems, perhaps the first important contribution in this arena was in the 1830s with Hamilton's introduction of coordinate transformations which was soon put on a firm theoretical foundation by Jacobi. This theory led to the Hamilton–Jacobi equation, an equation that is under extensive investigation to this day. The original goal of a coordinate transformation was to rewrite a system of differential equations, usually arising from a variational principle (i.e., the Euler–Lagrange

Dean A. Carlson
American Mathematical Society, Mathematical Reviews, 416 Fourth Street, Ann Arbor, MI 48103, USA, e-mail: dac@ams.org

George Leitmann
University of California, Berkeley, CA 94720, USA, e-mail: gleit@berkeley.edu

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