Mobile Phone Radiation Effects on Human Health

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Abstract

A boon for better communication, cell phone usage nonetheless has many health hazards. Various studies indicate that the emissions from a cell phone can be extremely harmful, causing genetic damage, tumors, memory loss, increased blood pressure and weakening of the immune system. The fact that this radiation is invisible, intangible, and enters and leaves our bodies without our knowledge makes it even more intimidating. Global System for Mobile Communications (GSM) and Code Division Multiple Access (CDMA) are the two most prevalent second generation (2G) mobile communication technologies. This paper discusses on the analysis conducted to study the effect of electromagnetic radiation of two mobile phone technologies with different frequencies and power level via experimental works. The experiment was conducted in a laboratory using 10 human volunteers. The period of operation is 10 minutes as the talking time on the phone. Electroencephalogram is used to monitor and capture the brain signals during the experimental analysis for 10 minutes interval. The result shows that mobile phone serving GSM has the larger effect on brain compared to mobile phone serving CDMA.

The effect of mobile phone radiation on human health is the subject of recent interest and study, as a result of the enormous increase in mobile phone usage throughout the world (as of June 2009, there were more than 4.3 billion users worldwide). Mobile phones use electromagnetic in the microwave range. Other digital wireless systems, such as data communication networks, The WHO have classified mobile phone radiation on the IARC scale into Group 2B - possibly carcinogenic. That means that there "could be some risk" of carcinogenicity, so additional research into the long-term, heavy use of mobile phones needs to be conducted. Some national radiation advisory authorities have recommended measures to minimize exposure to their citizens as a precautionary approach. The rapidly evolving mobile phone technology raised public concern about the possibility of associated adverse health effects. The current body of evidence is summarized addressing epidemiological studies, studies investigating adverse biological effects, other biological effects, basic mechanisms and indirect effects. Currently, the balance of evidence from epidemiological studies suggests that there is no association between mobile phone radiation and cancer. This finding is consistent with experimental results. There is some evidence for biological effects, which, however, are not necessarily hazardous for humans. No basic mechanisms of biological effects have been consistently identified yet.

Using a mobile phone while driving a car is significantly associated with a higher risk of vehicle collisions, independently of the use of hands-free kits. Medical equipment or implanted pacemakers may be affected by mobile phone radiation under very specific conditions. Current studies, however are affected by several limitations and do not generally exclude any increased health risk. Further high-quality research is therefore necessary. Furthermore, it is important that the results of scientific research are communicated to the public in a transparent and differentiated way.

Keywords: *GSM, CDMA, 2G, Electromagnetic Radiation, EEG, Mobile phone, hand-held Cellular telephone, Microwaves, non-ionizing radiation, radiation risk.*

I. INTRODUCTION

Safety is a legitimate concern of the users of wireless equipment, particularly, in regard to possible hazards caused by electromagnetic (EM) fields. There has been growing concern about the possible adverse health effects resulting from exposure to radiofrequency radiations (RFR), such as those from mobile communication devices. Mobile communication is where signal is transferred via electromagnetic wave through radio frequency and microwave signals. This signal produces electromagnetic radiation in the form of thermal radiation that consists of harmful ionizing radiation and harmless non-ionizing radiation. When using mobile phone, electromagnetic wave is transferred to the body which causes health problems especially at the place near ear skull region where they are known to affect the neurons. The radiations interfere with the electrical impulses that two neurons connect each other with.

This can lead to deafness and migraines. People using cell phones are prone to high blood pressure and other symptoms such as hot ears, burning skin, headaches and fatigue. There have been various studies into the connection between mobile phones and memory loss. Because of their smaller heads, thinner skulls and higher tissue conductivity, children may absorb more energy from a given phone than adults. International guidelines on exposure levels to microwave frequency limit the power levels of wireless devices and it is uncommon for wireless devices to exceed the guidelines. But these guidelines only take into account thermal effects, as non-thermal effects have not yet been conclusively demonstrated. This paper shows that the non-thermal radiation affects the human brain. Global System for Mobile Communications or GSM is the world's most popular standard for mobile telephone systems. GSM is a cellular network, which means that mobile phones connect to it by searching for cells in the immediate vicinity.

