MECHATRONICS BOOK SERIES

CONTROL AND INTELLIGENT SYSTEMS

Momoh Jimoh E. Salami
Abiodun Musa Aibinu
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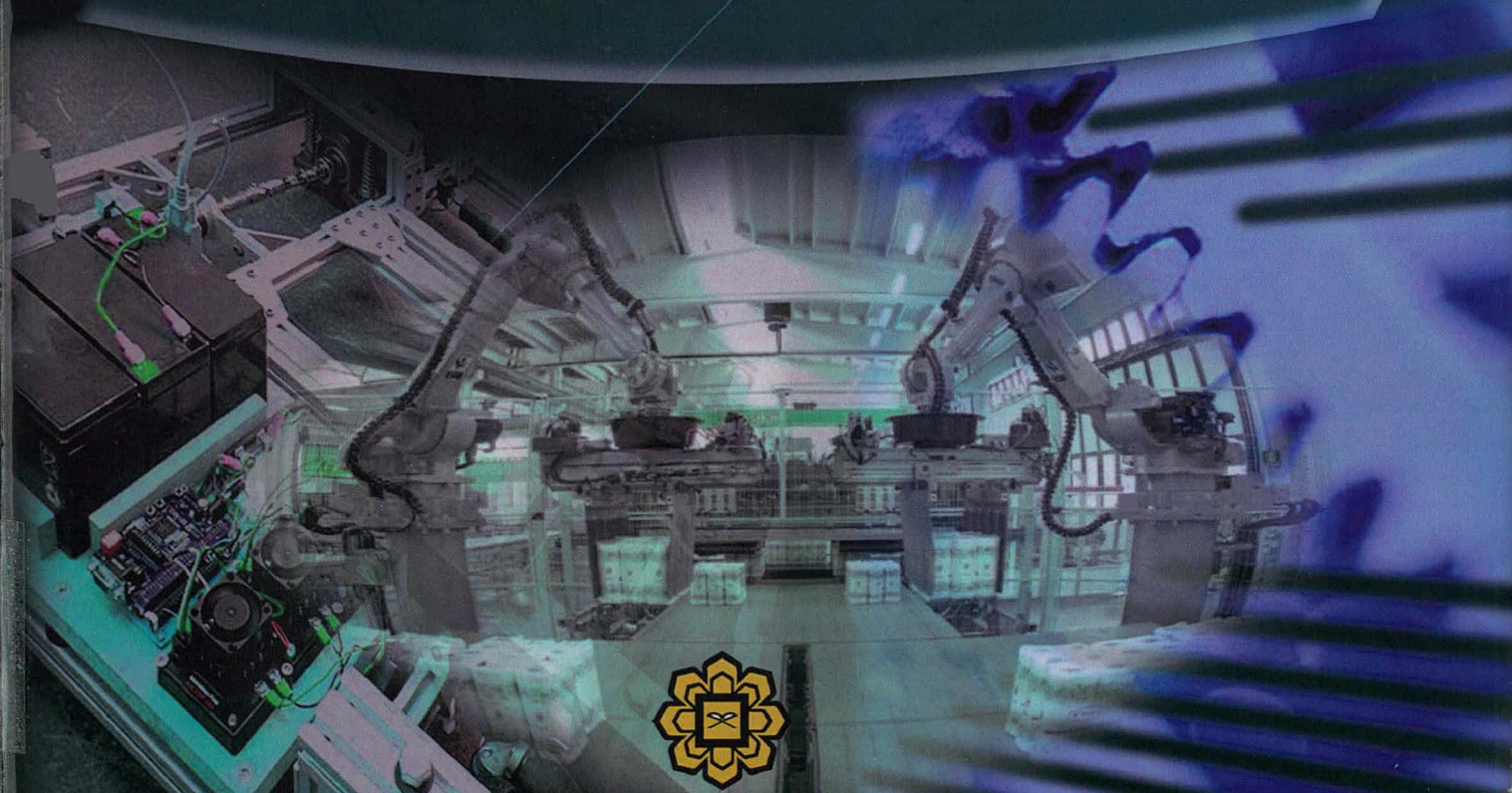

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Chapter 39
System Identification Technique for a Helicopter Using Genetic Algorithms

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39.1 Introduction

System identification using input and output data from a system has been part and parcel of establishing a good model without any *a priori* knowledge of the system. System identification is an integral part of any control system design and deals with the problem of building reliable mathematical models of dynamic processes based on observed input-output data [1]. Furthermore, in a model-based control framework, a pre-requisite to developing an effective control mechanism for a system is to model and predict the behaviour of the system based on the given input-output data [2]. By using system identification tools, one is able to obtain models which are in agreement with the physical reality and are useful for prediction and control. The identification results considerably determine the achieved control quality. System identification tools can be considered as reliable alternatives to obtain a transfer function of the model that may adequately describe the hovering motion 1DOF position of the TRMS [3].

Rotary wing aerial vehicles, such as helicopters, have distinct advantages over conventional fixed-wing aircraft in surveillance and inspection tasks as they can take off and land vertically in limited spaces and easily hover in places above a target. Compared to conventional fixed-wing aircraft, helicopters are much more complex in terms of system dynamics and control because the inputs are not directly applied torques or forces, but rather aerodynamic torques and forces created by the main rotors. The twin-rotor multi-input multi-output system (TRMS) is a laboratory facility retaining the most important helicopter features such as couplings and strong nonlinearities. More so, it can be perceived as an unconventional and complex 'air vehicle'. These system characteristics present formidable challenges in modeling, control design and implementation. As the advent of artificial intelligence era, noticeable approaches were found in terms of modeling and optimization on aircraft design [4].

Parametric modelling employing genetic algorithm (GA) technique has been widely used in the literature to obtain a linear transfer function of the system [5]. However, instead of working on the conventional bit-by-bit operation in Binary Coded GA (BCGA), a Real-coded GA (RCGA) is effectively used in this chapter with showcases reduced computational complexity, faster convergence and more accurate results as compared to BCGA. A thorough review related to real-coded genetic algorithms can be found in [6]. Recently, real-coded GA approach has been used in a number of applications where both the crossover and mutation operators are real-valued. A new real-coded GA is represented in [7]. The algorithm is a modified version of the normal GA but it includes biased initialization, dynamic parameters, and elitism. In this chapter, a real-coded GA based system is proposed to select the parameters of the transfer function based on Auto-regressive with exogenous (ARX) 4^{th} order model essential to resemble the 1 DOF hovering motion of the TRMS.