AN INVESTIGATION OF ELECTROMAGNETIC FIELD EFFECT ON A HUMAN CELL

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ABSTRACT

The interaction between electromagnetic waves and human cell has received renewed attention recently. This interaction can come from many sources such as cellular phone, the increased clinical application of magnetic resonance imaging (MRI) procedures, radio base station, power line, lightening and x ray radiation. The structure of a human cell will be studied from many school of taught such as biochemical in cell, cytoplasm, nucleus and membrane. The understanding obtained will be used as the basis in the developing of mathematical model. It understood from various researchers that when radiation enters to human body, the component of the cell will react through kinetic energy. The main objective of this project is to analyze the behavior and determine the parameters of the interaction in a single cell when expose to electromagnetic wave such as the attenuation coefficient. The outcome of this project will give an understanding about propagation of electromagnetic wave in human skin cell The Maxwell equations will be used as the basis of the modeling in this project with the aid of numerical method approaches specifically Finite Difference Time Domain (FDTD) techniques. To develop the model MATLAB tool will be used. Results obtained from the developed model will be verified with known result obtained from other researchers.

ABSTRAK

Interaksi diantara gelombang elektromagnetik dan sel manusia telah diberi perhatian sejak kebelakangan ini. Gelombang elektromagnetik datang dari banyak sumber seperti radiasi selular, prosedur MRI, stesen gelombang penghantaran, jalur kuasa, kilat dan radiasi X-ray. Struktur sel akan dikaji dari pelbagai sudut seperti biokimia dalam sel, sitoplasma, nucleus dan membran sel. Struktur-stuktur yang dinyatakan menjadi medium untuk membangunkan persamaan matematik. Telah difahami daripada pelbagai penyelidik menyatakan apabila gelombang elektromagnetik memasuki kedalam sel kulit manusia, komponen didalam sel akan bertindakbalas melalui tenaga kinetik. Tabiat dan parameter terhadap interaksi satu cell dengan gelombang elektromagnetik akan difokuskan. Persamaan Maxwell digunakan sebagai asas didalam pernodelan matematik. Analisis pengiraan di lakukan melalui penghampiran pembezaan terhingga permodelan berasaskan domain masa yang di gunakan di dalam pendekatan kaedah berangka di mana boleh dikira secara berkesan dengan menggunakan komputer peribadi. Pengantaramuka grafik pengguna telah diaplikasikan dalam pembangunan program simulasi ini dengan menggunakan perisian Matlab. Faktor-faktor yang menentukan ketepatan hasil simulasi juga dibincangkan.

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LIST OF SYMBOLS

b	-	Normalized propagation constant
c	-	Speed of light; Phase velocity [m/s]
B	-	Magnetic flux-density complex amplitude [Wb/m^2]
d	-	Differential
div	-	Divergence
D	-	Electric flux density [C/m^2]
E	-	Electric field [V/m]
F	-	Force [$kgms^{-2}$]
H	-	Magnetic-field complex amplitude [A/m]
H	-	Magnetic field [A/m]
j	-	$(-1)^{1/2}$ integer
J	-	Electric current density [A/m^2]
k_0	-	Free space propagation constant [rad/m]
l	-	length [m]
m	-	number of modes
M	-	Magnetization density [A/m]
n	-	Refractive index
ρ	-	Electric polarization density [C/m^2]
Q	-	Electric charge [C]
T	-	Time [s]
TE	-	Transverse electric wave
TM	-	Transverse magnetic wave
TEM	-	Transverse electromagnetic wave
φ	-	Total internal reflection phase shift [rad]

V	-	Voltage [V]
β	-	Propagation constant [rad/m]
ε	-	Electric permittivity of medium [F/m]
ε_0	-	Electric permittivity of a free space [F/m]
ε_r	-	Relative dielectric constant of the material[F/m]
θ	-	Angle
θ_c	-	Critical angle
λ	-	Wavelength [m]
λ_0	-	Free space wavelength [m]
μ	-	Magnetic permeability [H/m]
μ_0	-	Magnetic permeability of free space [H/m]
Φ	-	Angle in a cylindrical coordinate system
ω	-	Angular frequency [rad/s]
∂	-	Partial differential
∇	-	Gradient operator
$\nabla .$	-	Divergence operator
∇ x	-	Curl operator
∇_2	-	Laplacian operator
σ	-	Conductivity
σ_{eff}	-	Conductivity effective

LIST OF APPENDIX

CHAPTER 1

INTRODUCTION

1.1 Introduction

The effects of the interaction of electromagnetic radiation with biological tissues can be considered as the result of three phenomena such as the penetration of EM waves into the living system and their propagation into it. Beside that, the primary interaction of the waves with biological tissues and the possible secondary effects induced by the primary interaction [2].