GSM networks operate in a number of different carrier frequency ranges. GSM networks operate in the 900 MHz or 1800 MHz bands. Where these bands were already allocated, the 850 MHz and 1900 MHz bands are used instead Regardless of the frequency selected by an operator; it is divided into timeslots for individual phones to use. This allows eight full-rate or sixteen half-rate speech channels per radio frequency. These eight radio timeslots (or eight burst periods) are grouped into a TDMA frame. Half rate channels use alternate frames in the same timeslot. The transmission power in the handset is limited to a maximum of 2 watts in GSM850/900 and 1 watt in GSM1800/1900. Code division multiple access (CDMA) is a channel access method used by various radio communication technologies. One of the basic concepts in data communication is the idea that it allows several transmitters to send information simultaneously over a single communication channel. This allows several users to share a band of frequencies. This concept is called Multiple Access. CDMA employs spread-spectrum technology and a special coding scheme where each transmitter is assigned a code to allow multiple users to be multiplexed over the same physical channel. The transmission power in the handset is limited to a maximum of 6 to 7 mille Watts. Table 1.1 shows the specifications of GSM and CDMA mobile phone technologies, their power level and mode of transmission.

Table 1.1: Specifications of GSM and CDMA [1] [2].

MOBILE TECHNOLOGY	POWER LEVEL	MODE OF TRANSMISSION
GSM	1-2 watt	Burst
CDMA	6-7 mW	Continuous

II. EFFECTS

Many scientific studies have investigated possible health symptoms of mobile phone radiation. These studies are occasionally reviewed by some scientific committees to assess overall risks. A recent assessment was published in 2007 by the European Commission Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR). It concludes that the three lines of evidence, viz. animal, in vitro, and epidemiological studies, indicate that "exposure to RF fields is unlikely to lead to an increase in cancer in humans". With the way technology has grown, especially in the field of genetic engineering, has led scientists to figure out a way to alter how food is made. This raises concerns and lot of questions regarding the methods they are using. From what possible side effects can occur to the risks it poses to everyone and everything. Unfortunately, there has been limited research and testing done. With that in mind there is not enough information available about the hazards of genetically modified foods. But, what we do know is alarming. Most of the debate surrounding GM foods are focus on the following three issues: 1. Human and environmental safety, 2. Labeling , and 3. Consumer choice. In this section of the paper I will be discussing how genetically modified food can be dangerous on the health of humans. First we will start with the definition of Genetically Modified (GM) is "a special set of technologies that alter the genetic makeup of such living organisms as animals, plants, or bacteria. Bacteria is general term, refers to using living organisms or their components, such as enzymes, to make products that include medicines and vaccines, foods and food ingredients, feeds, and fiber

The unique structure of GM food creates risk to humans which can affect them in the following ways: allergic reactions, toxicity, antibiotic resistance, adverse health side effects and death. It is impossible to foresee the damage inflicted by genetic food; it is a matter of wait and sees what consequences occur because of it. During the genetic modification process, proteins from organisms that have never before been a part of the human food chain are being used and so, GM food may cause allergic reactions. Allergens could be transferred from foods people are allergic to into foods that they think are safe. For example in 1996, Pioneer Hi-Bred International Inc.

III. RADIATION ABSORPTION

Part of the radio waves emitted by a mobile telephone handset is absorbed by the human head. The radio waves emitted by a GSM handset can have a peak power of 2 watts, and a US analogue phone had a maximum transmit power of 3.6 watts. Other digital mobile technologies, such as CDMA2000 and D-AMPS, use lower output power, typically below 1 watt. The maximum power output from a mobile phone is regulated by the mobile phone standard and by the regulatory agencies in each country. In most systems the cell phone and the base station check reception quality and signal strength and the power level is increased or decreased.

