

ANALYSIS ON HUMAN-ROBOT COLLABORATION  
THROUGH AFFECTIVE ENGINEERING

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA



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**ANALYSIS ON HUMAN-ROBOT COLLABORATION  
THROUGH AFFECTIVE ENGINEERING**

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Robotic & Automation) with Honours

by

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**2015**

## DECLARATION

I hereby, declared this report entitled Analysis on Human-Robot Collaboration through Affective Engineering is the results of my own research except as cited in references.

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## **APPROVAL**

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotic & Automation) with Honours. The member of the supervisory committee is as follow:

.....

## **APPENDICES**



# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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TAJUK: **Analysis on Human-Robot Collaboration Through Affective Engineering**

SESI PENGAJIAN: 2015/16 Semester 2

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## ABSTRACT

Human-robot collaboration in our working environments is necessary, since robot can perform complex task that cannot be attained by human. By using robot, it can increase quality of product and improve the efficiency in manufacturing. Moreover, as to ensure a safe and pleasant working environment between human and robot a better understanding between them need to be created. Hence, the main purpose of this project is to analyze the significant human feelings (Kansei) towards the robot during their interaction. In a meantime, to develop the framework of collaboration system between human and robot. In order to achieve the objectives, this project will evaluate two groups of respondent by using a questionnaire through the interaction between human and robots in FKP laboratory. The data collected, will be analyzed by using SPSS software. Then, by using the SPSS software all the data are evaluated through ANOVA and Independence T-test as to find the most significant factor on each of the experiment conducted. Throughout the analyzed data, ten most significant feelings were identified which are *Panic, Nervous, Afraid, Hostile, Enthusiastic, Jittery, Distracted, Pressured, Attentive and Irritable*. In near future, throughout this project a good and safe working environment can be created between human and robot.

## ABSTRAK

Kerjasama antara Manusia dan Robot dalam alam pekerjaan adalah amat diperlukan. Ini adalah kerana Robot dapat melaksanakan tugas-tugas kompleks yang tidak boleh dicapai oleh manusia. Selain itu, penggunaan Robot dapat meningkatkan kualiti produk dan meningkatkan kecekapan dalam sektor pembuatan. Tambahan pula, bagi memastikan persekitaraan kerja yang selamat dan selesa antara manusia dan Robot, pemahaman yang mendalam antara mereka hendaklah diwujudkan. Oleh itu, tujuan utama projek ini adalah untuk menganalisis perasaan manusia (Kansei) yang signifikan terhadap Robot sewaktu berinteraksi. Dalam pada yang sama, projek ini adalah untuk membentuk rangka sistem kerja kolaborasi antara manusia dan robot. Bagi mencapai objektif projek ini, penilaian terhadap dua kumpulan responden menggunakan borang soal selidik melalui interaksi antara manusia dan robot di makmal FKP dijalankan. Data yang diperolehi dianalisis menggunakan perisian SPSS. Kemudian, dengan menggunakan perisian SPSS kesemua data akan dinilai melalui cara *ANOVA*, dan *Independence T-Test* bagi menilai faktor signifikan yang paling tinggi dalam setiap eksperimen yang dijalankan. Melalui data yang telah dianalisis, terdapat sepuluh perasaan paling signifikan telah dikenalpasti iaitu *Panic*, *Nervous*, *Afraid*, *Hostile*, *Enthusiastic*, *Jittery*, *Distracted*, *Pressured*, *Attentive* and *Irritable*. Pada masa akan datang, persekitaran berkerja yang baik dan selamat antara manusia dan robot dapat diwujudkan.



## **DEDICATION**

Especially dedicated to my beloved parents, Mohd Sukarno bin Ismail and Sulasteri binti Abd Hamid and to my supervisor, Dr.Fairul Azni bin Jafar, and all my friends who have encouraged, guided, and inspired me throughout this project.

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## LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURES

UTeM	-	Universiti Teknikal Malaysia Melaka
FKP	-	Fakulti Kejuruteraan Pembuatan
FTMK	-	Fakulti Teknologi Maklumat dan Telekomunikasi
FKM	-	Fakulti Kejuruteraan Mekanikal
FTK	-	Fakulti Teknologi Kejuruteraan
EMG	-	Electromyography
EEG	-	Electroencephalography
ERP	-	Event-Related Potential
FMRI	-	Functional Magnetic Resonance Imaging
lx	-	Illumination Unit
K	-	Kelvin
RV	-	Recreational Vehicle
IFR	-	International Federation Robotics
SPSS	-	Statistical Package for the Social Science
ANOVA	-	Analysis of Variance
HSD	-	Honestly Significance Difference
F	-	F Test (ANOVA)
SIG	-	Significance
P	-	Alpha Subset
T	-	T-Test
DF	-	Degree of Freedom
<	-	Less Than

# CHAPTER 1

## INTRODUCTION

This chapter gives an overview of a topic about Human-robot collaboration through Kansei/Affective Engineering which includes the background of the project. Next, the motivation which is the project inspiration will be discussed along in this chapter. The problem statement, objectives, scopes and report structure will also be discussed.