The word interaction is important. It stresses the fact that end results not only depend on the action of the field but also are influenced by the reaction of the living system. Living systems have a large capacity for compensating for the effects induced by external influences, in particular EM sources. This is very often overlooked while it is one main reason for which conclusions derived from models have to be taken with precaution. Physiological compensation means that strain imposed by external factors is fully compensated and the organism is able to perform normally.

The radiation of mechanism considered consists of a source that emits EM energy. Part of the incident energy is absorbed and transformed within the biological system. Hence, there is the sequence source-radiation-target. The physical laws of EM field theory, reflection, diffraction, dispersion, interference, optics and quantum effects, must be applied to investigate and explain the observed phenomena.

The increasing industrialization of the world and tendency to increase the power of equipment raised the question of health risks first for personnel, then for the general public. It gave an impetus to carry out large research projects and collect a vast amount of experimental data and clinical observations. Before starting any interpretation of the results obtained, however it is necessary to survey the basic phenomena involved in the interaction of electromagnetic radiation with living systems. To first step to analysis the interaction fully understands the basic of bioelectromagnetics.

1.2 Objectives

The main objective of this project is to investigate the interaction between skin human cell and electromagnetic waves. It also to explain the electromagnetic effect with the aid of mathematical modeling. The analysis will be concluded with various parameter associate with the interaction.

1.3 Scope of the work

Scope of this project begins with:

i) Understanding basic concept of human cell, behavior and parameters of interact in a single cell when exposed to electromagnetic wave.
ii) Understanding the Finite Difference Time Domain Method (FDTD) as a chosen method for developing Maxwell equations.
iii) Understanding the MATLAB software as a tool to build the simulation program and modeling.
iv) Testing the simulation to get the accurate result and make a conclusion.

1.4 Problem Statement

Not many mathematical model available to explain the effect of electromagnetic wave on human cell. Beside that difficult to verify the interaction between human cell and electromagnetic wave experimentally. The develop model from this project can be used as a foundation to assist the understanding how electromagnetic wave effecting human cell.

1.5 Motivation of the Work

The develop model can be used in various type of platforms such as medical industries, communication industries, etc. Furthermore the understanding how

interaction among single human cell with electromagnetic radiation can be extended for a larger group of cells. The develop mathematical model can reduce the overall cost by removing the experimental procedure. Beside that currently issues in the newspaper will be motivate done the research as shown in figure 1.1. When looking the others researchers done their research with various manners also give motivation to make a research as shown in table 1.1