IV. ELECTROMAGNETIC RADIATION

Electromagnetic radiation is a form of energy exhibiting wave-like behavior as it travels through space. Electromagnetic radiation has both electric and magnetic field components, which oscillate in phase perpendicular to each other and perpendicular to the direction of energy propagation. Electromagnetic radiation can be classified into ionizing radiation and non-ionizing radiation, based on whether it is capable of ionizing atoms and breaking chemical bonds Non-ionizing radiation is associated with two major potential hazards: electrical and biological. Extremely high power electromagnetic radiation can cause electric currents strong enough to create sparks (electrical arcs) when an induced voltage exceeds the breakdown voltage of the surrounding medium. These sparks can then ignite flammable materials or gases, possibly leading to an explosion.

The biological effect of electromagnetic fields is to cause dielectric heating. Complex biological effects of weaker non-thermal electromagnetic fields also exists, including weak Extremely Low Frequency magnetic fields and modulated Radio Frequency and microwave fields. Magnetic fields induce circulating currents within the human body and strength of these magnetic fields depends directly on the intensity of the impinging magnetic field. These currents cause nerves and muscles to stimulate which in turn affects biological processes. The influence of the weak EM radiations on human can be realized as sequence of events which includes exposure to EM radiations which when absorbed modulates the biological field patterns, accumulation of energy and information into the body fluid, change in the functional activities of cell which finally results into some disease.The number of mobile phone users has increased exponentially recently and it has become an important device in human daily life. Estimates suggest there are around 1.6 billion mobile phone users throughout the world and the numbers are increasing and hence the level of background electromagnetic radiation. Figure 1 shows the effect of electromagnetic radiation on human head.

Figure 1 shows the level of electrical activities generated in brain. The voltage level ranges from blue to red and represents electrical activities ranging from minimum to maximum.

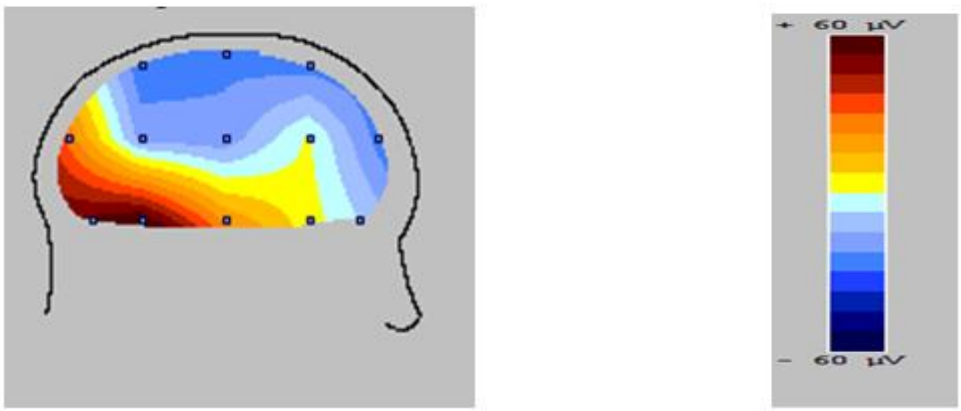


Figure 1: Effect of electromagnetic radiation on human brain

4.1 Harmful Effects of Nuclear Energy on Human Health and the Environment

Over the past decades, scientists, conservationists and environmentalists alike have been searching for clean, renewable sources of energy. As we enter move further into the Common Era, the human population will continue to grow exponentially; therefore, the demand for resources will grow as well. Energy is the primary resource needed to sustain a human population; however, commonly used energy resources, such as coal and oil, have either become scarce, or have caused harmful effects to the human environment. In recent years, scientists have discovered other sources of renewable energy. Wind, sunlight, water, and nuclear chemicals have been deemed the cost effective and harmless to the environment. Extensive research has led to the development of new technologies that utilize sources of renewable energy. However, it has been argued that salvaging nuclear energy has produced unnecessary radioactive waste, and has caused detrimental effects on human health the environment.

