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Measurement of Electromagnetic Field Radiation In The Internet Halls And Educational Computer Laboratories

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Abstract

There are more concerns about possible health effects related to electromagnetic fields from computer monitors and other video display terminals because of the widespread using of computers in laboratories ,offices and internet halls. This research aims to detect the effect of electromagnetic field radiations in these halls and laboratories and study the successful ways of minimizing its negative health effect on human health. The research has been performed on both the mathematical calculations and practical measurements. The obtaining results show that the practical measurements are consistent with the mathematical calculations results. Comparison of these results with the safety standard guideline limits shows that they are within the acceptable exposuring limits recommended by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and that means there is no health risk from exposure to these fields if the exposure is within the acceptable limits.

Keywords: Electromagnetic field, health effect ,computer laboratory, Internet halls.

حساب كمية الإشعاع الكهرومغناطيسي داخل قاعات الانترنت وفي مختبرات الحاسوب

الخلاصة

هناك مخاوف كثيرة من الآثار الصحية المحتملة الناتجة عن تأثير الأشعة الكهرومغناطيسية المنبعثة من أجهزة الكمبيوتر وأجهزة العرض الفديوية الأخرى بسبب اتساع نطاق استخدام الحواسيب في المختبرات ,المكاتب وقاعات الانترنت. يهدف هذا البحث إلى كشف تأثير الأشعة الكهرومغناطيسية في هذه القاعات وفي مختبرات الحاسوب ودراسة السبل الناجعة للحد من آثارها السلبية على صحة الإنسان. تم أنجاز البحث بطريقتين الحسابات الرياضية و القياسات العملية وقد تم إجراء القياسات العملية في مختبرين للحاسوب وقاعتين للانترنت. إن دراسة النتائج أظهرت آن القياسات العملية مطابقة للنتائج النظرية.كما أن مقارنة النتائج الحاصلة مع المعايير الآمنة بينت أن هذه النتائج تقع ضمن الحدود الآمنة المسموح بها دوليا المحددة من قبل ((اللجنة الدولية للحماية من خطر الإشعاع اللاايوني)) التابعة لمنظمة الصحة العالمية. .

الكلمات الدالة : المجال الكهرومغناطيسي , التأثير الصحي , مختبر الحاسوب , قاعات الانترنت

List of abbreviations

CRT : Cathode Ray Tube
DNA : Deoxyribonucleic Acid
EMF : Electromagnetic Field
EER : Energy Efficiency Ratio
ICNIRP :International Commission on Non-Ionizing Radiation Protec -ion.
WHO: World Health Organization

Introduction

When you go to your office, perhaps you walked through automatic doors, turned on overhead fluorescent lights, powered up your computer, fax and printer. This is the typical day for most of us. Nearly every aspect of our live is "electrically" oriented. Whether we know it or not, we are being exposed to millions of EMF's or electromagnetic

field frequencies (24) hours per day, without knowing what they are, what they do, who regulates them and whether they can potentially harm our bodies or not. Numerous studies from leading scientists have linked long-term EMF exposure to increased risks for: heart disease, leukemia ,brain tumor, depression and suicide, cancer and others. [1]

Background

EMF are present everywhere in our environment, some visible (light), but most invisible to the human eye. They are an interaction between electric and magn-etic forces. Natural sources of electric fields are produced by the local build-up of electric charges in the atmosphere associated with thunder-storms and the best known natural magnetic field surrounds the earth .But besides these natural sources, many man-made sources are present.

