

**EXACT NULL CONTROLLABILITY OF SEMILINEAR NONLOCAL
AND NON-AUTONOMOUS SYSTEM**

ABASS SOW, BOULKHAIRY SY AND CHEIKH SECK

ABSTRACT. In this article, by using the theory of linear evolution system and Schauder fixed point theorem, we study the existence of mild-solutions for fractional semilinear systems of non-autonomous deformable with nonlocal conditions in Hilbert spaces. Furthermore, we establish the exact null controllability of these systems. An example is provided to show the practical application of our results.

REFERENCES

- [1] G.W. Leibniz: *Letter from Hanover, Germany, to Johann G.F.A. L'Hospital, September 30, 1695*, Mathematische Schriften, Olms-Verlag, Hildesheim, Germany, **2**(1962) (First published in 1849), 301-302.
- [2] A.A. Kilbas, H.M. Srivastava and J.J. Trujillo: *Theory and Applications of Fractional Differential Equations*, Elsevier, 2006 (NHMS 204).
- [3] K.S. Miller and B. Ross: *An Introduction To The Fractional Calculus and Fractional Differential Equations*, J. Wiley and Sons, New York, 1993.
- [4] I. Podlubny: *Fractional Differential Equations: An Introduction to Fractional Derivatives, Fractional Differential Equations, to Methods of Their Solution and Some of Their Applications*, Elsevier, 1998 (MSE 198).
- [5] R. Khalil, M. Al Horani, A. Yousef and M. Sababheh: *A new definition of fractionnal derivate*, J. Comput. Appl. Math., **264**(2014), 65-70.
- [6] L. Byszewski: *Theorems about the existence and uniqueness of solutions of a semilinear evolution nonlocal cauchy problem*, J. Math. Anal. Appl., **162**(1991), No. 2, 494-505.
- [7] K. Deng: *Exponential decay of solutions of semilinear parabolic equations with nonlocal initial conditions*, J. Math. Anal. Appl., **179**(1993), No. 2, 630-637.
- [8] K. Ezzibni, X. Fu and K. Hilal: *Existence et régularité dans la norme η pour certaines équations différentielles partielles neutres avec des conditions non locales*, Nonlinear Anal., **67**(2007), No. 5, 1613-1622.
- [9] X. Fu: *Approximate controllability for neutral impulsive differential inclusions with nonlocal conditions*, J. Dyn. Control Syst., **17**(2007), No. 3, 359-386.
- [10] M. Guo, X. Xue and R. Li: *Controllability of impulsive evolution inclusions with nonlocal conditions (contrôlabilité des inclusions d'évolution impulsives avec des conditions non locales)*, J. Optim. Theory Appl., **120**(2004), No. 2, 355-374.
- [11] J. Liang, J. Liu and T.J. Xiao: *Nonlocal Cauchy problems governed by compact operator families*, Nonlinear Anal., **57**(2004), No. 2, 183-189.
- [12] A. Boucherif: *Inclusions d'évolution semi-linéaires avec des conditions non locales*, Appl. Math. Lett., **22**(2009), No. 8, 1145-1149.

Received: November 17, 2025. *Revised:* March 12, 2026.

2020 *Mathematics Subject Classification:* 47J25, 47H10.

Key words and phrases: Exact null controllability, semi-linear systems, nonlocal conditions, deformable derivative, non-autonomous systems, Schauder fixed point theorem.

- [13] P. Chen and Y. Yongxiang Li: *Monotone iterative technique for class of semilinear evolution equations with nonlocal conditions*, Results Math., **63**(2013), 731-744.
- [14] Ti-Jun Xiao et Jin Liang: *Existence de solutions classiques à des problèmes paraboliques non autonomes et non locaux*, Nonlinear Anal., **63**(2005), No. 5, 225-232.
- [15] J. Wang, M. Fečkan and Y. Zhou: *Approximative controllability of Sobolev type fractional evolution systems with nonlocal conditions*, Evol. Equ. Control Theory, **6**(2017), No. 3, 471-486.
- [16] N.I. Mahmudov: *Approximate controllability of evolution systems with nonlocal conditions*, Nonlinear Anal., **68**(2008), No. 3, 536-546.
- [17] D.P. Jha and R.K. George: *Exact null controllability of non-autonomous conformable fractional semilinear systems with nonlocal conditions*, 20 Apr 2025, arXiv:2409.16087v2 [math.OC], 20 pages.
- [18] F. Zulfequarr, P. Ahuja and A. Ujlayan: *New fractional derivative and fractional integral with some applications*, 26 Apr 2017, arXiv:1705.00962v1 [math.CA], 11 pages.
- [19] A. Meraj and D.N. Pandey: *Existence and uniqueness of mild solution and approximate controllability of fractional evolution equations with deformable fractional derivative*, J. Nonlinear Evol. Equ. Appl., **2018**(2019), No. 7, 85-100.
- [20] M. Etefa, G.M. N'Guérékata and M. Benchohra: *Existence and uniqueness of solutions to impulsive fractional differential equations via the deformable derivative*, Appl. Anal., **104**(2021), No. 1, 15-26.
- [21] K.M. Anjitha, V. Kavitha, S. Sivasundaram and M.M. Arjunan: *Existence results for fractional neutral differential inclusion via deformable fractional derivative in Banach spaces*, Nonlinear Stud., **30**(2023), 351-364.
- [22] S. Raju, R.B. Sevugan, R. Udhayakumar, G. Alnemer and U. Arunachalam: *Approximate controllability of neutral differential systems with fractional deformable derivatives*, Fractal Fract., **7**(2023), No. 10, 18 pages.
- [23] N.I. Mahmudov and S. Zorlu: *On the approximate controllability of fractional evolution equations with compact analytic semigroup*, J. Comput. Appl. Math., **259**(2014), 194-204.
- [24] W.E. Fitzgibbon: *Semilinear functional differential equations in Banach space*, J. Differential Equations, **29**(1978), No. 1, 1-14.
- [25] J.P. Dauer and N.I. Mahmudov: *Exact null controllability of semilinear integrodifferential systems in Hilbert spaces*, J. Math. Anal. Appl., **299**(2004), No. 2, 322-332.
- [26] Avner Friedman: *Partial Differential Equations*, Holt, Rinehart and Winston Inc., New York, 1969.
- [27] A. Pazy: *Semigroup of Linear Operators and Applications to Partial Differential Equations*, Springer-Verlag, New York, 1983 (AMS 44).
- [28] R.F. Curtain and H. Zwart: *An Introduction to Infinite-Dimensional Linear Systems Theory*, Springer Science and Business Media, 2012 (TAM 21).

Université Cheikh Anta Diop de Dakar
 Faculté des Sciences et Techniques
 Laboratoire de Mathématiques Appliquées (LMA)
 Sénégal
 Email address: abass.sow@ucad.edu.sn

Université Cheikh Anta Diop de Dakar
 Faculté des Sciences et Techniques
 Laboratoire de Mathématiques Appliquées (LMA)
 Sénégal
 Email address: boukhaïry.sy@ucad.edu.sn

Université Cheikh Anta Diop de Dakar
 Faculté des Sciences et Technologies de l'Éducation et de la Formation
 Département de Mathématiques de la FASTEF ex ENS, UCAD
 Laboratoire d'Analyse Numérique et d'Informatique (LANI), UFR SAT
 Université Gaston Berger, Saint-Louis
 Sénégal
 Email address: cheikh5.seck@ucad.edu.sn