Scientists from the National Institutes of Health claim that nuclear energy is produced "when an atom's nucleus is split into smaller nuclei by a process called fission." These fissions create a large quantity of energy that can be collected to produce electricity and provide suitable power for advanced technologies such as the atomic bomb and the space craft. The use of nuclear energy has been growing significantly; unfortunately, there are some drawbacks to the use of nuclear energy. The use of nuclear energy has been in debate for a long time. Nuclear waste can be detrimental to human health as well as the environment. Scientists commonly refer nuclear energy with the creation of nuclear weapons. If nuclear elements react in a manner that produces too much energy, the result could be tremendous.

V. ELECTROENCEPHALOGRAM

Electroencephalography (EEG) is the recording of the brain's spontaneous electrical activity produced by the firing of neurons within the brain over a short period of time, usually 20–40 minutes, as recorded from multiple electrodes placed on the scalp. Spontaneous activity is measured on the scalp or on the brain and is called the electroencephalogram. The amplitude of the EEG is about 100 μV when measured on the scalp, and about 1-2 mV when measured on the surface of the brain. The bandwidth of this signal is from under 1 Hz to about 50 Hz. Spontaneous activity implies that activity goes on continuously in the living individual. Evoked potentials are those components of the EEG that arise in response to a stimulus (which may be electric, auditory, visual, etc.). The information transmitted by nerve is called an action potential. A stimulus must be thousand levels above a threshold level to set an Action potential. Very weak stimuli cause a small local electrical disturbance, but do not produce a transmitted Action potential. As soon as the stimulus strength goes above the threshold, an action potential appears and travels down the nerve. For a human being the amplitude of the Action potential ranges between approximately -60 mV and 10 mV.

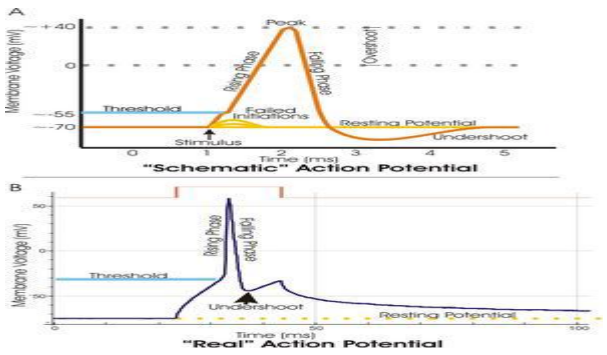
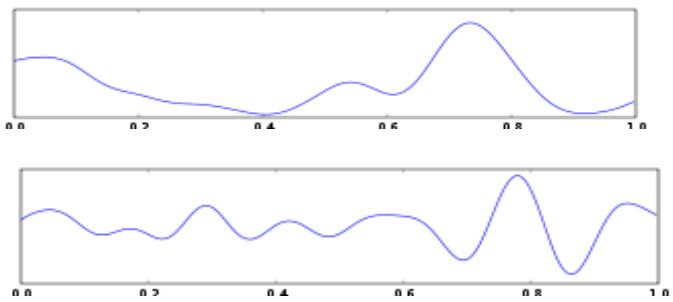


Figure 2.: Action potential generated in brain in response to a stimulus



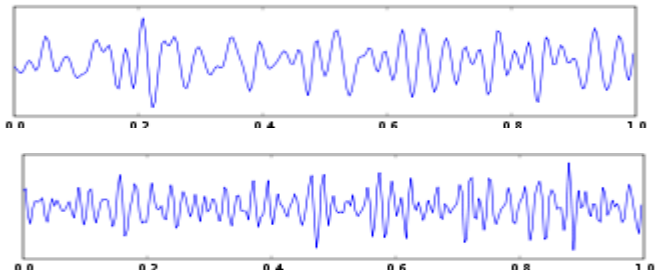


Figure 3: EEG Spectrum (δ, θ, α, β, γ)

Electroencephalogram (EEG) system consists of a number of delicate electrodes, a set of differential amplifiers (one for each channel) followed by filters. The computerized systems allow variable settings, stimulations, and sampling frequency, and some are equipped with simple or advanced signal processing tools for processing the signals. Correct EEG electrode placement is important to ensure proper location of electrodes in relation to cortical areas so that they can be reliably and precisely maintained from individual to individual. Figure 2.4 shows international 10-20 system for placement of electrodes on scalp for recording of electrical activities originating from the brain.