Literature review

With more than twenty years of research into possible health risks from ELF fields, much knowledge and understanding have been gained, but important scientific uncertainties still remain. In most epidemiologic studies reported to date, residential magnetic field measurement data have been evaluated using spot measurements or time weighted average level or medians of longer-term measures. The following studies are conducted to determine the risk assessment:

1. Preece.et.al(1997).assessed broadband magnetic fields at various distances from domestic appliances in use in the United Kingdom. The magnetic fields were calculated froma mathematical model fitted to actual measurements made on the numbers of appliances. They reported that few appliances generated fields in excess of 0.2 μT at 1 meter distance: microwave cookers 0.37 ± 0.14 μT; washing machines 0.27 ± 0.14 μT; dishwashers 0.23 ± 0.13 μT; some electric showers 0.11 ± 0.25 μT .[2]
2. Gauger (1984) and Zaffanella & Kalton (1998) reported narrow band and broadband data, respectively, for the USA. In Gauger's analysis of hand held hair dryers, at 3 cm from their surfaces, magnetic felds of about 6, 15, and 22 μT were produced for three types of hair dryers.[3].
3. Zaffanella (1993) found that at a distance of 27 cm from digital and analog clocks/clock radios, the median fields were 0.13 μT and 1.5 μT for digital and analog clocks, respectively. Preece et al. (1997) also measured the magnetic fields produced by hair dryers and electric clocks. At distances of 5 and 50 cm from hair dryers field measurements were 17 and 0.12 μT, respectively, and from electric clocks 5.0 and 0.04 μT, respectively. .[4]
4. Florig & Hoburg (1990) characterized fields from electric blankets, using a three-dimensional computer model; max. ,min .,and volume average fields within human forms were presented as a function of blanket type and geometric factors such as body size, body-blanket separation .[5]
5. Wenzl (1997) reported measurements on a 25 Hz AC electrified portion of the Northeast Rail Corridor in Maryland and Pennsylvania. Averages for workers were found to range between 0.3 and 1.8 μT , although 60 Hz and 100 Hz fields were also pres-ent from transmission lines suspended above the railway catenaries and from the

railway safety communications and signaling system respectively .[6]

6. Sandström et al. (1993) measured magnetic fields from VDUs in 150 offices and found that rms values measured at 50 cm from the screen ranged up to 1.2 μT (mean: 0.21 μT) in the ELF range (0–3 kHz) and up to 142 nT (mean: 23 nT) in the VLF range (3–30 kHz).[7]
7. Floderus et al. (1993) investigated sets of measurements made at 1015 different workplaces. This study covered 169 different job categories, and participants wore the dosimeters for a mean duration of 6.8 h. The most common measurement was 0.05 μT and measurements above 1 μT were rare.[8]

From the results of some of the recent studies we can see that The actual exposures of the general public to ELF magnetic fields are usually lower than the international exposure guidelines (Threshold level, generally considered as exposures ≥0.2, 0.3, or 0.4 μT). So there are a few effects for which the evidence is strong. However the public's concern often focuses on the possibility of long-term effects caused by low-level environ-mental exposure. Given the lack of conclusive data on possible long-term adverse health effects decision-makers are faced with a range of possible measures to protect public health.

Electromagnetic fields description

(EMFs) are invisible forces created by power charges that surround any electrical device and any wire caring electrical current .Electromagnetic field (EMF) consists of waves of electric and magnetic energy moving together through space at right angles to each other at the speed of light.[9]

Electromagnetic wave can be imagined as self-propagating transverse oscillating wave of electric and magnetic fields. The polarized wave. The electric field is in a vertical plane and the magnetic field is in horizontal plane fig.(1) .Electromagnetic fields can extend far beyond their sources, and are mostly imperceptible to people. electric and magnetic fields are both created by flow of electricity, both radiate into surrounding space in the form of waves, and intensity of both diminishes significantly with distance. However, these fields also have significant differences. For example, electric field is produced wherever there is a potential difference, even when electric current is not flowing , while magnetic field is produced only by electric current flow. Another significant difference is their susceptibility to shielding. Electric fields are susceptible to shielding effects by almost anything that stands in their way, substantially reducing its effect. On the other hand, magnetic fields are passing through any object, except those that have high concentration of iron. [9]

So this research has been focused to the magnetic field effects, and not electric field.

