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Design and analysis of different types of antennae for different applications

Raksha
Assistant Professor, Anand International College of Engineering Jaipur,
ECE Department, raksha149@gmail.com

Abstract- The research paper showcases detailed research about the design and evaluation of various antennae for different types of applications. This research paper also discussed that antennas are the critical components that are used in modern communication systems and their applications through cellular networks and wireless networks to satellite communications as well as radar.

Keywords- *Frequency range, antenna array, standing wave ratio, antenna efficiency*

I. INTRODUCTION

Various types of antennas are designed and examined for suitable and specific applications, based on their components, like their frequency range, sensitivity, and polarization. Some common types of antennas are dipole antennas, patch antennas, horn antennas, and Yagi–Uda antenna. Dipole antennas are mainly used in radio channels, Wi-Fi applications, Bluetooth applications, as well as television broadcasting. These antennas involve two conductive components that are positioned perpendicular to each other as a pole [1]. Patch antennas are mainly used in satellite transmission and cellular communication as well as in wireless communication. In the case of horn antennas, they are usually used in microwave applications, including radar and satellite transmissions [2]. These types of antennas have a flared shape and it helps to control the radiation pattern in a particular direction. On the other hand, yogi antennas are usually used in telecommunications, wireless communication and radio broadcasting.

II. OBJECTIVES

- To critically analyze the effectiveness of different types of antennae for wireless communication
- To critically analyze the advantages and disadvantages of high-dimensional antennae
- To examine the purpose of operating high-dimensional antennae for wireless communication
- To identify the significant factors of the high-dimensional antennae
- To assess the evolution of different types of antennae in the wireless communication system

III. METHODOLOGY

In present days, the uses of high dimensional antennas have increased both in telecommunications and radio communication systems. The antennas work through the process of transmission and reception of waves or signals [3]. The research paper discussed a thematic analysis that has been used to find out the characteristics and performance of high-dimensional antennae. Along with this, a descriptive and secondary qualitative method has been used here in this study to understand the validity and reliability of the research topic.

IV.THE FREQUENCY RANGE OF THE ANTENNA

(Source: 3)

The figure shows the frequency level of the different bands and details their wavelengths. Radar-frequency letter designations are mainly used to provide a convenient approach to describe the band in which the radar operates.

Band	Frequency Range	Wavelength
HF	3 to 30 MHz	10 meter to 1 meter
VHF	30 MHz - 300 MHz	1,000cm to 100cm
UHF	300 MHz - 1 GHz	100cm to 30 cm
L band	1 to 2 GHz	30cm to 15cm
S band	2 GHz - 4 GHz	15cm to 7.5cm
C band	4 GHz - 8 GHz	7.5cm to 3.8cm
X band	8 GHz - 12 GHz	3.8cm to 2.5cm
K_u band	12 GHz - 18 GHz	2.5 to 1.7 cm
K band	18 GHz - 27 GHz	1.7 to 1.1 cm
K_a band	27 GHz - 40 GHz	1.1 to 0.75 cm
V band	40 GHz - 75 GHz	0.75 to 0.40 cm
W band	75 GHz - 100 GHz	0.40 to 0.27 cm
mm	110 to 300 GHz	0.27 to 0.10 cm

Figure 1: Standard Radar and Frequency Letter-Band Nomenclature

(Source: 7)

The antenna can operate the frequency range of the antennas. The analysis of antennas needs a profound experience in the electromagnetic approach and pragmatic considerations of the antenna developers and also the capability of the used tools for optimizing the performance of antennas.

V. ANTENNA ARRAY

An antenna array is a combination of different types of antennas that are engaged in a specific pattern for achieving specific performance characteristics. It has been observed that antenna arrays are mostly used in wireless communication,

and radio communication like radar systems, satellite communication systems as well as radio astronomy. The basic thought behind the antennae array is to merge all the radio signals that are received from multiple antennas to increase some aspects of the signal, like directionality and signal-to-noise ratio [4]. This array can be achieved by different phases as well as amplitudes of the signals from every element of the antennae. There are various types of antenna arrays, such as linear arrays, planar arrays, phased arrays, and adaptive arrays. In the case of linear arrays, a row of antennas is aligned in a completely straight line [5].