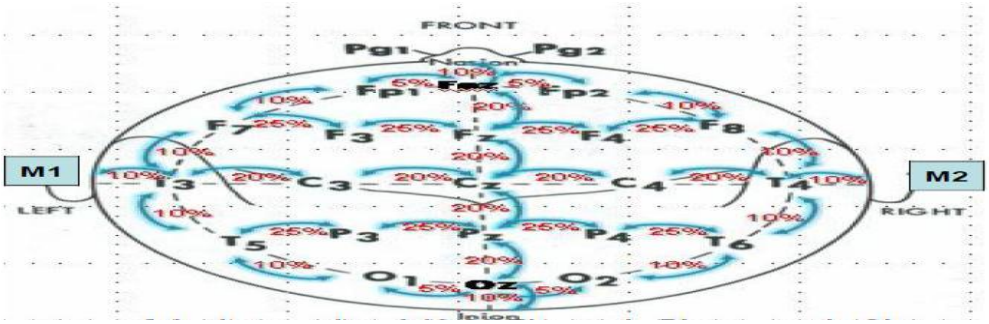


Figure: 4 International 10-20 Electrode Placement Systems

VI. METHODOLOGY

In this project electroencephalogram machine is used to capture the brain activity under three conditions, which are, without any radiations in the vicinity of volunteer, while using a GSM operated mobile phone and with a CDMA operated mobile phone as shown in figure 3.1. Data is recorded for duration of 10 minutes and the same experiment is performed with five different volunteers under same conditions.

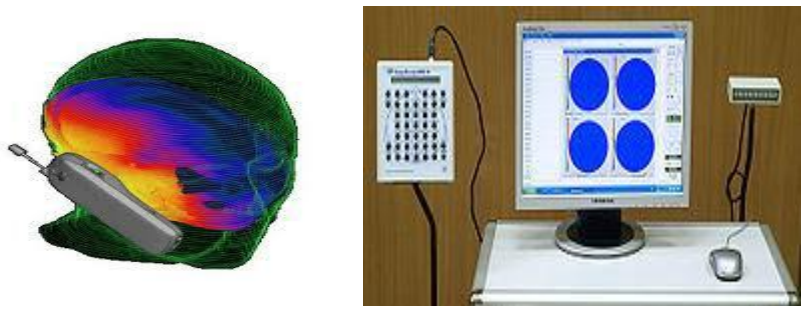


Figure 5: Setup for the Analysis of Electromagnetic Radiations of Mobile Phone

To examine the effect of electromagnetic radiations on human brain digital signal processing techniques are applied. Fast Fourier transform is calculated to obtain the power spectrum density of the acquired electrical signals originated in the brain in response to the stimuli impinged in the form of radiations emitted by the mobile phone. A fast Fourier transform (FFT) is an efficient algorithm to compute the discrete Fourier transform (DFT). An FFT computes the DFT and produces exactly the same result as evaluating the DFT definition directly; the only difference is that an FFT is much faster.

VII. ADVANTAGES AND BARRIERS OF MOBILE PHONE

Vast technology in communication world has made mobile phone important gadgets for 21st century. Now a day it is very rare to see people not having a mobile phone and it shows mobile phone playing an important role in everyday life.