Electromagnetic fields sources

Electricity is the most common source of power throughout the world because it is easily generated and transmitted to where it is needed. As electricity moves through wires and machines, it produces EMF. The power grids of nations consist of electrical generation, transmission and distribution facilities. As electricity is sent along the wires of the power grid, EMF is created. In cities, primary electric power distribution lines run across the top of utility poles and feed secondary transformers, which are then connected to the electric power meters of buildings. Once electricity is delivered to the user, it continues to produce EMF

throughout the wiring systems of offices, homes, schools, factories and other structures. The appli-ances and electrical equipment connected to these wiring systems produce their own EMF. [10]

In the workplace the generators of EMF include computers fig.(2) , cell phones, fax machines, copy machines, fluorescent lights, printers, scanners, telephone switching systems, electrical instruments, motors and other electrical devices. In homes, the immediate sources of EMF include electric blankets, electric water bed heaters, hairdryers, electric shavers, television sets, stereo systems, air condit-ioners, fluorescent lights, electric can openers, telephone answering machines, cell and portable phones, refrigerators, blenders, portable heaters, clothes wash-ers and dryers, coffee makers, vacu-um cleaners, toasters, and microwave ovens. EMF is not only produced by electricity moving through wires or machines, but it is the nature of all TV and satellite transmissions, as well as radio and micro-wave communication systems. [11]

Biological Effect of Electromagnetic Radiation

Many questions have been raised about the possible health effect of electric and magnetic fields (EMF), which are found wherever you have electric power. Many researchers believe that if there is a risk of adverse health effects from usual residential exposures to EMF, it is probably just at the detection limit of human health studies; nonetheless, the possible risk warrants further investigation. Laboratory experiments have shown that EMF can cause changes in living cells. [12]

Some scientists previously believed that the only way that EM radiation could produce damaging effects was if the radiation was sufficiently intense to cause a heating effect on the tissues. This theory has now been roundly discredited by many studies in which biological effects have been observed at intensities far too small to cause any measurable heating effect. The mechanisms by which electro-magnetic radiation may affect disease processes are not yet fully understood, but promising candidates include :

Deoxyribonucleic-acid (DNA) Damage:

Our cells have mechanisms to repair DNA damage to a limited extent, but it appears that EMFs can over whelm these mechanisms.Damaged DNA is implicated in several disease processes, including various types of cancer .[13]

Interference with Melatonin production:

EMF radiation appears to interfere with the production of melatonin, a hormone that is normally produced in the body .Low melatonin levels have already been linked to several diseases. [14]

Interference with Cellular Commun-ication

Our body cells communicate internally and externally by means of electrical signals. These signals can be altered by EMF radiation (which generates electrical currents within the body) causing changes in both cellular activity and cellular structure [15].

Safety Standards for Exposure to Electromagnetic Fields

The potential risk to human health gradually increases with higher exposure levels. Guidelines indicate that, below a given threshold, electromagnetic field exposure is safe according to scientific knowledge.[15]

In this research the focus will be on the limits and basic restriction applicable to frequency band interest, e.g.(50Hz).The maximum electromagnetic fields level of public Exposure to electromagnetic field from television and computer screens at

operator position (0.7μT max. exposure for TV and computer screens at operator position)and according toWHO (Regional Office for Europe) .Own exposure is likely to be much lower.[16]

Methods of determining electromagnetic field levels

In this research there have been two methods of determining the electromagnetic field levels :

1. Mathematically calculating the electromagnetic flux density (B)at five points in the computer laboratory number (1) with desk tops computers and determining the safe ranges in front and back of the computer monitor.
2. Practically Measuring the electromagnetic field levels at the computer laboratories number (1) and (2) , and in internet halls number (1) and (2) by using the portable electromagnetic field tester device type (EMF-872).

Mathematical calculation method

The magnetic field(magnetic flux density B) can be calculated mathematically using Amperes law which gives the magnetic flux density (B) when a current (***I***) flow through the computer[9]:

$$B = \frac{\mu_{0.I}}{2\pi.r} \quad \text{.....(1)}$$

Where :

B :Magnetic field (magnetic flux density), measured in Tesla (T).

