# DESIGN OF REAL-TIME HUMAN MACHINE INTERACTION FOR ROBOTIC ARM WITH MONITORING SYSTEM

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**Sesi Pengajian** : | 1 | 5 | / | 1 | 6 |

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***Specially dedicated to,***

***My beloved parent, family members and friends for your supports, guidance, understanding and all the favors. May Allah S.W.T bless all of you.***

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## ABSTRACT

In today's modern world, robotic technology has been used widely as a mean to ease both repeated and complicated task. The technology is in demand by industries as it can execute any task with precision. However, operating a robotic machine requires extensive knowledge in programming thus making it specific for certain individual to operate it. The project is focusing on controlling a robotic arm by human hand gesture. Therefore, by using Kinect technology, the robotic arm will be easy to be handled by everyone as it requires no programming to operate. Real-Time Human-Machine Robotic Arm with Monitoring System is designed by applying the Kinect technology which implements Natural User Interface (NUI). The Kinect sensor is connected to a computer, which is the platform to monitor the information captured by the sensor. In other words, the robotic arm will imitate all of the user's arm movements. In this project, Processing 3 is used as the main programming tools as it compatible with the Kinect sensor and can be linked to Arduino microcontroller at the same time.

# ABSTRAK

Dalam marcapada, teknologi robotik digunakan secara meluas sebagai maksud untuk memudahkan tugasan-tugasan yang berulang dan rumit. Teknologi ini menjadi permintaan sektor industry oleh kerana ianya mampu melaksanakan suatu tugas dengan tepat. Walaubagaimanapun, pengendalian mesin robotik memerlukan pengetahuan pengaturcaraan yang mendalam justeru hanya sesetengah individu sahaja yang mampu menggunakannya. Projek ini memberi tumpuan dalam mengawal tangan robot menggunakan gerak syarat tangan manusia. Sehubungan dengan itu, dengan menggunakan teknologi Kinect, tangan robot ini lebih mudah dikendalikan oleh kerana ianya tidak memerlukan pengaturcaraan untuk mengendalikannya. *Real-Time Human-Machine Robotic Arm with Monitoring System* direka dengan mengaplikasikan teknologi Kinect yang menggunakan Antara Muka Natural. Sensor Kinect ini disambungkan kepada komputer, di mana ianya sebagai platform untuk mengawasi informasi yang diolah oleh sensor tersebut. Dengan kata lain, tangan robot ini akan meniru pergerakan tangan pengguna. Di dalam projek ini, Processing 3 digunakan sebagai alat pengaturcaraan utama kerana ianya sepadan dengan sensor Kinect dan boleh berhubung dengan pengaturcara Arduino pada masa yang sama.

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| | |
|---|---|
| AC | Alternating Current |
| ALU | Arithmetic Logic Unit |
| CNC | Computer Numerically Controlled |
| DC | Direct Current |
| DOF | Degree of Freedom |
| NUI | Natural User Interface |

# CHAPTER I

# INTRODUCTION

## 1.1 Project Overview

Real time is a level of computer responsiveness which the user senses as sufficiently immediate or that enables the computer to keep up with some external process. Real-time is an adjective pertaining to computer or processers that operate in real time. Real time describes a human rather than a machine sense of time. Commonly, real time operating system are system that respond to input immediately and display objects moving across the screen at the same speed they would actually move. This robotic arm is an autonomous robot which allowing a direct mapping from a human machine is presented. This system was designed with combination of robotic arm and real time physical human machine. Besides, it enables users to control and interact with their computer without the need for a controller, through a natural user interface using gestures. The human body is detected by Kinect® sensor and then converted into skeletal data of the user which is then sent the robotic arm over a serial port correction. Arduino® programming is used as the processing device between human arm and robotic arm. The invented robotic arm is based on the study of five Degree of Freedom behaviour.

