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Journal of Differential Equations 314 (2022) 161–200

Journal of Differential Equations

www.elsevier.com/locate/jde

Geometric analysis of nonlinear differential-algebraic equations via nonlinear control theory

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Received 2 May 2021; revised 8 December 2021; accepted 6 January 2022
Available online 19 January 2022

Abstract

For nonlinear differential-algebraic equations (DAEs), we define two kinds of equivalences, namely, the external and internal equivalence. Roughly speaking, the word "external" means that we consider a DAE (locally) everywhere and "internal" means that we consider the DAE on its (locally) maximal invariant submanifold (i.e., where its solutions exist) only. First, we revise the geometric reduction method in DAEs solution theory and formulate an implementable algorithm to realize that method. Then a procedure called explicitation with driving variables is proposed to connect nonlinear DAEs with nonlinear control systems and we show that the driving variables of an explicitation system can be reduced under some involutivity conditions. Finally, due to the explicitation, we use some notions from nonlinear control theory to derive two nonlinear generalizations of the Weierstrass form.

MSC: 34A09; 93B17; 93B27; 93B10; 93C10

Keywords: Geometric control methods; Nonlinear differential-algebraic equations; Explicitation; Internal equivalence; Invariant submanifolds; Nonlinear Weierstrass form

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https://doi.org/10.1016/j.jde.2022.01.008