UNIVERSITI TEKNOLOGI MARA

# HUMAN BODY RADIATION WAVE ANALYSIS AND CLASSIFICATION FOR GENDER AND BODY SEGMENTS RECOGNITION

SITI ZURA BINTI A. JALIL @ ZAINUDDIN

Thesis submitted in fulfillment
of the requirements for the degree of
**Doctor of Philosophy**

**Faculty of Electrical Engineering**

November 2014

## AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has been not been submitted to any other academic institution and non academic institution for any degree or qualification.

I, hereby, acknowledege that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research..

| | | |
|---|---|---|
| Name of Student | : | Siti Zura A. Jalil @ Zainuddin |
| Student I.D. No | : | 2008779823 |
| Programme | : | Doctor of Philosophy (EE990) |
| Faculty | : | Electrical Engineering |
| Thesis Title | : | Human Body Radiation Wave Analysis and Classification for Gender and Body Segments Recognition |
| Signature of Student | : | ..... |
| Date | : | November 2014 |

## ABSTRACT

This thesis presents a novel analysis and classification of human radiation wave for gender and body segments recognition. The human body has been shown to emit radiation into space surrounding their body. The research study frequency radiations at 23 points of the human body segregated into body segments of Chakra, Left, Right, Upper body, Torso, Arm and Lower body. Initially, the characteristics of frequency radiation are examined using statistical tools to find the correlations between variables. Multivariate analysis of variance (MANOVA) is employed to compare the differences of frequency radiation characteristics between genders. Then, the classification algorithm of *k*-nearest neighbor (KNN) is employed to discriminate between genders, and between body segments. The classifiers are evaluated through analysis of the performance indicators applied in medical research of accuracy, precision, sensitivity and specificity in receiver operating characteristics (ROC) analysis. The findings obtained from this research show that the wave radiation characteristics of a male and a female human body are different. The proposed technique is able to distinguish gender and classify body segments, and it is justified using MANOVA statistical tests. The individual features of gender differences using analysis of variance forms a significant outcome on 13 points that are located close to the forehead, left and right side of abdomen, palms, arms, shoulders and head. In KNN classification, the outcomes for the classifiers are consistent with the MANOVA. For gender recognition, the classifiers have successfully differentiated male from female human body, and achieving a performance of 100% for accuracy, sensitivity and specificity. For body segment recognition, the classifiers are also able to distinguish between the body segments producing 100% accuracy in classifying of Chakra, Left and Right, whilst 93.75% accuracy is obtained in classifying of Upper body, Torso, Arm and Lower body. The sensitivity and specificity computed for body segment recognition are found to be more than 80% indicating a good classification performance. The outcomes of this study demonstrate that a male and a female human body, and also the different body segments, have different frequency radiation characteristics. The finding offers new opportunities in research and application based on human body radiation such as biometrics and surveillance systems.

## TABLE OF CONTENTS

# CHAPTER ONE
# INTRODUCTION

## 1.1 INTRODUCTION

In recent years, there has been an increasing interest in scientific investigation of the endogenous electromagnetic fields generated by the living body. All living objects, especially human beings, have been found to emit radiation into the space surrounding their body. The radiation from a human body encircles the physical body and can be described as endogenous energy fields generated by and contained within the body [1]. With the advancement in science and technology, the phenomenon of human radiation has been identified to be electromagnetic in nature and is generated by the biological system of the body [2, 3].

The concept of human radiation has been discussed in many studies, including those due to thermal or heat radiation [4, 5]. However, in this study, the radiation field surrounding the human body is explained based solely on the electromagnetic activities in the body, and several studies have been investigated in order to rule out the thermal effect. With thermal radiation, also known as blackbody radiation, the spectrum and intensity of the radiation is determined by the temperature of the body, and this is known as Planck's law [6]. Thermal radiation appears black at room temperature as most of the energy radiates in the infrared region that cannot be seen by the human eye [7]. Generally, the form of heat transfer from the skin to the environment is due to thermal radiation, conduction and convection, while evaporation of sweat is a form of heat loss from the body [8]. Most thermal models developed to describe the heat transfer phenomena of the human body assumed that thermal conditions in the body is determined by the environment factors [9, 10]. The temperature of the human body can be maintained in the range of 23°C to 28°C ambient temperature [11], while thermal comfort can be achieved at 23.6°C [12]. However, it has been found that the temperature of human body remains constant over time even when the body conditions are changed [13]. In other studies, it has been found that the thermal comfort of a human body is significantly affected when the human body is exposed to electromagnetic fields [14, 15]. When exposed to the