I : Elec. current measured in ampere (A)

r :distance from the source of EMF measured in meter (m).

μ_0:Permeability of free space measured in Tesla .meter/ampere (T .m / A)

$$\mu_0 = 4\pi \times 10^{-7} \; T.m/A \quad \text{.....(2)}$$

a-we will calculate the magnetic field(B) at five different points in the computer laboratory number (1) only and the results will be compared with the practical results in the same computer laboratory :

When a current (I = 1.2 A) flowing through the computer which is mounted on the instructor table in the computer laboratory number (1) fig (3) .the magnetic field (B) at point (p_1) which is at a distance of (r =0.75 m) from the computer screen will be :

$$B = \frac{4\pi . 10^{-7} . (1.2)}{2\pi . (0.75)} = 32.10^{-6} \; Tesla$$

$$= 0.32 \; microTesla < 0.7 microTesla \text{....(3)}$$

It is within the guideline limits, So, according to (WHO), It is a safe range .And so on for the other four points (p2,p3,p4,p5)which are at a different distances r (m) from the computer screen as shown in table (1) .

b-A CRT-based computer radiates as far as eight times its own diagonal, with the most intense emission at close range within a(110°) cone area in front and back of the screen, so, the safe ranges in front of the computer screen , when a current of about (1.2A) flow in the computer, the magnetic field (B) will be as shown at table (2).

c-The safe ranges in back of the computer screen , when a current of about (1.2A) flow in the computer, the magnetic field (B) will be as shown at table (3).

According to these results and to the World Health Organization (WHO) Regional office for Europe ,we can determine the safe ranges in the front and back of the desk top computer screen as follows :

1. The safe range in the front of the monitor is (25cm) from the screen to the operator Position.
2. -The safe range from the source of EMF in front of the computer is 35 cm (10 cm inside + 25 cm outside the monitor) .
3. The safe range in the back of the screen is (30) cm (from the back of the monitor to the point of interest).
4. The safe range from the source of EMF in back of the computer (35 cm)
5. (5 cm inside + 30 cm outside the monitor) .the safe ranges are illustrated in figure (3).

Practical measuring method

In this research ,electromagnetic exposure levels have been carried out at low frequency (50 Hz) by using (EMF-872) tester with wireless probe as follows:

a) -Detecting the electromagnetic levels at four corners beginning from (p_1) which is at a distance (0.75 m) from the instructor computers monitor in the computer laboratory , and the next points (p_2,p_3,-p_4,p_5) which are at a distances (1.1m),-(0.9m),(1.25m),(1.5m) respectively in the computer laboratory number (1) which contains some electrical devices which operate on low frequency (50 HZ) and effect the levels of EMF ,Fluorescent lamp (8),desktop computers(10), air conditioner (2),UPS (10) as shown in figure (4).

b) -Detecting the electromagnetic levels in the computer laboratory number(2) in four corners beginning from (p1) , (p2) , (p3),(p4) and (p5).

c) -Detecting the electromagnetic levels at five different points in the internet hall number (1), which contains desk top computers beginning from point (p1) ,(p2),(p3) , (p4) and (p5) at which the points (p1,p2.p3.p4.) represent the four corners of the internet hall,and point (p5) represent the center position. figure (5) .

d)-Detecting the electromagnetic levels at five different points in the internet hall Number (2), which contains desk top computers beginning from point (p_1) ,(p_2),(p_3) ,(p_4) and (p_5) .

e)-Finally ,this results are studding and analyzing individually.

Measuring results

a) The average values of the measuring electromagnetic field levels at points (p_1,p_2,p_3,p_4 p_5,) in two computer laboratories which Contains desktops are illustrated in table (4) .

b) Average values of the measuring electromagnetic field levels at points-(p_1,p_2,p_3,p_4,p_5) in computer laborat-ories which Contains laptops are illustrated in table (5).

c) The average values of electromagn-etic field levels at points (p_1,p_2,p_3,p_4, p_5) in two internet halls With desktops computer are illustrated in table (6) .

d) The measured safe ranges in front of the computer screen are illustrated in table (7) .

e) The measured safe ranges in back of the computer screen are illustrated in table (8).

