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International Seminar on Electrical, Informatics, and Its Education (SEIE) 2013

"Cloud Computing and Its Application on Education"

as

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which held at Graha Cakrawala Building, The State University of Malang

Oct 5th, 2013

Keynote Speaker | 1. Mr. Anthony Ngo (MICROSOFT Asia Pacific)
2. Mr. Gatot Hari P. (Director of SEAMOLEC)

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PROCEEDINGS

Cloud computing is when the user use servers that are not stored in user's location, not owned by user, and not maintained by user, to provide the user with the programs that user use and to store and retrieve user's data. This is contrast to hosting and maintaining own server, loading and updating own software, and storing and backing up own data.

Today, the development of cloud computing is raised rapidly. There are many companies develop this model and a many kinds of cloud computing appeared. Such as Ubuntu one's Canonical Ltd and SkyDrive's Microsoft as cloud storage, Google apps and office web apps as cloud application, and windows azure as cloud operating system.

More important, it provide a lot of benefits for education. Nowadays, at first glance it sounds a little scary since it relies on someone other than ourselves and our own organization for services that are most likely critical to our operation. So why are schools increasingly turning to cloud computing as an alternative? Several reasons we have found why this to be the right solution for our educational system are: Saving money, Saving time, Anytime anywhere access, Reduced compatibility issues, Increased collaboration, Increased services offered, Foundation for new projects, Peace of mind, And many more.

For those in education sector, "the cloud" can seem like a nebulous and unattainable technology goal, used only by large enterprises and corporations. But the cloud has the power to drastically advance the goals of the educational system; to make it easier for institutions to empower their students to succeed while at the same time cutting costs and expanding accessibility.

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PREFACE

International Seminar on Electrical, Informatics and Its Education 2013 (SEIE 2013) is a media for the dissemination of information and publication of researches from universities, researchers, teachers, and practitioners. SEIE will accommodate the dissemination of information and research on Electrical, Information Technology and Education of both.

SEIE 2013 is an international seminar organized by the Electrical Engineering Department, Faculty of Engineering, State University of Malang. This seminar is the third of SEIE first seminar which was held in 2009 and held every two years on a regular basis.

Article published, packed with international categories classified in two groups. The first group contains papers on the topic of electro and its application in education. The second group contains papers on the topic of informatics and its application in education.

The authors came from the local Indonesian and overseas including Japan, Libya, Taiwan and Vietnam. Any posts or articles that have been entered in a review by a competent reviewer.

The committees want to deliver big gratitude for your participation, and congratulation for author that the papers accepted and published SEIE 2013's procreeding. Criticis and suggestions are expected for the improvement this seminar. We hope this proceeding can be used as one of reference technology development in electrical and informatics engineering and its education.

Malang, October 5th, 2013
Chairman,

Dr. Hakkun Elmunsyah,S.T., M.T.

PREFACE FROM HEAD OF ELECTRICAL ENGINEERING DEPARTMENT ENGINEERING FACULTY STATE UNIVERSITY OF MALANG

International Seminar on Electrical, Informatics, and Its Education (SEIE) 2013 held after the Engineering Faculty 48th Anniversary which simultaneously of State University of Malang 59th Anniversary. SEIE 2013 is held every other year by Electrical Engineering Department, Faculty of Engineering, State University of Malang. In 2009, it was called National Seminar Electrical, Informatics, and Its Education (SNEIE) 2009. For SEIE 2013 has already included an International area and has published to some neighborhood countries as Japan, Libya, Taiwan, Vietnam, etc.

The seminar packed with international categories classified in two groups. The first group contains papers on the topic of electro and its application in education. The second group contains papers on the topic of informatics and its application in education.

Hoping this seminar would be a place of researchers and practitioners to publicize and then disseminate the results of these researches that have taken place due to the progression of sciences and education throughout Electrical Engineering and Informatics Engineering.

Malang, October 5th 2013
Head of Electrical Engineering Department

Drs. Slamet Wibawanto, M.T.

