# FOURIER TRANSFORMATION AND ITS APPLICATION IN CELL PHONE

Himanshu Sah, Himanshu Sharma, Hemant yadav
*Department of Electronics and Communication Engineering*
*Dronacharya College of Engineering, Gurgaon, India*

***Abstract-*** **Communication is based on Mathematics, be it digital, wired and wireless. Signals transmission is done through the modulation i.e. amplitude modulation (AM), frequency modulation (FM) or phase modulation (PM). At receiving end the transmitted signals are demodulated to extract the information. All these techniques are based on mathematics. While modulating the information signals , a high frequency sinusoidal carrier signal is used to transmit the message signal through a medium . It is then received and demodulated using Fourier Transformation analysis. So for understanding the communication technology, the processes of modulation, demodulation and Fourier Transformatio need to be explored . In this paper, we have discussed how Fourier Transformation is used in cell phone networking.**

***Index Terms-*** **Signals processing, Base Transceiver Station (BTS), Nuclear Magnetic Resonance (NMR), Frequency Identifier Descriptors (FID).**

## I. INTRODUCTION

**mathematics is everywhere almost in every phenomenon, technology, observation, experiments and in other things.**

It becomes quite easy to analyze some difficult calculations before making conclusions. The present era of communication technology provides some major catalysts in the development of the modern human society. Communication includes the automatic transmission of data and information over wires and radio circuits .

Signal is basically considered as a means of transmitting informations in accordance with certain prearranged system or code. It includes audio, video, speech, images, communication, geophysical, sonar, radar, medical and even musical signals.

One of the most prominent communication devices, the Cell Phones are dramatically changing the way people interacts and communicate with each others. Cell-phones emit small amounts of electromagnetic signals via radio waves through a low power transmitter. While talking over the cell phones, the transmitter take the sound of voice & changes it into continuous sine waves. Sine waves are measured in terms of frequency. Transmitter sends the sine waves to antenna. Antenna transmits the sine waves in the form of electromagnetic signal to BTS. Cell phones work by communication between service network through the BTS

or cell towers. Cell towers divide the city or state or even a country into small areas oe cell. As the user moves from one cell to another, the signals along with the information is then handed over from tower to tower.

Today ,cell phones are the best communication service which provides not only the basic functions of telephone and radios but also act as a data sharing device. Being cheap and reliable, cell phone is the fastest adopted technology in human history.

**How mathematics is involved in making cell phone work and in making calls?**

The cell phones are designed by using a lot of mathematics in just about every aspect of their designs. Also cell phones operate by principles of electro-magnetics, which are described mathematically as .

- One has to dial a number that it is based in Internet Protocol (IP). Protocol is considered as a set of rules.
- The phone has to use coordinates to locate Satellite to receive and transmit the signals to the other end.
- They have to convert from electric system or wave system into a voice system that it is based in alphabetic words, and then translated between the 2 systems based in a numerical system called binary system .

- This binary system is integrated into satellites, transmitter and receivers through the motherboardwhich is integrated in each system, then incorporated into each one through programming and all it is traversed by mathematics. By the way, the binary system it is multiple of 2's, and they go by 0's and 1's and also it is known as machine language because those dome machine only works with electric impulses like On and Off.

When we place a call, the phone must send out an electronic signal which carries digitalized version of our speech (maths comes into play here through the use of errors correction and data compression). These signals must be sent at a frequency which will not interferes with the calls that are being placed by other users of cell phones,otherwise there will be degradation of the signal's quality or in the worst case it can be a "dropped call." This refers to a call which has been connected but during the conversation there can be a loss of signals which disconnects the calls.