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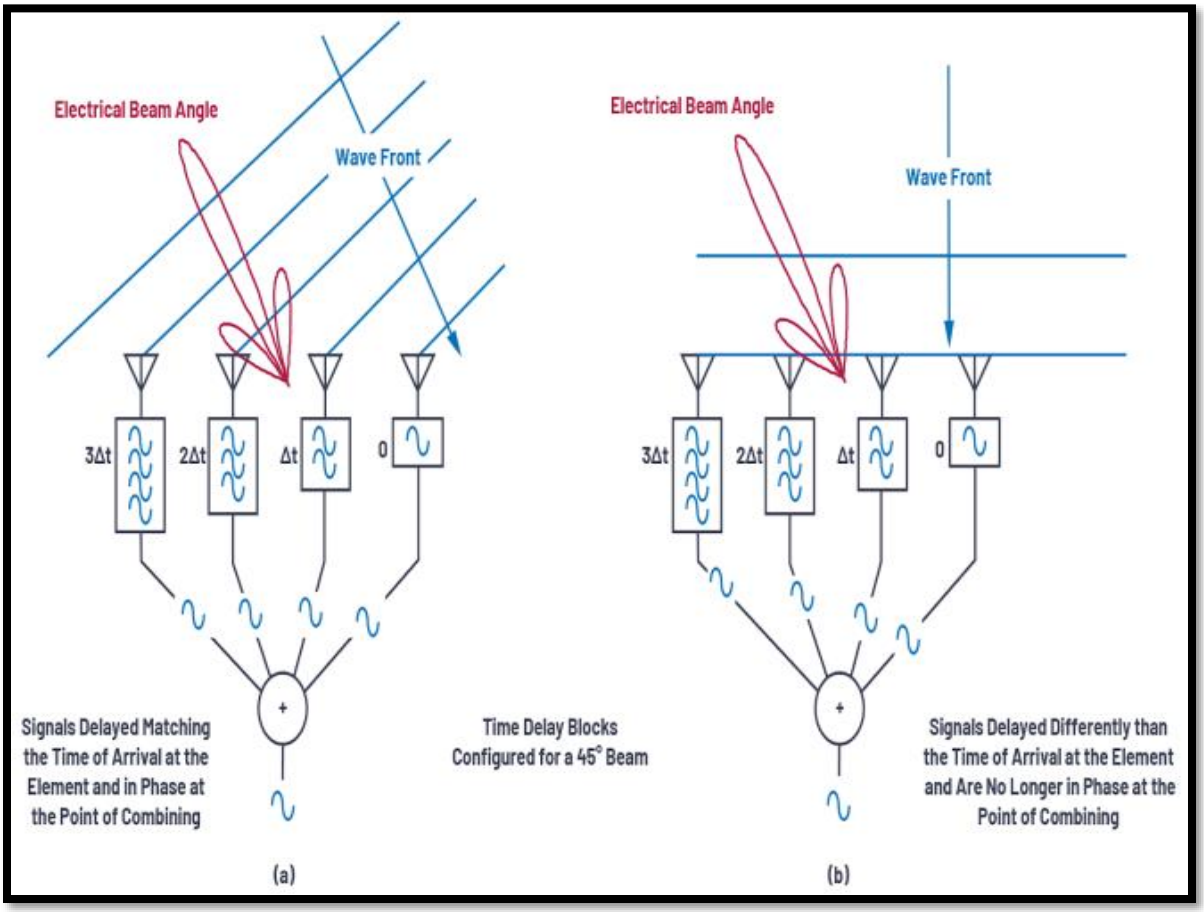

Figure 2: Structure of antenna array
(Source: 6)

Along with this, linear types of arrays are mainly used for radar applications as well as directional communication. It has been observed that planar arrays mostly involve various antennas that are arranged in a totally two-dimensional pattern like rectangular as well as circular grids. Besides this, these arrays are majorly applied for satellite communication and radar imaging. On the other hand, phased arrays include different types of antennas with adjusted electronic tools to support the radiation patterns [6]. Along with this, phased arrays are mainly used in radar systems and wireless communication systems. Besides this, the adaptive arrays are connected with the electronic components as well as the amplitude of different weave signals in real time for optimizing the activities and performance of an antenna in changing environments.

