NEW TRENDS ON INTEGRITY RELIABILITY FAILURE

J.F. Silva Gomes
Shaker A. Meguid
Editors

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EDITORS' PREFACE

IRF2016 is the fifth international gathering of a prestigious series of Integrity-Reliability-Failure conferences coordinated by the International Scientific Committee of Mechanics and Materials in Design. This series of conferences are wholy devoted to advances in mechanics, materials, structural integrity and design. IRF2016 is jointly sponsored by the University of Porto and the University of Toronto, and it took place in the facilities of FEUP-Faculty of Engineering of University of Porto, in the beautiful city of Porto/Portugal, from 24 to 28 July 2016. The conference attracted over 200 participants with 220 accepted submissions involving 510 authors from 38 different countries around the world. The conference themes which address novel and advanced topics on Integrity, Reliability and Failure focused on Computational Mechanics, Experimental Mechanics, Fracture and Fatigue, Composite and Advanced Materials, Tribology and Surface Engineering, Mechanical Design and Prototyping, Biomechanical Applications, Civil Engineering Applications, Energy and Thermo-Fluid Systems, and Industrial Engineering and Management, among other topics.

We believe that the meeting offered our delegates a forum for the discussion and dissemination of their recent work in assessing the integrity, reliability and failure of engineering structures, components and systems, fostered research that integrates mechanics and materials in the design process, and promoted exchange of ideas and international co-operation among scientists and engineers in this important field of engineering.

We are particularly indebted to the authors and special guests for their presentations. Each of the 220 contributions offered opportunities for thorough discussions with the authors. Particularly, we acknowledge the excellent contributions of the participants, their innovative ideas and research directions, the novel modeling and simulation techniques, and the invaluable critical comments. We are also indebted to the outstanding keynote speakers who highlighted the conference themes with their contributions and covered the main topics of the conference. We also take this opportunity to thank the members of the International Scientific Committee and the reviewers for their time, effort and helpful suggestions.

We offer our sincere gratitude to the symposia organisers for their efforts and valuable contributions to the success of the event, and the local organising committee for attending to the conference demands and delegates needs.

All in all, IRF2016 was a great success and the credit must go to all the participants for their significant contributions and lively discussions, the keynote speakers for bridging the gap between the different disciplines and the organizing committee for an absolutely superb organization of the meeting in this magnificent city. To all of you, we offer our gratitude.

Given the rapidity with which science is advancing in all areas of mechanics and materials, the next conference in this series (Mechanics and Materials in Design - M2D2017) will take place in Algarve, Portugal in June 2017. Undoubtedly, we expect M2D2017 to be as stimulating and interesting as IRF2016, as evidenced by the excellent contributions offered in this current event. We look forward to seeing all of you in Algarve 2017.

Shaker A. Meguid and J.F. Silva Gomes
Porto / Portugal, July 2016

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FUZZY BASED CONTROL AND MODELLING OF A MR DAMPER FOR VIBRATION REDUCTION OF SDOF STRUCTURAL SYSTEMS

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ABSTRACT

Passive, active, semi-active and hybrid control of wind and seismic induced vibrations in civil structures has been widely studied and reported in the last decades. Due to the noticeable advantages .over other control approaches, semi-active control constitutes a promising technology to civil engineering applications, in particular intelligent damping systems such as those based on MR dampers. Besides, fuzzy based control systems are particularly suitable for non-linear structures or uncertain systems such as civil structures. In this context, this paper presents a semi-active control approach for a SDOF structure equipped with a MR damper under earthquake excitation. A fuzzy model of the MR damper and a fuzzy control algorithm are proposed and numerically studied. The results show the effectiveness of the suggested semi-active control system in reducing the response of the SDOF structure.

Keywords: Fuzzy control, semi-active control, MR damper.

INTRODUCTION

Structural control systems are designed to improve the response and mitigate damage in civil structures. The mechanical simplicity of MR dampers represents a considerable advantage to design reliable semi-active control systems. However, the complex hysteretic behaviour of MR dampers and also the non-linear nature of most civil structures require advanced control algorithms to design feasible control system for civil engineering applications. Soft computing techniques such as fuzzy logic algorithms represent an appropriate approach to deal with non-linear systems. Besides, the fuzzy control does not need an accurate model of the system, which can be represented by a set of fuzzy variables and fuzzy rules that can deal with model non-linearities and uncertainties (Zimmermann, 2001). However, establishing reasonable fuzzy rules is a very challenging task mainly because there is no systematic method to define those rules. In most cases, fuzzy rules are created based only on the knowledge about the dynamics of the system (Braz-César 2015a,b).

In the present study, a semi-active fuzzy based control system is proposed to reduce vibrations due to seismic loading of a SDOF structure using a MR damper. The device can be operated as a passive device and a semi-active control actuator, i.e., the dissipative behaviour of the MR damper can be modified in accordance with the system response by means of a control algorithm that computes the required control action providing a continuous control instead of the bi-state type control offered in typical controllers. Furthermore, a neuro-fuzzy

developed based on the numerical results of the modified Bouc-Wen model. The Simulink model of the semi-active fuzzy based controller is shown in Figure 1.

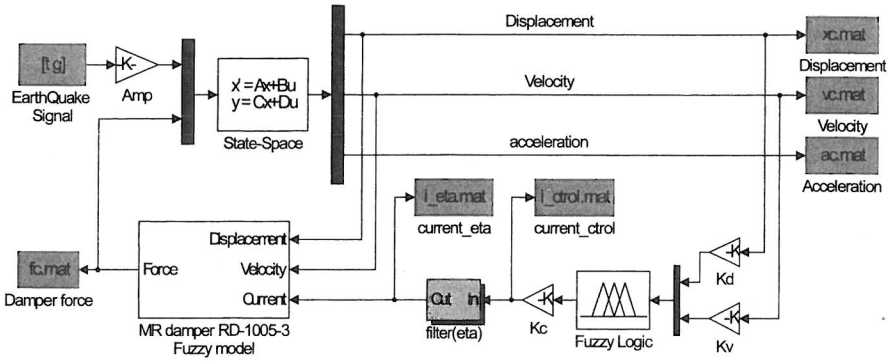

Fig. 1 - Simulink model of the fuzzy based semi-active control system.

This paper presents the results of the proposed semi-active control system. It is shown that this fuzzy control approach can be effective in reducing seismic-induced vibrations of a SDOF structure compared with passive control modes.

RESULTS AND CONCLUSIONS

In this paper, a fuzzy based semi-active control approach is used to reduce the response of a SDOF structure. A simple fuzzy logic controller computes the control signal based on the system states, which is used to command a MR damper to generate the desired damping force. The proposed control algorithm in combination with the fuzzy model of the MR damper has proven to be an effective control system in reducing the structural response over the uncontrolled and passive control cases. Further research using the proposed model will be carried out not only in simple structural systems, but also in tridimensional multi-DOF structures with several MR damping devices.

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About the Book:

This volume contains the extended Abstracts of papers accepted for presentation in the *IRF2016 - 5th International Conference on Integrity-Reliability-Failure* held in Porto/Portugal, 24-28 July 2016. The book is complemented by an accompanying CD-ROM containing the full length papers.

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