RADIATION EMISSIONS FROM VIDEO DISPLAY TERMINALS

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Bachelor of Engineering with Honors
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Date

RADIATION EMISSION FROM VIDEO DISPLAY TERMINALS

RAZIS BIN PAIMIN

This project is submitted to
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UNIVERSITI MALAYSIA SARAWAK
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DEDICATION

Dedicated to my beloved family and friends…

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I would like to wish my special thanks and gratitude to my supervisor, Miss Shafrida Binti Sahrani for her guidance in finishing my final year project. She really gave a lot of advices that valuable for me when I had problems during my experiments and report writing. Without her guidance, maybe it is hard for me to finish this project.

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ABSTRAK

Elektromagnetik merupakan salah satu tenaga alam selain daripada tenaga nuklear dan graviti di mana ia hampir boleh dijumpai di mana-mana. Tenaga ini digunakan dalam pelbagai cara tetapi orang ramai masih kurang memahami tentang ciri-ciri asasnya. Banyak ciptaan yang berdasarkan elektromagnetik dari kegunaan rumah hingga pejabat, amat penting dan mempunyai kelebihan. Sebagai contoh, aplikasi komputer dan disertai dengan penggunaan terminal paparan video mengubah cara hidup dan pekerjaan. Pengeluar dan pengguna individu komputer semestinya mengetahui kelebihan terhasil daripada teknologi ini tetapi amat sedikit pengguna yang mengetahui risiko sebenar hasil daripada pendedahan pemancaran radiasi elektromagnetik daripada terminal paparan video. Oleh itu, kajian ini dijalankan untuk mengkaji masalah kesihatan yang mungkin berlaku disebabkan radiasi. Eksperimen dijalankan untuk mengira suhu bahagian badan yang terdedah pada radiasi. Suhu dikira menggunakan kamera haba dalam tempoh tertentu dan dikira menggunakan rumus tertentu untuk mengira kadar serapan spesifik. Keputusan eksperimen akan menunjukkan jumlah radiasi yang terdedah kepada manusia dan dalam jangka masa panjang, ini mungkin memberi kesan kepada kesihatan manusia.

ABSTRACT

Electromagnetism is an example of nature force, besides than nuclear energy and gravity where it can be found almost everywhere. This energy is used in many ways but people still lack the full understanding of its fundamental properties. A lot of creations based on electromagnetism ranging from everyday home to offices appliances are important and advantageous. For examples, the application of computers and the accompanying use of video display terminals (VDTs) are changing the living and working lifestyles. Manufacturer and individual users of computers are certainly aware of the benefits generated from this technology but only few users are aware of the real risks derived from the exposure to the electromagnetic radiation emissions from VDTs. Thus, the research is done to study the possible adverse health effect that may occur from the radiation. Experiments are conducted to measure the temperature of the body part that exposed to the radiation. The temperature is measured using thermal imaging camera in certain amount of time and calculated using appropriate equation to measure the specific absorption rate (SAR). The results of the experiment will demonstrate the amounts of radiation that expose to the human body and in longer period, it may affect human health.

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LIST OF SYMBOLS

λ	-	Wavelength
c	-	Speed of light, $3\times10^{8}\,ms^{-1}$
f	-	Frequency
$\mathbf{E}$	-	Electrical field strength
σ	-	Conductivity
ρ	-	Density of tissue
ΔT	-	Change in temperature
Δt	-	Change in time
Q	-	Heat transfer
m	-	Mass of substance
E_{photon}	-	Energy released by photon
h	-	Planck's constant, $6.6261\times10^{-34}\,(J/Hz)$
v	-	Velocity
d	-	Distance

LIST OF ABBREVIATIONS

VDTs	-	Video Display Terminals
SAR	-	Specific Absorption Rate
VLF	-	Very Low Frequency
ELF	-	Extreme Low Frequency
VDU	-	Video Display Unit
CRT	-	Cathode Ray Tube
VGA	-	Video Graphic Array
EM	-	Electromagnetic
UV	-	Ultraviolet
IR	-	InfraRed
RF	-	Radio Frequency
CPU	-	Central Processing Unit
FLIR	-	Forward Looking InfraRed
LCD	-	Liquid Crystal Display

CHAPTER 1

INTRODUCTION

Video Display Terminals (VDTs) are also known as monitors. They are the important link between computers and people. VDTs interpret complex computer languages into displayed text and pictures where humans can understand and use. Computers without monitor can still be the major application used by high-tech laboratories and university researchers to perform mathematical computations with complex printouts as their only output. From the creation of VDTs, the activities of a computer has expanded and significantly contributed to the daily use of the machines, plus their usability has been added greatly with the existence of monochrome and colour displays.

There are two types of radiation that related to VDTs which known as Very Low Frequency (VLF) and Extremely Low Frequency (ELF) radiation. They are emitted from the back, top and sides of the VDTs. Even though televisions also emit these types of radiation, ELF and VLF radiation cause more of a risk from a VDTs since people usually sit much closer to their computers in order to use them properly.

Studies involving ELF and VLF radiation have suggested that they can cause miscarriage, birth defects and contribute to the growth of cancerous tumors [1]. Since these types of radiation have been proven to cause cellular change, the concern over these possible effects has been increased.