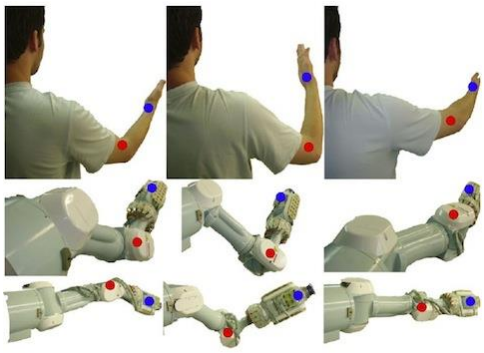

Figure 1.1: Human movement with robotic arm

With the growth of interest towards humanoid robots, several robotic arm more or less humanoid have been developed as the goals of each project were different. Generally, research on a real time robotic arm is very useful for maintenance work in hazardous environment. Surely human life is priceless compared to high intelligence machine. However, the control system of the humanoid robot becomes more complicated if more degree of freedom are additionally used for robot arm design.

## 1.2 Problem Statement

The problem statement of this study can be expressed as follows:

Controlling an automated arm with a conventional controller can be exceptionally troublesome. It is non-instinctive, complex, and obliges preparing to control the arm complicatedly. It is hard to control different degrees of flexibility at the same time, and in this way the arm can't be utilized to perform smooth motions that a human arm is prepared to do. In this way, its full power can't be acknowledged utilizing a conventional controller.

In today's modern world, robotic technology has been used widely as a mean to ease both repeated and complicated task. The technology is in demand by industries as it can execute any task with precision. However, operating a robotic arm requires extensive knowledge in programming thus making it specific for certain individual to operate it. Therefore, by using Kinect® technology, the robotic arm will be easy to be handled by everyone as it requires less programming to operate.

## 1.3 Research Objectives

The aim of this project is:

i. To develop a user friendly robotic arm system, as it can easily be operated by users that have least knowledge in programming.
ii. To design a robotic system that can perform any tasks in any kind of environment.

## 1.4 Scope of Work

The followings are the scope of the project:

i. Design the prototype of robotic arm with 5 Degree of Freedom (DOF).
ii. Development of user interface for the industrial robotic arm by using the Kinect® sensor and Arduino programming.
iii. Validation of the robotic arm movement according to the human movement with the Kinect® sensor.

## 1.5 Contribution of the Work

There are significant outstanding issues related to the identification and control of real time system that need to be investigated. From the research as discussed previously for the problem statements and the importance, several contributions can be made in the vicinity of identification, control strategy and application. These are also reflected in several journal and conference papers arising from this research study. The main research contributions of this study are as follows:

i. A design of prototype for robotic arm.
ii. A robotic arm system with the real time physical human controller by applying the Kinect sensor.

## 1.6 Structure of the Thesis

Chapter 2 present the literature review on robot arm for it system, technology, and research and development. The discussion is based on human interface for the robot arm and the real time reaction. The review is discussed in detail on chapter 3.

The methodology to build robot arm for real time by apply for the haptics application is present in Chapter3. This chapter deal with the modelling and control strategies of robotic arm. Firstly, the hardware that used is identify to build this project. Then, the type of programming is identify to make the coding as the software for this project.

Chapter 4 presents the result and discussion of this project on how the robotic arm function that use Processing 3 programming as the coding. This chapter will also discuss the results obtained in detailed manner.

Conclusion and future research presented in Chapter 5 discuss the advantages and the weakness of this project that can be developed in the future to make this arm robot more functional.

# CHAPTER II

# LITERATURE REVIEW

## 2.1 Introduction

This chapter will discuss and analyse different kind of robotic arms in the field of robotic industry, specifically focused on humanoid real time robotic arm which requires human interface as the input. In addition, the theory of real time robotic arm will be discussed in this chapter. The analysis is used to determine an exact design and understanding the requirement for the development of this project.

## 2.2 Robotic Arm System

In the course of the most recent decade, robots go with individuals in ordinary life and assume control over their day by day routine techniques. Robotics is an exceptional building science which manages outlining, demonstrating, controlling robots' usage. Robots were additionally perceived as straightforward activity performer as well as a machine that have various and assortment purposes and uses. A mechanical controller is a gadget equipped for moving in diverse headings (base, shoulders, elbow, yaw, pitch, move bearings) with respect to base and controlled Haptics. Its base is impelled by a DC engine mounted underneath it. The Degrees of Freedom (DOF) is a joint on the arm, a spot where it can flex or pivot.

