Dinâmica de Sistemas Multicorpo

Embriogénese

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O que é a dinâmica?

A dinâmica é, por definição, a disciplina da mecânica em que se estuda a relação entre o movimento dos corpos e as causas que o provocam.

Na dinâmica estudam-se as caraterísticas do movimento e o modo como esse movimento é produzido.

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Qual é o cerne da dinâmica de sistemas multicorpo?

A dinâmica de sistemas multicorpo permite compreender como é que o movimento acontece e, assim, saber qual é o papel das forças no movimento produzido.

O âmago da dinâmica de sistemas multicorpo está na conexão entre as causas (forças) e o efeito (movimento).

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Em dinâmica de sistemas multicorpo, a massa e a força são os ingredientes essenciais, uma vez que possibilitam o estudo do modo como o movimento sucede.

A dinâmica de sistemas multicorpo alicerça-se no florilégio de conhecimento que a mecânica clássica encerra, nomeadamente nos estudos de Galileu, que rompeu definitivamente com a mecânica aristotélica.

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Qual é a génese da dinâmica de sistemas multicorpo?

O princípio de inércia de Galileu constitui uma das bases da dinâmica de sistemas multicorpo.

Este princípio diz que um corpo permanece em repouso ou movimento uniforme a menos que sobre ele atua uma força externa, *i.e.*, um corpo não se move espontaneamente.

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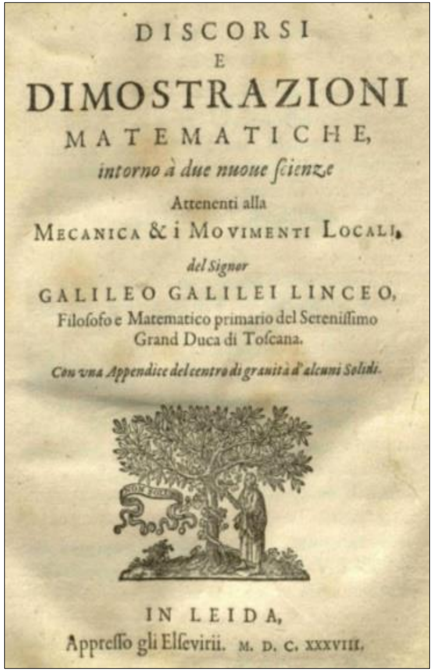
A obra "Discurso sobre as Duas Novas Ciências"

Galileu
Galilei
1564-1642



"A Bíblia mostra a trajetória para o céu, mas não as trajetórias dos céus."

"As leis da natureza foram escritas pelas mãos de Deus na linguagem da matemática."

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Genealogia académica

Galileu Galilei

1564-1642

Vincenzo Viviani

1622-1703

Isaac Barrow

1630-1677

Isaac Newton

1642-1727

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Genealogia académica

Isaac
Newton

1642-1727

Roger
Cotes

1682-1716

Robert
Smith

1689-1768

Walter
Taylor

1700-1743

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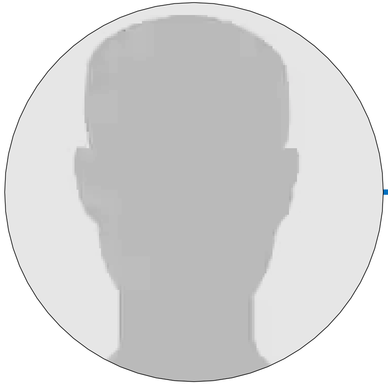
Genealogia académica



Walter
Taylor

1700-1743

Stephen
Whisson

1710-1783

Thomas
Postlethwaite

1731-1798

Thomas
Jones

1756-1807

Genealogia académica

Thomas Jones

1756-1807

Adam Sedgwick

1785-1873

William Hopkins

1793-1866

Edward Routh

1831-1907

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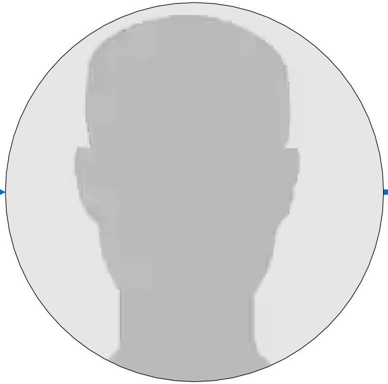
Genealogia académica