1.1 Project Objectives

The main objectives of this research are to study the possible adverse health effect that may occur from the radiation emitted from VDTs and to perform an experiment resulting data from exposure to radiation. The data will be simulated using programming language such as MATLAB.

1.2 Statement of Problems

Most of the problem that related to VDTs is visual problem. The percentage of workers suffering visual problems increases in proportion to the number of hours worked at the Video Terminal Unit (VDU). Surveys of those working more than six hours a day at the VDU have found up to 91% experience visual problems [2].

1.3 Project Approach

For the research, an experiment will be conducted in order to get the required data such as temperature of the part of human body focusing on the head after exposed to radiation. The temperature is determined through the captured image from thermal imaging camera. An application from MATLAB can measure the temperature more accurately from the captured image. The equations involves in this project are Specific Absorption Rate (SAR), specific heat capacity, and photon energy.

1.4 Expected Outcomes and Contribution

A set of data are expected to determine the value of SAR which will prove that human bodies are exposed to radiation emitted from VDTs and may cause some possible adverse health effect. This research can contributes in helping people to be carefully choosing the correct monitor and follows some safety tips in using the monitor. Besides that, the manufacturers will gain some advantage to create a monitor with less radiation.

1.5 Project Outlines

The project outlines summarized the entire chapter in this research. In this report, it contains three chapters which are introduction, literature review and methodology.

Chapter 1 is the introduction on VDTs and some issues related to it. The project objectives are stated in this chapter. The statements of problem give some motivation to further investigate the problems with appropriate approach. Thus, outcomes are expected which will contribute to the society or other research related.

The most common VDTs used are cathode ray tubes (CRT). The basic operation of CRT explained in Chapter 2. This chapter briefly describes a few important components inside CRT and their functions. An introduction on electromagnetic radiation also been discussed in this chapter. The most important points are the explanation about the radiation emitted from VDTs and possible adverse health effect that may occur. The past research is also included in this chapter for the purpose of gaining knowledge and able to improve something for the research.

Chapter 3 is the most important part in this research where the project approach or the methodology discussed. The equations that will be used in the experiment are stated. This chapter also includes the software and the procedures of the experiment.

In chapter 4, the captured images from the experiment will be analyze and discuss. The data can be collected from the images using MATLAB simulation.

Chapter 5 is the conclusion and recommendation. This chapter will conclude the research based on objectives, methodology, results, problem encountered and solution to the problems.

CHAPTER 2

LITERATURE REVIEW

This chapter explains about the basic operation and the components of the cathode ray tube (CRT) displays. Besides that, this chapter includes explanation on electromagnetic radiation, and possible adverse health effect that may occurs from radiation emitted from video display terminals.

2.1 Basic Operation of CRT

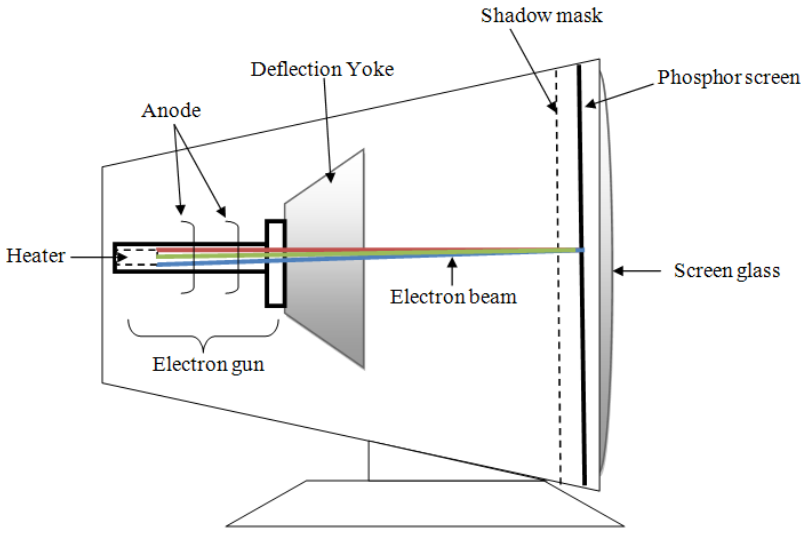

Figure 2.1: Components in CRT displays

A CRT is a glass tube that been evacuated and it has a source of electrons at one end and a screen, which is coated on the inside with a phosphor at the other end as shown in Figure 2.1. An electron gun is used to generate a single electron beam can be located at the back of the tube for a monochrome CRT. For colour CRT, a triple gun is used to generate three electron beams.

A deflection yoke generates magnetic field which it will deflect electron beam that passing through the yoke. The deflection is arranged where the electron spot scan the screen line by line. For colour CRT, the yoke must be specifically designed to make sure all the three beams are deflected towards the same point on the screen. The three beams pass through holes in the shadow mask where each beam strikes only its own phosphor (red, green, blue). After striking the phosphor, the energy of the electrons is converted into light which then passes through the screen and seen by the user [3].

