A study about various kinds of antennas in RF(Radio Frequency) fields ; one of the basic technologies in wireless mobile communication services

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***Abstract* — We've heard that there are kinds of antennas according to the polarization while attending a class of electromagnetic waves of Prof. Choi. Therefore, we started to be concerned about kinds of antennas, and the reason why different antennas are used for lots of services. Now is the time that many kinds of wireless services(i.e. UWB, WLAN, mobile phone, RFID, etc.) became powerful, so our team will survey about antennas for various wireless services in this project.**

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I. INTRODUCTION

There are several kinds of wireless services such as WLAN, UWB, and RFID, etc., and it is obvious that the antenna is a main component of these systems as a RF front-ends part, because it transmits and receives waves directly. Therefore, it can be easily expected that many types of antennas exist according to their purposes. That is, many specifications of antennas such as bandwidth, polarization, beam-width, and size make so many different kinds of antennas. For example, in UWB systems, antenna with narrow bandwidth cannot be used, but bandwidth enhanced antenna more than 25% should be utilized.

So, in this paper, we study about the reason why EM waves are used in antenna and basic principles to know about the required EM wave characteristics for the application of it. Next, the survey about different antennas for various wireless mobile communication systems will be followed and finally, the current market trend for antenna and where the future direction of it is moving into will be also researched.

II. BASIC CONCEPT OF ANTENNA

Antennas is defined by "a usually metallic device (as a rod or wire) for radiating or receiving radio waves (Webster's Dictionary)" or "a means for radiating or receiving radio waves (IEEE Std 145-1983)" . In other words, it is Energy transitional structure between free-space and a guiding device.

The guiding device or transmission line may take the form of a coaxial line or a hollow pipe (waveguide), and it is used to transport electromagnetic energy from the transmitting source(time-varying currents and charges) to the antenna, or from the antenna to the receiver in Fig. 1, 2, 3, 4, 5.

By resonating (impedance matching) the terminal on a specific frequency, a type of electromagnetic energy forms and spreads externally, instead of the signal returning. After all, the size of antenna completely depends on frequency.

The main parameters of the antenna are as follows : Radiation(Antenna) Pattern(a mathematical function or a graphical representation of the radiation properties of the antenna as a function of space coordinates), Directivity(the ratio of the radiation intensity in a given direction from the antenna to the radiation intensity averaged over all directions[dB]), Gain(the ratio of the intensity, in a given direction, to the radiation intensity that would be obtained if the power accepted by the antenna were radiated isotropically[dBi] or [dBd]), Polarization(the curve traced by the end point of the arrow representing the instantaneous electric field), Bandwidth(The range of frequency that satisfies the standard of the antenna's performance), Input impedance(the impedance presented by an antenna at its terminals or the ratio of the voltage to current at a pair of terminals or the ratio of the appropriate components of the electric to magnetic fields at a point, function of frequency)

And the principle types of antennas are as follows : Wire Antennas such as Dipole, monopole, loop, helical; Aperture Antennas such as Pyramidal Horn, Conical Horn, rectangular waveguide; Microstrip Antennas such as Rectangular patch, Circular patch; Array Antennas such as Yagi-Uda array, aperture array, microstrip patch array, slotted-waveguide array; Reflector Antenna such as Parabolic, Cassegrain, Corner Reflector; Lens Antenna such as Convex, Concave.

III. ANTENNA OF CELLULAR PHONE

Cellular phone used to have large external antennas, but nowadays most cellular phones use an internal antenna. Consumers do not (and should not have to) understand antenna theory, but design engineers needs to understand it. Right Cellular antenna for the application yields a good signal coverage, increased S/N ratio, reduced bit error rate, and lower power consumption all at very low cost. For example, a 1/4-wave 4-inch analog cellular "whip" antenna at 800 MHz becomes a 1.5-inch digital PCS "stubby" antenna at 1900 MHz.

Old cellular used monopole used retractable antennas (stubby antennas). This kind of monopole antennas are implemented using lambda/4 length. They are the antennas of choice for wireless device designers implementing an external antenna. Typical antennas you will see in more modern cellular is a helix radiator using 1/4-wave or 1/2-wave resonances.