CONTENTS

Electrical And Its Education

Informatics And Its Education

Real Time System Identification of a Nonlinear Two-Link Flexible Robot Manipulator

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Abstract

The nonlinear model of a two-link flexible manipulator is derived in several publications. Otherwise for controller design, real time system identification usually is used in this step. Although the theoretical model is difficult to exactly characterise the dynamical behaviour of the system, it provides valuable a priori knowledge about this system. Confidence in the dynamic model was established by validating with experimental exercises. However, for control of the nonlinear and high complexity model control design methods often require excessive computational time. In practice, the reduced-order model is used to conform to computational limitations. In this work, real time system identification is used to construct a linear model of the system from the nonlinear system. These linear models and its uncertainty bound can then be used for controller synthesis. The real time nonlinear system identification process to obtain a set of linear models of the two-link flexible manipulator that represents the operating ranges of the dynamic system. With a selected input signal, the data of stimulation and response is acquired and nonlinear system identification is performed using Matlab to obtain a linear model of the system. The linear system can then be utilised for development of control algorithms of a two-link flexible manipulator system. A multisine signal produces sinusoids of different amplitudes and frequencies, which can be summed to constitute a persistently exciting signal for the identification process. In this work, the signals are carefully adjusted to provide very low speed operation, which is essential for examination of the system nonlinearities.

Keywords : Nonlinear, real time, system identification, two-link flexible robot manipulator.

I. INTRODUCTION

Flexible manipulators have several advantages over rigid robots: they require less material, are lighter in weight, consume less power, require smaller actuators, are more manoeuvrable and transportable, have less overall cost and higher payload to robot weight ratio. These types of robots are used in a wide spectrum of applications starting from simple pick and place operations of an industrial robot to micro-surgery, maintenance of nuclear plants and space robotics [1]. For practical applications, two-link flexible manipulators are preferred as they provide more flexibility in their applications. However, control of flexible manipulators to maintain accurate positioning is an extremely challenging. The complexity of the problem increases dramatically for a two-link flexible manipulator as the system is a kind of multi-input multi-output (MIMO) system and several other factors such as coupling between both links and effects of vibration between both links have to be considered. Moreover, the dynamic behaviour of the manipulator is significantly affected by payload variations. If the advantages associated with lightness are not to be sacrificed, accurate models and efficient controllers for a two-link flexible manipulator have to be developed.

The main goal of modelling of a two-link flexible manipulator is to achieve an accurate model representing the actual system behaviour. It is important to recognise the flexible nature and dynamic characteristics of the system and construct a suitable mathematical framework. Modelling of a single-link flexible manipulator has been widely established. Various approaches have been developed which can mainly be divided into two categories: the numerical analysis approach and the assumed mode method (AMM). The numerical analysis methods that are utilised include finite difference and finite element methods. Both approaches have been used in obtaining the dynamic characterisation of single-link flexible manipulator systems incorporating damping, hub inertia and payload. Performance investigations have shown that the finite element method can be used to obtain a good representation of the system [2].

Previous study utilising the AMM for modelling of a single-link flexible manipulator has shown that the first two modes are sufficient to identify the dynamic of flexible manipulators. A good agreement between theory and experiments has been achieved [2]. Besides, several other methods have also been studied. These include a particle swarm optimisation algorithm [3], extended Hamilton's principle and generalised Galerkin's method [4] and a reduced approximated finite order model [5].

Similar to the case of a single-link manipulator, the finite element method and AMM have also been investigated for modelling of a two-link flexible robot manipulator. However, the complexity of the modelling process increases dramatically as compared to the case of a single-link flexible manipulator. Yang and Sadler [6] and [7] have developed the finite element models to describe the deflection of a planar two-link flexible robot manipulator. De Luca [8] have utilised the AMM to derive a dynamic model of multilink flexible robot arms limiting to the case of planar manipulators with no torsional effects. A single-link flexible manipulator model which is suitable for development of a two-link flexible manipulator model has also been described [9]. The results have shown that the accuracy of a single-link model can be improved by inclusion of a shear deformation term. Subudhi and Morris [10] have also presented a systematic approach for deriving the dynamic equations for n-link manipulator where two-homogenous transformation matrices are used to describe the rigid and flexible motions respectively.

The nonlinear model of a two-link flexible manipulator is derived by M Khairudin [11] and for controller design, system identification will be used. Although the theoretical model is difficult to exactly characterise the dynamical behaviour of the system, it provides valuable a priori knowledge about this system. Confidence in the dynamic model was established by validating with experimental exercises. However, for control of the nonlinear and high complexity model control design methods often require excessive computational time. In practice, the reduced-order model is used to conform to computational limitations [12]. In this section, system identification is used to construct a linear model of the system from the nonlinear system. These linear models and its uncertainty bound can then be used for controller synthesis.

II. SYSTEM IDENTIFICATION

Figure 1 shows the laboratorium scale of two-link flexible manipulator. The system identification will identify the nonlinear system of two-link flexible manipulator to find a model for designing suitable contoller. The specification of the two-link flexible manipulator can be shown at Table 1.

