Betts, John T.

Practical methods for optimal control using nonlinear programming. (English) Zbl 0995.49017
Advances in Design and Control. 3. Philadelphia, PA: SIAM. x, 190 p. (2001).

The book is devoted to the study of algorithms for solving numerically optimal control problems (OCP) of ordinary differential equations. The main emphasis is on the so-called transcription method, that consists in a time discretization that reduces the OCP to a nonlinear programming problem (NLP). The NLP is then solved by an algorithm that will possibly take advantage of the dynamic structure. After that, the time discretization may be refined and a bigger corresponding NLP solved, until a sufficient accuracy is obtained. The book starts by an overview of the basic theory of nonlinear programming problems, and of the implementation of sequential quadratic programming algorithms, the quadratic program being solved using active set strategies. A special attention is given to the implementation for large scale and sparse problems. In a second part, the transcription method is described, mainly in the framework of Runge-Kutta discretization schemes. The mesh refinement, scaling, and sparse finite differences are discussed. A comparison with shooting algorithms is given. Finally, several significant real world problems are discussed, including aircraft trajectories and the control of industrial robots. A description of the software of the author is given.

The book is very well written, and gives a concise and well illustrated view of the power of discretization schemes for ordinary differential equations, combined with optimization algorithms, for solving significant problems; no book of this kind existed before. All practical aspects are discussed in detail, and hence, engineers and practitioners will find it quite useful.

Reviewer: Joseph Frédéric Bonnans (Le Chesnay)

MSC:

49M37	Numerical methods based on nonlinear programming
90C30	Nonlinear programming
65L50	Mesh generation, refinement, and adaptive methods for ordinary differential equations

Keywords:

optimal control; transcription method; ordinary differential equations; nonlinear programming