It is within guideline limits, so, according to (WHO), it is a safe ranges .

Results and Discussion

It is found from the results that:

1-The electromagnetic field levels at points (p1,p2,p3,p4) in the computer laboratory which Contains desktops are approximately similar and they are within the exposure limits set by the ICNIRP (below 0.7 μT) see table (1), that means they don't pose any risk for human health if the exposure not being for along period .

2-The electromagnetic field strength at points (p_1,p_2,p_3,p_4) in the computer laboratory which Contains laptops are approximately similar and they are within the exposure limits set by the ICNIRP (below 0.7 μT) ,this meaning that they also don't pose any risk to human health if the exposure not being for along period.

3-The Electromagnetic levels at different points in the computer laboratory with laptops are lower than the levels in case of laboratory with desktops as a computer devices, that means we can minimize the strength of EMF using laptops instead of desk tops in computer laboratories ,in personal work places and internet halls as shown in see fig. (6).

4-The electromagnetic levels at different points in two internet halls are approximately identical and they are within the exposure limits set by ICNIRP (below 0.7 μT),this means that they also don't pose any risk to human health if the exposure not being for along period.

5-The safe range in front of the monitor is about (25 cm) at which EMF level= 0.675(μT) is below the maximum exposure level (o.7 μT) and the safe range in back is about (35 cm)) (at which EMF level(0.60μT) is below (0.7)μT that means the back side of the computer is actually more dangerous than front side, so with rows of computers, it must be taken into account the safe ranges in the front and the back of the computer screen

6-The mathematical calculations and the practical results of magnetic flux density (B) show that there is no much deference between these two methods and all these (EM F) levels are laying within the acceptable exposure levels.

Discussion

What can be done to minimize the negative health effect of EMF exposure and provide holistic EMF protection?

Based on the measuring results and theoretical analysis, we can conclude the following Options to minimize negative health effect of EMF Exposures :

1-It is better to use laptop computers instead of desktop or the monitor should be (LCD) type instead of (CRT) type for the desk top computers at the laboratories or at a personal work places .

2-Since the human health risk of EMF fields increase with increasing the exposuring period for these fields, it is better to reduce the spending time working on the computer if it is not necessary.

3-Because exposure to the electroma-gnetic field increases exponentially as you move towards the source, every one of us must keep away as much as possible from the sources that cause electroma-gnetic pollution.

4-When shopping for appliances, it is better to choose those with a Higher EER (energy efficiency ratio) which produce lower EMF levels and are therefore they are safer than others.

5-When arranging the computers in the laboratories or in the internet halls with rows of computers , it must be taken into account the safe ranges from the front and back sides of the computer screen.

6-Computers screen must be good shielded to reduce the electromagnetic fields radiation from it.

7-It is strongly recommended to avoid introducing school children to computers laboratories or internet halls at earlier grad levels.

8-It is recommended to avoid placing any non-protected CRT-based VDT in a child's room, behind a wall next to a living or a bedroom , a hospital room, etc.

Conclusions

measurements of determining electrom-agnetic fields are carried out in two methods ,mathematical calculations and practical measuring. Measurements are conducted at five different points for every one of the three laboratories and at five points for every one of the two internet halls by using the electroma-gnetic field radiation tester (EMF -827). The results are considered and studied individually. The comparison of these results with the standard exposure limits which set by the International Comm-ission on Non-Ionizing Radiation Prot-ection (ICNIRP) shows that they are below the limits recommended in the guidelines set by the International Comm-ission on Non-Ionizing Radiation Prote-ction (below 0.7 μT), so they don't pose any risk to human health if the exposure is for intermittent periods. However, a risk does exist if the humans exposure is for a long and continuous periods.

