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A Review on Modern Age Antennas

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ABSTRACT

Antenna plays a vital role in this modern wireless age. It is an important element of today's wireless communication systems. They are used in various systems like radio broadcasting, satellite communication, cell phones, radar, wearable devices etc. It acts as a device used to convert the electrical current into Electromagnetic waves and vice-versa. Now-a-days, the growth in usage of compact handheld devices makes it more attentive topic in the field of research and antenna designing. For effective communication between two points, antenna should be designed very precisely. In this paper, a review on antennas, its types, applications in various fields are discussed. The antenna designing software with solvers are also discussed.

Keywords— Modern age antennas, PIFA,Microstrip antennas,Antenna designing,HFSS

I. INTRODUCTION

I.

An Antenna is a device used to receive as well as radiate Electromagnetic (EM) waves. It converts the electrical current into EM waves and vice-versa. There are various definitions to describe an antenna, of which the two definitions are presented. According to Webster's dictionary, an antenna is defined as "a usually metallic device (as a rod or wire) for radiating or receiving radio waves [1]." According to IEEE Standard Definitions of Terms for Antennas (IEEE Std 145-1983), an antenna is defined as "a means for radiating or receiving radio waves [1]." An antenna works as a transitional element between free-space and guiding device or transmission line. The power delivered to the source travels through the guiding device and finally radiated by the antenna in free-space.

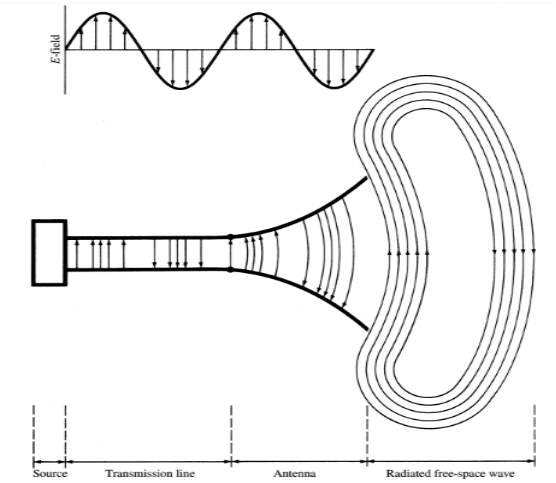

Fig. 1: Antenna as a transitional device[1]

Fig. 1 shows the antenna as a transitional device.

II. TYPES OF ANTENNAS

The types of antennas are broadly classified into following categories[1]:

- ***Wire antennas***- Wire antennas are the simplest type ofantennas consisting of a wire in any shape. It may be a straight wire, a loop or a helix. They are used as external antennas on automobile, aircrafts, buildings and so on.
- ***Aperture antennas***- Aperture antennas are mostly used in aircraft and spacecraft applications because of their ease in surface mounting. They are used in the applications where high antenna gain is required. Examples of these antennas are horn antennas, rectangular waveguides etc.
- ***Microstrip antennas (MSA)***- Microstrip antennas consists of a metallic patch on the ground plane with a dielectric substrate sandwiched between the both. The metallic patch can be of any shape like rectangular, circular, elliptical, ring and so on. They have several advantages in terms of low profile, ease of fabrication, less cost and conformable structure which makes it suitable for use in aircrafts, missiles, satellites and mobile phones etc.
- ***Array antennas***- Array antennas are the antennas in which a number of antenna elements are aggregated together to achieve desired radiation characteristics e.g. to

achieve maximum radiation in desired direction and less in others. The examples of array antennas are Yagi-Uda, Microstrip patch array etc.

- ***Reflector antennas-*** Reflector antennas are used for the communication at greater distances. The common form of reflector antenna is parabolic reflector and another is corner reflector. e.g. parabolic dish antenna.
- ***Lens antennas-*** Lens antennas are used to shape the undesired divergent energy into desired plane waves by selecting appropriate material and shape of geometrical configuration of the lenses. They are used as parabolic reflectors in similar way at high frequencies.