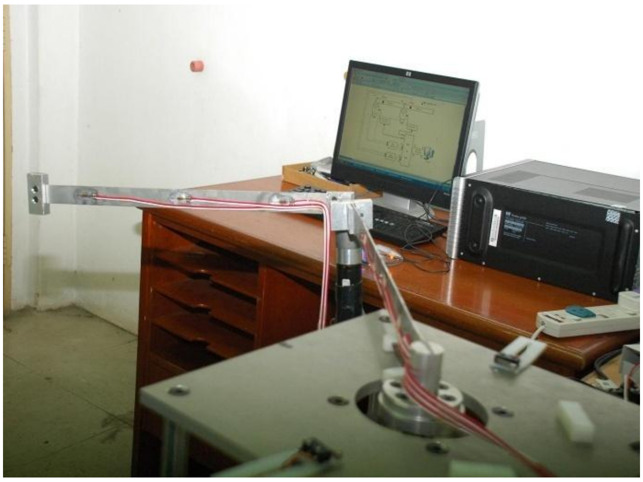

Figure 1: The experimental two-link flexible manipulator

Table 1. Parameter Characterisation of two-link flexible manipulator

Symbol	Parameter	Link-1	Link-2	Unit
m_1 , m_2	Mass of link	0.08	0.05	kg
ρ	Mass density	2666.67	2684.56	kgm^{-1}
EI	Flexural rigidity	1768.80	597.87	Nm^2
J_{h1} , J_{h2}	Motor and hub inertia	1.46 x10^{-3}	0.60 x10^{-3}	kgm^2
M_p	Payload mass (maximum)	-	0.1	kg
$\bar{J}_P$	Payload inertia (maximum)	-	0.05 x 10^{-3}	kgm^2
l_1, l_2	Length of link	0.5	0.5	m
	Width of link	0.03	0.025	m
	Thickness of link	2 x10^{-3}	1.49 x10^{-3}	m
J_{o1} , J_{o2}	Moment of inertia	5 x10^{-3}	3.125 x10^{-3}	kgm^2
M_{h2}	Mass of the centre rotor	-	0.155	kg

Figure 2 shows a block diagram of the nonlinear system identification process to obtain a set of linear models of the two-link flexible manipulator that represents the operating ranges of the dynamic system. With a selected input signal, the data of stimulation and response is acquired and nonlinear system identification is performed using Matlab to obtain a linear model of the system. The linear system can then be utilised for development of control algorithms of a two-link flexible manipulator system.

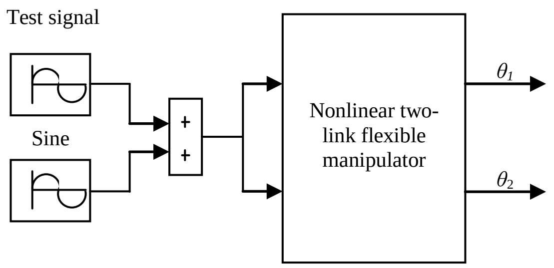

Figure 2: Nonlinear system identification

A multisine signal produces sinusoids of different amplitudes and frequencies, which can be summed to constitute a persistently exciting signal for the identification process. In this work, the signals are carefully adjusted to provide very low speed operation, which is essential for examination of the system nonlinearities. Figure 3 shows the multisine input signal used in this work.

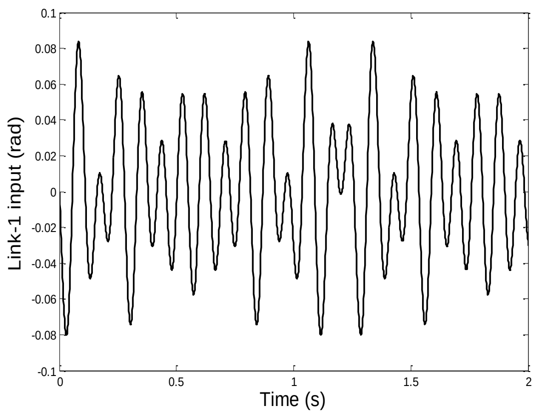

Figure 3: Input signal

III. RESULTS

Based on the input and output data, least square technique is then performed to identify the parameters of the transfer function model. For the system without payload, a sixth-order identified model of link-1 that relates hub angular position output to the voltage input is obtained as

$$G_{11}(s) = \frac{-58.9\,s^5 - 807\,s^4 - 3301.1\,s^3 - 3330s^2 + 1991.8s + 3605.9}{s^6 + 21.7\,s^5 + 196\,s^4 + 926.9s^3 + 2261.3s^2 + 2292.1s + 704}$$

where s is a Laplace operator. On the other hand, the transfer function for link-2 is obtained as

$$G_{21}(s) = \frac{-84.1s^5 - 840.9\,s^4 - 2571.1s^3 - 2782.5s^2 - 1080.3s - 91.2}{s^6 + 10.9041s^5 + 50.9482\,s^4 + 113.1691s^3 + 112.1175s^2 + 47.4569s + 6.8364}$$