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Table (1) : Mathematical calculations of EMF levels in the computer laboratory with Desktops

Position	r (m)	B(μT)	Comment
Point 1	0.75	0.32	< 0.7
Point 2	1.1	0.218	< 0.7
Point 3	1.25	0.192	< 0.7
Point 4	0.9	0.267	< 0.7
Point 5	1.5	0.164	< 0.7

Table (2) : Mathematical calculations of EMF levels in the in front of the screen

Position	r (m)	B(μT)	comment
Point 1	0.15	1.6	> 0.7
Point 2	0.35	0.685	< 0.7
Point 3	0.60	0.409	< 0.7
Point 4	1.1	0.228	< 0.7

Table (3) : Mathematical calculations of EMF levels in the back of the screen

Position	r (m)	B(μT)	Comment
Point 1	0.10	2.4	> 0.7
Point 2	0.30	0.8	> 0.7
Point 3	0.35	0.685	< 0.7
Point 4	0.55	0.436	< 0.7
Point 5	1.05	0.228	< 0.7

Table (4): Practical measurements in two computer laboratory with desktops

Laboratories Contains desk- tops	Magnetic flux density (B) at some points in the computer laboratory in micro Tesla (μT)				
	P1	P2	P3	P4	P5
Laboratory No.1	0,338	0,227	0,184	0,288	0,162
Laboratory No.2	0,324	0,250	0,173	0,274	0,150
Average values	0,331	0,239	0,179	0,281	0,156

Table (5) : Practical measurements in two computer laboratory with laptops

Laboratory contains laptops	Magnetic flux density (B) at some points at the computer laboratory in micro Tesla (μT)				
	P1	P2	P3	P4	P5
Laboratory No.1	0.016	0.014	0.013	0.011	0.007
Laboratory No.2	0.015	0.016	0.015	0.013	0.009
Average values	0.016	0.015	0.014	0.012	0.008

Table (6): Practical measurements in two internet halls with desktops

Internet hall contain desktops	Magnetic field (B) at some points in the internet hallsin micro Tesla (μT)				
	P1	P2	P3	P4	P5
Hall .1	0,326	0,285	0,187	0,193	0,169
Hall .2	0,293	0,261	0,178	0,208	0,151
Average values	0,309	0,273	0,183	0,201	0,160

Table (7) : Practical measurements of electromagnetic levels in front of screen

Measuring direction	Magnetic field (B)in (μT)			
	at (5cm)	at (25cm)	at (50cm)	at (100cm)
in front of the computer screen	1.543(μT)	0.675(μT)	0.403(μT)	0.213(μT)

Table (8) Practical measurements of EMF levels in the back of computer screen

Measuring Direction	Magnetic field (B) In (μT)			
in back of computer screen	at (5cm)	at (30cm)	at (50cm)	at (100cm)
	2.433 (μT)	0.603(μT)	0.405 (μT)	0.217(μT)

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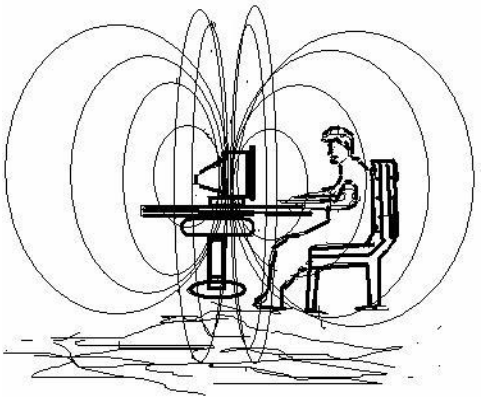

q: Electric charge
E : Electric field
B : Magnetic field
K : Direction of wave propagation