Modern age antennas: The antennas mostly used for today's wireless applications (mobile phones, Satellite TV, medical applications etc.) can be categorized as follow:

- ***Microstrip antenna (MSA) or patch antenna*:** As discussed earlier in this section, MSA consists of a radiating metallic patch built over the ground plane with a substrate material inserted between them.

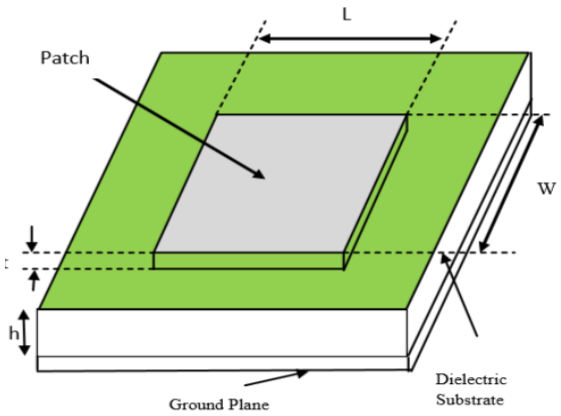

Fig. 2: Rectangular Microstrip antenna

Fig. 2 shows the structure of rectangular Microstrip antenna. Here, L, Wand t are the length, width and thickness of patch respectively and h is the height of the substrate.

- ***Planar Inverted F Antenna (PIFA)*:** PIFA is the variant of IFA (Inverted F Antenna), which is the monopole wire antenna bent and given feed to become an inverted F shape monopole antenna. The PIFA consists of a planar element patch instead of a wire and a shorting pin or plate[2].Fig. 3 shows the structure of PIFA.

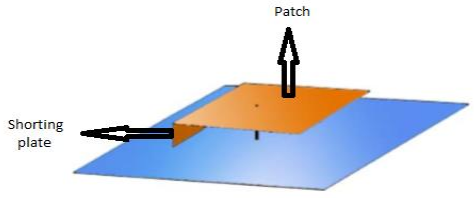

Fig. 3: Planar Inverted F Antenna

- ***Parabolic dish antenna*:** Parabolic dish antenna is a type of parabolic reflector antenna used to receive signals from Satellites.Fig. 4 shows the reflection principle in parabolic antenna.

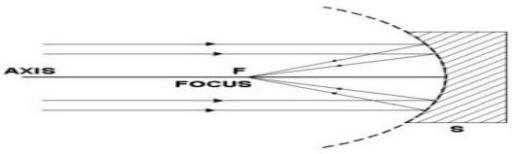

Fig. 4: Parabolic dish antenna

III. APPLICATION AREAS

There are numerous applications of antennas, of which some applications arediscussedin Fig. 5 as follow:

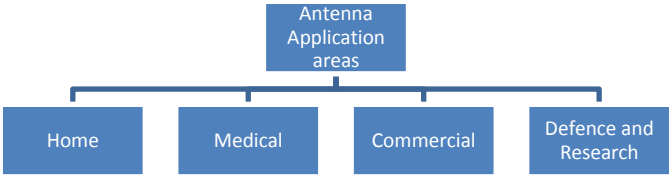

Fig. 5: Application areas of antenna

The application areas are illustrated as follow:

- ***Home Applications*:** Antennas are needed in all wireless equipment used in our homes i.e. cell phones, Satellite TV, wireless garage door openers, Wireless modems and many more. The antennas suitable for cell phones are Microstrip patch antenna and PIFA antenna while for SatelliteTV, the parabolic dish antennas are preferred for large distance communication. Fig. 6 shows internal PIFA antennas for cell phones.