An analogue sensor has also been used in making an automated arm [1]. A glove with flex sensors is fabricated. A standout amongst the most vital capacity of arms was jointed robot controller that permit robots to communicate with their surroundings [2]. Numerous have locally available controllers to rearrange correspondence, however they may be controlled straightforwardly or in any number of ways. Because of this, standalone arms are regularly delegated full robots [3]. The robot utilized as a part of this task is 4 pivot automated arm intended for little versatile robots. It can grasp objects with the size up to 60 mm with the power up to 250 gms. The arm has a range of 23 cm. it can lift the payload up to 400 gms. Initial two hub of the arm are made of NRS-955 double bearing substantial obligation metal rigging servo engines. Pivot 2 and 3 empowers gripper to keep up its edge steady with the surface while it climbs and down. The mechanical arm can do Left-Right, Up-Down, Twist movements and Grasping activity while keeping gripper parallel to surface. 5 Amps supply current are required for legitimate operation of this mechanical arm.

To get conduct of every point of automated arm, simulation programming in view of ODE library was produced [5]. The system can be intelligently controlled by utilizing console catch and additionally gave arrangement of robot arm edge information. For a robot arm, the significant issue brought on by the absence of DOF in the shoulder contrasted with a human arm [6]. Since most humanoid robots have two DOFs in the shoulder, they are not ready to perform each human arm stance. The reason is the needed DOF in the robot shoulder contrasted with human shoulder. Accordingly, there is a need to assess the postural closeness between a human arm and a robot along these lines the robot arm will be acclimated to have the comparable stance of human as could be expected under the circumstances. From the point of view of joint edge to assess the likeness metric, the joint edges in human and robot arms ought to be gained. Then again, since the revolution grouping of the joint edges in a human shoulder is a riddle to kinesiologist, it is infeasible to get the three Euler joint points in the human shoulder without perceiving the turn arrangement from human exhibition information.

There are truly a large number of diverse applications as of now performed by modern robots. With more than 1 million multifunctional robots being used around the world, they have turned into a standard in robotization (Gramazio, 2008). The purpose

behind their across the board use lies in their adaptability is they have not been upgraded for one single undertaking, but rather can perform an assortment capacities. Not at all like other Computers Numerically Controlled (CNC) machines, which can be executed both subtractive and added substance schedules. Among different operations, they can stack, empty, place, cut, twist, stack, splash, weld and mill [7].

In today's society, robots are used in various areas especially in fields where high precision tasks is required [8]. Some of the examples where robotic arms found their appliance are in vehicle construction where efficiency and reliability are required. For example, in chemical industry where the environment may be harmful to workers and in medical filed where robotic arm precision is used during operations and etc [9]. Robots have improved life standards and we are upgrading their performances in order to make our lives easier and more comfortable.

Since the advent of the robots, they are widely applied in many areas of industry all over the world. With the advancement of the robot, many new research theories and technologies are developed on it [9].

## 2.3 Technology of Automated Arm

Keeping in mind the end goal to control the mechanical arm in the genuine modern plant, numerous innovations have been done to get the great result. One of the innovation have connected to outline and actualize an automated arm and control it is by utilizing haptics innovation [2]. Perceiving hand movement that is controlled by haptics innovation for virtual environment and human-machine frameworks fit for haptic connection utilizing remote. Haptic is utilized as a part of building frameworks to make virtual environment as a material criticism innovation which exploits applying so as to feel of touch movements, vibrations or strengths to the client. This robot arm can pick any light weight using so as to thing and worked the haptics glove, which fits over the client's whole hand like an exoskeleton has potentiometers on finger, wrist and grabs change in resistance with hand development. The haptics glove make the robot arm climbed and down when the human who wear it and move wrist here and there individually etc. Hand movements changed over into electrical sign from gadget

act as transducers, which is the sensor on the haptic and it recreated utilizing a mechanical arm is the essential thought of this paper. The task is partitioned into two modules in particular, Haptics glove (Transmitter) and Robot side (Receiver). The essential objectives by giving haptic signals is to encourage the learning of complex human movement abilities that are useful to incite wanted developments. There are a few impediments on connections in telemedicine must have 0% deficiency rates for expanded timeframes, Robots are not as suitable for settling on entangled choices, and Auxiliary controls are required to move the workspace of the gadget to another area.