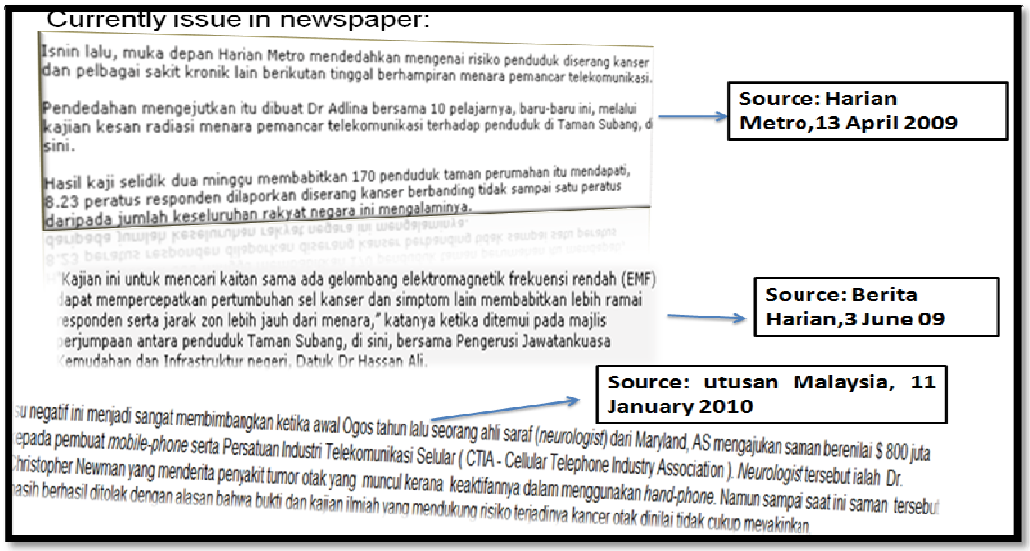

Figure 1.1: Currently issues in newspaper

Table 1.1: Others researchers approach

Researchers	Approach
Kharkov National University, Institute of Biology Ukraine,2006	Experimental objects and methods. Experiment were performed on human buccal epithelium cells.
Domenico Formica ,School of biomedical engineering, Rome Italy, 2007	Experimental approach with using the MRI (magnetic resonance imaging) as the sources.
Dr Adlina, Faculty of medical,uitm Shah Alam, Malaysia, 2009	Questionnaires approach with take 170 respondents of Taman Subang resident.
Researchers from University of Houston, Houston USA,2009	Numerical approach for human head tissue.

1.6 Methodology

Implementation and works of the project are summarized into the flow chart as shown in Figure 1.2. Gantt charts as shown in Figure 1.3 and Figure 1.4 show the detail of the works of the project that had been implemented in the first and second semester.

