

## ON CONTROLLABILITY OF LINEAR AND NONLINEAR FRACTIONAL INTEGRODIFFERENTIAL SYSTEMS

MOHAMMED M. MATAR

**Abstract.** In this article we investigate the controllability problem of linear and nonlinear fractional integrodifferential systems. We justify the controllability concepts on a fractional integrodifferential linear system, and use results, as well as Schauder's fixed point theorem, to obtain the controllability of the corresponding nonlinear system. Some applications are introduced to explain the theoretic parts.

*Mathematics subject classification (2010):* 34K37, 93B05.

*Keywords and phrases:* Controllability, fractional differential system, Caputo, Schauder's fixed point.

### REFERENCES

- [1] A. B. SHAMARDAN, M. R. A. MOUBARAK, *Controllability and observability for fractional control systems*, Journal of Fractional Calculus **15**, (1999), 25–34.
- [2] A. KILBAS, H. SRIVASTAVA AND J. TRUJILLO, *Theory and Applications of Fractional Differential Equations*, Elsevier, Amsterdam, 2006.
- [3] B. SIKORA, J. KLAMKA, *Constrained controllability of fractional linear systems with delays in control*, Systems & Control Letters **106**, (2017), 9–15, doi.org/10.1016/j.sysconle.2017.04.013.
- [4] D. XU, Y. LI, AND W. ZHOU, *Controllability and Observability of Fractional Linear Systems with Two Different Orders*, The Scientific World Journal, Article ID **618162**, (2014), 8 pages, <http://dx.doi.org/10.1155/2014/618162>.
- [5] I. PODLUBNY, *Fractional Differential Equations*, Academic Press, San Diego, 1999.
- [6] J. KLAMKA, *Controllability of Dynamical Systems*, Springer, Netherlands, 1991.
- [7] J. P. DAUER , N. I. MAHMUDOV, M. M. MATAR, *Approximate controllability of backward stochastic evolution equations in Hilbert spaces*, J. Math. Anal. Appl. **323**, (2006), 42–56, doi:10.1016/j.jmaa.2005.09.089.
- [8] K. BALACHANDRAN, *Controllability of Nonlinear Fractional Delay Dynamical Systems with Multiple Delays in Control*, in: Babiarz A., Czornik A., Klamka J., Niezabitowski M. (eds.), *Theory and Applications of Non-integer Order Systems*, Lecture Notes in Electrical Engineering **407**, Springer, Cham, 2017.
- [9] K. BALACHANDRAN, M. M. MATAR AND J. J. TRUJILLO, *Note on controllability of linear fractional dynamical systems*, Journal of Control and Decisions **3**, 4 (2016), 267–279, doi.org/10.1080/23307706.2016.1217754.
- [10] M. MATAR, *Existence of solution involving Genocchi numbers for nonlocal anti-periodic boundary value problem of arbitrary fractional order*, Revista de la Real Academia de Ciencias Exactas, Físicas y Naturales Serie A. Matemáticas **112**, 4 (2018), 948–956, doi.org/10.1007/s13398-017-0403-x.
- [11] M. MATAR, *Controllability of Fractional Semilinear Mixed Volterra-Fredholm Integrodifferential Equations with Nonlocal Conditions*, Int. Journal of Math. Analysis **4**, 23 (2010), 1105–1116.
- [12] R. HILFER, H. J. SEYBOLD, *Computation of the generalized Mittag-Leffler function and its inverse in the complex plane*, Integral Transforms and Special Functions **17**, 9 (2006), 637–652.
- [13] R. J. NIRMALA, K. BALACHANDRAN, *Controllability of Fractional Nonlinear Systems in Banach Spaces*, Journal of Applied Nonlinear Dynamics **5**, 4 (2016), 485–494.

- [14] S. KUMAR AND N. SUKAVANAM, *Approximate controllability of fractional order semilinear systems with bounded delay*, J. Differential Equations **252**, 11 (2012), 6163–6174.
- [15] T. KACZOREK, *Cayley-Hamilton Theorem for Fractional Linear Systems*, in: Babiarz A., Czornik A., Klamka J., Niezabitowski M. (eds.), Theory and Applications of Non-integer Order Systems, Lecture Notes in Electrical Engineering **407**, Springer, Cham, 2017.
- [16] Z. FAN, *Approximate controllability of fractional differential equations via resolvent operators*, Adv. Difference Equ. **54**, (2014), 11 pages.