Dynamics of Continuous, Discrete and Impulsive Systems
Series **B:** *Applications & Algorithms* **30 (2023)** 123-133

CONTROLLABILITY OF SUSPENSION BRIDGE MODEL PROPOSED BY LAZER AND MCKENNA UNDER THE INFLUENCE OF IMPULSES, DELAYS, AND NON-LOCAL CONDITIONS

Walid Zouhair[1] and Hugo Leiva[2]

[1]Cadi Ayyad University Faculty of Sciences Semlalia LMDP, UMMISCO (IRD-UPMC), B.P. 2390 Marrakesh, Morocco, walid.zouhair.fssm@gmail.com.

[2]Universidad Yachay Tech, San Miguel de Urcuqui, School of Mathematical Sciences and Information Technology, Ecuador, hleiva@yachaytech.edu.ec , hleiva@ula.

Abstract. The main purpose of this paper is to prove the controllability of the model proposed by Lazer and Mckenna under the influence of impulses, delay, and non-local conditions. First, we study approximate controllability by employing a technique that pulls back the control solution to a fixed curve in a short time interval. Subsequently, based on Banach Fixed Point Theorem we investigate the exact controllability.

Keywords. Lazer and Mckenna's model, suspension bridges, controllability, impulsive semilinear evolution equation, delays, nonlocal conditions, Banach Fixed Point Theorem.

AMS (MOS) subject classification: Primary 34K35; Secondary 37L05.

1 Introduction

Impulsive dynamic systems are a type of hybrid system for which the trajectory admits discontinuities at certain instants due to sudden jumps of the state called pulses (see more in [3]). The dynamic behavior of many systems in real life can be characterized by abrupt changes that appear suddenly, such as heartbeats, drug flows, the value of stocks, impulse vaccination, and bonds on the stock market. In the past few decades, many authors worked on existence, stability, and controllability results for impulsive dynamic systems, we mention [4, 6, 7, 12, 13, 15, 20, 23]. In particular, there are some relevant studies on impulsive systems with delay, and non-local conditions, see for instance [2, 17, 19, 24]), and the references therein.

When a real-life problem is mathematically modeled, there are always intrinsic phenomena that are not taken into account, and which can affect the behavior of such a model. For example, in the case of suspension bridges, the resonance phenomenon is well known by its external forces that can have the same natural frequency as the bridge, causing it to vibrate until it breaks. To solve this problem, several authors launched different studies