Edward
Routh

1831-1907



Robert
Webb

1850-1936

Richard
Southwell

1888-1970

Derman
Christopherson

1915-2000

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Genealogia académica

Derman Christopherson

1915-2000

Duncan Dowson

1928-2020

Sousa Miranda

PhD 1983

Pimenta Claro

1957-2018

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Pimenta
Claro

1957-2018

Paulo
Flores
PhD 2005

Jorge
Ambrósio

PhD 1991

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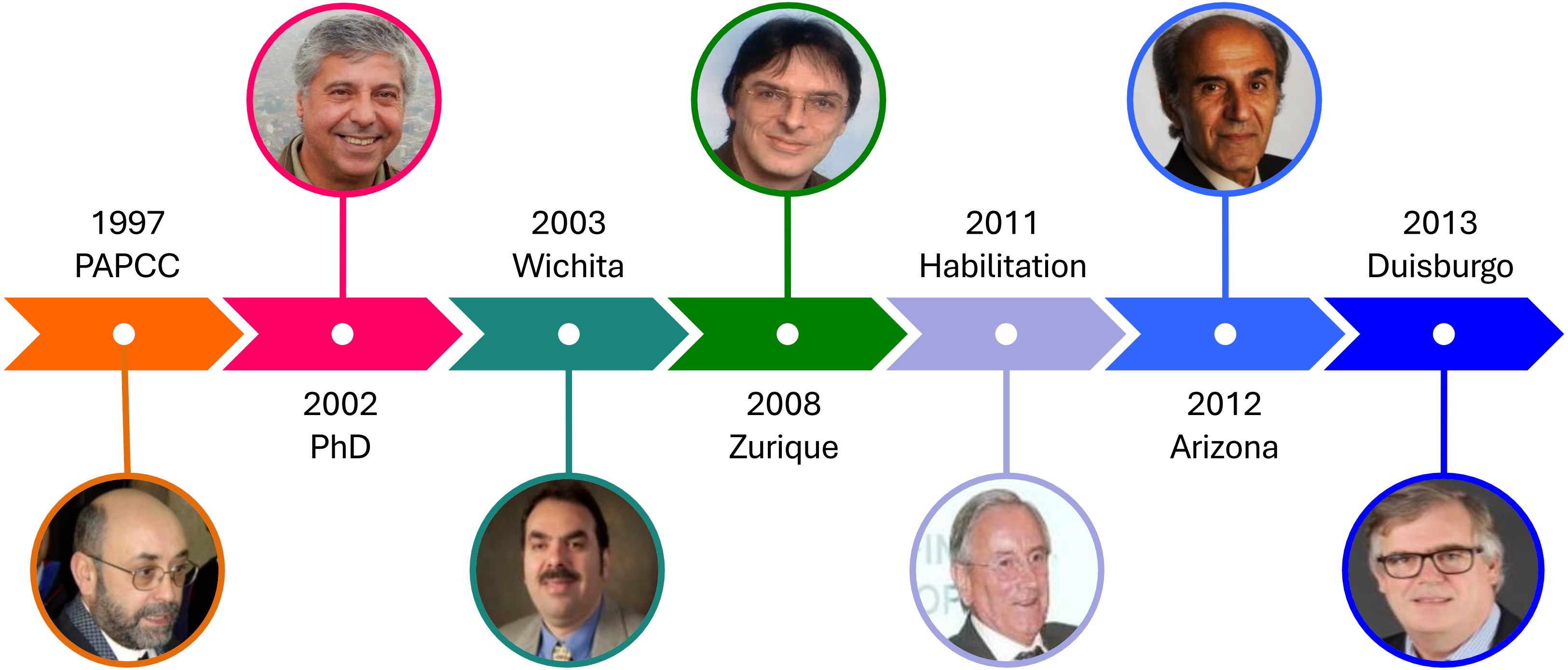
Contributos



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O que vimos neste vídeo?

