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APPLICATION OF FOURIER TRANSFORM IN WIRELESS COMMUNICATION

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ABSTRACT

Communication is based on Mathematics, whether it is analog, digital, wired or wireless. Signal transmission is done through modulation i.e. amplitude modulation (AM), frequency modulation (FM) or phase modulation (PM). At the receiving end the transmitted signal is demodulated to extract the information. All these techniques are based on mathematics. While modulating the signal, a high frequency sinusoidal carrier signal is used to transmit the message signal through a medium (OFC cable or air). It is then received and demodulated using Fourier Transform analysis. In this paper, we have discussed how Fourier Transform is used in wireless networking.

Keywords: ***Signal processing; Base Transceiver Station (BTS); Nuclear Magnetic Resonance (NMR); Frequency Identifier Descriptor (FID).***

I.INTRODUCTION

Mathematics is in all phenomenon, technology, observation, experiment etc. All we need to do is to understand the logic hidden behind. Since mathematical calculations give way to the ultimate results of every experiment, it becomes quite pertinent to analyze those calculations before making conclusions. The present era of communication technology has provided some major catalysts in developing the modern human society. Communication includes automatic transmission of data over wires and radio circuits through signals. In communication systems, signal processing, and electrical engineering , signal is a function that conveys information about the behavior or attributes of some phenomenon. Signal is basically a means of transmitting information in accordance with certain pre arranged system or code. It includes, among others, audio, video, speech, image, communication, geophysical, sonar, radar, medical and musical signals. One of the most prominent communication devices, the wireless devices is dramatically changing the way people interact and communicate with each other .The wireless devices emit small amount of electromagnetic signals via the radio waves through a low power transmitter. While talking over the wireless device, the transmitter takes the sound of voice & changes it into a continuous sine wave. Sine wave is measured in terms of frequency. Transmitter sends the sine wave to antenna. Antenna transmits the sine wave in the form of electromagnetic signal to the BTS. Wireless devices works by communication between service network through BTS.Network towers divide the city into small areas. As the user moves from one area to another, the signal along with the information is handed over from tower to tower. A lot of work is done on communication and signal process by Davis [1], Simon [4] and Taub [5]

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Today wireless devices are the best communication service which provide not only the basic functions of telephone and radio but also act as data sharing devices.

II. MATHEMATICS INVOLVED IN MAKING WIRELESS DEVICES WORK.

The Wireless devices are designed by using a lot of math in just about every aspect of their design. Also the devices operate by principles of electromagnetic, which are described mathematically.

- One has to dial a number that it is based in a protocol named Internet Protocol (IP). Protocol is basically a set of rules.
- The device has to use coordinates to locate the Satellite to receive and transmitted to the other end.
- They have to convert from an electric system or wave system into a voice system that it is based in alphabetical words, and then translated between the 2 system based in a numerical system called binaries.
- This binary system it is integrated into satellites, transmitter and receivers by the motherboard integrated and each system, then incorporated into each one by programming and all it is traversed by mathematics. By the way the binary system it is multiples of 2's, and they go by 0's and 1's and also it is called machine language because those dome machines only work with electric impulses like On and Off.

When we place a call, the device must send out an electronic signal which carries a digitalized version of your speech (mathematics comes into play here through the use of error correction and data compression). This signal must be sent at a frequency which will not interfere with the calls that are being placed by other nearby users of cell phones; otherwise there will degradation of the signal quality or in the worst case a "dropped call." This refers to a call which has been connected but during the course of the conversation there is a loss of signal which disconnects the call.

High sounds have higher frequencies and low sounds have a lower frequency. A higher frequency produces a higher pitch, and a lower frequency produces a lower pitch. For example, thunder has a frequency of only 50 hertz, while a whistle can have a frequency of 1,000 hertz, which means the high frequency wave has completed more cycles over the time whereas the low frequency wave has completed less cycles over the same time. If we increase the amplitude of a sound, we are making it louder, just as we do we you turn up the volume on your radio. If we decrease the amplitude, it making the sound softer (turning down the volume). The amplitude of a wave is related to the amount of energy it carries. A high amplitude wave carries a large amount of energy; a low amplitude wave carries a small amount of energy. The average amount of energy passing through a unit area per unit of time in a specified direction is called the intensity of the wave. As the amplitude of the sound wave increases, the intensity of the sound increases. Sounds with higher intensities are perceived to be louder.

III. ROLE OF FOURIER TRANSFORM (FT) IN WIRELESS DEVICES

Jean Baptiste Joseph Fourier, the French mathematician/physicist made an astonishing discovery in 1800. According to Fourier, every function could be represented by an infinite series of elementary trigonometric functions: sine and cosine. For example, consider decomposing the signal into its trigonometric constituents reveals the fundamental frequencies (tones, overtones, etc.) that combine to produce the instrument's distinctive timbre. Fourier analysis is an essential component of much of modern applied (and pure) mathematics. It forms

an exceptionally powerful analytical tool for solving a broad range of partial differential equations. Fourier analysis lies at the heart of signal processing, including audio, speech, images, videos, seismic data, radio transmissions, and so on. Many modern technological advances, including television, music CD's and DVD's, cell phones, movies, computer graphics, image processing, and fingerprint analysis and storage, are, in one way or another, founded upon the many ramifications of Fourier theory.

The principle of the Fourier transform is that any signal, such as the sound produced by a musical instrument, e.g., piano, violin, trumpet, or drum , any sound recording can be represented as the sum of a collection of sine and cosine waves with different frequencies and amplitudes. This collection of waves can then be manipulated with relative ease—for example, allowing a recording to be compressed or noise to be suppressed. This Fourier decomposition lies at the heart of modern electronic music; a synthesizer combines pure sine and cosine tones to reproduce the diverse sounds of instruments, both natural and artificial, according to Fourier's general prescription. Anyone who's marveled at the tiny size of an MP3 file compared with the same recording in an uncompressed form has seen the power of the Fourier transform at work. The Fourier Transform is an algorithm used in many functions, including signal processing or statistical applications across a broad range of applications. Every wireless device--netbook, notebook, tablet, and phone have been built in high-speed cellular data connection, just like Fourier Transform. The Fourier Transform is a method for doing this process (signal processing) very efficiently. For more details about Fourier Transform, I refer to Bracewell [3], Howell [2].

The Fourier Transform is a mathematical procedure which transforms a function from the time domain to the frequency domain. Fourier Transform is a mathematical method using the trigonometric functions (sin and cos) to transform a time domain spectrum into a frequency domain spectrum. Sine and cosine are keys to the success of Fourier Transform because sound may be represented by a complex combination of their waves. Humans, very easily perform FT mechanically almost every day without having idea of it. FT is the mathematical way of gathering unique frequencies from a broad spectrum of frequencies, like in the FID spectrum obtained in NMR. Fourier Transform can be used to convert from the series of numbers to sound.

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

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