Object sorting framework utilizing automated arm has been create to exhibit a shrewd methodology for a constant assessment and determination of items in consistent stream [3]. By utilizing Image preparing technique detects the articles in a picture caught progressively by a webcam and afterward distinguishes shading and data out of it. This data is handled by picture preparing for pick-and-put component. The sorting procedure depends on a 2 stage agent strategy characterized as a self-learning step where the mechanical assembly figures out how to recognize objects and an agent choice procedure where items are identified, grouped utilizing a decisional calculation and chose continuously. It points in characterizing the hued objects by shading, size, which are going ahead the transport by picking and putting the items in its individual pre-modified spot. In this manner dispensing with the tedious work done by human, accomplishing exactness and speed in the work.

Constant Human Motion Imitation of Anthropomorphic Dual Arm Robot Based on Cartesian Impedance Control examination is did by Ren C. Luo, Bo-Han Shih, Tsung-Wei Lin [4]. The robot is controlled by human exhibit progressively utilizing Kinect sensor, which is can mimic the human arm movement by human show continuously. The smooth robot arm development directions are created by an on-line direction generator used to confine the change of robot arm speed with speed and increasing speed limitations. Movement catch gadget was available in this task by utilize the Kinect sensor created by the Microsoft. Kinect sensor made out of a RGB camera and a profundity sensor is broadly utilized as a part of movement catch framework as of late as a result of its relative low cost. The fundamental procedure of the profundity sensor is to extend an organized infrared light constantly and compute profundity from the impression of the light at diverse positions. By preparing the

profundity picture, client's skeleton joints can be caught and gave continuously. To start with, the movement catch framework gives the following focuses to the robot to take after. Second, by method for the direction generator, we can maintain a strategic distance from the change of following targets too quick and get robot arm moving direction much smoother. At last, Cartesian impedance control was utilized to track the charge directions and apply the idea of virtual spring to create ghastly drive to forestall self-impact furthermore confine the joint limit to keep the harm of the robot. By continuing the previously stated procedures, an ongoing human impersonating framework by a humanoid double arm robot accomplished.

## 2.4 Research and Improvement

Automated frameworks have spurred numerous scientists along the years to propose diverse methodologies of controllers to show signs of improvement exactness and better element execution. A blend of Haptics sensors, Microcontroller-AVR 8535, RF handset modules, Antenna, RF handset module-CC2500, Microcontroller-AVR 8535, Motor Drivers and Gear Motor to assemble a complete Robotic Arm framework. Haptics sensors or likewise called as locator is a gadget that measures a physical amount and changes over it into comparable electrical sign [2]. The client so as to move the robot ought to make a hand development. This distinctive development is detected by potentiometer and accelerometer joined to haptics gloves. Potentiometer is utilized as a part of haptic suit alongside ADC for position input of joints. It gives the input as voltage. Accelerometer is associated with on other glove for position criticism of hand development either left or right. The yield of this sensors are in simple structure, along these lines they are joined with simple port of microcontroller AVR-8535. This venture utilized Microcontroller-AVR 8535 otherwise called AT90S8535 has a low-power CMOS 8-bit microcontroller taking into account the AVR RISC structural engineering. It has inbuilt ADC. Subsequently electrical sign get at pins of ADC port are changed over into proportionate computerized signal. At that point the microcontroller procedures it and creates code utilizing programming for this computerized information. As indicated by programming at once any one information is bolstered to RF handset cc2500 for adjustment reason.