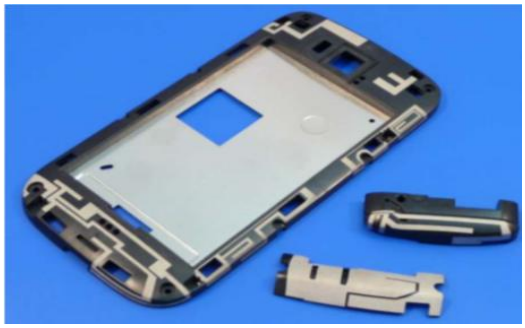

Fig. 6: PIFA for cell phones [2]

- ***Medical Applications*:** To monitor the health parameters of human beings like blood pressure, temperature, insulin level etc., implantable antennas are required to wirelessly transfer the information from body implanted devices [3]. The Microstrip patch antennas are suitable for this application [4].
- ***Commercial Applications*:** The antennas are of a great importance in commercial market. The antennas are available for the commercial applications like RFID (Radio Frequency Identification) tags, WiMAX (Wireless Interoperability for Microwave access), Cellular, marine,

MIMO (Multi Input Multi Output), Wireless LAN etc. [5,6].

- ***Defence and Research applications*:** Indefence applications,there are naval antennas, airborne antennas and earth station antennas e.g. radar antenna for Automatic Carrier Landing System (ACLS), high frequency conical antennas, parabolic grid reflector antennas etc. [7]. The requirements of high performance for telecommunication and space applications, the reconfigurable antennas are usedwith integration of varactor diodes, PIN diodes etc.[8].

The Table I shows application areas or services of antennas based on frequency band.

TABLE I
ANTENNA SERVICES ON THE BASIS OF FREQUENCY [7]

Frequency band	Designation	Typical services
3-30 KHz	Very Low Frequency (VLF)	Navigation, SONAR
30-300 KHz	Low Frequency (LF)	Radio Beacons, Navigational Aids
300-3000 KHz	Medium Frequency (MF)	AM broadcasting, Maritime radio, Coast guard communication, Direction finding
3-30 MHz	High Frequency (HF)	Telephone, Telegraph and Facsimile, Amateur radio, Ship-to-coast and ship-to-aircraft communication
30-300 MHz	Very High Frequency (VHF)	Television, FM broadcast, Air traffic control, police, navigational aids
300-3000 MHz	Ultra High Frequency (UHF)	Television, Satellite communication, Surveillance RADAR, navigational aids
3-30 GHz	Super High Frequency (SHF)	Airborne RADAR, Microwave links, Satellite communication
30-300 GHz	Extremely High Frequency (EHF)	RADAR, Experimental

IV. ADVANTAGES AND DISADVANTAGES

Advantages and disadvantages of modern planar antennas (MSA) are given in the Table II as follow:

TABLE II
ADVANTAGES AND DISADVANTAGES OF MSA

Advantages	Disadvantages
Cheap to manufacture	Large ohmic losses in feed structure of arrays
Light in weight	Low efficiency
Conformal structure	Low gain
Performance is as good as dipole antennas	Low bandwidth
Capable of multiband operation	Requires complex feed structure for high performance arrays

Antenna designing software: There are various software tools available for designing antennas which are discussed as follow in Table III.

TABLE III
SOFTWARE TOOLS FOR ANTENNA DESIGNING [2]

Software	Solver
Ansoft HFSS	FEM
Mentor Graphics IE3D	MoM
Agilent EMPro	FEM, FDTD
CST Microwave Studio	FIT, FEM, FDTD, MoM, TLM, MLFMM
EM. CUBE	FDTD
FEKO	MoM MLFMM PO, GO UTD, FEM
HFWorks	FEM
XFdtd	FDTD
EMA3D	FDTD

V. CONCLUSION

Antenna is an essential component of all wireless devices for sending information from one point to another. There are various types of antennas available for every particular application. There are several advantages of modern antennas in terms of size, weight and performance etc.The SAR (Specific Absorption Rate) of modern antennas is also consideredan important parameter for the modern compact devices which tells how much power is absorbed by the human head. The SAR should be less for the safety concerns as well as for optimum performance of devices. The wide range of antenna designing software tools gives the flexibility to design antennas in an easy and best way.

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