Through mobile phone, communication between people become fast, easier and cheaper especially people in different countries. For business purpose, important event such as meeting and discussion can be held through mobile phone that is much more efficient and cost effective. While in emergency situation, we can easily reach emergency help line or the loved ones through mobile phone. In the past, we need map for travelling but nowadays mobile phone can be use as navigator or to check the weather forecast. Despite all the above, mobile phone still cannot eliminate its disadvantages. Communicate with mobile phone behind steering wheel can cause a serious crime because it's not only dangerous to the driver itself but also people surrounding. In 2009, a report stated that more than 45 countries already banned using mobile phone while driving. Other than that enhanced technology allows the transmission of pictures and videos through mobile phone that is offensive and inappropriate that can create unhealthy atmosphere among youngster. This can lead to immoral ethic and can cause social problem in our society. Mobile phone can also give impact to human health such as cancer, hearing capability, sleeping disorder and blurring vision. Even though all the above matter still not proven scientifically from medical perspective but we cannot ignore the possible consequences.It is crucial that in every aspect mobile phone makes our life easier. However we still cannot ignore the negative impact in our society. Today, mobile phone has become popular with everybody as it is very convenient to use. The advantage of having a mobile phone is you can communicate with your family and your friends no matter where you are. For instance, you can contact your friends easily by calling or sending messages everywhere. It is the main reason why almost all people today choose to own a mobile phone.

Students need the phone for safety and security reasons. From the customer's point of view, it is obvious that mobile phones assist you in business a lot, such as, make schedule of working, surf the internet, and keep in touch with their companies. Moreover, you can relax with mobile phone's applications, for example, play games, listen to music, or chat with your friends. On the other hand, there are certain disadvantages.
Using a lot mobile phone can harm your brain, particularly teenager and children who are under 16yearsold. If you constantly use mobile phones, it might may you feel dizzy, or cause blood-brain barrier, or ears problems. In addition, when you use mobile phones while you are driving, can cause a fatal accident. Moreover, "radiations emitted from the phone are dead harmful for the eardrum", and it has been proved by many scientist. It has irritating effect on other people in restaurants, cinema halls, and buses etc. from users shouting down their phone.Owning a mobile phone in your hand can solve many issues and hold most of information around the world. Mobile phone is a good technology which has added quality to our lives. It's up to us how we can maximize its advantages over disadvantages.

Using mobile phones has lots of advantages and disadvantages and most you will be aware of that. Earlier days, when we are out of home or office, we need to search for a public telephone booth to make a phone call, but now, just pick up your mobile phone and dial. I am trying to list the Pros and cons of using a mobile phone in this post. Advantage of using a mobile phone. You are always connected; anybody who knows your mobile number can contact you. If you are travelling out of your territory or to another country, you can use the roaming facility to be connected anywhere and all the time.

You can use features like Text messaging to send messages, receive messages, and send greetings, MMS for sending pictures, get information like news, flight timings and many more features. Now most of the mobile phone service providers has GPRS or EDGE or 3G enabled network. You can using internet anytime and anywhere. If you need to check your mail, you can do that when you are travelling or out of your office. You can reply to important messages or emails from your mobile phone itself. Features like Microsoft Exchange and Blackberry are really great. When you receive an email at your server, you get it pushed to your mobile phone. Latest PDA's, or iPhone are not just mobile phones, you even term it as Mobile Office. I get all my mails pushed to my HTC TyTN II. Even if I am travelling, I am always aware of the important messages and I can respond quickly without entering my office. I use remote desktop with my Pocket PC using wi-fi connections, through which I can access all my office desktop computers from anywhere in the World. There is an excellent service called Legmen, which is something I have been using for long time. Other excellent feature of mobile internet is that you can use internet sharing to using internet on your laptop while you are travelling. Just connect your PDA or pocket pc or your mobile phone with GPRS or EDGE or 3G internet.

7.1 Advantages and Disadvantages of Mobile Phone Effect

As time passes by technology are growing faster and move faster. The most important and common part of technology in our life is mobile phone technology. We bring mobile phone with us in everywhere that we go and use it on a daily basis. It is being the part and parcel of our daily life. Mobil phone have been around for quite some time, but as time goes on, mobile phones continuous to gain many features. A mobile phone started out as simple device that had only numbers, and most people used them for emergencies only. Nowadays, cell phones have many features such as phone calls, text messaging, taking pictures accessing the web, using calculator etc as many accessories. People become addicted in cell phone because they are getting many facilities by using it. For example whenever they go outside they can take the phone with them because of its size, networking range, a full charge battery, essay connection etc.There is no doubt about the benefits of mobile phones. Mobile phones have so many advantages but there have some disadvantages too. It has become a vital element for every person but nowadays it has also becoming an addiction to the young generation. If we talking about Bangladesh, nine out of ten young people in the town area, have own a mobile phone. They use it in various purposes. Their attraction of mobile phone is increasing day by day. Medical science says that the radiation of mobile phone is too bad for human health.