The cellular phone antenna radiator is mounted on a plastic carrier, the antenna is a solid and compact unit. On dual band antennas usually 1/4-wave is used for GSM and 1/2-wave for DCS/PCS. Those antennas are generally matched for 50 ohm impedance. A rapid growing market for wireless communication has create a remarkable trend towards the development of integrated antennas for mobile phones. Many modern small cellular do not use external antennas anymore. Those cellular phones use a tiny planar or otherwise miniature special antenna which can be embedded into the phone plastic case. Antennas are slowly becoming more integral as new antenna technology becomes available. Today there are four leading antenna architectures that are commonly used in embedded applications:

1. Micro-strip lines : an extension of the monopole.
(Advantage : can be easily fabricated by etching a copper strip of 1/2- or 1/4-wavelength onto the radio circuit board / Disadvantage : very inexpensive to make, performance is limited by surrounding electronics, only a single-frequency solution)
2. Patch antennas : a good choice for a system that requires a beam pattern focused in a certain direction.Patches are fabricated out of square or round copper clad on the top surface of a circuit board. Their radiation beam is normal to the surface of the board.
3. Planar Inverted 'F' Antenna (PIFA) : literally looks like the letter 'F' lying on its side with the two shorter sections providing feed and ground points and the 'tail' providing the radiating surface. PIFAs make good embedded antennas in that they exhibit a somewhat omni-directional pattern and can be made to radiate in more than one frequency band. PIFA has a low profile, and it can easily be incorporated into wireless handsets. PIFA antennas are generally used with a ground plane, which is generally the cellular phone circuit board ground plane.
4. Meander Line Antenna (MLA) : a new type of radiating element, made from a combination of a loop antenna and frequency tuning meander lines. MLAs can be designed to exhibit broadband capabilities that allow operation on several frequency bands

IV. ANTENNA OF UWB

Recently, the UWB (Ultra Wide Band) communication is in the lime light as a novel wireless application. The UWB communication supports high data rate, low cost service, and low power consumption therefore it is being briskly research ed for the commercial use.

According to the trend UWB system development, the research on the UWB antenna has been actively carried out. Ordinary, as the antenna with the ultra wide band characteristics, that is dispersive antenna. However, at these antennas the impulse input generates chirp waveform that the frequency changes rapidly as time passes, and pulse width is expanded by phase change of spectrum. This phenomenon is not suited for the UWB communication. Beyond these antennas, as the ultra wide band antenna the non-dispersive characteristic, that is non-dispersive antenna. Because the antennas have large size, they are not suitable for WPAN (Wireless Personal Area Network) which is the most expected application if the UWB communication. Therefore, the recent researches have been focused on both the performance

improvement and the size reduction of the UWB antenna, In that results, the UWB dipole and monopole antennas with the good radiation patterns and the size enough to make use to WPAN application are reported. FCC released the regulations that the UWB system is allocated to utilize the spectrum from 3.1 GHz to 10.6 GHz, that is 7500 MHz of available spectrum for unlicensed use. Let's consider the kinds of antenna.

1. Dispersive/Non-dispersive antenna
   ⅰ) Dispersive antenna
      → Usage : Surface-penetrate radar
      → Configurations : Spiral antenna, Logarithm ic planar antenna, Vivaldi antenna, slot antenna, exponential horn
   ⅱ) Non-dispersive antenna
      → Usage : Feed element for radio astronomy, satellite tracking, radar
      → Configurations : Monopole, dipole antenna, reflector type antenna
2. Radiation pattern
   ⅰ) Omni-directional radiation patterns
      → Usage : Set top box, Application for WPAN
      → Configurations : Monopole, Dipole, Helical antenna, etc
   ⅱ) Directional radiation patterns
      → Usage : Remote controller, Application for Fixed WPAN
      → Configurations : Vivaldi antenna, Spiral antenna, Slot antenna, etc
3. Miniaturization
   ⅰ) Planar (2-D) antenna
      → Usage : Portable and small WPAN applications such as Camcorder
      → Configurations : Planar monopole, Planar dipole, Vivaldi antenna, Spiral antenna
   ⅱ) 3-D antenna
      → Usage : Performance is more difficult than size such as Set top box, Server
      → Configurations : Whip Antenna, Wire dipole antenna, Helical antenna, PIFA

IV. ANTENNA OF RFID

USN (Ubiquitous Sensor Network) needs RFID system and wireless sensor. RFID system consists of tag and chip. Tag is antenna on chip. Identification codes or information are memoried in chip. And tag divided into active tag and passive tag. Reader consists of RF circuits, modem, real-time signal processing module and protocol processing in Fig. 6.