Figure (1) EMF wave propagation

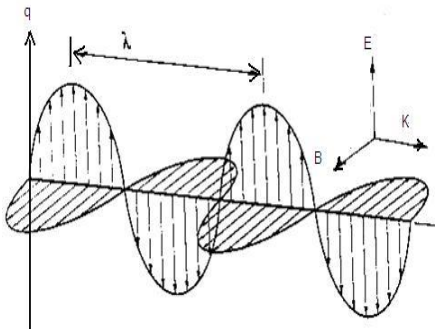

Figure (2) EMF radiation from computer

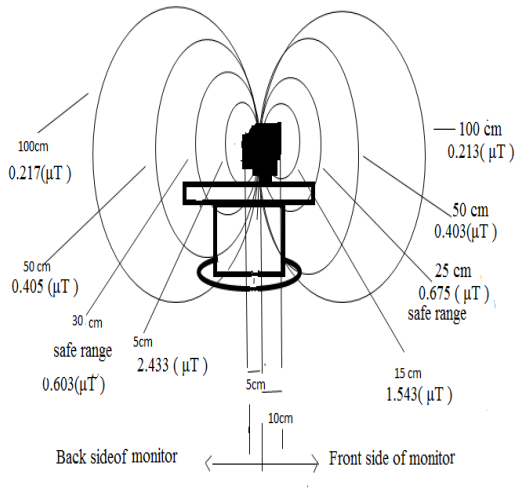

Figure (3):safe ranges at the front and the back of computer

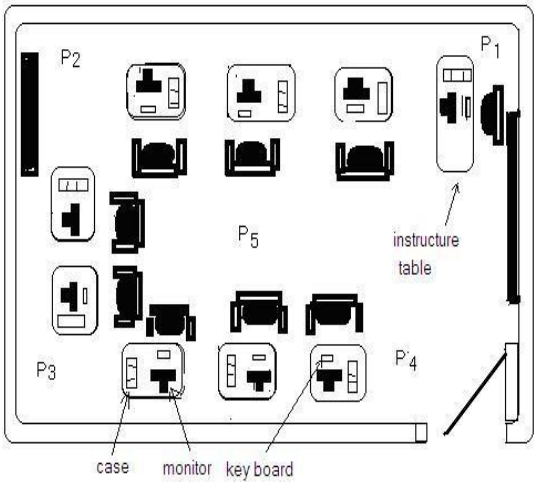

Figure (4) :Top view of the computer laboratory

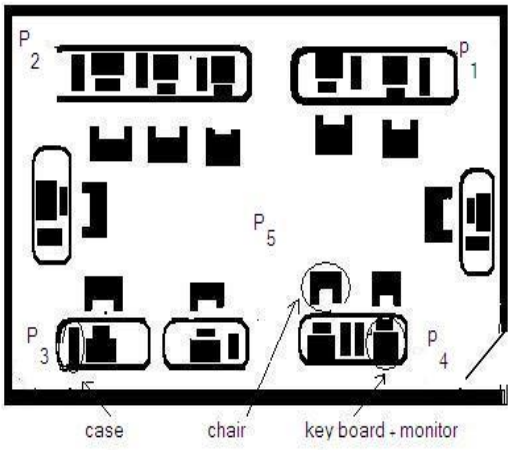

Figure (5) : Top view of the internet hall using laptop instead of desk top

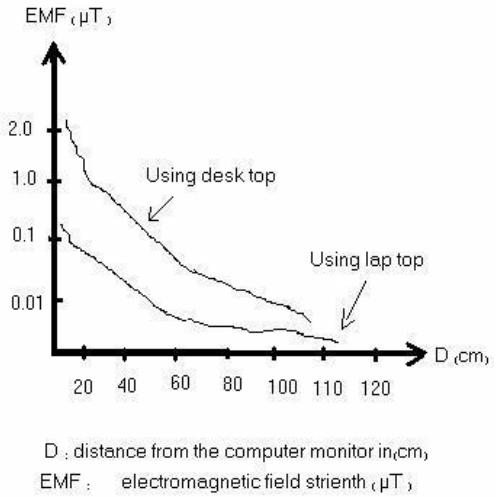

Figure (6) Reducing EMF radiation