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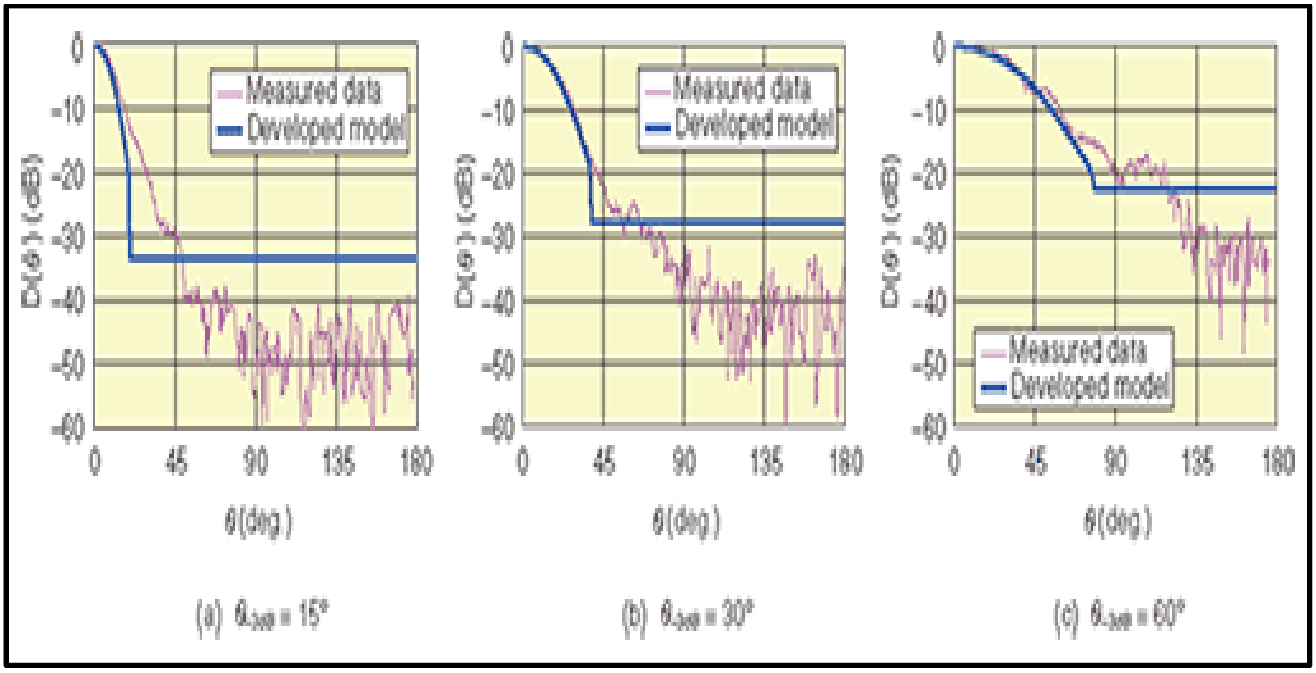

Figure 3: Comparison of calculated and measured antenna patterns
(Source: 4)

The figure 4 shows the different patterns of antennae and how the antenna patterns are using design models and various measured patterns. It has been observed that the main lobe structure of the design model is aligned with the measured pattern [7]. Besides this, the side lobe of the model is stable and almost approximate with the values of measured patterns. Therefore, the antenna patterns are effective in the millimeter wave of the WPAN system design.

VI. ANTENNA EFFICIENCY

Antenna efficiency is mainly a measure that shows how effectively an antenna transmits electrical power into electromagnetic radiation. Antenna efficiency is the major parameter that helps to evaluate the activities, characteristics and performance of an antenna [8]. The efficiency of the antenna relies on different factors such as its dimension, pattern, operating frequency, as well as the nearby environment. A well-structured antenna with good features can be a good transmitter or receiver and they have greater efficiency which means most of the input power is transformed into radiation [9]. Other than this, an antenna with a poor structure has a lower efficiency and also wastes the maximum of the input power. The efficiency can be measured by the radiated power and input power where the radiation power indicates the radiated power and input power indicates the delivered power to the antenna. For measuring efficiency, different significant ways and methods can be used; the measures are a differentiation of radiated power to input power, calibrated strength parameters as well as the different specialized antenna testing facilities like anechoic chambers.