In the CRT, the electron beam moves across the screen in a series of horizontal lines starting at the top left and moving down left to right. In order to cover the screen from top to bottom, the turn lines are displaced vertically. The electron beam is steered horizontally and vertically by the fast changing magnetic fields at the neck of the tube.

The beam must be swept constantly across the screen by an increasing of magnetic field for each horizontal line. This is done while the electron beam turned on. When the beam reaches the right hand edge of the screen, the beam is turned off and retraced to the left side of the screen by a rapidly decreasing magnetic field. The change of magnetic field produces a sawtooth-shaped waveform such in Figure 2.2.

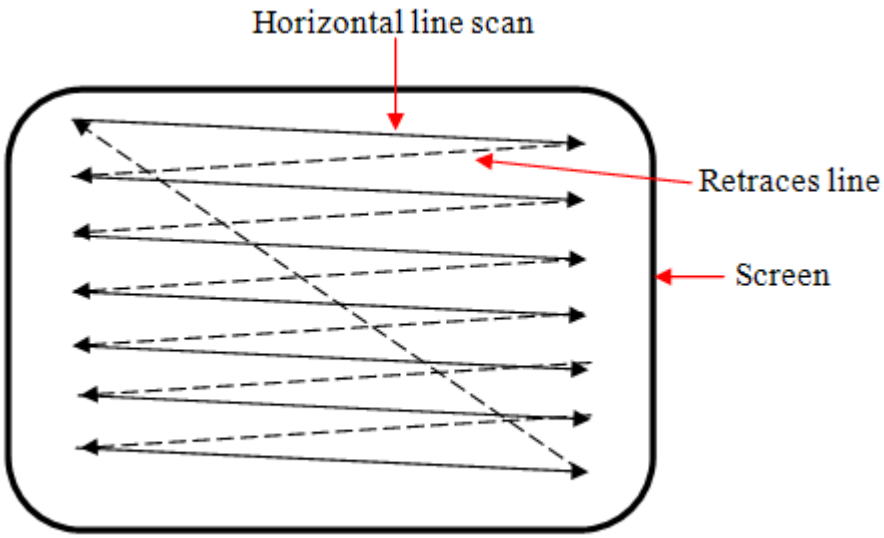

Figure 2.2: Screen scanning

For a typical Video Graphic Array (VGA) mode computer monitor, about 31,500 horizontal lines are painted each second which requires 31.5 kHz magnetic field aligned, or polarized, in the vertical direction [4]. Horizontal deflection system is the circuit that controls the horizontal movement of the beam. For this system, the scanning process is called horizontal scan rate where it describes the number of horizontal line displayed per second. It operates at a frequency of 15.75 kHz to over 60 kHz.

The circuit that controls the vertical movement of the beam is called the vertical deflection system which operates at a frequency of 30 Hz to 75 Hz in most VDTs. The scanning process for this system is known as vertical scan rate or refresh rate. The refresh rate describes the number of times per second a screen is completely scanned.

2.2 Components in CRTs

There are a few components in the CRTs monitor which will be explained in the next subtopic.

2.2.1 The Electron Gun

The function of the electron gun is to generate an electron beam and accelerate with a high anode potential. The electron gun includes the heater (filament), cathode, focusing anode and accelerating anode for three electron beams. The heater heats the cathode and creates a cloud of electrons. Electrons are negatively charged and will be attracted to a positive charge. The anode is a positive charge with very high charges, between 10 k and 30 k volts [5]. The two anodes turn the cloud of electrons into an electron beam. The accelerating anode attracts the electrons and accelerates them toward the screen while the focusing anode turns the stream of electron into a very fine beam. The electrons strike the phosphor screen at almost the speed of light after receiving a large amount of energy. Therefore, the higher the anode voltage, the higher the phosphor will glow.

2.2.2 The Deflecting Yoke

The deflection yoke is a precision wound coil of fine wire placed at the neck of the tube where it starts to expand out to the screen. The function of the yoke is to deflect the beams horizontally and vertically. The beam of electron is deflected by the yoke's magnetic field and can be placed anywhere on the screen with great

precision. The yoke is controlled by deflection amplifiers which operate at very high speeds, up to 100 kHz for a very high resolution monitor [5]. The amplifiers drive the yoke with voltage swings up to several hundred volts.

A deflection yoke can only provide self convergence when the three beams of the CRT are in-line, meaning that the middle one of the three beams lies between the two outer beams. The deflection yoke has the ability to handle high scanning frequencies. For a given field frequency, the line frequency follows directly from the number of lines that are scanned within one field. Higher line densities result in higher scanning frequencies. The number of lines increases with the height of the display. The fields produced by the yoke are extending over a distance greater than the yoke geometry which means that the fields also present outside the monitor.

2.2.3 The Shadow Mask

The shadow mask CRT is the most common type of colour display device used in homes and offices. The colour selection is based on the ability of the shadow mask to transmit electrons from a particular gun only to specific areas of the screen. Only those areas are coated with particular phosphor required for that gun. The remainder of the screen is in shadow from the mask. Electrons from a particular gun directed towards these areas are absorbed by the shadow mask and are unable to excite the phosphors associated with either of the other two electron guns [6].