- ✓ Revisão sobre o conceito de dinâmica,
- ✓ Cerne da dinâmica de sistemas multicorpo,
- ✓ Génese da dinâmica de sistemas de corpos múltiplos,
- ✓ Genealogia académica desde Galileu até hoje.

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Sugestões de leitura complementar.

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Contact mechanics for dynamical systems: a comprehensive review

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Abstract
This work reviews the main techniques to model dynamical systems with contact-impact events. Regularized and non-smooth formulations are considered, wherein the fundamental features associated with each approach are analyzed. A brief description of contact dynamics is presented, and an overview of the state-of-the-art of the main aspects related to the contact dynamics discipline is provided. This paper ends by identifying gaps in the current techniques and prospects for future research in the field of contact mechanics in multibody dynamics.

Keywords Contact mechanics · Dynamical systems · Multibody dynamics · Contact detection · Contact resolution · Regularized methods · Non-smooth formulations

1 Introduction

Many applications of multibody dynamics to real-world mechanical systems demand the analysis of contact scenarios [1]. Contact behavior depends on the matter at hand, material properties, and technique utilized to model the contact dynamics. In a simple and comprehensive manner, a contact dynamics formulation is a threefold problem, involving the determination of potential contact points between the colliding bodies within a multibody system, the evaluation of the contact-impact forces, and the establishment of the transition between contact and non-contact scenarios, and between different contact states [2].

Contact mechanics can be understood as the study of the deformation of solid bodies when they collide with each other. Frictional contact mechanics analyzes the interaction of colliding bodies in the presence of friction phenomena [3]. It is worth noting that contact mechanics is omnipresent in many multibody dynamics applications, and in many cases, the performance of the systems depends on the modeling process of the contact-impact events [4–11]. Contact dynamics, which deals with the motion analysis of multibody systems subjected to collisions, is still one the most challenging and complex areas in science and engineering [12–31].

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Contact-impact events with friction in multibody dynamics: Back to basics

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ABSTRACT

Multibody dynamics deals with the study of mechanical systems composed of multiple bodies, whose motion interactions are governed by the presence of kinematic constraints and by the application of external forces. Frictional contact-impact events are among the most complex and important phenomena that can be modeled under the umbrella of multibody systems, since their behavior depend on critical factors, including geometry of the contacting surfaces, material properties of the colliding bodies, and constitutive laws utilized to mimic the contact response. This paper is aimed to present a comprehensive description of the most relevant aspects and the state-of-the-art techniques concerning the modeling collisions in multibody dynamics. For that purpose, the contact geometry, contact detection and contact resolution procedures are subjected to a critical analysis. Particular attention is given to the regularized or continuous models to treat frictional contacts in dynamical systems. Moreover, relevant numerical ingredients associated with contact-impact events in multibody systems are examined with the intent to discuss the computational accuracy and efficiency. Application examples are provided whose results allow to highlight the key features related to the modeling process of frictional contacts and impacts in multibody systems.

1. Introduction

This paper is aimed at presenting a general introduction and a comprehensive discussion of the state-of-the-art on the computational techniques to address frictional collisions within the discipline contact-impact dynamics in multibody systems. The topic of contact-impact dynamics can be understood as the study of the motion of mechanical systems in the presence of contact-impact forces or impulses. The main motivation for this work comes from the continuous existing interest in developing models for the dynamic simulation of multibody models with frictional collisions. Contact dynamics problems are omnipresent in wide spectrum of practical applications, as in many mechanical systems, the function and performance of the systems strongly depend on the contact-impact phenomena. The spirit of this work lies on the critical analysis of the basics and fundamentals of contact dynamics returning to the simple and most important aspects related to the frictional collisions in multibody systems.

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