• Antenna for RFID service
① Passive Tag : High efficiency small antenna
② Active Tag : Active antenna
③ Reader : Beam forming antenna, Multi-band antenna, Broad band antenna

V. CONCLUSION

In this work, we investigated the various types of antenna for wireless mobile communication services, or cellular phone, UWB, and RFID. The current trend by mobile telephone manufacturers is to incorporate the antenna into the body of the handset (known as an in-built or integrated antenna) rather than have it located externally. Not only does this reduce the possibility of the antenna being broken off but it makes the handset smaller, more beautiful and also reduces the possible health hazard of electromagnetic radiation. The UWB dipole and monopole antennas with the good radiation patterns and the size enough to make use to WPAN application are reported. The antenna for RFID systems is gradually small-sized, cheap.

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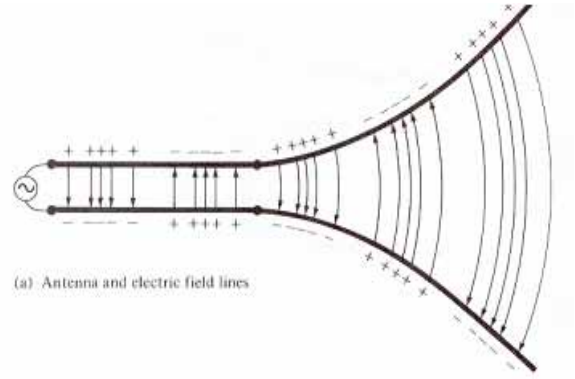

Fig. 1. Antenna and electric field lines

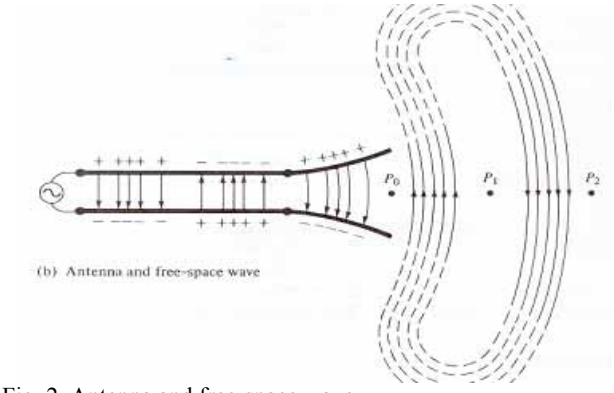

Fig. 2. Antenna and free-space wave

$$\nabla \times E = -j\omega\mu H + M$$
$$\nabla \times H = j\omega\varepsilon E + J$$
$$\nabla \cdot D = \rho$$
$$\nabla \cdot B = 0$$

Fig. 3. Basic Maxwell Equation.

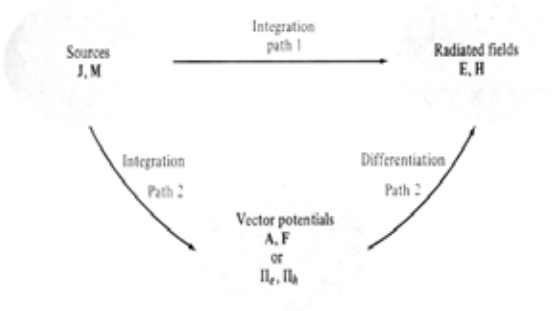

Fig. 4. Basic concepts of radiation pattern

$$E \cong -j\omega A = -j\frac{\omega\mu}{4\pi}\iiint_V J\frac{e^{-jkR}}{R}dv'$$
$$H \cong \frac{\hat{a}_r}{\eta} \times E_A = -j\frac{\omega}{\eta}\hat{a}_r \times A$$

Fig. 5. E & H in Far-region

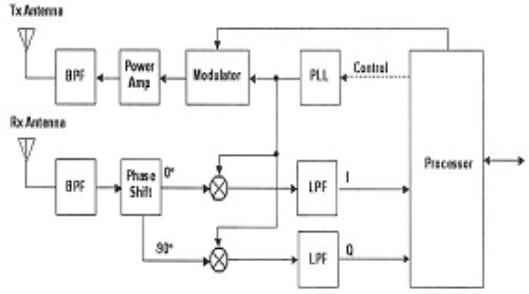

Fig. 6. RF circuits, modem, real-time signal processing module and protocol processing