

EXPERIMENTAL MODELLING AND CONTROL OF A TOWER CRANE IN THE FREQUENCY DOMAIN

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Abstract: The laboratory tower crane by INTECO is used in research and education of control engineering for mechatronics. Its modelling and control include several subsystems. The paper deals with identification of dynamic model of trolley motion along the jib and trolley position controller design, as well as design of compensator to damp payload oscillations in the direction along the jib. A thorough frequency domain analysis of obtained results is provided.

KEYWORDS: Bode diagram, control, frequency domain, Nichols chart, oscillations damping, tower crane

1 Introduction

A crane can be described as a lifting device that lifts objects in a vertical or horizontal positions within a defined space. Cranes are often used in construction, engineering, metallurgical industries, commerce, on oil platforms, in refineries and nuclear power plants etc. Cranes can be divided into static cranes (including tower cranes, unloading cranes and telescopic cranes) and mobile cranes (including auto cranes, belt cranes, train cranes, portal cranes and ship cranes). In general, a crane construction has a supporting part, several pulleys, a jib and counterweights.

Crane control is a very difficult task and provides many problems to solve. The most important task is to ensure that the desired setpoint of the object is achieved with a required accuracy. For this reason, the control is important to minimize costs, increase work efficiency and also minimize the risk of damage to nearby objects. A serious problem are payload oscillations which can occur as a result of weather conditions or incorrect weight distribution of the carried object but primarily they are due to the payload lift-line and can be transferred to the crane construction and impair its stability. The payload oscillations can be greatly reduced using input shaping controllers in combination with PD controllers [1].

This paper deals with the above problems for a laboratory model of a tower crane (TCR) by the INTECO company who is a leader in the design and manufacture of mechatronic systems for real-time control design and implementation. The TCR laboratory plant is popular among researchers in control engineering for mechatronics. Its modelling and control include the following subsystems: motion of the trolley along the jib, angular displacement of the jib, vertical displacement of the payload, and damping of payload oscillations [2]. Specifically, the paper focuses on dynamic model identification and controller design of the trolley position along the jib, and damping of payload oscillations also along the jib. Once these problems are resolved, their solution can be generalized for angular displacement. A frequency domain analysis based on Bode and Nichols diagrams describes frequency properties of the model with the designed compensator for oscillations damping. The frequency response approach is appropriate for this kind of problems and provides good results without need of measured data

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Experimental Modelling in Engineering F. W. David, H. Nolle, 2013-10-22 Experimental Modelling in Engineering presents the principles of experimental modeling methodically and in such a generalized manner that they may lend themselves to application in practically all fields of technology The book covers related topics such as modeling based on conditions of similarity units and dimensions the applications of homogeneity and dimensionally homogenous equations in the field and the selection of variables in dimensional analysis Also covered in the book are topics such as the use of models in experiments the principle of similarity examples in experimental modeling and problems in dimensional analysis and model design The text is recommended for engineers who would like to know more about the principles concepts behind experimental modeling as well as its applications in engineering and other related fields

Design and Modeling for Computer Experiments Kai-Tai Fang, Runze Li, Agus Sudjianto, 2006 Emphasizing a practical approach Design and Modeling for Computer Experiments provides useful techniques for statisticians engineers and scientists to apply the methodologies presented

Concurrent Engineering Approaches for Sustainable Product Development in a Multi-Disciplinary Environment Josip Stjepandić, Georg Rock, Cees Bil, 2012-08-10 The CE Conference series is organized annually by the International Society for Productivity Enhancement ISPE and constitutes an important forum for international scientific exchange on concurrent and collaborative enterprise engineering These international conferences attract a significant number of researchers industrialists and students as well as government representatives who are interested in the recent advances in concurrent engineering research and applications Concurrent Engineering Approaches for Sustainable Product Development in a Multi-Disciplinary Environment Proceedings of the 19th ISPE International Conference on Concurrent Engineering contains papers accepted peer reviewed and presented at the annual conference held at the University of Applied Sciences in Trier Germany from 3rd 7th of September 2012 This covers a wide range of cutting edge topics including Systems Engineering and Innovation Design for Sustainability Knowledge Engineering and Management Managing product variety Product Life Cycle Management and Service Engineering Value Engineering

Identification of Parametric Models Eric Walter, Luc Pronzato, 1997-01-14 The presentation of a coherent methodology for the estimation of the parameters of mathematical models from experimental data is examined in this volume Many topics are covered including the choice of the structure of the mathematical model the choice of a performance criterion to compare models the optimization of this performance criterion the evaluation of the uncertainty in the estimated parameters the design of experiments so as to get the most relevant data and the critical analysis of results There are also several features unique to the work such as an up to date presentation of the methodology for testing models for identifiability and distinguishability and a comprehensive treatment of parametric optimization which includes greater consideration of numerical aspects and which examines recursive and non recursive methods for linear and nonlinear models

Hydraulic and Civil Engineering Technology VIII Mijia

Yang, Pijush Samui, João C.G. Lanzinha, Jianhui Hu, 2023-12-15 All of us are dependent on a built environment constructed and maintained by civil and hydraulic engineers and for those working in these fields keeping up to date with the latest technological developments is vital for the safe and efficient design and operation of this infrastructure This book presents the proceedings of HCET 2023 the 8th International Technical Conference on Frontiers of Hydraulic and Civil Engineering Technology held from 25-27 September 2023 in Wuhan China HCET is an international conference which aims to enhance the development of hydraulic and civil engineering in China with a focus on high end intelligent and green technologies It seeks to do this by consolidating global wisdom and achievements and providing scientific support HCET also offers an excellent opportunity for scientists researchers and engineers from around the world to exchange their findings and discuss developments establishing a basis for national and international collaboration A total of 316 contributions were received for the 2023 edition of which 187 were ultimately accepted after a rigorous review process and checks for quality and plagiarism Topics covered include the research and development of concrete structure design and analysis structural mechanics and structural engineering building and future materials hydraulic engineering geological exploration and earthquake engineering building technology urban planning road bridge and traffic engineering energy infrastructure environmental engineering and advanced engineering technologies and interdisciplinary sciences and applications Covering a wide range of subjects related to hydraulic engineering and civil engineering technology and associated transdisciplinary sciences the book will be of interest to all those working in the field

Engineering Experiment Station Series University of Wisconsin.
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Shipbuilding & Marine Engineering International, 1922 *International Journal of Engineering Research in Africa Vol. 74* Akii Okonigbon Akaehomen Ibadode, 2025-06-02 The 74th volume of the journal contains articles that present research results and engineering solutions in materials science biogas upgrading techniques green building materials grey water treatment and solar water pumping orthogonal simulation test for evaluating fretting wear in low speed diesel engine connecting rods and the development of a control system for a waste to energy thermal power plant This edition will be helpful to a wide range of engineers from various industrial branches **Engineering Production**, 1920 *International Marine Engineering*, 1916 *Radio & Model Engineering*, 1928 Engineering News and American Contract Journal, 1904
Transactions of the International Engineering Congress, 1916 Transactions of the International Engineering Congress, 1915, 1916 *Marine Engineering/log*, 1898 **Engineering**, 1926 *The Model Engineer and Amateur Electrician*, 1905 *Mechanical Engineering* American Society of Mechanical Engineers, 1921 History of the American society of mechanical engineers Preliminary report of the committee on Society history issued from time to time beginning with v 30 Feb 1908

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