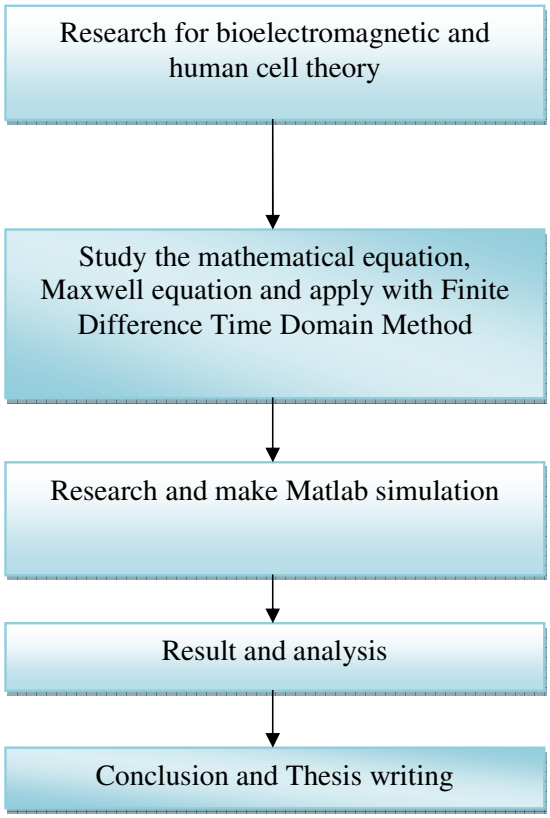

Figure 1.2: Overview Project Flow

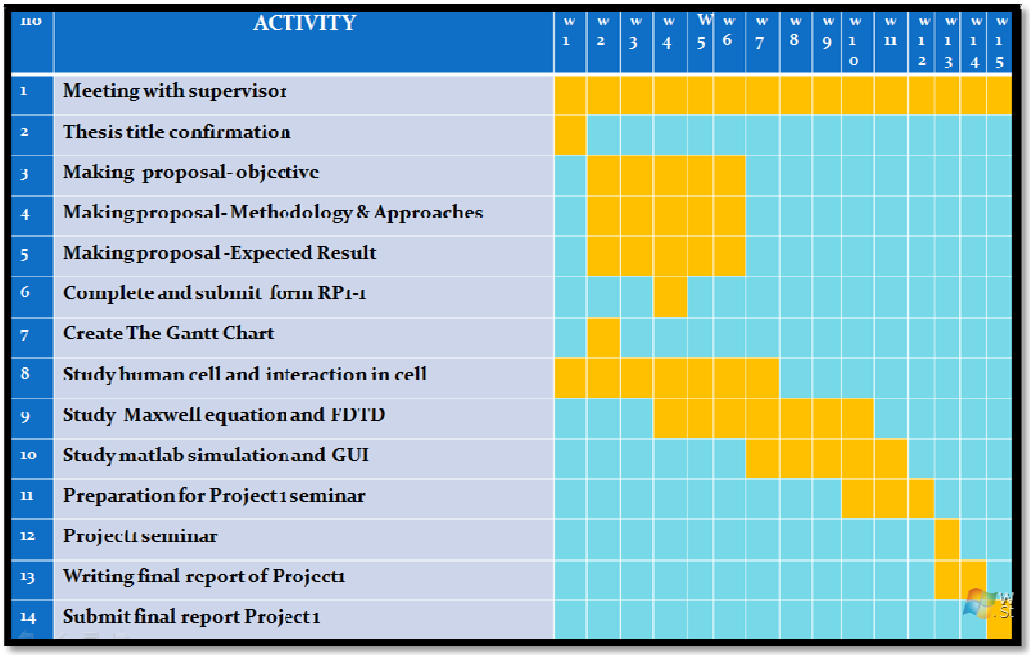

Figure 1.3: Gantt chart Project 1

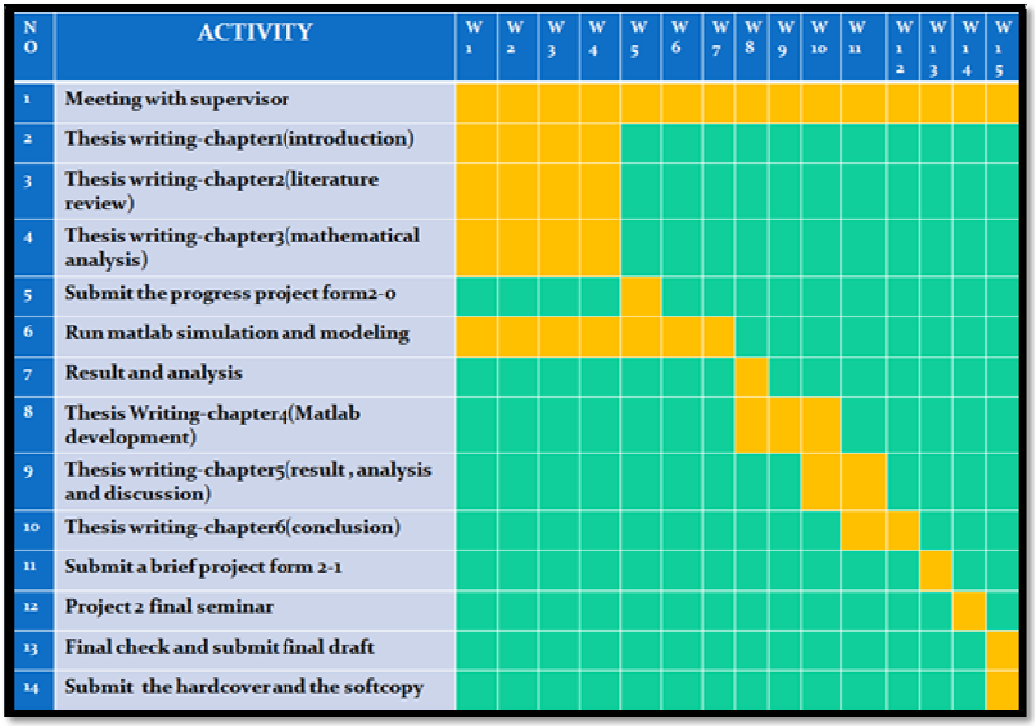

Figure 1.4: Gantt chart for Project2

1.7 Structure of the thesis

This thesis consists of six chapters including this introduction follow the university thesis standard which including objectives, scope of the works, problem statement, motivation of the work and methodology. In second chapter present the literature review of interaction of electromagnetic wave and skin human cell. The structure of skin human cell also will be discussed in this chapter and its function within electromagnetic propagation. Beside that the behavior and structure of three layers also be mentioned.

Mathematical analysis will be present at chapter three. Based on Maxwell equations, a set of wave equations governing the propagation of E-field in the straight propagation are derived. Then, the interactions have been analyzed using the numerical method based on finite difference time domain approach.

Meanwhile the chapter four focused on MATLAB development which its show how mathematical equation was apply in MATLAB file. The flow chart will be presented and this chapter also mentioned an assumption considered to design the interaction of electromagnetic wave with human cell. The parameters of relative permittivity and conductivity at different frequency also discuss to obtain the result and analysis.

Beside that chapter five present the result, analysis, verification and discussion which the value of attenuation and skin depth will be mentioned and the relation each others will be discussing. Finally in chapter six the main contributions and future works are summarized to conclude this thesis.

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