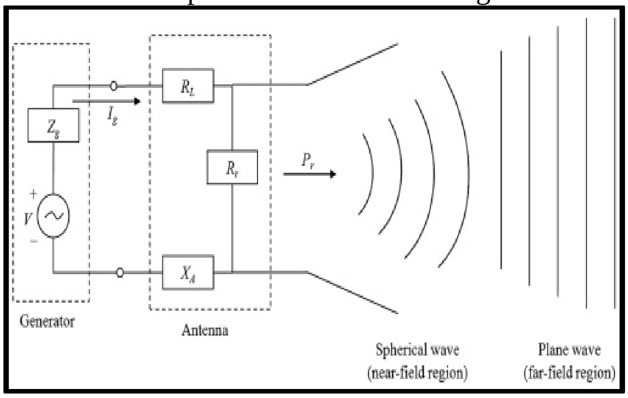

Figure 4: Structure of antenna efficiency
(Source: 9)

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Therefore, it can be deluded that, antenna efficiency helps in the designing and analyzing of antennas and it also impacts the effectiveness and performance of a given application.

VII.WIRE DIPOLE ANTENNA MODEL

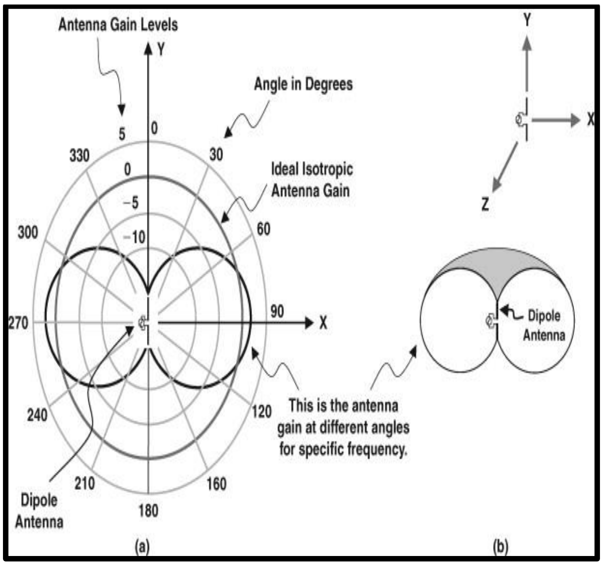

Figure 5: Wire dipole antenna model
(Source: 10)

The wire dipole antenna model is one of the typically used models. It is mainly used in radio communication systems and telecommunication systems, and wireless communication. This model is based on different parameters such as length, separation, feed point, and impedance. This model provides the idea of an antenna length that is typically half of the signal wavelength and is developed for transmitting or receiving. Along with this, the length of the antenna is almost equal to half of the wavelength [10]. The divergence between two wire components is usually small and almost around 1/20 to 1/10 of the wavelength. It has been noted that the model also gives the idea of the feed point where the weave length signals work as input or output. Besides this, the feed point is usually located in the middle of the two wire elements.

On the other hand, the wire dipole model shows that the impedance of the antenna can be determined by its size which was almost around 70-75 ohms for a dipole antenna [11]. It has been noted that when a signal is devoted to the feed point of the wire dipole antenna, it forms a voltage discrepancy between the wire elements and that drives the antenna to release electromagnetic waves into the nearby spaces. The pattern of radiation depends on the size of antennas as well as their orientation and also can be characterized by different parameters like directivity and polarization [12]. Therefore, the wire dipole model provides the idea of a simple and efficient antenna structure that is mostly used in radio communication applications and telecommunication systems due to low expenses, ease of construction, and performance features.

VIII. PROBLEM STATEMENT

Antenna arrays parent various issues like increased complexity and high expenses. Along with this, this process requires proper calibration and control of each antenna element. The common issue of the use of high-dimensional antenna design can lead to a huge amount of challenges like low gain, inadequate radiation pattern, incompatible impedance, and limited bandwidth. All these issues can degrade the version and the performance of radio communication systems through antennas [13]. Therefore, it can be deduced that poor antenna design can reduce the communication range communication quality and safety risks. Hence, it can be deduced that for avoiding all these issues it is important to design the antennas carefully and test them for ensuring their optimal performance as well as reliability.

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CONCLUSION

From the overall study, it can be concluded that, for designing and analyzing various types of antennas for some significant applications, developers use different types of tools and techniques like electromagnetic simulation software, computational tools, and physical prototyping tools and testing devices. The chapter also outlines that to optimize the various parameters of the antenna, developers consider some important factors like, manufacturing expense, dimensions and weight limitations, as well as environmental conditions like temperature and humidity.

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