Robust mixed order backstepping control of non-linear systems

Por: Gallegos, JA (Gallegos, Javier A.)[1] ; Duarte-Mermoud, MA (Duarte-Mermoud, Manuel A.)[1,2]

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Abstract

Robust backstepping control of non-linear systems with derivation orders (commensurate or non-commensurate) lying at interval (0, 2) is proposed in this study. The stability and robustness properties are proved using a linearisation procedure in contrast to the classic recursive Lyapunov approach to backstepping. Vector, adaptive and robustness extensions are then developed to solve general tracking and stabilisation control problems. The adaptive extension is proved with a non-Lyapunov approach based on inequalities on non-negative fractional integrals. The mixed-order nature enables to control integer order systems using fractional operators. Through simulations, it is shown that the performance of the controllers depends on their derivation orders. In particular, for transient behaviour and the root mean square value of the control signal, the fractional controllers proposed exhibit improved responses as compared with the integer ones.

Palabras clave

Palabras clave de autor:robust control; control nonlinearities; nonlinear control systems; linearisation techniques; vectors; adaptive control; mathematical operators; robust mixed order backstepping control; nonlinear systems; stability properties; robustness properties; linearisation procedure; vector; adaptive extensions; general tracking problems; stabilisation control; nonLyapunov approach; nonnegative fractional integrals; mixed-order systems; integer order systems; fractional operators; transient behaviour; root mean square value; control signal; fractional controllers
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Información del autor

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+ Univ Chile, Dept Elect Engn, Ave Tupper 2007, Santiago, Chile.

Direcciones:

+ [1] Univ Chile, Dept Elect Engn, Ave Tupper 2007, Santiago, Chile

+ [2] Univ Chile, Adv Min Technol Ctr, Ave Tupper 2007, Santiago, Chile

Direcciones de correo electrónico:jgallego@ing.uchile.cl

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