### 1.1 Background

In current era of technology, the use of robots in human life is inseparable. Robots are designed to assist human various type of tasks, especially on complex, dangerous, and hazardous task. Furthermore, the use of robot in a large industrial scale has brought a substantial improvement in productivity and a reduction of production cost (Cappeli, 2003). Despite it benefits on product, it will benefits to the manpower by reduce manpower's fatigue as robots can perform their work cycle consistently and repeatability that cannot be attained by humans. Apart from being used in industry, robots are also been applied in human's daily life which can be classified as service robot. A service robot is used to assist human activities such as cleaning, teaching, chores, guider for the needed, medical aid tools and many more. Hence, it is important to consider the development of robot as to ensure it can fit well and effectively collaborate with human environment. To achieve an effective collaboration for both parties, assorted method is scrutinize and one of them is through Kansei Engineering.

Kansei or Affective engineering is a technology, method or theory to translate human affective information or image to the production of real things or to design of objects. (Watada et al., 2013). Kansei engineering has been used since long ago and had introduced by Nagamachi in the early of 70's. Increasing number of universities and companies have adopted and implemented the method, and for now there are about 1,000 scientists working with Kansei Engineering in Japan alone; approximately 100 of them professors, and approximately 300 engineers in several companies (Schutte, 2002). Kansei applications are widely used in industry especially on product on system development process. Mazda, Nissan and Honda are among the pioneer to the Kansei method. The car's design has been develop based on the method by taking account the customer's desired and requirements. Kansei is an important perspective for realizing manufacturing and information service should appeal to each individual consumer. Thus, it has been applied in robotic technology as well, from there a suitable system of collaboration between human and robot can be determine and develop.

The collaboration between robot and human helps to create an effective environment during the interaction session. Human need to generate a positive affective feeling toward robot as to promote a safe and conformable environment and assure a robot performance during executing a task, must be adaptable to manpower output. In conjunction of that, human and robot collaboration plays a fundamental role in the development of robot that operate in an open environment and cooperate with humans. (Cappelli, Giovannetti; 2003).

## 1.2 Project Motivation

Ishiara and Harada (2010) have established a research on Kansei to the movement of autonomous robot. They had done a similar approach with this proposed project, which to analysis the human feeling towards the robot. They were using a small LEGO SPYBOTICS robot as their manipulator. Other than that, Hinds, Roberts and Jones (2004) also had done a similar study but using different robot manipulators. The robot manipulators were designed based on human –like and machine-like appearance. Most of the research were similar to this proposed project, where it focused on service robot or humanoid robot that are normally used in human’s daily life. Meanwhile, as declared in Japan for the most high technology country, implementation of robot in their daily life are not a new things for them, but what really an issue is how they are really feel when interacting with those robot, are they excited, scared, anxious, happy, or nervous. Due to that, all researchers are keen to do an analysis on interaction between human and robots.

Instead of doing an analysis on service robot, less research had found on manufacturing robots. Anyhow if they do, majority of studies were using operators or workers as their respondents. Hence, the positive outcome of Kansei will showed out as they already familiar to the robot’s behavior and workspace. Nevertheless, an inexpert user, visitor or new employees are the one that should be consider in term of their feelings as to create and promote a comfortable and safe environment to work with the robots even on their first time used. In conjunction to that, it motivates to do a project in analysis of human-robot collaboration through Kansei by using a manufacturing robot manipulator that involving expert and inexpert users as respondent.

### 1.3 Problem Statement

Robotic technology is used to design and develop an industrial robot to perform required task that has been done by human. Robotic Industries Association defined an industrial robot system include the robot(s) (hardware and software) consisting of manipulator, power supply, controller, end effector, any equipment, devices and sensors with which the robot is directly interfacing. An industrial robot can be categorize based on their geometrical shape such as Cartesian, Cylindrical, Spherical/Polar and Articulated/Jointed Arm. Different shape of robot will undergo different motion and position in work cell. The different motion of robots do triggered the human's feeling whenever they are dealing with it. However, robot's appearance, robot's size, robot's function also do take in account to trigger human feeling. In industry, usually they are using a big size robot with a high speed motion, hence human need a courage to deal with the robot. In such a way, feeling afraid or doubtful during collaborate with the robot might be arise in human feeling, whereby with this feeling it might be hard for them to concentrate during collaborating with the robot.

In spite of analyzing robot's behavior towards human, this project's purpose is to analyze human's emotion or feeling towards robots during their collaboration through Kansei engineering. Besides, a robot should be aware as well, of human work area so it can improve the quality of working environment between them. All the negative feeling present throughout interaction between human and robots can be removed along with secure and comfortable ambiance. In near future, robots with a more user friendly system can be designed, especially for those who are not familiar with it or the first timer users dealing with robots.

## **1.4 Objectives**

The objectives of this project are:

a) To analyze the significant human feelings (Kansei) towards robot during the interaction between them.

## **1.5 Scope**

The scope and limitation of this project are:

a) Robot used for this project are Robot Manipulator and Robot Welding provided by the Faculty of Manufacturing Engineering. Considering that, these are the robot in real manufacturing environment

b) Program the robot movements by using robot's teach pendant

c) This project only focused on reaction or feeling (Kansei) that participant express when collaborating with the robot

d) Participant involved during collaboration are limited to UTeM students and staff only.

e) The analysis process will be based on survey study conducted after interaction session and validate the data.

f) The experiment will be conducted at FKP laboratory.

## **1.6 Report Structure**

In Chapter 1, it briefly explained on the background of the project, project motivation, problem statement, project objective, project scope, and project limitation. Firstly, background is discussing the general idea about the project. Next, the inspiration that motivated to do analysis on this project. Thirdly, problem statement which explain the situation that need to be addressed before solve the problem. Next, the goal that to be achieved are listed in objective. Lastly, the scope will explain the range of the project will be done. As for report structure, each chapter will be explained.