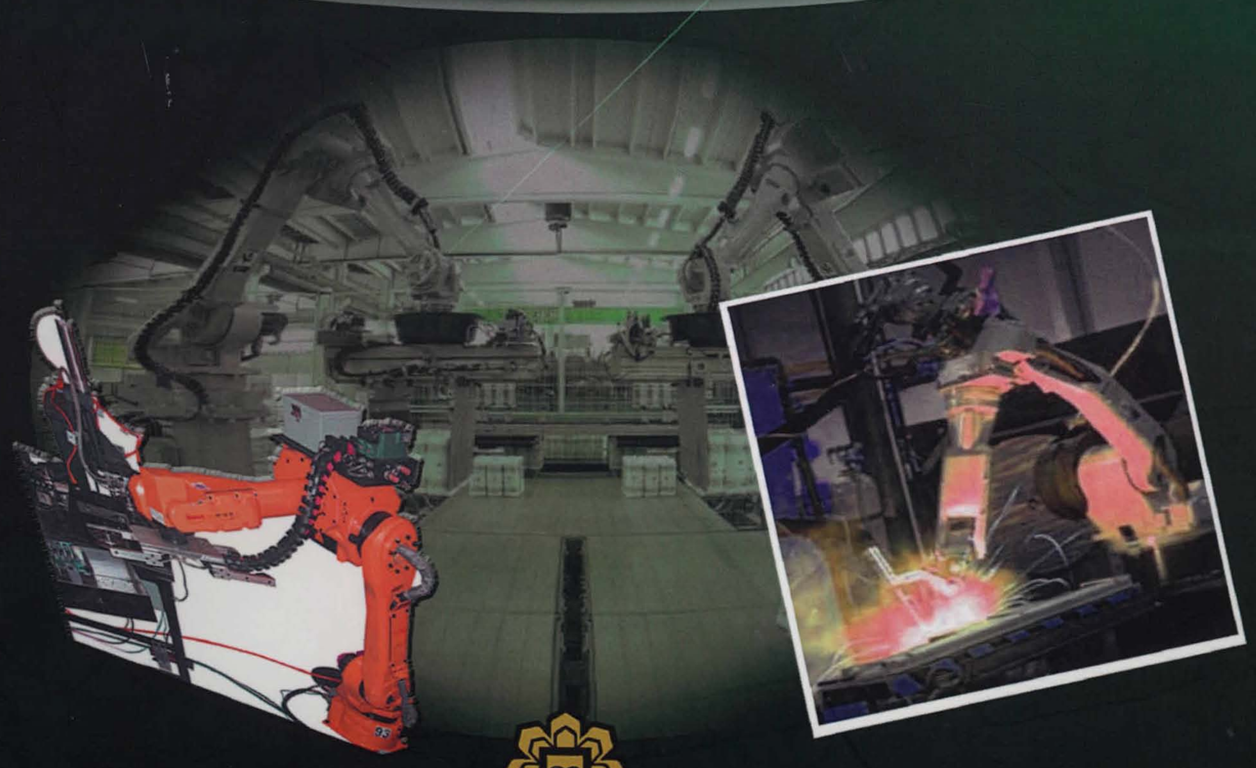
MECHATRONICS BOOK SERIES

ROBOTICS AND AUTOMATION

Rini Akmeliawati
Wahju Sediono
Nahrul Khair Alang Md. Rashid



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Editors

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Tel: **+603-6188 1542 / 44 / 45** Fax: **+603-6188 1543**
EMAIL: iiumprinting@yahoo.com

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CHAPTER 5

Humanoid Robot Arm

A. A. Shafie[1,a] and Mohd N. Y.[2,b]

[12]Department of Mechatronics, Kulliyah of Engineering

International Islamic University Malaysia (IIUM),

50728 Kuala Lumpur

[a] aashafie@iium.edu.my

5.1 Introduction

New generations of robots currently are being built to perform service oriented tasks by equipping them with advanced sensors and effectors [1]. These robots, also known as service robots, are supposed to interact and communicate with human naturally in the sense of touching, speaking ,etc, thus forming a new class of robots named humanoid [2]. Dillmann et al (1998) said that humanoid robot also have to share same workspace with human and human friendly [3].

An example of a humanoid robot named Cog, developed by Massachusetts Institute of Technology (MIT), considered to use spring-like to imitate the motion of each joint [4,6]. Research done by Waseda University, Japan, brought up that humanoid arm should be designed to monitor the forces between the robot and the environment in which the arm may contact. The arm has 7-DOF arm that has a characteristic of lightweight manipulator that provides strength while exhibiting compliant motion [5].

Previous work on biomechanics of the human arm concludes that in order to emulate the human arm, the design should consist of 7-DOF, which includes 3-DOF at the shoulder, 2-DOF at the elbow and 2-DOF at the wrist [7. 8, 9, 10]. Each joint has a rotational motion with respect to the universal frame. But practically, only 6-DOF is applicable for a robot in order to do further analysis such as Denavit-Hartenberg and Jacobian [10]. Thus, one joint will be considered as redundant in order to accommodate the analysis. What is meant by the redundancy of joint is that the particular joint will be utilized to avoid obstacle when grasping object [11,12]. Usually, the redundant joint is the elbow joint which rotates with respect to z-axis of the universal frame.

Other important parts in designing a humanoid arm are sensors and controllers used. For sensors, each joint should have at least one sensor, normally force sensors and position sensors[13]. The sensors could act as inputs for the arm or robot, for example, the force sensor will measure the force exerted by each motor so that it will not exceed the limit.

5.2 Literature Review

How is movement control of a humanoid arm organized? Which variable(s) are controlled? These questions have become a growing concern for motor neurophysiologist [14], [15] especially in the medical field. Currently presented investigations have traditionally focused on single muscle contractions or single joint movement; these systems cannot reveal the problems confronted by the central-nervous system in the control of normal joint movements. Even a two-joint movement is vastly more complicated than a single-joint motion. These complexities especially on the role of the central nervous system in organizing these joint movements in the theme of the research presented.

Recently few studies of the kinematic and dynamic aspects of multi-joint human and monkey arms have been conducted. The objective of these studies was to identify the common kinematic features