Subsequently, accuracy and applicability of the models are verified by comparing the predicted and nonlinear outputs. Figure 4 shows the predicted and nonlinear outputs of hub angular position response of link-1 of the manipulator. Both outputs are found to be almost similar with a matching degree of 94 %. Besides, predicted and nonlinear responses of the hub angular position of link-2 are shown in Figure 5 with a matching degree of 96 %. The accuracy of the identified models is further verified with step response of both links. Figures 6 and 7 show almost similar step responses for both, the predicted and nonlinear models for link-1 and link-2 respectively. Thus, confidence in utilising the identified models has been established.

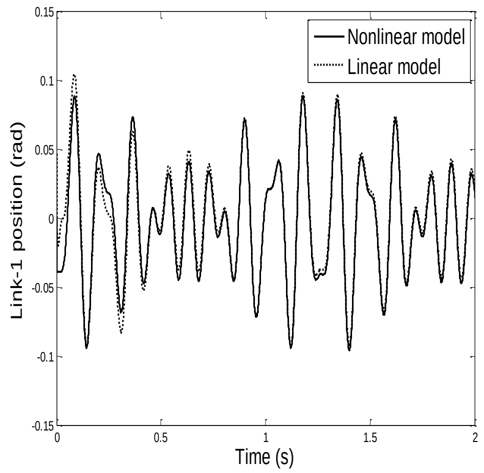

Figure 4: Hub angular position response of link-1 with multisine input signal for linear and nonlinear models

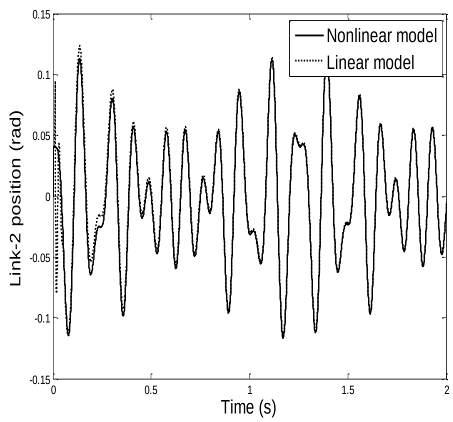

Figure 5: Hub angular position response of link-2 with multisine input signal for linear and nonlinear models

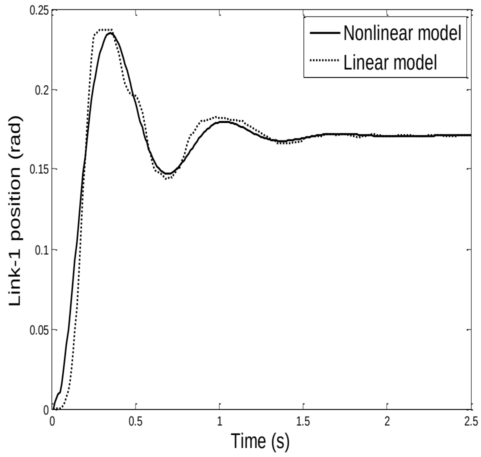

Figure 6: Step response of hub angular position of link-1 with linear and nonlinear models

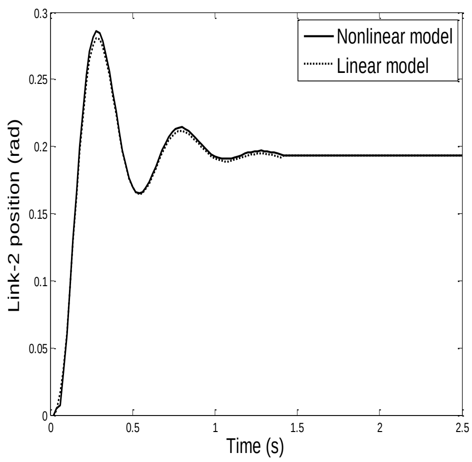

Figure 7: Step response of hub angular position of link-2 with linear and nonlinear models

IV. CONCLUSION

Results showed similarities identification system to achieve an accurate model through identification results between system identification results (linear systems) with nonlinear systems. So that the linear system can be used on a laboratorium scale on the design of a model-based control system and mathematical analysis.

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