In 1995 mobile phone has introduced to Bangladeshi people. The first mobile service provider company was City cell. Then Grameenphone, Aktel, Banglalink, Teletalk, and Warid which is being named as Airtel an Indian telecom company who has also started their business in Bangladesh. In the arena of communication mobile has becoming the latest fashion and also the most essential means of communication. These mobile phones let us enjoy all the comforts within a single device.

VIII. RESULTS AND DISCUSSION

The result is shown in Table 2 and Figure 4.It shows that GSM operated phone has highest effect on brain activity as compared to a CDMA operated mobile phone.

Table 2: Average PSD Values of Four Channels (CH1, CH2, CH3, and CH4) Of Montage For Three Conditions Of Recording.

	CH1	CH2	CH3	CH4
GSM	13655	13914	20291	94619
CDMA	6482	3119	4361	4711
IDLE	3009	626	2512	3399

The result shows powers spectral density values for the three conditions of experiment that includes, idle with no radiation in vicinity, with GSM phone and with a CDMA phone. It can be seen from the table that PSD values with phone serving GSM technology has highest values whereas when no phone is present that is when there is no radiation in the vicinity of the subject, has the least values and values for the phone serving CDMA lies between GSM and Ile condition.

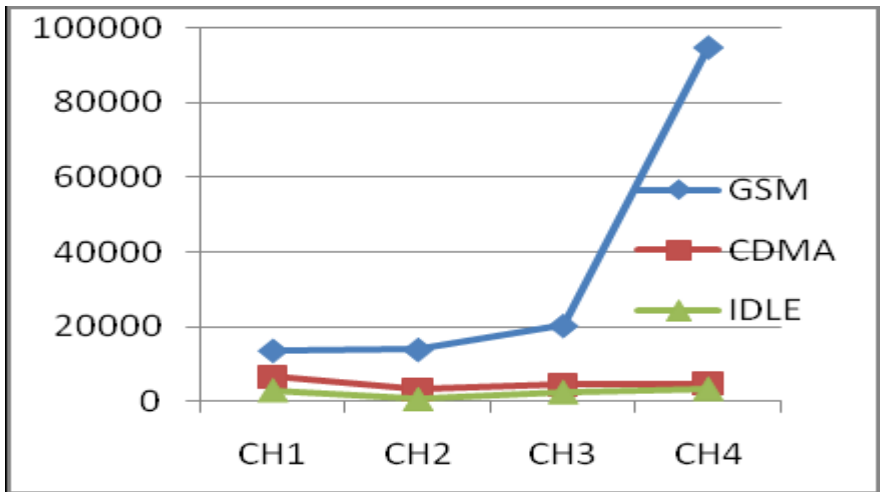


Figure 6: Plot of Average Psd Values of Four Channels of Montage

Analyses shows that mobile radiations effect human brain and GSM operated mobile phones has the higher effect on brain activity as compared to CDMA operated mobile phones. Globalization is the new mantra. In this age, it is very difficult not to have technology. But as shown in this study, with every technology invented to facilitate human beings, there come certain hazards. The only way to beat these negative aspects of new technologies is again, a new but better technology. Electromagnetic radiation is everywhere. More and more wireless communication services are expected, so is the artificial electromagnetic radiation. It seems that there is no way to reverse this trend. Scientists and engineers must develop better and safer wireless systems and devices. Smaller cell size, better base station antennas and other more advanced technologies will allow future cell phones to radiate much lower power and make technology a real boon.

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