High sound have higher frequencies and low sound have lower one . A higher frequency produce a higher pitch, and a lower frequency produce a lower pitch. Example, thunder has a frequency of only 50 hz, while a whistle can have a frequency of 1000 hz, which means that the high frequency waves has completed more no. of cycles over the time whereas the low frequency waves has completed less no. of cycles over the same time. If we increase the amplitude of a sound, we are making it more louder, just as you turn up the volume on your radios. If you decrease the amplitude, you are making the sound to become more softer (i.e. turning down the volume). The amplitude of waves are related to the amount of energy it carries. A high amplitude wave carries large amount of energy and a low amplitude wave carries small amount of energy. The average amount of energy passing through the unit area per unit time in a specified direction is called the intensity of that specified wave. When the amplitude of the sound wave increases, the intensity of the sound increases and vice versa . Sounds with higher intensities are perceived to be louder in comparison with others which have lower intensities.

The word that musicians use for frequency is called pitch. The shorter the wavelengthof a sound , the higher the frequency and the higher the pitch . In other words, short waves sound higher , long waves sound lower. In fact ,cell phone works on the same principle.

**Role of Fourier Transform in Cell phones**

Jean Baptiste Joseph Fourier was a French mathematician and physicist made an astonishing discovery in 1800$^{th}$ century. According to Mr.Fourier, every function could be represented through a infinite series of elementary trigonometric functions i.e. sine and cosine. Example, consider decomposing the signals into its trigonometric constituents reveals the basic fundamental frequencies

Fourier analysis is an essential component of modern applied and also pure mathematics. It forms exceptionally powerful analytical tool for solving broad range of partial differential equations. Fourier analysis lies at the heart of signal processing including audio, speechs, images, video, seismic data, radio transmission, and so on. Many modern technologies including televisions, music CD's and DVD's, cell phone, movies, computer graphics, image processing, and fingerprints analysis and storage are in one way or other, founded upon the many ramifications of Fourier transform theory.

The principle of the Fourier transformation is that any signal, such as the sound produced by a musician by an instrument like piano, violin, trumpet, or drum any sound recording can be represented as the sum of collection of sine and cosine waves all with different frequencies and amplitudes. This collection of waves futher can be manipulated with relative ease ,for example, allowing a recording to be compressed or a noise to be suppressed. This Fourier decomposition lies at hearts of modern electronic music, a synthesizer combines pure sine and cosine tones to reproduce diverse sounds of instruments, according to Fourier's general prescription. Anyone who's marveled at the tiny size of MP3 file compared with same recording in an uncompressed form has seen the power of the Fourier transformation at the work. The Fourier Transformation is an algorithm used in many functions, including signal processing and statistical applications across a broad range of real life applications. Our mobile phones has devices performing Fourier Transformation. Every mobile device like netbook, notebook, tablet, and phones have been built in high speed

cellular data connections, just like Fourier Transformation. The Fourier Transformation is a method for doing this signal processing very efficiently.

The Fourier Transformation is a mathematical procedure which transforms a function from the time domains to the frequency domains. Fourier Transform is a method which uses the trigonometric functions (sine and cosine ) to transform a time domain spectrum into frequency domain spectrum. Sin and cos are keys to the success of Fourier Transformation because sounds may be represented by a complex combinations of their waves. Humans can very easily perform FT mechanically almost every day without having any idea of it. Example, when you are in a room with great deal of noise and you selectively hears your name above all the noise, you have just performed Fourier Transform. FT is the way of gathering unique frequencies from a spectrum of frequencies, like in the FID spectrum obtained in a NMR. Fourier Transformation can be used to convert from the series of numbers to the sounds.

The Fourier Transform works like a prism which splits white light into spectrum of colors. The informations on a CD has sounds of all frequencies mixed together with eah other and CD player splits apart the sound frequencies so they further can be amplified and sent to the speakers. In our ears, the cochlea enables us to hear differences in the sounds coming to our ears. The cochlea serves to transform the air pressure signals experienced by the ear drum into a frequency information which can be interpreted using the brain as tonality and the texture.

REFERENCES

1.http://www.math4mobile.com
2.http://en.wikipedia.org .in
3.https://www.google.com
4.http://mathworld.wolfram.com/FourierSeries.htm
5.http://math.stackexchange.com/questions/579453/what-are-some-real-world-application of-fourier-series